RADIO MAINTENANCE

OCTOBER 1945

A BOLAND AND BOYCE PUBLICATION

to our Readers

RADIO MAINTENANCE *Magazine* 295 BROADWAY NEW YORK 7, N. Y.

The publishers of Radio Maintenance Magazine express sincere gratitude for the unusually fine reception given to the first issue of Radio Maintenance as evidenced by the thousands of letters we have received from Servicemen.

In response to your expressed needs, Radio Maintenance Magazine will be published monthly beginning January, 1946.

Radio Maintenance will continue to be devoted entirely to the men who service and sell electronic equipment. We promise that you will find in every issue the finest technical and trade news articles in the field of electronic maintenance.

Radio Maintenance is published in your interest. Send in your questions, suggestions and criticisms, we are here to serve you.

Yours very truly,
BOLAND & BOYCE, INC.

William F. Boyce

William F. Boyce
Publisher

WFB:ab

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RADIO MAINTENANCE

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2. Radio Maintenance — Overseas and Under Fire
3. Measuring and Correcting Distortion, Using the Oscillograph
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RADIO MAINTENANCE

WILL BECOME A MONTHLY BEGINNING JANUARY 1, 1946

Due to the overwhelming response to the first issue, Radio Maintenance will be published monthly in 1946.

Subscription rates are $2 a year, or $3 for two years.

The backlog of scientific development and research in electronic maintenance will unfold before you in forthcoming issues.

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RADIO MAINTENANCE

INCLUDING ELECTRONIC MAINTENANCE

Volume 1 OCTOBER 1945 Number 2

Contents

Departments

Radio Maintenance is published quarterly, until January 1946, after which time it will be published monthly, by Boland & Boyce, Inc., 295 Broadway, New York 7, N. Y. Subscription Rates: In U. S., Mexico, South and Central America, and U. S. possessions, $2.00 for 1 year, $3.00 for 2 years, single copies 25 cents; in Canada, $2.50 for 1 year, $4.00 for 2 years, single copies 30 cents; in British Empire, $3.00 for 1 year, $5.00 for 2 years, single copies 40 cents; all other foreign countries, $4.00 for 1 year. Subscribers should allow at least two weeks for change of address.

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Coming

The Problems of Organization

By John F. Rider, the first of a series of six articles by the radioman's mentor.

Using the Oscillograph to Measure Distortion

A new method permitting determination of distortions as low as 1% in A-F Amplifiers.

The Economic Side of Servicing

By Joseph J. Roche. Another in this series designed to put intelligent management into the radio servicing business.

Residence Radio Installations

By John Winslow. The second of this series describes the high-fidelity A-M tuner, with full constructional details.

A Midget A-F Oscillator

By Rex Gilbert. How to make an extremely portable battery-operated test instrument.

Synthetic Bass Receivers

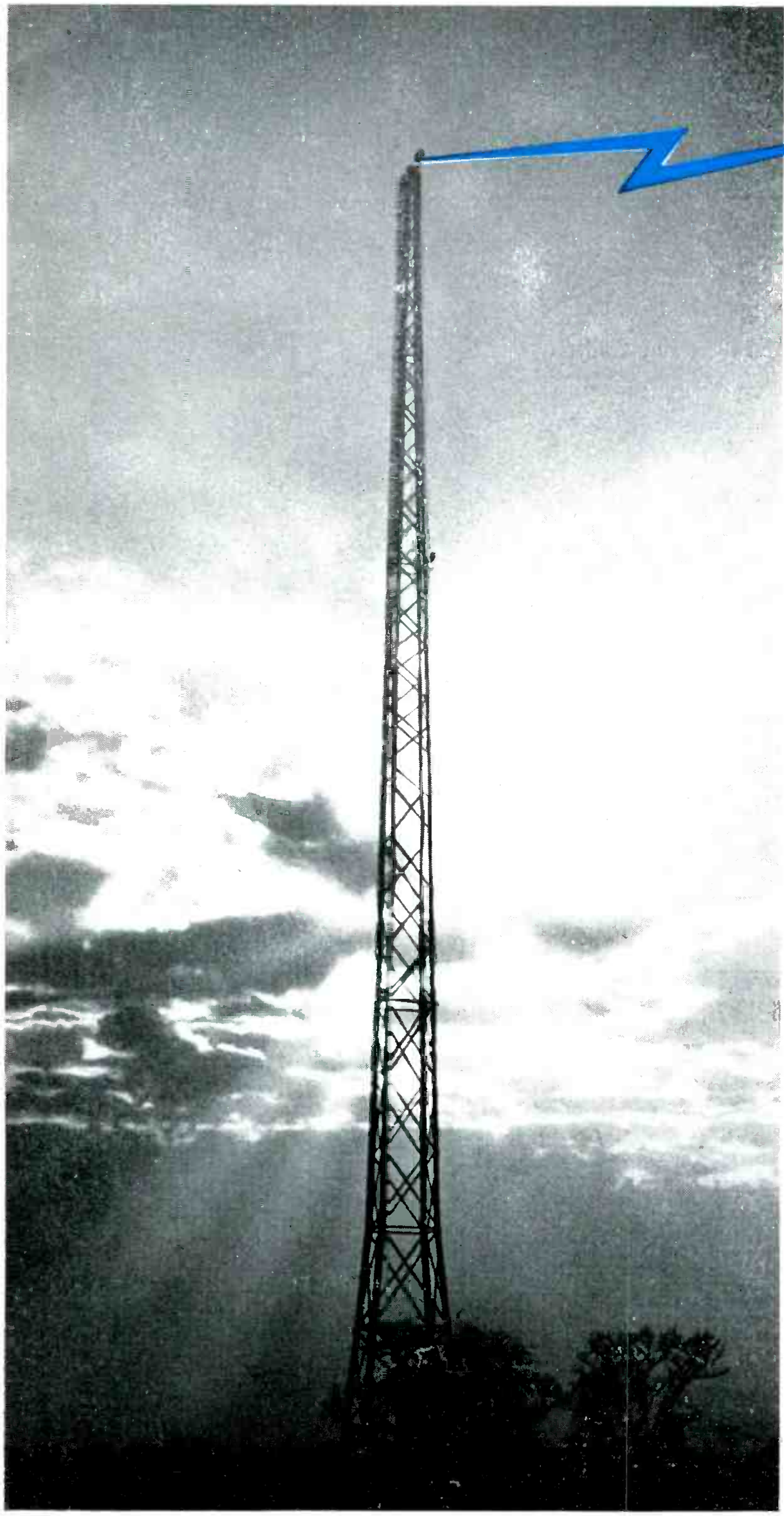
By Warren E. Tuttle. Maintaining sets with this feature.

Equalized Amplifier for Magnetic Pickups

By E. S. Cross. Methods for compensating for pickup and recording characteristics.

THE KIND OF ANTENNAS THAT WILL GIVE THE LISTENER OR

ANTENNAS *for* F-



By Charles Chilton

THE value of a properly designed and correctly installed antenna system for F-M or television is between twenty-five and two hundred dollars. This estimate is based on a balance between the results that can be achieved and the planning and installation work involved.

In these very high frequencies the importance of antenna quality is such that it can mean the difference between satisfactory operation or complete absence of reception. In the urban districts, buildings and other obstacles or high noise level may prevent reception of desired signals. In rural areas static is low but so is field strength from most stations.

Static is not usually troublesome with F-M sets, because of the basic principles under which these receivers operate, but it is still necessary to get enough signal applied to the input of the set to "lock up" the limiter in order to take advantage of the fine qualities of this system of reception. When the listener is located on the fringe of the service area of these stations or behind some obstacle, some means must be resorted to for increasing the signal pickup.

The problems are somewhat simplified in the areas outlying the large broadcasting centers, as the majority of signals will come from essentially the same direction, and most of the customers' homes will be single family dwellings. This means directional antennas and good position possibility, which will insure the success of the antenna installation. In cities, apartment houses are common, and stations are often located in many different directions from the listener. Apartment house installations have quite a variety of problems, from long lead-in runs to disagreeable superintendents, all of which must be taken into account when the cost is being estimated.

LOOKER THE BEST RECEPTION—AND HOW TO INSTALL THEM

M and TELEVISION

Another "HOW" article to enable you to make more profitable installations and to create more customer satisfaction

However, antenna designs can overcome most of the purely electrical problems of reception — some of the others will require diplomacy. In order to be familiar with all the conditions that we can overcome or make use of, let us first examine what constitute the basic elements of a high-frequency antenna, and then review all the types, both commercially available and "custom-built."

Basic Elements of Antennas

A complete antenna system is composed of a number of elements, each of which is important to the functioning of the whole. They are: the radiator, which may be quarter-, half-, or full-wave, or even longer; the director; the reflector; the impedance match to transmission line or lead-in; the transmission line itself and the impedance match from the transmission line to the receiver. Figure 1 shows these various elements as parts of a complete system employing both reflector and director, although these elements are not always used.

The radiator (using a term applied to transmitting antennas and which is not exactly applicable to receiving antennas, but is used due to the lack of a better term) may be of various lengths depending upon the type of antenna used. Quarter-wave, half-wave, and full-wave antennas derive their name from the length of the radiator which is one-quarter, one-half, or one wave length long, as the name implies. Each has certain characteristics of its own which govern the choice.

The quarter-wave antenna is often used vertically and is very effective in reception from all directions. It is somewhat difficult to match to the transmission line, and this limits its application to commercial installations to a large extent. Inasmuch as the standard transmission of F-M and television stations is polarized horizontally, the use of a vertically polarized receiving antenna is not advisable. In general, present forms of the quarter-wave antenna are not recommended for this application.

The half-wave antenna has found

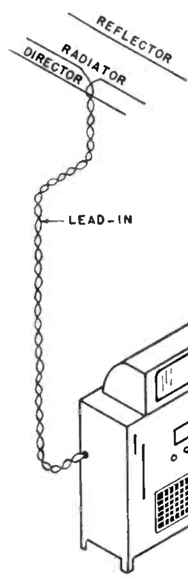


Fig. 1. The elements of an antenna system suitable for F-M and Television, with director and reflector, together with transmission line to set.

much greater favor than any other type for F-M and television reception. It is simple to install, and is comparatively effective. It is generally used as a doublet, with the lead-in connected at the exact center, and the two halves extending in opposite directions from the center. It often appears with many variations, such as the double-doublet and the triple-doublet. These forms make use of two or three half-wave doublets, each for a different portion of the frequency spectrum, and all connected at the center to a common insulator, and to the same lead-in. The two or three doublets are fanned out in a vertical plane with angles between the different wires approximating 30 deg. The half-wave antenna has a directional characteristic, which may be used to advantage. The pattern of its effectiveness consists of two lobes, each approximately 60 deg. wide, with the center of the lobe, and the maximum reception, perpendicular to the line of the antenna. Reception is a minimum off the ends of the wires. This pattern is modified by the height of the antenna above ground, as will be described later.

The full-wave antenna is twice as long as the half-wave, approximately, and it has a different reception pattern, consisting of four lobes, with the maxima 36 deg. each side of the perpendicular. Due to its length, the waves on this form of antenna are so disposed that it has a high impedance at the center, whereas the low impedance points

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ANTENNAS for F-M and TELEVISION

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are one-quarter of the way from the ends.

Antennas of greater lengths than one wave length have still different characteristics, some of which will be described more fully in following paragraphs.

A director is an additional conductor placed parallel to and in front of the radiator, that is, between the radiator and the transmitting station. Directors are rarely used for receiving antennas over a band of frequencies because of the difficulty in adjusting them for optimum performance at more than one frequency.

Reflectors are additional conductors placed parallel to the radiator, but differ from directors in that they are in back of it — away from the transmitting station — and that the reflector is slightly longer than the radiator. The gain obtained by the use of either a director or a reflector is in the order of five db, and by the use of both it approximates seven db. Reflectors are particularly advantageous in reducing interference reaching the antenna from the rear. This helps in eliminating "ghosts," in the case of television, due to reflections from adjacent buildings or hills which cause multiple path transmission from the transmitting antenna to the receiving antenna. Reflectors are quite commonly used in television installations, and may become increasingly popular with F-M listeners in some areas.

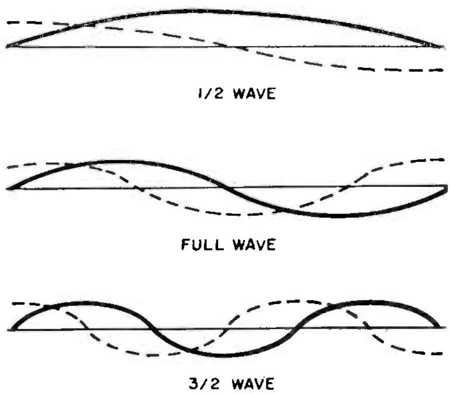

Fig. 2. Current waves (solid), and voltage waves (dotted) on antennas of various lengths.

As recently as September 15th, many manufacturers of receiving antenna systems were canvassed with a view to determining what their post-war products would be, but nothing new in the field was ready to be announced at that time. Some of the manufacturers signified that they had systems in design or nearly ready to announce, but not sufficiently far advanced to permit of describing and portraying them.

To avoid losses due to impedance mis-match at the point where the antenna connects to the lead-in or transmission line, it is necessary that the impedances be very nearly the same. Figure 2 shows current distribution along antennas of different lengths as solid lines, and voltage distribution as dotted lines. Practical considerations demand that the transmission line be of low impedance, therefore it is advisable to determine at what point on the antenna the impedance is lowest. The impedance of a half-wave antenna is at a minimum at the center, which is a current loop (maximum) and a voltage node (minimum). At this minimum, the impedance is approximately equal to the radiation resistance, and, for an installation sufficiently removed from surrounding objects so they do not affect the characteristics, is approximately 73 ohms. This is also approximately the impedance at the current loops on full-wave, and longer antennas. For maximum transfer of energy from the antenna to the transmission line, it is necessary, therefore, that the latter have the same impedance as the antenna at the point of connection, or else that some means of transformation be inserted in the antenna to match the impedance of the transmission line. However, there are a number of transmission lines available with a characteristic impedance of 73 ohms, It is quite practical, therefore, to use a transmission line of this type and to couple it to the antenna at a point where the impedance is 73 ohms.

Two general types of transmission lines are commonly used — twisted pair and co-axial, as shown in Fig. 3. The former is composed of two rubber insulated, stranded wires, twisted together and equipped with an overall covering of weatherproofed braid. When properly connected to the antenna, and with the input coil in the receiver center-tapped and effectively grounded, the transmission line does not pick up any signals, neither does it pick up any static disturbances. 73-ohm antenna transmission line is available from most of the wire manufacturers, and from many of the receiving set manufacturers. Transmission line for this application has losses between four and ten db per 100 feet at presently used F-M and television frequencies. Co-axial cable consist of a conductor in the center of a metallic shield, such as a copper tube or a braided-wire covering. The center conductor is spaced from the outer conductor by insulating beads, variout styles being used by different manufacturers. Co-axial cable losses do not generally exceed one db per 100 feet of line.

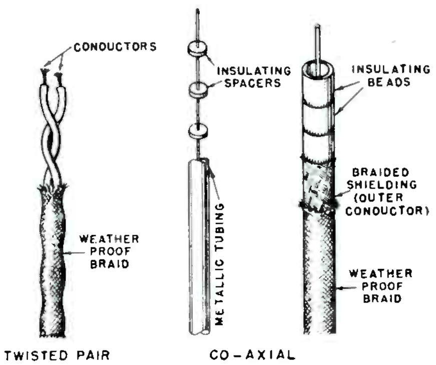

Fig. 3. 73-ohm transmission line — twisted pair, and two types of co-axial cable.

The final element of the antenna system is the connection of the transmission line to the input terminals of the set. This has been taken care of by the manufacturer who has, in most cases, designed the input circuit to match the doublet and the corresponding transmission line. In most cases, it will be sufficient to connect the transmission line to the input terminals of the set.

All of these factors must be kept in mind when planning an antenna installation. Various other features will be discussed in the following paragraphs, such as lobing, length, and the number of elements and their arrangements. We will consider lobing first for multi-directional reception, as that is one feature which offers advantages when reception from several stations is desired.

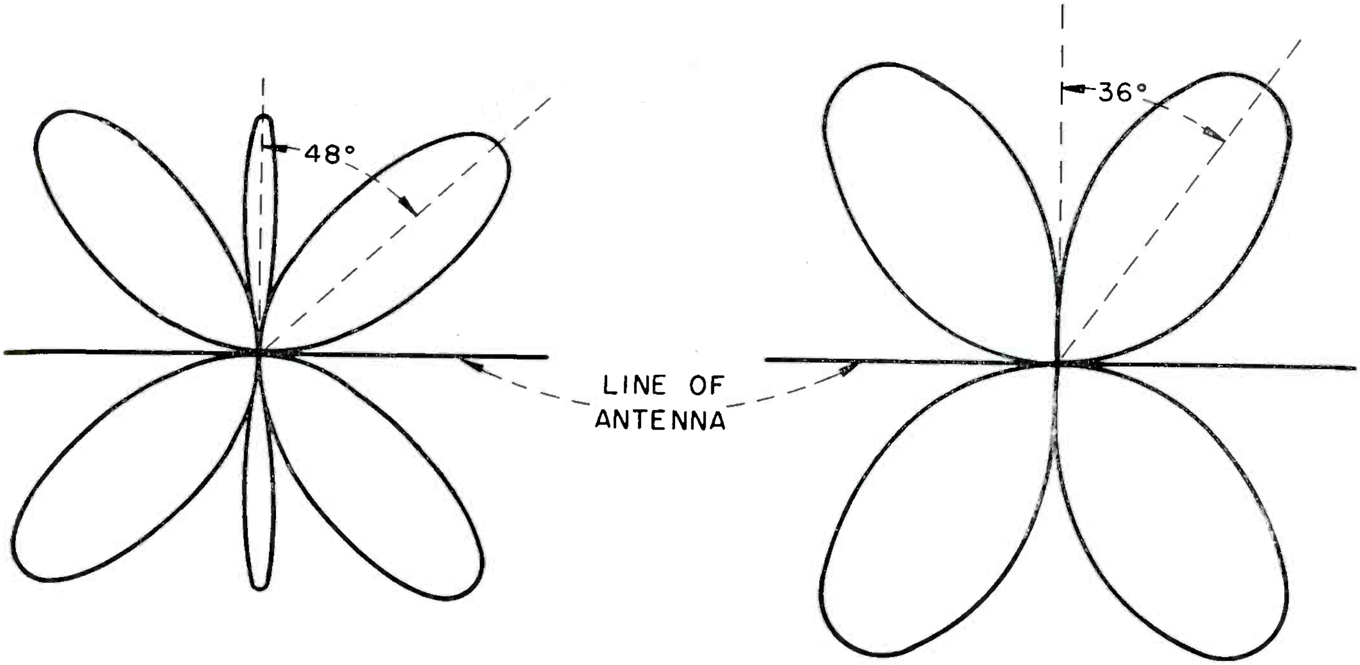

Fig. 4. Directional sensitivity lobes for a 3/2-wavelength antenna (left) and for full-wave antenna (right).

Lobing

Doublet antennas have different patterns, depending upon their length. As mentioned before, a half-wave doublet has two lobes, the axis of which is perpendicular to the line of the wire. To listen to a group of stations all in approximately the same direction, such as might be encountered in an installation thirty miles from a "center" of broadcasting, it should be sufficient to erect a half-wave doublet of proper length with the axis of the lobes passing through the station locations. When the listener is located more closely within this "center," it is probable that the stations will be located all around him, or at least at several different angles. Then the use of a full-wave doublet, or of a 3/2 doublet may enable the various lobes to encompass all the stations. Figure 4 shows the pattern of these two types, together with the axes of the lobes. It will be noted that the full-wave doublet has four lobes, with their angles 36 deg. from the perpendicular, and that the 3/2 doublet has six lobes, with one pair centered on the perpendicular, and the other pairs 48 deg. each side of the perpendicular. To use these characteristics, it is only necessary to select a pattern which, when centered on the customer's location, will have axes passing through or close to the station locations. For shop use, it is a simple matter to trace these axes onto a piece of celluloid or acetate (obtainable from artist's supply houses) and use the patterns as guides. Insert a pin through a hole at the center of the pattern and through the customer's location on a map upon which the station locations are marked. This method is illustrated in Fig. 5, showing the lobe axes placed for optimum reception of the F-M stations in the Greater New York area by a listener located in the eastern portion of the Bronx.

Height

Antenna height has some effect upon performance, naturally, since the reflection and masking effects of surrounding objects must be taken into account. Generally speaking, it is most advantageous to erect an antenna as high as is feasible from all aspects. The lobing diagrams of Fig. 4 are modified somewhat by

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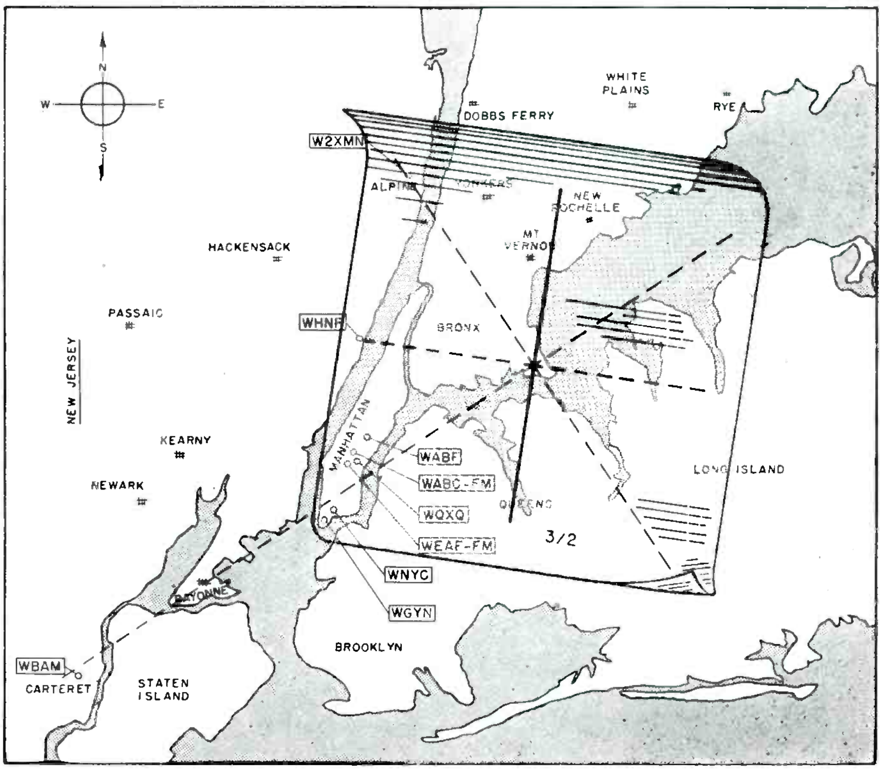
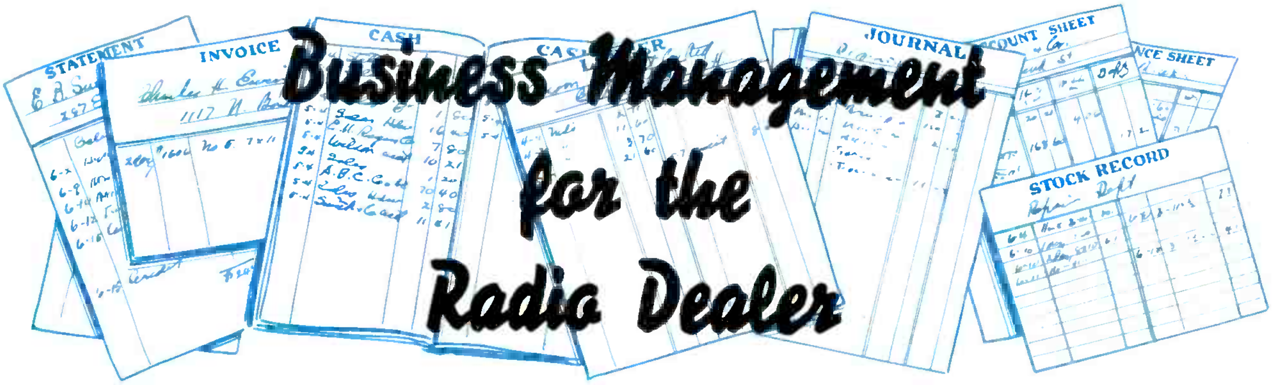


Fig. 5. Using a piece of acetate with axes of lobes of 3/2 wavelength antenna laid out on it to determine azimuth of antenna for optimum reception from several stations at customer's location.



Business Management for the Radio Dealer

By Joseph J. Roche

ONE OF THE PRIME QUESTIONS confronting the operator of a radio maintenance and merchandising business is whether or not it is possible to increase an already substantial profit by the application of sound business principles. The answer is clear—predetermined planning of operations in all phases of the business will definitely result in greater profit in radio maintenance organizations just as it does in any other enterprise.

The principal phases of any commercial operation are, in the order of their importance, selling, financing, and producing. To intelligently plan the allowable expenditures, the necessary returns, and other basic elements of any business, the first step is to establish the size of the operation contemplated. It is not necessary to make elaborate surveys and involved calculations to arrive at this figure, but it is desirable that an approximation be made. When this is done, the year's operations can be planned within limits of economic conditions in the community, the competition, the availability of capital, and other factors.

Assuming that the necessary capital is available, an investigation of general business conditions in the community is advisable. One such survey asked the following questions:

1. What was your average volume of business over the last three years?
2. What was the average volume of your competitors' business during the same period?
3. What are the limitations of area that you can cover economically?
4. How many families are there in the area you intend to cover?
5. What is the average wealth per family in this area?
6. What are the requirements of taste and temperament in this area?
7. How many enterprises are there in this area to divide the business?

A complete analysis of this sort should be made, and the conclusions will serve as a guide to the maximum size and to the style or a business towards which you should aim. No sample analysis of this type of survey will be made here as the figures for different parts of the country will vary greatly. However, to establish a financial basis of operation from which the selling requirements are derived, the typical operating statements shown in Tables I, II, and III will approximate the conditions for a one-, three-, or five-man operation. Note that these are approximations, and are not to be construed as representing any particular business. They are shown purely as samples to indicate the sort of information that must appear on such a statement. It should also be noted that the owner-operator is counted as one of the "employees"; that is, a three-man operation is composed of the owner and two employees.

Table I
MONTHLY OPERATING STATEMENT

Sales		$950.73
Cost of Sales:		
Purchases	258.00	
Payroll	413.88	
Total		671.88
Gross Profit		278.85
Depreciation; furniture, fixtures, & equipment	10.00	
Travel expense, delivery, etc.	30.00	
Rent	50.00	
Office Supplies & postage	2.00	
Advertising	10.00	
Professional Fees	5.00	
Telephone & Telegrams	10.00	
General Expenses	3.00	
Total		120.00
NET PROFIT		$ 158.85

Typical operating statement approximating conditions for a one-man business

With all this in mind, these tables may be used as a basis for this discussion. For example, it is known that labor standards vary throughout the country, and no attempt has been made to make these tables agree with any one condition. While we would like to see the standard raised everywhere in the radio maintenance and merchandising field, we do not feel that this falls within the scope of this article.

You will note that the owner-operator's wage is shown to increase from $1.75 per hour for a one-man shop to $2.00 for a three-man shop, and to $2.25 for a five-man shop. The increase was added to compensate for the additional exercise of management duties with the increased staff. Also note that in all of these calculations, an assumption is made with reference to the merchandise sales. This will include repair parts, over-the-counter sales of tubes and accessories, and new and used radio equipment. The assumptions were based on the average total merchandise sales of $100 per week per person. Undoubtedly this will vary more greatly than any other factor, but it is not an unreasonable figure, and the statements will show that a profit can be made with such a volume.

Determining Service Rate

Before any Operating Statement can be made, it is necessary to determine the rate to be charged for time spent in servicing. To do this, it is logical to total the overhead items such as rent, depreciation, advertising, cost of operating the delivery and service car, office supplies, telephone and telegraph charges, professional fees such as those paid to an accountant or for legal advice, and the multitude of general items including light, heat, insurance, and the Social Security taxes and unemployment and compensation insurance premiums. For a one-man enterprise, these latter items are not necessary. After determining this amount, properly called overhead,

It is not enough to take in what you can, pay out what you must, and keep the balance as your own compensation. Cut yourself in for a salary in addition to the profits.

it is necessary to add to it your labor costs. In computing labor costs, it is just as necessary to include a fixed wage for the owner-operator as it is to include the errand boy, for the owner is entitled to a wage for the hours he puts in just as surely as is any other employee. It is not enough to take in what you can, pay out what you must, and keep the balance as your own compensation. To calculate a fair rate for service, the owner-operator's time must be thought of in exactly the same fashion as if he were another employee, because if he were to operate the business from a sick-bed, for example, someone would have to spend the hours working on the service bench, or delivering sets, or selling, and that someone would certainly have to be paid.

Table II

MONTHLY OPERATING STATEMENT

Sales		$2375.97
Cost of Sales:		
Purchases	774.00	
Payroll	981.48	
Total		1755.48
Gross Profit		620.49
General Deduction from Gross Profit:		
Depreciation; furniture, fixtures, & equipment	15.00	
Travel expense, Delivery, etc.	45.00	
Rent	100.00	
Office Supplies & Postage	5.00	
Advertising	28.00	
Professional Fees	10.00	
Telephone & Telegraph	15.00	
General Expense	5.00	
Taxes—Social Security, Compensation & Unemployment Insurance	10.00	
Total		233.00
NET PROFIT		387.49

Typical operating statement for a three-man business

Having determined the overhead and the labor costs per week, these two items are added together to make the Direct Costs of the operation. To the Direct Costs must be added the cost of any merchandise sold. This is done at this point to arrive at a Total Cost of Sales (of both merchandise and service time). On this Total Cost of Sales, a profit of 20% should be added —10% being a reasonable amount to consider as *profit, and* the additional 10% profit to be held in reserve. This is only good business, as some reserve *must* be kept available for carrying over slack periods.

Having determined a reasonable amount — 20% — for profit, we return to the computations again. Going back to the figure called Direct Costs, we add the calculated profit, and the sum of these two items is the amount which must be recovered by sale of service time. If we now divide this figure by the number of hours worked by the owner-operator, we have an hourly rate for service labor. No mention has been made, intentionally, of the profit accruing from the sales of merchandise, either sets or parts. The cost of this merchandise was included in the Total Cost of Sales for calculating the profit, but the actual profit from the sale of the merchandise must be considered as paying for the "non-productive" hours (that is, not spent in servicing time) that the employee spends in selling it.

By this form of calculation, it can be shown that a fair rate for service time in a one-man business is approximately $3.25 per hour, whereas for a three- or five-man business it is $2.50 per hour. Again it must be stressed that this is the result of a set of calculations based on reasonable averages for businesses of this type. The rate allowed for the "wage" of the owner-operator is meant to be remuneration for hours worked, putting him in a similar status to that of any other industrial employee for whom an hour worked is so much earned, without any deviation from hour to hour.

The hourly income for hours worked is independent of profit, overhead, reserves, or any other direct or indirect business expense. This is a fundamental concept of business, and it must be clearly understood, and carefully followed, so that the basic wage structure of the electronic maintenance trade, and the social and economic status of the families of these men be kept on a sound footing.

Table III

MONTHLY OPERATING STATEMENT

Sales		$3973.20
Cost of Sales:		
Purchases	1290.00	
Payroll	1537.25	
Total		2827.25
Gross Profit		1145.95
General Deduction from Gross Profit:		
Depreciation; furniture, fixtures, & equipment	20.00	
Travel Expenses, Delivery, etc.	80.00	
Rent	200.00	
Office Supplies & Postage	10.00	
Advertising	100.00	
Professional Fees	20.00	
Telephone & Telegraph	25.00	
General Expense	10.00	
Taxes—Social Security, Compensation & Unemployment Insurance	20.00	
Total		485.00
NET PROFIT		$ 660.95

Typical operating statement for a five-man business

It is known that if the maintenance department is operated efficiently, and a sufficient volume of merchandise is moved both in new sales and in repair parts, the use of the standard price charts will give an overall average piece work basis that will be equivalent to these figures. If the operation is run at top efficiency, with plenty of business being available, and with full utilization of promotional possibilities, increases in sales volume with attendant increase of labor will substantially increase both the amount of profit and the percentage of profit. This is occasioned by the fact that the overhead should not increase proportionately with in-

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Are YOU like this?

"No matter how I figure it, I'm still only making fourteen cents an hour."

RADIO MAINTENANCE

Maintenance of Aircraft Transmitters and Associated Equipment

By Lieut. Myron F. Eddy, USN Ret.

NOTE: In the July issue, Mr. Eddy discussed aviation radio servicing methods and the maintenance of private plane and transport type receivers. Here he follows up with transmitter maintenance, showing how you can handle radio repairs on planes carrying two-way communication equipment. Bonding, shielding, power packs, radio beacons and other C.A.A. airways equipment will be covered in future issues of RADIO MAINTENANCE. Look for these articles; they should prove helpful to any radio technician who wants to know how to work on aircraft or at airports.

IN THE PAST, radio shop owners and privately employed radio repairmen have been mostly called upon to repair home receivers. But as more and more airplanes are built and flown, these same men will be given the opportunity to install, calibrate, test, and repair aircraft sets. In such cases, it would prove embarrassing personally and financially to be forced to admit complete ignorance of the transmitter end of the two-way communication equipment most frequently carried by flyers. It is to dispel any such feeling of ignorance that this article has been written.

Aircraft Transmitter Maintenance

The maintenance work connected with transmitters installed aboard aircraft, especially large transports, involves a considerable amount of associated equipment: the antenna, bonding and shielding systems, radio power units, and their wiring circuits, remote control equipment, and so on.

Aircraft transmitter maintenance work includes pre-flight bench tests, ground operating and calibrating tests, and flight tests; also daily, monthly, and yearly checks; servicing work, trouble-shooting, and repairs. It should again be stressed that airline companies have developed their own policy in regard to what work is done on transmitters, and when, and how. This is all based on a sound philosophy of engineering experience gained in a highly specialized service where operating efficiency must be maintained at its highest possible point. Manufacturers of aircraft sets furnish detailed instructions for the proper installation, operation and maintenance of transport transmitters, and these should be read and referred to in order that you may acquire the knowledge of maintenance procedure required for airline radio men. Figures 1 and 2 will give you some idea of the records that are kept by one of the major airlines. These reports of failure, inspection, and repair are invaluable in maintaining a communication system on a fleet of planes and the many ground stations.

Bench-Testing Transmitters

Each transmitter test bench should have a power supply, either a transformer-rectifier unit for operation from an A-C source, or a power unit of the kind used in the airplane, with the necessary batteries to operate it. All meters should be permanently wired into the circuits, so that a test kit is not required. An adjustment of voltage of both the primary supply and the high-voltage supply should be possible.

If the transmitter being tested is operated normally at 1000 volts, the highest voltage available on the test bench should be 1500 volts; this latter will serve to test the equipment for short periods. Any part of the apparatus which is about to break down will usually show up on the high-voltage test, and in this way, you will anticipate failures that might occur in the air. Remember that voltage spark-over occurs very much more easily at high altitudes. The raising of the voltage on the ground test simulates this condition; all voltages will be higher than normal with the 1500 volts applied to 1000 volt transmitters. A dummy antenna, which exactly duplicates the conditions found in flight, should be made a part of the test bench; this will allow adjustment of the transmitter so that it may be installed in the plane with no further adjustment.

Operating Maintenance for WE 27A Transmitter

Aircraft transmitters are subject to a routine servicing at the fixed periods — monthly, every four months, annually. The work done on the Western Electric 27A Transmitter at these times is typical and offers an excellent example of a good routine service schedule.

Monthly routine service is restricted to tubes and the dust filter. Tubes are replaced at the end of a certain number of hours service, this service time being set up by each airline company; it is generally the same service time allowed between major engine overhauls.* First clean the set, using air and/or a soft cloth (not oily waste). Then check all connections,

*NOTE: This is not in accordance with commercial practice which is generally to leave tubes in until they weaken as they are far more likely to burn out during the first few hours of operation.

IN Aviation

nuts, screws, and bolts, and also clean all relay contacts. Vacuum tubes have a limited life and unless their ultimate failure is anticipated, interruption of service may result. The best safeguard is to keep a record of the date of installation and service hours of each tube.

The ventilating inlet on the side of the transmitter is provided with a spun glass filter which will become filled with dust. Operation of the transmitter with a dirty filter will reduce the ventilation and increase the operating temperature. The filter unit should be removed and cleaned by immersing the filter in a solution of soap and warm water and rinsing in clean warm water.

Four-Month Routine Service

Remove the end bells of the dynamotor. If the dynamotor has been in use approximately 1000 hours, the bearings should be lubricated as follows: Remove the bearing grease plugs and apply enough N. Y. — N. J. Lubricant Co. F-927 Grease or equivalent, to cover the bearings. Do not pack bearings nor allow dirt to enter them. Keep the grease off the commutators. The commutators should be cleaned with a soft cloth moistened with gasoline. If the commutators are pitted they should be carefully sanded with No. 00 sandpaper. Do not use emery cloth. Blow any accumulation of brush or commutator dust out with clean air. Worn brushes should be replaced by new brushes of the same type as those removed.

Yearly Service

The equipment should first be cleaned of any dust that has accumulated by blowing it out with dry compressed air. The insulating parts should then be cleaned with a cloth moistened in chemically pure carbon tetrachloride. All screws, nuts and electrical contacts should then be thoroughly inspected.

Next, remove the clutch gear box cover. If the lubricant is not up to the center line of the worm gear, add a sufficient quantity of F-926 Grease, or its equivalent, to bring it to this level.

Although the pins and contact clips will necessarily show wear because of the contact pressure required for good electrical connections, they will give satisfactory service for many thousands of operations. However, any contact pins and clips which are too badly worn should be replaced.

Tuning the WE 27A Transmitter

Unlike the routine servicing accomplished and recorded at certain stated intervals, it may become necessary to tune a transmitter at any time. Here again we turn to established procedure on a known transmitter for guidance and instruction, using the WE 27A as a model.

The initial tuning adjustment of this set is accomplished on the test bench, while the final output circuit tuning must be made in the airplane. All tuning adjustments are made on the plug-in Type 101 Tuning Units. There are two of these (101A and 101B) available for use with the 27A Radio Transmitter. They are alike except for their output coils, the interstage coils being interchangeable between the two units. The 101A Tuning Unit has an output coil of about

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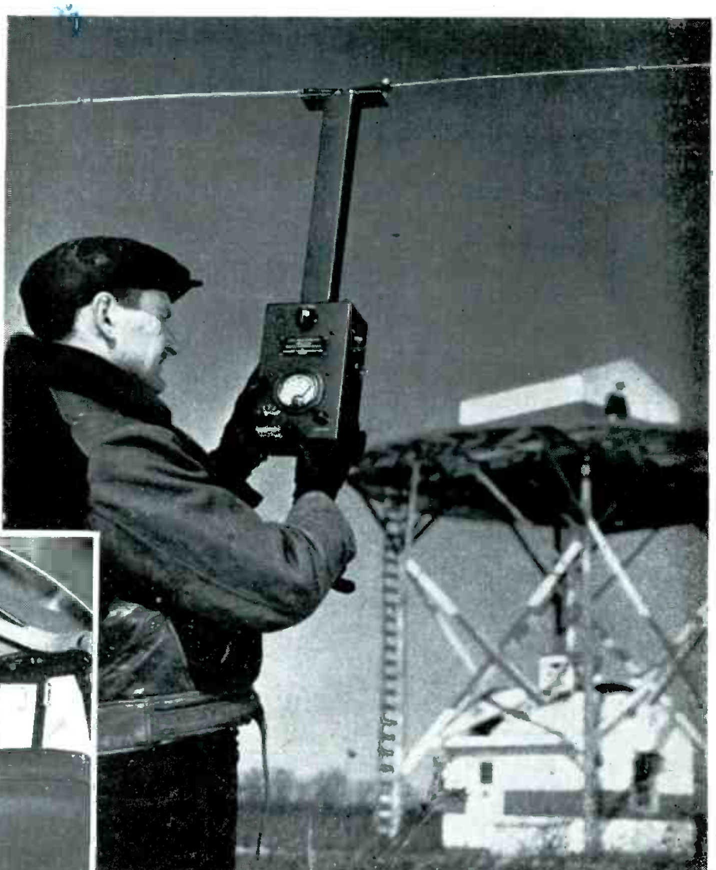
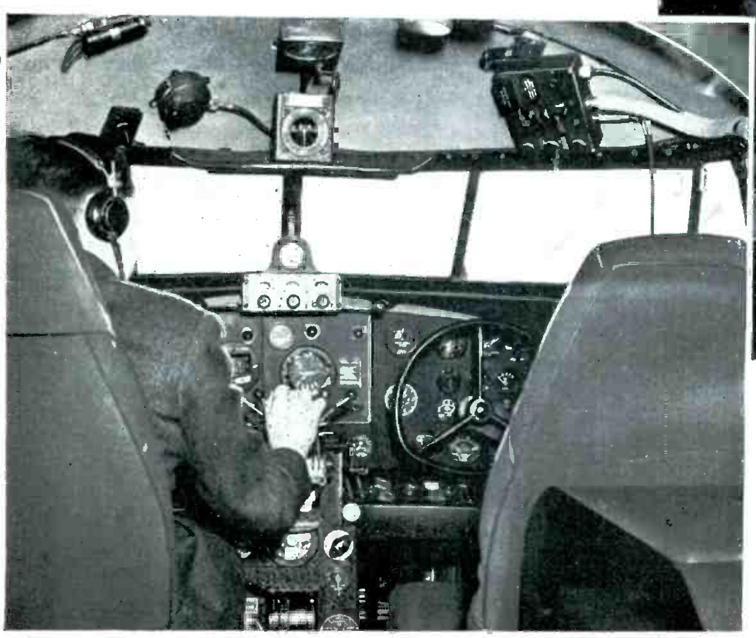


CAA Engineers making measurements on UHF range station.



CAA Pilot checking ranges in patrol plane.

Using the Signal Generator

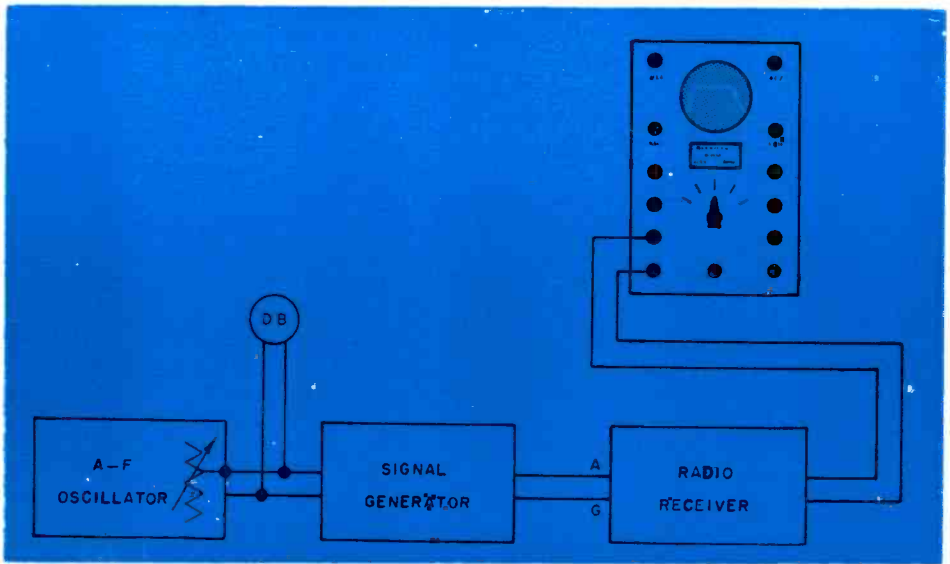


Fig. 1. General method of making overall frequency response measurements, using audio-frequency oscillator, R-F signal generator, and an oscillograph for continuously indicating the output signal.

Part TWO

for Overall Response Measurement

By C. G. McProud

LAST month we discussed the use of the signal generator and oscillograph for the alignment of tuned circuits — a subject which is fairly well known to most servicemen. Continuing this series, we will cover the use of these two service instruments for audio-frequency response measurement, measured from the antenna terminals to loudspeaker.

Overall frequency response measurement is of value because of the effect of tuned circuits on the audio quality obtainable from any receiver, and because failures of components in the audio amplifier may also cause loss of quality.

While the simplest method of measuring frequency response is undoubtly by the use of an R-F signal generator modulated by an A-F oscillator, and a simple output meter, this is a laborious process, and one which is only suitable for laboratory use. What the radio serviceman needs is a simplified process which will give comparable results, without the degree of accuracy required by development engineers. However, in order to acquaint the reader with several of the methods, we shall describe them, and list their attendant advantages and disadvantages before proposing an instrument which is capable of giving the answer quickly and accurately, with the least amount of effort on the part of the user.

Principles of Operation

In order to measure the frequency response characteristics of an audio amplifier, the applied signal must be adjustable from about 20 cps to at least 10,000 cps. For high fidelity equipment, the upper limit should be about 20,000 in order to provide measurements up to the 15,000 cps upper limit desired from F-M receivers, and to some point beyond, because the characteristics in the bands above and below the normal frequency range of the equipment contribute to the overall quality.

To measure the overall characteristic of a radio receiver, it is not sufficient to measure the audio amplifier. Sharply tuned intermediate-frequency circuits will "cut side bands" and reduce the higher audio frequencies, so this effect must be taken into account when making response measurements. The measuring system should provide a method of determining the characteristic from the input to the output. This demands the use of an R-F signal generator which is modulated by a variable audio source.

Most good signal generators have provision for external modulation. The output of the audio oscillator may be plugged into the signal generator and it will therefore modulate the R-F signal. This demands a constant level of applied audio signal. Assume, for example, that the R-F oscillator operates with a plate voltage of 120, and that it draws 4 ma. The impedance of the circuit to be modulated is therefore 120/.004, or 30,000 ohms. To modulate 100 percent, the same audio voltage is necessary to modulate as the supply voltage furnished to the oscillator. However, it is not necessary to modulate the signal generator 100 percent—50 percent is considered sufficient, and many standardized measurements are made with only 30 percent modulation. Fifty percent modulation will require an audio frequency source of 60 volts. The

and Oscillograph

power required from the audio oscillator is then E^2/R or $60^2/30{,}000 = 0.12$ watts, which is generally available from the audio source.

It is also necessary to match impedances to perform the modulating operation satisfactorily. If the audio oscillator has an output impedance of 500 ohms, a transformer will be necessary between it and the external modulation jack in the signal generator. This transformer should have an impedance ratio of 500/30,000 for the example in question.

The modulation percentage and the R-F output signal must both be kept constant. The output of the generator may be measured by means of a meter which should be connected ahead of the attenuator. The modulating voltage can be measured at the output of the audio oscillator.

After the modulated R-F signal passes through the R-F, first detector, and I-F stages, and is demodulated at the second detector and further amplified as an audio signal, the output from the set must be measured either by means of a meter or by observing the vertical deflection on an oscillograph. Most measurements of fidelity are rated in db, whereas the oscillograph indicates the output by the height of a trace which is proportional to the voltage. Both of these methods are satisfactory and both are used, depending upon the application.

What we are trying to measure, however, is the overall frequency response of a receiver, over a wide band of frequencies, and by means of a continuous operation, if possible. We would like to apply an R-F signal that is modulated by a continually varying A-F signal to the input of the receiver, and observe the output voltage plotted, preferably in db, as a function of frequency. To do this requires a variety of types of equipment, although results of a certain value can be obtained simply, as will be described later.

One of the primary requisites is that the audio signal be "swept" from its lowest to its highest frequencies, or vice versa. To reproduce it properly on an oscillograph demands that it be swept fairly rapidly. On the other hand, if it is swept at a rate of, let us say, 60 times per second, we are in trouble immediately, because the lowest frequency we desire to observe is less than the sweep rate. Consider a sweep rate of 60 times a second over a band from 20 to 20,000 cps. If the frequency were swept in a logarithmic fashion, it would take 1/60 second to sweep the entire band, and it would take 1/180 second to sweep it from 20 to 200 cps. This indicates that it would take but 1/360 second to sweep it from 20 to approximately 63 cps, which is the mean between 20 and 200.* It can be seen that it would be difficult for 20 cps signal to reach its maximum amplitude in 1/360 second, which is less than one-fourth as long as the time required for the signal to build up from zero to the crest of the first half-cycle. This signal build-up is required not only by the audio amplifier, but by the audio oscillator, the modulator, and the measuring device. Therefore, it seems to be necessary that a minimum time of 1/10 second be used for each sweep.

We have been talking about 20 cps as the lowest frequency of the sweep. This is well below the required audio frequency range for even the highest quality receivers. 50 cps is a much more reasonable figure, but the 20 cps figure was used to show some of the parameters that must be taken into account in developing a method of measurement. The sweep rate of 1/10 second is reasonable, however, and we shall keep this figure in mind as a probable sweep rate.

In sweeping the frequency over the range from lowest to highest, some definite relation must be followed in order that the successive sweeps all be exactly alike.

Sound is composed of frequencies. These frequencies bear a logarithmic relationship to each other. In other words, frequencies corresponding to equal increments in pitch — for example, an octave — are related to each other in a logarithmic fashion. If the frequency of one tone is 100 cps, the frequency of a tone one octave higher is 200 cps, and of an octave higher than that it is 400 cps, and of the next octave 800 cps. In plotting curves of the audio spectrum, it is customary to make the "octave" spacing linear — that is, equally spaced vertical lines on the graph paper represent octaves. This being the case, a logarithmic scale is necessary when plotting frequencies. 50 cps to 100 cps is one octave, and takes up a certain distance along the horizontal axis of the curve. 5000 cps to 10,000 cps is also one octave, and takes up the same distance on the curve. This digression leads us to the thought that if the horizontal sweep of the indicating device — for example, an oscillograph — is linear, the sweep itself should be logarithmic. More about this later.

The main advantage of logarithmic sweeping is that it makes it possible to plot the output without any means of modifying the linear horizontal sweep of the oscillograph. The main disadvantage is that such a sweep is not very easy to obtain. Exactly the opposite conditions obtain with linear sweeping — it is relatively simple to obtain, but it is necessary to modify the horizontal sweeping of the oscillograph.

In just the same fashion that it is necessary to synchronize the sweep of the oscillograph — assuming that one is being used as the indicator — with the sweep of the oscillator when using the latter with a signal generator for receiver alignment, so also is it necessary to synchronize these two instruments when making response measurements.

So far, we have discussed quite generally the principles of making measurements of frequency response of a complete receiving system without offering any specific methods for doing so.

*The mean is determined by taking the square root of the product of the extremes — that is, $\sqrt{20 \times 200}$ or 63.2 cps.

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USING the OSCILLOGRAPH and SIGNAL GENERATOR

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Methods

There are a number of methods that may be used to make overall frequency response measurements. The simplest is to modulate a signal generator with an audio oscillator, maintaining a constant output from both, apply this signal to the input of a receiver, and make output measurements at a number of fixed frequencies. This is a slow and laborious process, and is definitely not continuous.

In the absence of a suitable audio frequency oscillator, it is possible to use two signal generators, connecting the outputs of both to the antenna terminals of the receiver being measured, as in Fig. 2. When

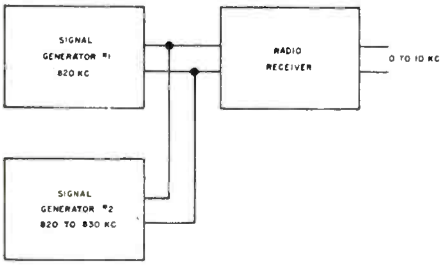

Fig. 2. Method of mixing outputs of two R-F signal generators to obtain modulated signal furnishing audio frequencies from 0 to 10,000 cps.

both of the oscillators are tuned to the same frequency, the resultant audio tone or beat note at the output of the set will be of zero frequency (and therefore not audible at all) and as one is tuned gradually to a frequency differing from the other by 10 ks, the resultant audio tone will vary from zero to 10,000 cps. The output of the set may be measured at various points in this range, and a curve plotted, although no simple method is available to determine the actual frequency at which the measurement is being made. However, it is possible to get some useful information from this sort of measurement, particularly if you are well enough acquainted with the frequency scale that your ear will recognize the various frequencies at least approximately. In this regard, it might be mentioned that the lowest tone that the average person can whistle is very near 500 cps, and the highest note is very near 2500 cps. This must not be considered a definite and positive assertion applying to everyone, but it is an indication of two points for reference.

Another method that was presented several years ago in RCA Application Note 76 provides for automatically deflecting the beam of the cathode ray tube proportional to the frequency on a logarithmic scale, and this deflection is caused by the signal itself. Pictured in Fig. 3, this method makes use of a dual rectifier, one half for the signal output from the receiver being measured, which is then amplified and fed to the vertical plates of the oscillograph, and the other half being used as a rectifier from the output of the modulating audio-frequency oscillator, the output of which must be kept constant. It will be noted from Fig. 4 that the R-C network causes the deflection applied to the horizontal plates to be proportional to the logarithm of the frequency. Figure 5 shows curves such as might be obtained from such an arrangement. This method is very useful in that it does not require any synchronization between the oscillator and the oscillograph, nor does it require any particular linearity of the sweep. Its main disadvantage lies in the time it takes for the curve to be traced, thirty seconds being recommended by RCA in the Application Note. When this method is used, the horizontal deflection is correct for any particular frequency, and the vertical deflection is proportional to the voltage output of the set. This makes the curve appear to be much worse than it actually is, as compared to the generally portrayed response curves plotted in db, because a deflection of one-half of the reference value corresponds to 6 db, whereas the linear decibel scale — which more closely approximates the way the ear hears it — generally covers a range of 15 db above and 15 db below the reference level. The diagram is self-explanatory, with the cautions about maintaining a constant value of A-F signal, and of

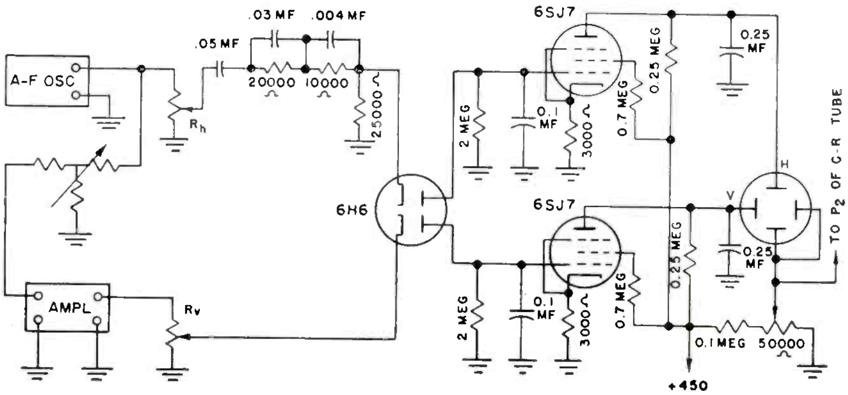

Fig. 3. Schematic of circuit for making curves of audio frequency response. Horizontal deflection is approximately proportional to frequency on a logarithmic scale, and vertical deflection is proportional to voltage output from the amplifier. (Courtesy RCA, from Application Note 76.)

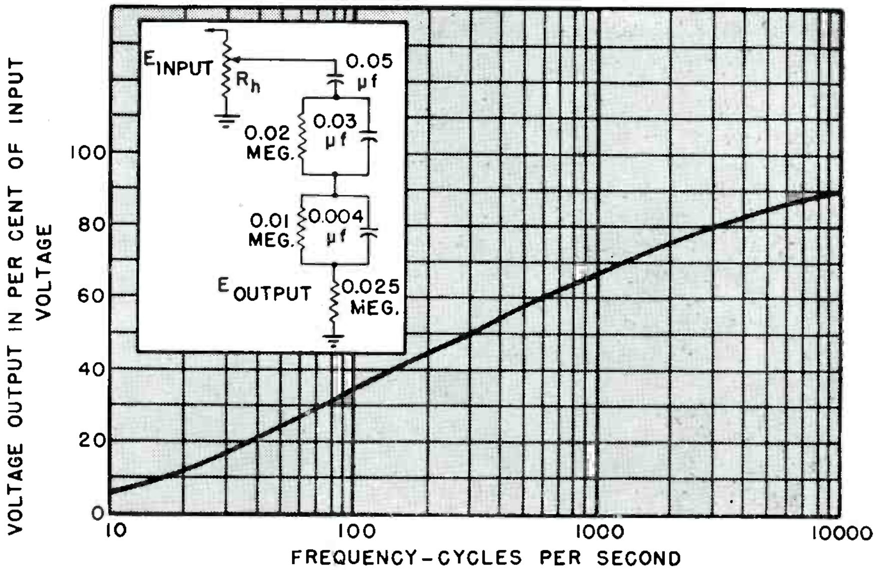

Fig. 4. Curve showing horizontal deflection voltage available from circuit of Fig. 3 as a function of frequency.

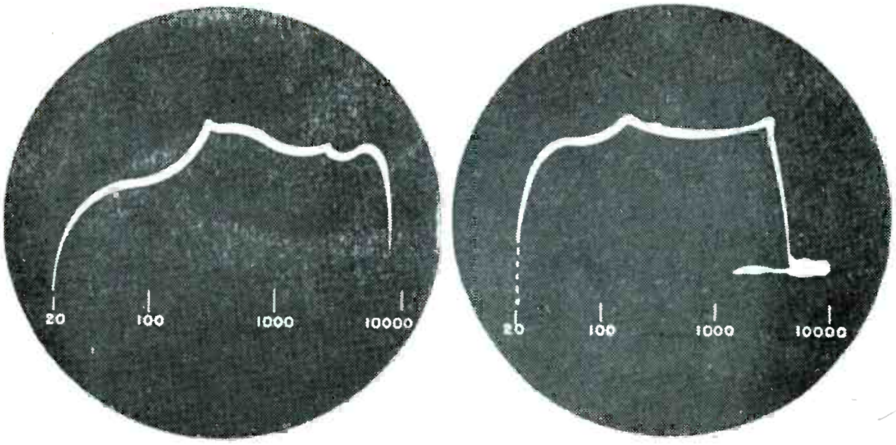

Fig. 5. Response curves obtained by method outlined in RCA Application Note 76. Left figure shows various resonances by peaks in the curve. Right figure indicates attenuation of high frequencies by tone control.

making a slow sweep. This slow sweep is the cause of another disadvantage of this system — namely, that of requiring a long persistence screen on the oscillograph, or of covering the screen with a piece of tracing paper and tracing the path of the beam as the frequency is swept over the range.

With this method, another source of A-F modulating voltage is usable. There are available several phonograph records of audio frequencies, some being recorded with a number of fixed frequencies, and others with a constantly varying frequency starting at 10,000 cps and progressing downwards to 30 cps. (Victor No. 84522 has a very good recording of this type on one side, and constant frequencies of 1000 and 2300 cps on the other.) By playing this record through an amplifier with sufficient equalization that the output is constant over the entire record, and using the output of this amplifier to modulate the signal generator, a slow sweep is provided, which will be ideal for the method described above. This will leave both hands free to plot the response curve on the tracing paper as described above.

From the standpoint of the radio serviceman, the use of two signal generators presents several advantages. In the first place, the serviceman is almost certain to have at least one signal generator, and it should not be too difficult to either borrow the use of another one, or to make a simple oscillator operating at some frequency within the broadcast band. If this is done, the tuning condenser for this extra oscillator should have an additional "band-spread" condenser across it. This should be of only sufficient capacity to give a sweep of about 15 kc. When using two service oscillators, it is advisable that the output from one be at least three times the output from the other in order that the audio signal resultant obtained at the second detector shall be of good waveform.

If one of the two oscillators being beat together in this method is frequently-modulated, either electronically or by means of a motor-driven condenser, the available signal will be frequency-swept over the audio range. It will be swept too rapidly for accurate measurement, but it will be useful, as will be outlined in later paragraphs.

Certain of the frequency-swept signal generators are so arranged that the frequency-sweep is applied to one oscillator of essentially fixed frequency in order that a panel control may be calibrated in kilocycles of sweep, and the other oscillator is tunable over a wide range — the two signals being mixed together to furnish a third frequency that is frequency-swept over a definite range. Such an instrument is the RCA No. 150 oscillator. It contains one oscillator swept around a median of 800 kc, and a tunable oscillator which covers a wide range. The outputs of these two oscillators are mixed together and the resultant frequencies are fed to the output jack. The tuning dial is calibrated at the difference frequency. By selecting a certain point on the dials of the receiver and the signal generator, this one unit may be employed to furnish two signals simultaneously — one of a fixed frequency, and the other of a swept frequency varying from the fixed frequency of the other to a point 10, 15, or 20 kc from it. This gives us just what we need, with the possible exception of its being swept too rapidly. Again, this instrument will give somewhat useful information about the performance of a radio receiver.

Figure 6 represents the pattern obtained by this method from a receiver of fairly high quality. At the left side of this figure the zero beat may be observed, with the relatively poor response of the lowest frequencies. Toward the right the response falls off slowly up to about

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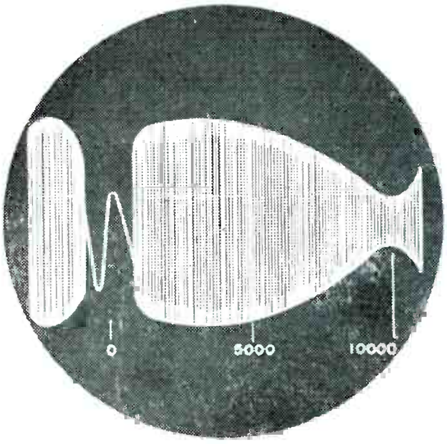


Fig. 6. Response curve obtained by beating two R-F oscillators together, one being frequency-swept, and feeding combined output to input of radio receiver of fairly good quality.

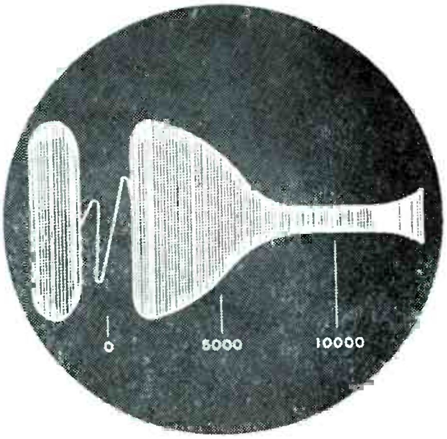


Fig. 7. Response curve of the same set as in Fig. 6, but with tone control set for minimum high frequency response.

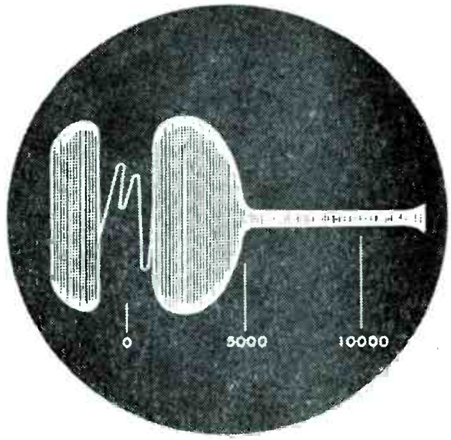
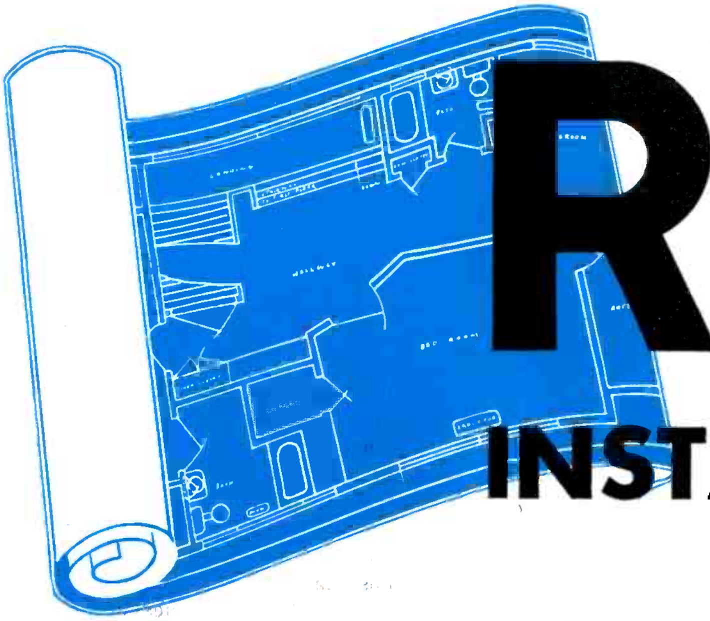


Fig. 8. Showing relatively poor response from receiver with very sharply peaked I-F stages. Attenuation of high frequencies extremely noticeable.



RESIDENCE RADIO INSTALLATIONS

How to cash in on a big and interesting field for the enterprising radioman

By John Winslow

THERE ARE a large number of radio listeners who would like better quality and greater convenience from their sets. Catering to their wants can easily become a profitable sideline, and in certain localities where there are at least five stations that have good programs, and a sufficiently high signal strength, a little salesmanship will undoubtedly put you in the way of some business.

The term "Residence Radio Systems" is used specifically to describe an installation of radio receivers, amplifiers, remote control circuits and equipment, and loudspeakers in a private residence. It differentiates an installation of this type from the common variety of midget or console radio sets which are in the majority of homes.

Residence radio systems are of interest to you because they will enable you to make extra profit. They are individually "tailored" for each installation, generally, and provide a large variety of functions, depending upon the taste and pocketbook of the customer.

The evolution of the private dwelling over a period of years has seen many utilities and conveniences built in at the time of original construction. The present day trend is toward the inclusion of more and more equipment, particularly in the kitchen. Why, therefore, should we not include radio as part of the built-in equipment, installed as the house is being built? With this in mind, let us examine the possibilities of a complete residence radio system that fits this description. While it is equally possible to install a complete system in any house, practically, with almost the same results, running wiring around an already finished house gets to be a problem at times. But if you like problems, and have an active imagination, you will enjoy the work.

In this series of articles, the various elements entering into residence radio systems will be taken up one by one.

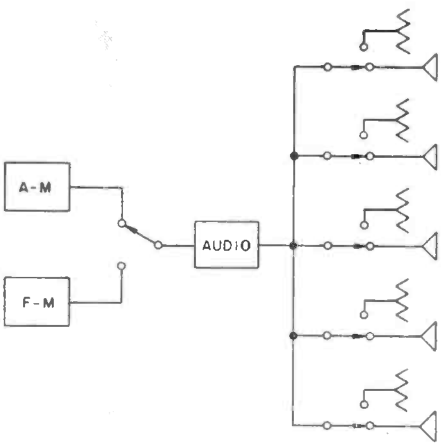


Fig. 1 The simplest system—A-M and F-M radio, with five speakers.

This part deals with the facilities that can be made available to the customer. Later issues will carry information regarding the A-M tuner, the F-M tuner, the phonograph equipment, the audio amplifier, the speakers, remote control systems, and wiring.

In selling a complete installation, you will need to know just why such a system is superior to an ordinary radio. While there are many fine console receivers on the market, they only supply reception in one place, and they may not furnish all the facilities that are possible from a properly designed installation. But primarily, a custom-built radio system *can* be definitely superior, from the standpoint of quality of reproduction, to any standard receiver. There is almost no limit to the amount of money that can be spent on high-quality installations; the range with which the writer is familiar represent an investments of from $750 to $10,000, and even now, it is only necessary for the radio man who installed the largest of these to tell the owner of new and improved circuits or components to increase this amount. As a matter of fact, this particular installation is good for at least $500 worth of additional work each year. This is undoubtedly an exception and the average radio man will have few customers like this one. Systems may be as simple as to have only an A-M receiver, and one additional speaker, with no provision for remote tuning. And they can be sufficiently flexible that a different program may be played at each of a dozen or more different speakers, with the selection controlled at each speaker location.

While the radio man can really have a field day in designing and building each installation, the logical and profitable way to proceed is to standardize the units as much as possible, and assemble the different units as may be required to fit the job. With this in mind, the writer feels as though a few standard units can make up a system of any desired degree of flexibility. With this in mind, a brief description of the units is advisable at this point.

First, and of probably greatest importance to high fidelity of reproduction, is the A-M tuner. This unit is a broadcast tuner exclusively, having no provision for short wave reception. It contains six tubes, three serving as R-F amplifiers, one as an infinite impedance detector, one as an a.v.c. rectifier, and the last as an audio stage. The circuit is a band-pass t-r-f design, following quite closely the basic circuit of the famous Western Electric 10A Receiver, which was for a long time the standard for high-fidelity radio reception. The tuner may be equipped with an output transformer, for use with the larger installations, or with a plate-load resistor and a coupling condenser. The filaments are series wired, and connected to a plug which makes them easily adaptable for D-C operation. For A-C use, the same plug serves to connect both the plate and the filament supplies, the latter being 6.3 volts. The plug is so wired as to parallel the filaments when A-C is used. All of these refinements are not necessary, but are designed into the chassis so as to be completely flexible. Users in localities where no D-C lines are apt to be found may omit these parts. This chassis is equipped with a switch to select A-M, F-M, or phonograph.

Here are only a few of the advantages of

RESIDENCE RADIO SYSTEMS

1. **High quality of reproduction**
2. **Convenience in operation**
3. **Permanence, and reliable performance.**
4. **Flexibility of facilities.**

The use of the circuit employed in this tuner will permit of a constant band-width over the entire broadcast frequency band, this band-width being approximately 15 kc. Unless you have heard A-M reproduction over a receiver of this type, you have no conception of just how good a quality of music is possible from a radio. This sounds like quite a claim, but a demonstration will prove this statement beyond all doubt.

For F-M programs, the use of a standard converter is recommended. Several good ones were available before the war, and many more will undoubtedly be on the market within a few months. For use in D-C districts, one of these should be selected that is designed for this form of supply.

In phonograph equipment a wider choice is expected. From the simple motor and turntable requiring manual changing of records, to the multi-record turnover changer, there is a model for every purse. The larger and more complex the installation, the better and more elaborate the phongraph will be.

For audio amplifiers, we again enter the flexible, standard unit category. Three types of amplifiers are suggested for A-C operated equipment, differing mainly in the power handling capacity. The smaller systems will require only a small amount of power, but the smallest amplifier in the series is rated at ten watts. The next size is rated at twenty watts, and the largest at forty. These are all of the same type, and differ only in size or number of output tubes employed. The smallest unit uses 2-6V6's; the next size uses 2-6L6's; and the forty-watt model uses 4-6L6's in push-pull par-

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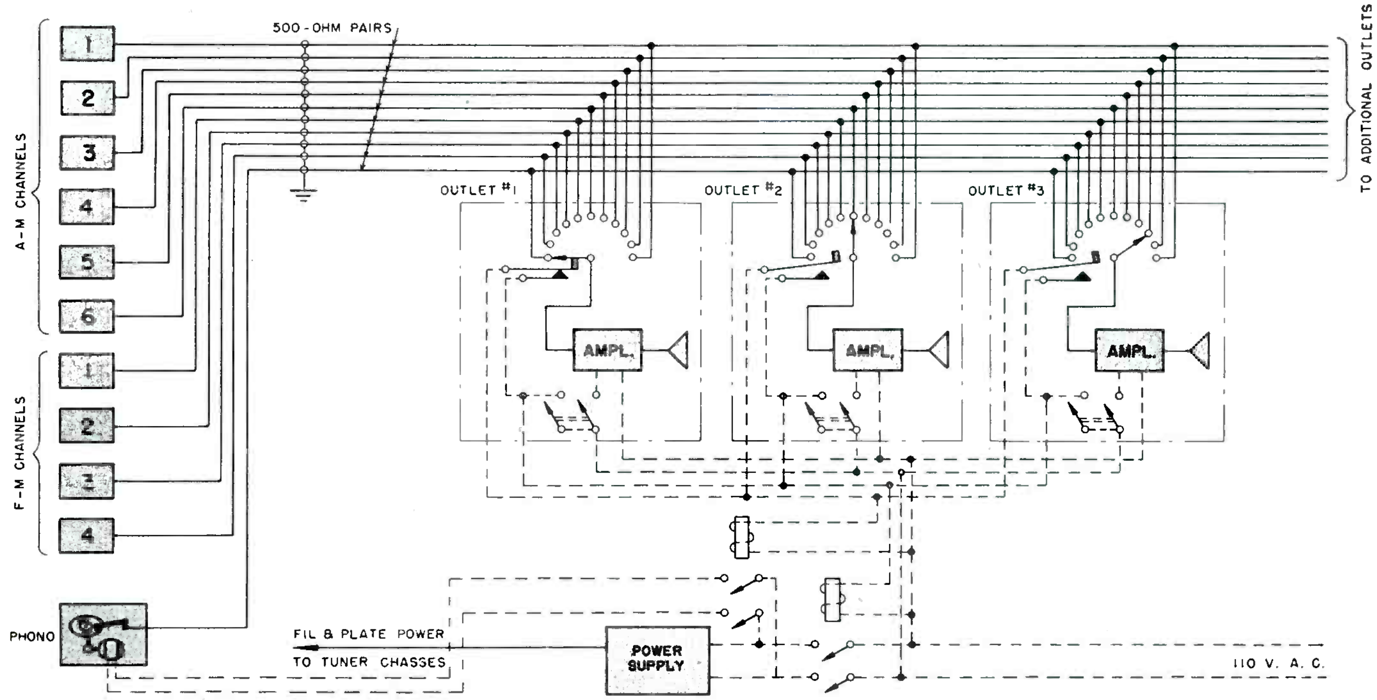

Fig. 2 The fully flexible system, providing a variety of programs available to each outlet, regardless of what any other outlet is playing. Especially suitable for large homes, particularly where there are children.

RESIDENCE RADIO INSTALLATIONS

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allel. The circuit is simple, and employs considerable negative feed-back.

For D-C operation, a similar amplifier can be used, which has most of the features described above. For multi-speaker installations, it will undoubtedly be simpler to use a larger number of the small amplifiers, rather than to increase the output capability of one single unit to sufficient power to handle all the speakers in the entire system.

The remainder of the radio facilities that can be supplied will depend largely on the territory in which the installation is located, the proximity of television stations, the desire for home recording equipment, and the amount of remote control required.

There is not, as yet, sufficient information about the television equipment that will be available when the manufacturers get into full production with this part of the radio picture. There is no doubt, however, that remote video screens will be a feature of some of the television sets in this new period of radio growth. It will probably be sufficient for some time that one television receiver be available, particularly because viewing a television program will necessitate almost complete attention to the screen, and, unlike radio, it will not need distribution throughout a home. For the man of the house to try to watch a television screen while he is shaving does not seem like a possibility, yet a remote speaker in the bathroom is ideal for the man who like his news during his shaving period. So, for this month, at least, we will skip television.

For complete flexibility of radio program distribution, and to satisfy the listening habits of every member of the family, the centralized distributing system is ideal. This is somewhat more complicated in original installation and quite a bit more costly, but it does permit a variety of different programs to be heard in the house at the same time. While the simple system consists of one A-M tuner, one F-M tuner, and one audio amplifier, as shown in Fig. 1, the centralized distributing system has many more elements. Figure 2 shows this form of the residence system. It consists essentially of as many separate, fixed-tune, high-fidelity, receiver chasses as there are stations that are regularly listened to by the customer. In general, it has been found that the average listener will want one station of each of the four networks, and probably two of the better independent stations. There is no reason why the listener cannot have as many channels as there are stations in the area, but most will not want that many. Also supplied are as many F-M channels as the listener wants.

The outputs of all of these units, at a maximum level of about -10 vu, are fed through a multi-pair cable throughout the house, and appear on terminal strips at each speaker location. At each outlet, a small audio amplifier and a suitable speaker are located, with a channel selecting switch, a volume control, and an off-on switch. Wiring is provided so that when any one of the output amplifiers is turned on, a relay at the location of the tuner bank, probably in the basement, also closes the circuit to the power supply for the tuners. This prevents the tuner bank being kept on continuously, and avoids the necessity of going to some central location to turn on the main tuner power supply. It is a simple circuit, and well worth the extra wire required to install it.

The advantages of this type of system are mainly in having different programs available at any spot in the house. The main disadvantage is that of cost, as each outlet will cost nearly as much as a separate small radio receiver, and the multi-pair cable should have each pair separately shielded.

At this point it is well to put in a word of caution regarding distribution systems of this type. It is definitely recommended that the lines feeding the remote amplifiers be separate pairs, and that a common return be avoided. While the outputs of the individual tuner chasses are grounded on one side, due to the use of a cathode-follower type of output, the use of a common return will result in cross-talk between the channels in many cases. This could be avoided by the use of a separate return from each remote unit, rather than by using pairs, but the paired cables are available, and when an installation of this type is laid out, it is just as easy to do it with proper attention to good engineering as it is to "haywire" the job. One of the things to be avoided in system installations is the possibility of poor design or poor construction requiring a lot of "tinkering" after the job is completed.

So far, no mention has been made of the antenna requirements for this type of system. A good antenna should be erected, not necessarily high or elaborate, but well placed, and with suitable attention to noise reducing details. The RCA "Magic Wave" antenna serves exceptionally well for the broadcast band, and avoids the pickup of unwanted noises arising from other electrical equipment in the house. The multi-channel system provides necessary means for coupling to one antenna for the A-M channels, and to another for the F-M channels.

It is probable that some form of remote control should be provided for the single channel installation. This may take several forms, though the use of the motor-tuned type is the most satisfactory when it is once completed and adjusted, although it often causes headaches in the construction. Not every outlet will need control, but the ones in the living room, master bedroom, and kitchen are certain to need it if the owner gives much thought to the subject.

With just a few words about the speaker outlets, we will come to the conclusion of this introductory article about the possibilities of residence radio installations. For the musically-minded listener who demands the finest quality that it is possible to obtain, you may want to provide a two-way system of the theatre type to give satisfaction. Requiring about ten cubic feet, a speaker of this type can make radio reproduction take on a new meaning, in spite of the obvious disadvantage of the space requirement. This type of speaker consists of a good low frequency unit, well baffled; a high frequency unit with a multi-cellular horn; and a dividing network to feed each speaker the band of frequencies over which it is intended to operate.

Next in the quality group is the "duplex" speaker, which is essentially the same in principle, but somewhat more compact. Next in order of im-

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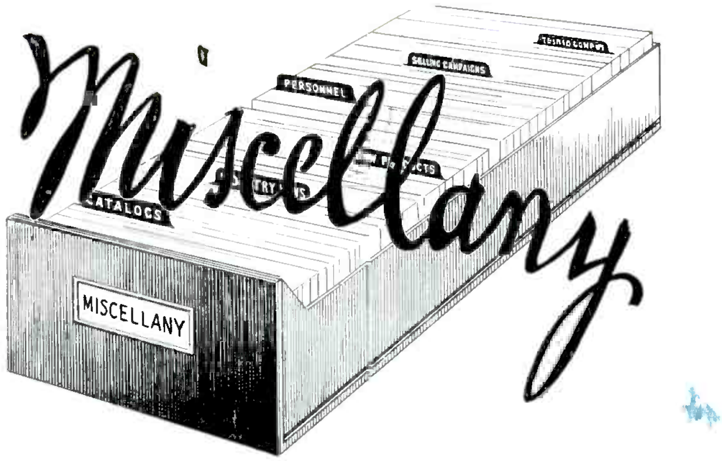

HOFFMAN OPENS S. F. BRANCH

Hoffman Radio Corp., Los Angeles, opened a San Francisco branch in August, according to announcement from R. J. McNeely, sales manager.

It is located in the Merchandise Mart with offices and display rooms. Warehousing facilities are in the wholesale district.

Walter Epstein, the past 15 years radio manager for The Emporium, and one of the best known and informed radio men in the west, heads the new office.

The sales area covers the coastline from Palo Alto north to the Oregon border, and the counties of Alameda and San Leandro. Outside salesmen will contact the trade in this territory continually.

Hoffman Radio, with a background of more than 15 years in manufacturing receivers, portables and the custom-built Mitchell-Hughes combination radio-phono-recorders is resuming the manufacture of its standard lines, as well as some new developments in the electronic and communication field.

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JENSEN MONOGRAPH DISPLAY READY

A combination counter and window display and dispenser for Monographs, the interesting and instructive booklets on electroacoustics, has been announced by Jensen Radio Manufacturing Company, loudspeaker manufacturers.

The display, which measures 17½ by 21 inches in size, is substantially made of heavy display board and is attractively printed in two colors. Pockets are provided for a half dozen copies of each of two Monographs and the display which comes flat is easily put together for counter or window display.

Jensen distributors are offered these displays without charge so that their Monographs can be displayed at point of sale. Requests for displays are being handled by the Technical Service Department, at 6601 S. Laramie Ave., Chicago 38, Illinois.

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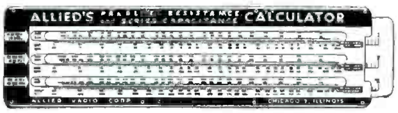

PARALLEL-RESISTANCE AND SERIES-CAPACITANCE CALCULATOR

Allied Radio Corp., Chicago, has released a new Parallel-Resistance and Series-Capacitance Calculator. This new calculator is essentially a slide-rule device, designed to provide a rapid and accurate means of determing the reciprocal of the sum of two reciprocals as expressed by the formula $1/x = 1/a + 1/b$. A single setting of the slide automatically aligns all pairs of a and b values which will satisfy the equation for any given value of x. This calculator indicates in one setting the numerous pairs of resistance which may be connected in parallel, or capacitances in series, to provide any required resistance or capacitance value. Range: 1 ohm to 10 megohms; 10 mmfd. to 10 mfd. However, the capacitance and resistance figures on the face of the rule can just as well serve to represent inductance, impedance, reactance, or other units which can be handled in a similar manner. Thus, the calculator becomes equally valuable in solving problems involving inductance in parallel, coupled inductance, numerical magnitude of impedance, parallel reactance, etc.

An invaluable time-saving aid to students, technicians, engineers, and others in the radio and electronics field.

Priced at 25c. Available from ALLIED RADIO CORP., 833 West Jackson Blvd., Chicago 7, Illinois.

E-L SIMPLIFIES CAR RADIO VIBRATORS

A drastic stock simplification plan through which 95% of the existing demand for auto radio vibrators may be met by four vibrator models has been announced by Walter Peek, vice president in charge of sales, Electronic Laboratories, Indianapolis. Use of the new E-L Auto Radio Vibrator Replacement line will enable radio distributors, dealers and servicemen to reduce their inventories of vibrator types as much as 92%, Mr. Peek said.

Recent surveys indicate that there will be more than 8,000,000 car radios in need of repair by the time replacement parts become available.

A program to promote the E-L Auto Radio Vibrator Replacement plan through advertising, publicity and related activities has already been initiated by Electronics Laboratories.

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FIRST FLUORESCENT CHRISTMAS TREE LAMPS

Fluorescent Christmas tree lights will be on the market this year for the first time. Developed and manufactured by Sylvania Electric Products Inc., the new lamps come in four pastel shades of blue, green, coral and maize, are round in shape, and need no auxiliary equipment in order to operate. In addition to providing a soft, attractive glow to the tree, the fluorescent bulbs provide new and unusual color effects for Christmas decoration.

The lamps come eight to a string, have a screw-type base and are independently operated. A string of the fluorescent lamps may be added to a string of incandescent Christmas tree bulbs by just plugging it into the socket. Each lamp burns about five watts of current and each has an approximate life of up to 1,000 hours. Because they burn cool, the new lamps help to retard drying up of the tree. Designed for use on either indoor or outdoor trees, a string of eight lamps sells for about $7.50, with replacement lamps costing 60c apiece.

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A PAGE DEVOTED TO LETTERS FROM OUR READERS

Radiomen's Opinions

Theodore Harsney
1475 Republic Ave.
Youngstown 6, Ohio

Dear Sirs:

I happened to read your first issue of Radio Maintenance magazine and was well pleased with it. Your publication looks like its future will be very bright. I am an operator and maintenance man in our city police radio system and don't want to pass up any new ideas so kindly put me on your mailing list for your magazine starting with the No. 1 issue. Best wishes and thank you.

Yours truly,
T. H.

Warren, Pa.

Dear Editor:

A few days ago I came across a copy of Vol. 1, No. 1 Radio Maintenance Magazine, and was very much impressed with the very fine articles. I have been servicing and building radio receivers since 1911 and do not think a finer service magazine has appeared on the market.

I would like to be put on your mailing list, and if you should find it necessary to charge for this fine magazine you can count on me.

For the last three years I have been Warren County Radio Aide in addition to my other work as a Radio Serviceman.

Yours truly,
Raymond M. Rapp

Radio Station WBNX
New York 51, N. Y.

Dear Editor:

I believe you have hit upon the most original idea in radio-technical periodicals published in the past decade. It's just what we technicians and engineers would have ordered, if asked.

Can you please place me on your subscription list? Your coming events in instrumentation and maintenance is too good to be missed.

Sincerely yours,
Philip Rosenblatt

Gentlemen:

I had the opportunity to see and read the July issue of your very interesting magazine RADIO MAINTENANCE. I was very much interested in the article "Modifying the RCA Volt Ohmyst" as I had been thinking of adding a diode probe to my instrument.

I also do quite a bit of work on radio equipment in private aircraft and feel the series of articles by Lt. Eddy will help me in this work.

Thanking you in advance, I remain,
Yours very truly.

M. N. Sandefur, Supervisor of Radio
Alexandria Police Dept.
Alexandria, Louisiana.

Rockville Center
New York

Editor, Radio Maintenance
Dear Sir:

In looking over your July issue, I see very little about radio servicemen themselves and what they are doing. I think some space should be given to the various activities of both individuals and associations for surely such news would be welcome to the average reader.

I am also hoping Radio Maintenance will report on what new products we can expect from the various manufacturers in the near future. I, personally, would like to learn about new electronic devices of any nature.

How about it?

Sincerely yours,
E. W. Haynes

EDITORS NOTES

1. Starting in January, there will be a monthly department called "Servicemen's Activities." (Thanks for your letter with this suggestion).
2. About new products: We are pleased to announce a monthly column headed "The Industry Presents—" which will keep all hands up to date on the latest thing in radio.
3. "Electronically Speaking" is the tentative name of another new column which will appear in the back of the book advising as to the latest electronic equipment to come on the market.
4. Also on FM and Television, you will probably be pleased to note complete coverage. J. H. Ruiter of Du Mont Laboratories Inc. starts a series on Television in the January issue. Don't miss it. Write again and tell us what you think of it.

Radio Maintenance
295 Broadway, New York

Just received my first copy of your magazine.

I like it better than any of the periodicals, the material is well selected and nicely presented.

I would gladly subscribe at any price. May you have a long life.

M. H. Little
602 North Tenessee Ave.
Lakeland, Florida

Dear Editor:

I saw the first copy of the magazine "Radio Maintenance Magazine" at Radio Station WLAK yesterday afternoon.

In my opinion this is a most enlightening publication for which there has long been a need.

Sincerely yours
George W. Friend, Jr.
Friend's Radio Sales & Service

Practical SHORT CUTS in Radio Servicing

THE $100 Victory Bond in our first contest is awarded to E. M. Cline, of Yuma, Arizona, for what the editors consider the winning suggestion received since the announcement of the contest. To all others who submitted Short-Cuts that did not receive recognition, we extend our appreciation, and we hope we get as many more for the next contest. Closing date for entries in the January issue is November 15th. Here is Mr. Cline's winning "Short-Cut."

There are innumerable problems facing servicemen today, such as shortages of tubes, parts, etc., but one of the most aggravating of problems facing this serviceman is one of line voltage. With a line voltage variation from a peak of about 116 to a low of 106 over a period of 48 hours as checked by the power company, the actual voltage as the outlet of some homes in this vicinity will be near the 100 volt mark during low periods.

The type of radio most effected by this condition is the portable, AC-DC-battery set. The most generally used filament circuit in this type of set is the series 1.4 volt type tubes, connected in series with a filament dropping resistor, together with filter condensers, plate and screen current shunts, etc. (See Fig. 1) These sets generally perform satisfactorily on a well regulated power voltage from 110 volts up to 120 volts. When the line voltage reaches 105 or lower, the mixer tube filament drops below 1 volt usually, and it is necessary to compensate for this drop or put the radio away to be used only on batteries or in some locality where the line voltage is normal.

I have successfully overcome this problem in several hundred of this type of radio by using a shunt across the filament dropping resistor. This is of course provided that the tubes themselves are good, filters not dead or leaky, and rectifier emission normal.

Figure 1 shows a typical filament hook-up used in a portable AC-DC-battery set. R3 is the filament dropping resistor.

The value of the shunt to be used may be calculated from the formula (R1 × R2)/(R1 + R2) where the available D-C voltage at the output

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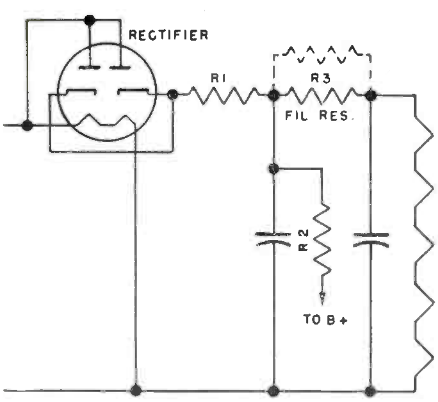

Fig. 1. Simplified schematic of typical filament circuit of AC-DC-Battery set to show location of shunt across dropping resistor.

MISCELLANY

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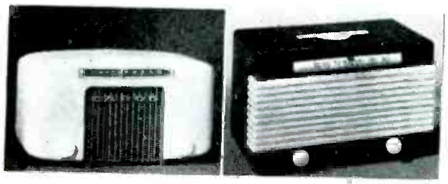
GAROD DISPLAYS LINE

The Garod Radio Corporation has just concluded the most successful sales meeting in its entire history serving the dual purpose of exhibiting the complete line of Garod Radios and of announcement and discussion of an aggressive merchandising program on a national scale.

Reflecting the many advances in engineering and design that required only the end of the war to be translated into reality, the Garod exhibit revealed the fullest possible utilization of both woods and plastics so as to command maximum consumer acceptance.



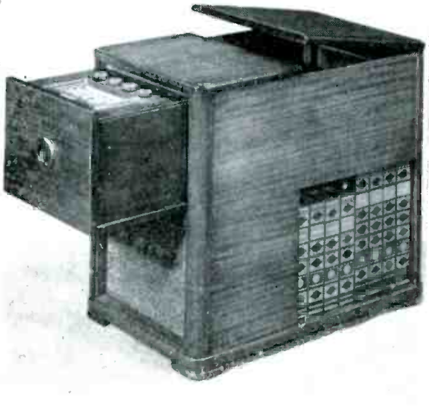
GAROD Models 5A2 and 6A1

The distributors saw six different table model radios, in both wood and plastic, which offered the purchaser a variety of styles, sizes and finishes. Supplementing this group is a table phonograph combination. also in plastic and in wood, as well as a combination having an automatic record changer. Several three-way portables were shown, a feature of which was the design for easy portability.

Outstanding for beautiful design and maximum utility was the series of ten console combinations, including two chair-side models. Most of the console combinations will be in both walnut and mahogany . . . in addition, there will be models featuring bleached mahogany finishes. These consoles reflected a wide range of period designs including Sheraton, 18th Century, Hepplewhite, Neo-Classic, and a breakfront cabinet.

The following sales representatives have been appointed:

C. R. "Connie" Strassner of Los Angeles, California, who has offices in San Francisco as well as Los Angeles, will cover the entire states of California and Arizona.



GAROD Model 6DPS3

GAROD Model 8BPY6

Pete Bach, with headquarters in Portland, Oregon, will represent Garod in Oregon and Washington.

The area of Eastern Pennsylvania, Maryland and Virginia will be handled by Sam Levine, with offices in Philadelphia.

Pat Haggerty has been appointed to represent Garod in the state of Michigan and the northwestern corner of Ohio, including Toledo.

Assigned to the South, with offices in Atlanta, Georgia, is Reid H. Cox, who knows practically every dealer by first name in the seven states he will cover.

The Southern Electric Co. of Staunton, Virginia, has been appointed the distributor for the north central territory of Virginia.

The Incandescent Supply Co. of Fresno, California, will handle the Garod line in the Fresno area.

The Associated Distributing Corp., Baltimore, Md. are exclusive distributors of Garod radios for the State of Maryland and the District of Columbia.

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NAVY SPEC 'SCOPE TO BE AVAILABLE TO RADIO MEN

Reiner Electronics Co., 152 W. 25th St., New York 1, N. Y. plans to market a three-inch oscillograph of the same quality of construction as those furnished by the company to the U.S. Navy. Using a 3BP1 tube with all four deflecting plates separately brought out, and with push-pull amplifiers for both vertical and horizontal deflection, this instrument is strictly professional in quality, yet not encumbered with the multitude of controls generally furnished with the larger instruments. This 'scope is constructed completely in accordance with Navy specifications, and is, of course, thoroughly tropicalized and fungus-treated. The price of $145 is higher than average for a three-inch 'scope, but the radio man who uses a 'scope often and wants reliable operation will welcome the opportunity of obtaining such a piece of equipment, especially after a humid season has caused equipment failures.

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MECK RECEIVER GETS BOTH OLD AND NEW F-M BANDS

Charles Wexler, chief engineer of the John Meck Industries, Inc., Plymouth, Indiana, announced recently that the company had notified the Federal Communications Commission that its engineering staff had developed an F-M receiver which will provide reception on the new 92 to 106 megacycle band. The set will also cover the present broadcast band of 42 to 50 megacycles which under the FCC ruling will become obsolete within a reasonable period of time. The set will also cover the band of 88 to 92 megacycles assigned for non-commercial uses where the FCC hopes 800 new stations may be established.

This new set will make it possible for a purchaser to own an F-M receiver which would be ready for reception, without changes or adjustment, the moment that the station changed to the new wave band. The FCC had been notified of this circuit "in the public interest" since it will eliminate costly converters, or the necessity of sending the set back to the factory or to the serviceman for adjustment to the new wave band.

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UNIVERSAL MICROPHONE NOW HAS GENERAL MGR.

Universal Microphone Co., Inglewood, Cal., has announced the appointment of a general manager, F. G. Gardner. The newly created position has been made necessary because of reconversion and postwar planning, according to statement from James L. Fouch and Cecil L. Sly, co-partners.

Mr. Gardner's last previous position was as Los Angeles representative for the Federal Telegraph and Radio Corp. He spent 16 years with A. T. and T. on field assignments, with the Bell Laboratories, in the New York office and at other points.

He was with International Telephone and Telegraph for ten years in commercial work at the London office; a year with its Rio de Janeiro branch and three years in South Africa for the organization.

During World War I he was with the Army Signal Corps in the AEF and he spent a year in Chicago with Kellogg Switchboard and Supply Co.

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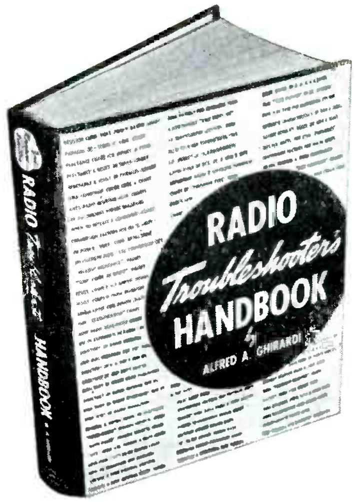
CLAROSTAT ANNOUNCES POST-WAR JOBBING SETUP

Better to serve its jobber-distributor customers, Clarostat Mfg. Co., Inc., Brooklyn, N. Y., manufacturers of resistors, controls and resistance devices, announce several innovations in their jobbing setup.

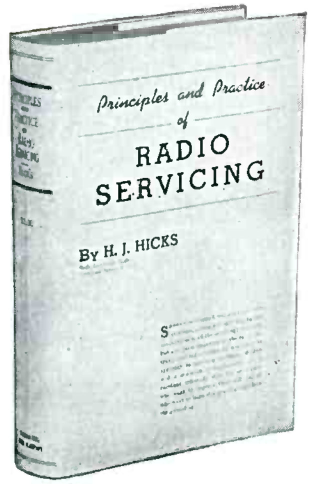
First is the appointment of Fran Chamberlain as Assistant Sales Manager of the Jobber Division, who is already working closely with jobbers in speeding up their wartime orders. Fran, a veteran of World War II (four years with the Tank Corps including combat duty in the European Theatre) is being trained for his important post by Leon L. Abelman, the Advisory Sales Manager.

Second, an outstandingly compete jobber stock of Clarostat controls, resistors, ballasts, and other popular items, is being set up as rapidly as conditions permit, in order to speed up the shipment of all future jobber orders. Although engaged 100% in the war effort and listed among the very first manufacturers to earn the Army-Navy "E" with subsequent stars, Clarostat is already well on the way with its reconversion plans.



BOOK DEPARTMENT

A Service for the Reader



WHILE MAGAZINES DO THEIR SHARE in keeping the reader up to date in his chosen profession, there can be no doubt that for the original instruction in a subject, and for reference, the possession of a library relating to basic principles, tables, charts, formulas, and general data provides the backbone of necessary technical reading.

This listing by no means professes to be a complete catalog of all of the books in the radio field. It does, however, point out a few of those which are especially useful to the radio serviceman. Others are indicated for training in fundamentals, while still others will give insight into the designing and engineering aspects of the art. Inasmuch as the listing is primarily intended for the serviceman, those in which he is especially interested are placed first.

Use the coupon on page 27 to order any of these books. Merely check off the ones you want and mail with your check or money order.

Especially Recommended

These books should, in our opinion, be on the shelf in every radio service shop. They contain valuable reference matter, and, while not supplanting the volumes of circuits and instructions, they do fill a definite place in the reference library of the radio serviceman.

1. **Radio Troubleshooters Handbook**, Ghirardi...... 5.00
744 pp, 8½ x 11, Cloth, 3rd edition. Murray Hill Books, Inc.
Case histories of common trouble symptoms and remedies for 4820 models of 202 makes of home and auto radios, and 74 other sections of useful and valuable reference data on servicing, tubes, batteries, auto radio installation, tube testers, pilot lamps, resistors, condensers, volume and tone controls, wire tables, filter design charts, and directory of manufacturers, schools, book publishers, and magazines.

2. **MYE Technical Manual**, P. R. Mallory & Co..... 2.00
406 pp, 9 x 12, Cloth
Reference material on record changes, circuits, condensers, and many other valuable points direct from a manufacturer with hints for maintenance on many aspects of radio. Valuable, worthwhile and basic.

3. **Radiotron Designers Handbook**................. 1.00
F. Langford Smith, Editor. 356 pp, 6 x 9, Cloth RCA
Considered by many as the biggest dollar's worth in radio books, this contains chapters on component circuits of radio receivers, and on audio and radio frequencies, rectification, filtering, tests and measurements, tube characteristics, and general theory. Especially suited to the radio set designer, but of value to all experimenters, amateurs, radio engineers, servicemen, and others interested in the fundamental principles of practical circuit design.

Recommended

The selection of a number of books for the radio serviceman is a difficult problem. There are so many that are good, and each fills its own place in the varied field of activities that compose radio servicing. However, for general instruction and methods the following are recommended:

4. **Servicing by Signal Tracing**, John F. Rider...... 4.00
360 pp, Cloth
Full and complete exposition of the idea of following the only thing common to all radio receivers—the signal. Find where the signal stops, and there you will find the trouble.

5. **Servicing Receivers by Means of Resistance Measurement** 2.00
By John F. Rider. 203 pp, Cloth
Another tried and useful method of servicing, useful in all sets, and basically sound. Ties in closely with the actual daily work of those who are "on the bench."

6. **Radio Servicing Course Book**, M. N. Beitman.... 2.50
224 pp, 8½ x 11.
22-lesson course on radio servicing, with hundreds of simplified diagrams, practical hints, and pictures. Includes many lessons for the beginner. Good introductory material for those starting in radio servicing.

7. **Shop Job Sheets in Radio**, Robt. N. Auble, Book I 1.50

8. **Shop Job Sheets in Radio**, Robt. N. Auble, Book II 1.50
Book I, 134 pp, Book II, 128 pp. The Macmillan Co.
Each shop exercise or "job" in these manuals deals with a specific problem in radio. Good review material. Book I gives a practical working knowledge of the electrical fundamentals of radio, and supplies foundation training for telephone, teletype and radio repairmen. Book II applies these fundamentals to standard radio equipment.

9. **Principles and Practice of Radio Servicing**...... 3.50
H. J. Hicks. 391 pp, 6 x 9. McGraw-Hill Book Co., Inc.
Second edition of a practical book that shows how to install, test, and repair radio receivers. Provides the radioman with the technical knowledge for diagnosing receiver troubles and remedying them accurately.

10. **Radio Service Trade Kinks**, Lewis S. Simon.... 3.00
269 pp, 7 x 10, Spiral Bound. McGraw-Hill Book Co., Inc.
A useful manual for radiomen, giving quick reference to common radio ailments, and practical methods of correcting them. This manual has grown out of experience, giving you the probable causes of failure in sets of 96 manufacturers.

11. **Modern Radio Servicing**, Alfred A. Ghirardi..... 5.00
1300 pp, 6 x 8½, Cloth. Murray Hill Books Inc.
How to learn radio servicing. While the latest developments in radio have come too fast, this book is good for a start in servicing. The fundamentals of servicing must be learned, regardless of how much further radio develops. Good for the beginner, and not too elementary for the old-timer at servicing.

Radio Principles

For the man who is interested in radio as a career, the fundamentals of radio will have to be mastered before specialization can begin. In this category, the following listings may be considered excellent texts, and are always basic reference books.

12. **Principles of Radio**, Keith Henney............ 3.50
534 pp, 5¼ x 7¾, Cloth. Fifth Edition, John Wiley & Sons, Inc.

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RADIO MAINTENANCE in Aviation

→ From Page 9

28 microhenries inductance while the 101B Tuning Unit has an output coil of about 7 microhenries. Each Tuning Unit is supplied with the following associated parts: 2 unwound coil forms, 1 spool of No. 18 AWG D.S.C. wire, 1 spool of No. 28 AWG D.S.C. wire, 3 output circuit link connectors, 2 contact pins, 2 No. 6-32 screws and elastic stop nuts.

Before any adjustment of these tuning units is attempted, one should become completely familiar with their assembly. One of the precautions that must be observed is that the tuning units, although fairly rugged when once adjusted and fastened to the turret, are necessarily fragile when removed, due to the mycalex end plates and isolantite coils. It is necessary during adjustment to move one roller contact on the output tuning coil with respect to the other. This may be done by pressing the springs of the roller contacts toward the bar with a screwdriver and then sliding the contact along the bar.

For preliminary adjustments involving only the interstage tuning, the only connection required is D-C power supply, connected directly to terminals 15 and 16 of the transmitter power plug. First, insert all the tubes in their respective sockets and tighten the tube clamps. Insert a dynamotor into the rear of the transmitter. Then select a tuning unit and quartz plate suitable for the frequency desired.

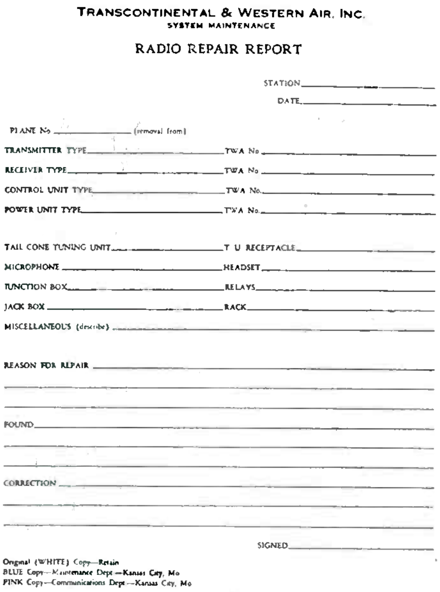
Apply power to the transmitter with the EMISSION switch in the MCW position and the CODE SEND-RECEIVE switch in the RECEIVE position. Select the desired tuning unit and place the CODE SEND-RECEIVE switch in the SEND position. Insert the plug of a milliammeter in the 2ND RF grid-current jack.

The circuit is in tune when the insertion of either end of the tuning tool in the first amplifier coil causes a reduction of the second amplifier grid current. At the high-frequency end only slight changes in inductance are required and can be obtained by changing the spacing of the end turns. Spreading the turns lowers inductance while decreasing the spacing increases the inductance. After the first amplifier coil is adjusted repeat the above procedure for the oscillator plate coil.

The coil forms and the wire supplied with the tuning units are wax impregnated and no further protective coating is necessary. However, after the coils have been properly adjusted, a thin coating of coil "dope" should be applied to hold the turns firmly in place.

After the interstage coils of each tuning unit have been adjusted for the various output frequencies required, the equipment is ready for the output circuit adjustments, using the high-voltage power unit.

Next, check the overall performance of the complete transmitting equipment by operating the transmitter into an artificial antenna. Such an antenna should consist of a 0-5 ampere R-F ammeter in series with a 15-25 ohm non-inductive resistor capable of dissipating 125 watts, connected between the antenna terminal and ground. The plate and antenna rollers of the output coil should be placed on the front (HIGH) end of the coil, care being taken to ascertain that the roller connections are on a turn and not between turns.



TRANSCONTINENTAL & WESTERN AIR, INC.
SYSTEM MAINTENANCE

RADIO REPAIR REPORT

STATION ________
DATE ________

PLANE No ________ (removal from)
TRANSMITTER TYPE ________ TWA No ________
RECEIVER TYPE ________ TWA No ________
CONTROL UNIT TYPE ________ TWA No. ________
POWER UNIT TYPE ________ TWA No. ________

TAIL CONE TUNING UNIT ________ T U RECEPTACLE ________
MICROPHONE ________ HEADSET ________
JUNCTION BOX ________ RELAYS ________
JACK BOX ________ RACK ________
MISCELLANEOUS (describe) ________

REASON FOR REPAIR ________

FOUND ________

CORRECTION ________

SIGNED ________

Original (WHITE) Copy—Retain
BLUE Copy—Maintenance Dept—Kansas City, Mo
PINK Copy—Communications Dept—Kansas City, Mo

Repair Report form, as used by TWA

Tuning the Antenna

A fixed antenna is usually employed in air transport radio installations. The constants of a fixed antenna for a given frequency vary widely, depending not only on the physical size and shape of the antenna, but also on the particular type of airplane on which it is installed, making it necessary to determine the output circuit tuning adjustments by experiment.

In order to operate the transmitter into a trailing-wire antenna that is to be adjusted to one-quarter wave length while in flight, a remote indication of antenna current is necessary. This can be had by installing a thermocouple in the transmitter.

Tune the transmitter at the desired frequencies into the artificial antenna previously described, and when it is properly adjusted replace it with the trailing-wire antenna. With the airplane in flight let out the trailing-wire antenna until the combined length of lead-in and antenna is approximately one-quarter wave-length. In order to avoid tuning to a second harmonic, the approximate length of wire to resonate at one-quarter wave-length should be calculated from the following formula before beginning the flight adjustments:

$$\text{Length in feet (lead-in plus trailing wire)} = \frac{246{,}000}{\text{Freq. in kc}}$$

Adjust the length of the antenna wire to obtain maximum antenna current without making any transmitter adjustments. Then the 2ND RF plate current should be checked, and if it differs materially from that obtained when operating into artificial antenna, the plate roller on the output coil should be readjusted and the output coil adjusted for resonance. When properly adjusted, the position of the output coil should be safety-wired, and the setting of the antenna reel recorded.

An unweighted trailing-wire antenna with an unshielded lead-in is tuned in the same manner as the fixed antenna. The length employed will depend on the desired operating frequencies. Preliminary tuning into this type of antenna can be made with the plane on the ground by supporting the free end. The final adjustments, however, will have to be made while in flight.

Shooting Trouble on the WE 27A Transmitter

The WE 27A, like other aircraft transmitters, is removed from the plane in the event that it develops trouble, installed on its test bench, and then connected to a dummy antenna. A volt-ohmmeter should then be used for checking as follows:

No R-F output. See that the filaments are lighted and that the 500-volt and 1050-volt dynamotors are running. If not, check battery voltage, fuses in the power unit and transmitter, and the transmitter starting relay S-3.

If the antenna relay S-1 is not operative, check to see that voltage is present at the coil terminals of the antenna relay and that the control circuit is grounded by the microphone push-button switch. If the antenna relay operates, check to see that it closes the power control relay S-2. Check to see that all the contact pins of the tuning unit are properly engaged in their spring clips.

Measure the currents at the test

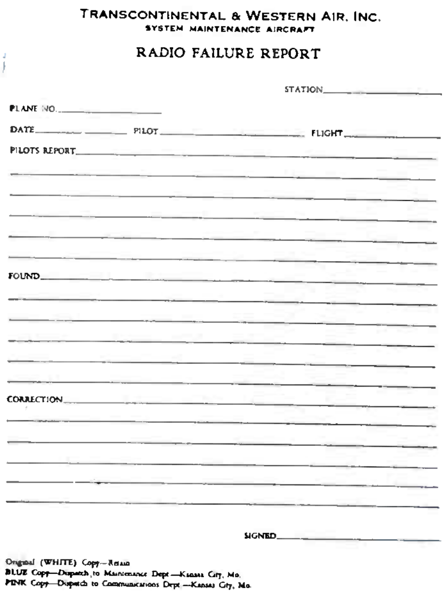
jacks on the front of the transmitter with a KS-7313 milliammeter or its equivalent. The R-F circuits should be checked stage by stage beginning with the oscillator. The absence of oscillator grid current indicates the quartz plate is not oscillating, which in turn may be due to a defective quartz plate or oscillator tube, no plate voltage, or an open circuit.

Low R-F Output. With full battery voltage, low R-F output may be due to a defective quartz plate, R-F tube, or dynamotor, or to a detuned radio-frequency circuit.

Normal Output but no Modulation. This indicates defective apparatus or an open circuit in the audio amplifier. To remedy:

(1) Try another microphone.

(2) Place the test meter in the 3RD A-F plate-current jack and make a loud sustained noise in the microphone. The current should rise from approximately 30 ma. to around 200 ma. The failure of this current to rise indicates defective power audio tubes or trouble in the audio driver stages.


TRANSCONTINENTAL & WESTERN AIR, INC.
SYSTEM MAINTENANCE AIRCRAFT
RADIO FAILURE REPORT

STATION________
PLANE NO.________
DATE________ PILOT________ FLIGHT________
PILOTS REPORT________
FOUND________
CORRECTION________
SIGNED________

Original (WHITE) Copy—Retain
BLUE Copy—Dispatch to Maintenance Dept.—Kansas City, Mo.
PINK Copy—Dispatch to Communications Dept.—Kansas City, Mo.

Failure Report form, as used by TWA

(3) Place the test meter in the 1ST AND 2ND A-F plate-current jack. If this current is very low, try a new second audio tube. If the current is normal, replace the first audio tube. If the trouble has not been located by a change of tubes, it will be necessary to remove the small audio panel and check wiring and apparatus.

(4) If the transmitter operates satisfactorily on PHONE but does not modulate on MCW, check the small audio keying relay S-7 to see that it closes the audio feedback circuit when the telegraph key is pressed.

Failure of Frequency Selection. Try selecting a different frequency. If the turret does not turn, check the clutch S-5, see that operating voltage is applied by the control relay S-4. If the turret rotates but does not stop in position see that the control relay operates when the turret passes through the selected position.

Trouble Shooting Hints for Aircraft Transmitters

When a specific guide to trouble shooting a set, such as the one above, is unavailable, the following summarized instructions as to working procedure should aid you:

Before the transmitter is removed from the plane, the wiring should be checked over to see that all leads are in their proper places, that the equipment is properly grounded to the bonding system, etc. Then the transmitter is removed from the plane and set up on the test bench. A dummy antenna having the proper electrical constants is used in conjunction with the set to be tested.

Troubles in radio transmitters are often caused by improper operation of switches, or by faulty adjustments. Therefore, the first thing to do is to inspect these items carefully. After this, any stages that are not operating properly should be located by a process of elimination.

In the event of failure to obtain a carrier, measure the filament voltage of each of the vacuum tubes and inspect the crystal and holder if a crystal is used. If there is no oscillator grid current, the crystal is not oscillating. If there is no grid current in any R-F stage, make sure the quartz crystal is clean and that the proper contact is made to each side. Each inductance switch or clip must be set on the proper tap. If still no grid current is indicated, check the complete grid-bias and plate circuits. If the above tests have not located the trouble, change the quartz crystal frequency control unit for one of a different frequency. Be sure to check all oscillator connections, R-F chokes, blocking and by-pass condensers. If the unit does show grid current, it is apparent that the trouble is not in the unit itself.

If the oscillator is operating properly, the grid current indicated on the intermediate and modulating amplifiers should be noted. If no grid current is indicated, check the tuning of all neutralizing taps, grid excitation connections, coupling condensers, grid circuit components, resistors, chokes, etc. If frequency doubling is used make sure that each buffer stage is tuned to the correct harmonic of the oscillator or preceding amplifier.

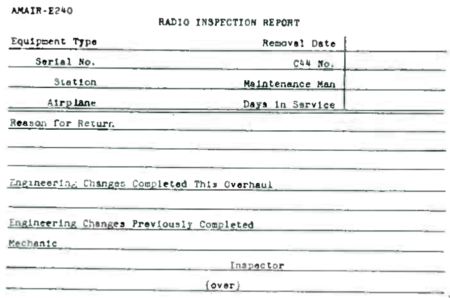
When each stage is brought into proper resonance, the plate current for that stage will be minimum and the grid current maximum. If the two do not occur simultaneously, the maximum grid current reading should be used to determine the proper setting of the tuning apparatus.

If the modulating amplifier and modulators are not working properly, check all the relays in the modulator system if the transmitter is of the telegraph-telephone type. Note all meter readings, bias readings and grid current readings. If these are all right, check connections and parts for continuity and make sure that all taps are properly located.

If the power amplifier operates properly on a dummy antenna but there is no power in the regular external antenna, then the trouble is usually that the antenna is not tuned properly or that the transmission line is open. Check for neutralization by noting meter readings while keying. No grid current should flow in any tube affected by the key or beyond it in the transmitter system when the key is up.

A record of all faults found and the manner in which they were remedied must be entered over your signature in the transmitter log book.

Believe it or not, the most prevalent cause of trouble in aircraft power lines is still in poor contacts. To check supply from sources to transmitter, first look to the fuses, then switches, circuit breakers, and terminal connections.


AMAIR-E240
RADIO INSPECTION REPORT

Equipment Type — Removal Date
Serial No. — C44 No.
Station — Maintenance Man
Airplane — Days in Service
Reason for Return
Engineering Changes Completed This Overhaul
Engineering Changes Previously Completed
Mechanic
Inspector
(over)

Inspection Report form, prepared by mimeograph, as used by American Airlines.

"Ring out" the circuit with any kind of test rig you like that will prove there are no shorts, grounds or opens.

Batteries

If a dynamotor is used as a source and it does not run, or if it delivers low voltage or dies down when loaded, check the battery that drives the motor end of this machine. If it is fully charged, then check the line from battery to dynamotor. If, on the other hand, the battery is low, don't recharge it; replace it with a known good battery, even if you have to take the old one in exchange and adjust the service charge later on, in accord-

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RADIO MAINTENANCE in Aviation

→ From Preceding Page

ance with its condition as you find it after proper charging and test discharge. (The point is, never send an aviator on his way with a doubtful battery—and if you find a battery in a discharged condition there is plenty of reason for doubt as to its ability to take a charge and hold it.)

Dynamotors

The question of the dynamotor involves more consideration, but a quick check to see that there are no open or grounded coils and that the leads are properly connected sometimes pays big dividends. If the trouble lies deeper, insist upon removing the machine. Take it to your shop and if you are not thoroughly familiar with this sort of work, get an electrician who is.

Removing vital parts of an airplane's communication system usually grounds the plane, and all private pilots are always in a hurry. The itinerant pilot will tell you the reason he owns a plane is to be able to go some place in a hurry and then when he gets there he wants to go to some other place. He may want you to "just fix it up so it will work for the next leg of the flight." My answer to this class of pilot is the same about doubtful generators as it is about doubtful batteries: If you can supply him with a sound machine, even after some delay, let him have it. Take a deposit and then take your time to fix the other machine.

Don't make temporary repairs, and don't haywire *anything* in radio on *any* plane *ever* — at *any* price offered you. If you do it may cost a life in the end.

Occasionally a transmitter will not "put out" because the antenna system or the bonding system of the plane is faulty. In the next article we will discuss in a little more detail the servicing of bonding, shielding, and antenna systems. √ √

SHORT-CUTS

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of the rectifier is known, and the value of the filament resistor is known. A simpler method of determining this value quickly is to build a resistance box, equipped with a tap switch to which are connected a number of resistors of various values, and a pair of alligator clips which can be clipped across the filament resistor quickly. In this manner different values can be switched in as a shunt. It is best to start with the

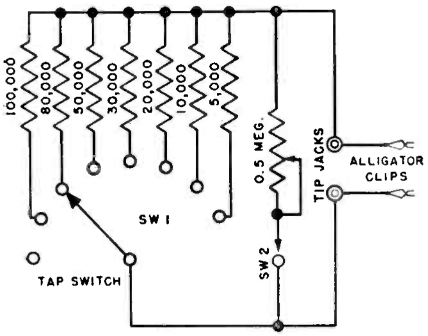


Fig. 2. Simple resistance box with switch used to determine proper value for shunt across filament dropping resistor.

highest value in the resistance box, gradually switching in the lower values until the proper value has been found. During this process the filament voltages at the tube base should be measured to insure against getting too high a voltage, thus shortening the life of tubes, or causing burn-outs.

This remedy is simple and fast. However, the shunt finally selected should be one that just brings the tube filaments up to operating values, and yet not upset other circuit constants such as plate and screen voltages. Further, it is wise to inform your customers exactly what you have done and caution them to be sure and have the radio filament circuit returned to normal before using in other localities where the line voltage might be higher.

Before making this change, determine whether or not the set will be in use during the time of peak voltage, which in this vicinity occurs between 1 A.M and 7 A.M. A measurement of the filament voltages during this peak and after the shunt has been installed is the safest method of finding out if they are too high during peak periods. These simple precautions will enable those servicemen in sections that have low line voltage to keep those radios playing in spite of abnormal conditions, which it is hoped the power companies will be able to overcome soon.

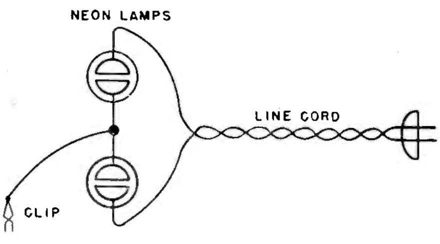
Circuit wiring for resistance box is shown in Fig. 2. The variable 500,000 ohm resistor is used to find values between the fixed resistors without having to calculate these. For example, if one wanted to find the value of an additional resistor between 5000 and 10,000 ohms, for example, 8000 ohms, disconnect the alligator clips from the circuit filament resistor, and using an ohmmeter, switch in the variable resistor and adjust until 8000 ohms is read on the ohmmeter. Then by switching out the 10,000-ohm fixed resistor, the ohmmeter will read the resistance of the shunt or variable resistor, which in this case is 40,000 ohms. This value resistor shunted with a 10,000-ohm resistor across the original filament resistor will make a total of 8,000 as a shunt value.

Extreme caution must be exercised in using this variable resistor and always see that it is in its highest position and that the switch is off before connecting the alligator clips across the set resistor.

Five dollars goes to Ralph F. Hunter, Catskill, N. Y., for this simple and helpful suggestion.

Today, one of the greatest shortages faced by the professional radio serviceman is that of time itself. There are just not enough hours in the day to do all the work which he is caled upon and expected to do.

Any saving of time, or, in other words, any short-cut in solving the problem at hand must be welcomed by the servicing fraternity. Such a problem confronting him ever since the beginning of radio has been this — which is the aerial lead-in and



Ground detector composed of two 2-watt neon lamps, a line cord, and a test lead with a clip.

which is the ground wire? For instance, he delivers a radio to the customer and finds two wires coming up through a hole in the floor, disappearing in the coal bin below or perhaps running through Aunt Susie's bedroom to Heaven knows where. The screwdriver mechanic will hook it up anyway so long as the radio makes a noise, but the conscientious serviceman will lose many precious minutes tracing the wires to their source.

Here is a gadget, costing less than a dollar, which saves the trouble. Two 2-watt neon lamps are connected in series across a line cord and plug, and a lead with clip attached to the midpoint as shown in the diagram. Since one side of the A-C line is

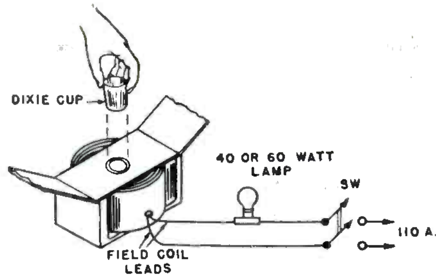
Short-Cuts (Cont'd)

grounded at the meter box, when the clip is touched to a grounded wire, one of the lamps will light. These lamps may be mounted on a small strip of wood or, better still, in a small box with holes in the cover so that they may be seen. The whole thing is light and takes up almost no room in the repair kit. It is only necessary to plug it in and touch the clip to each of the two wires in question. If a lamp lights when a wire is touched, it is the grounded wire. If neither wire causes a lamp to light, the ground connection is defective. If both wires cause a lamp to light, the antenna is grounded and should be investigated. Perhaps it is lying on the ground or rubbing on a tin gutter or rain pipe or perhaps the lightning arrester is shorted.

This simple device can also be used to check other things for grounds, such as motors. It is truly a handy and versatile gadget which should prove a help to every radioman.

Willard M. Davis, of Pasadena, California, gets $3 for his suggestion about the perennial rattling speaker.

One of my pet practices with the many discarded radios that have nothing wrong but a dynamic speaker whose voice coil and magnet are jammed with magnetized shavings is



Using A-C to demagnetize the speaker temporarily enables the Dixie Cup to dislodge and remove iron filings that become attracted to the pole pieces.

simply explained by the drawing. This is my humble Short-Cut which momentarily de-magnetizes the iron core, thereby releasing the aforementioned particles. The Dixie cup was chosen for its rigidity and usual cleanliness as well as its practical thickness. A little added tapping at the rear of speaker with the diaphragm facing downward ejects more particles. A small bellows will also aid in loosening particles. Human breath is too likely to contain moisture, so do not blow on it.

Send in your favorite short-cut. Maybe you too will win a prize. Only original, unpublished material will be considered; the decision of the editors is final; Radio Maintenance reserves the right to publish any short-cut submitted. In the case of two similar items, the one arriving first wins the War Bond.

SEEK'N'OFFER

The end of the war coming so soon after the first issue of Radio Maintenance almost removes the necessity of this department. However, here are a few of the inquiries received from our readers—other have been fulfilled.

S. R. Shell, RT3/c, of Barracks 19, Co. 85B, Radio Material School, Treasure Island, San Francisco, Calif. is badly in need of a 117Z6 tube.

Gerald L. Condrey, 108 Woodstock Road, Route 8, Box 231, Richmond, Va. would like Rider Manuals I to XIV, and an R-F Signal Generator such as Precision E-200, Supreme 571, or any other good instrument of this type. He is also in need of 12-, 35-, and 50-volt tubes.

Frank Toomey, Chief Engineer of Radio Station KWJB, Globe, Arizona expresses a desire for a 7.5 KVA power transformer with 440-volt primary, and secondaries for 220 and 110 volts.

Our only letter from a reader of the fair sex came from Virginia Calvert, of the Knight-Campbell Music Co., of Denver, Colo. who offers for sale or exchange surplus parts in the following categories: 2 boxes miscellaneous RCA-Victor parts, new and used; 1 box of headphones and parts; 33 assorted new power and audio transformers; 30 miscellaneous filter condensers and chokes; 2 Atwater-Kent power packs; and—shades of 1927—1 new UX-199 Catacomb (presumably from Radiola-24,-26, or-Super-Heterodyne.

New York Radio Row stores are already beginning to bet in stocks of the hard-tog-get tubes, and surplus stocks of condensers, chokes, power transformers are filling their shelves and counters. But this department will continue to serve—as long as there is any need for it.

Address your inquiries to "Seek'-n'-Offer Department."

RESIDENCE RADIO

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portance is the "co-axial" speaker, which is still capable of fine reproduction. It is not suggested that anything less than speakers of this quality be used for the main outlet in the living room. For the remainder of the speakers in the house, a good fidelity speaker of six to eight inch size should suffice. The better speakers in this category before the war were the RCA MI-6234 and the Jensen PM8-CT; these, or other and better ones, will undoubtedly make their appearance again very shortly. For bathroom and kitchen installation, a waterproof unit should be employed. For patio use, a waterproof unit should certainly be used, preferably one designed for outdoor service.

This description sounds as though it would only be practical for those who are interested in spending several thousand dollars for the inclusion of such a system in their homes. Such is not necessarily the case inasmuch as primary design and development engineering have progressed to such a point that a six channel system with six outlets should probably run in the neighborhood of $600 complete with wiring, installation, tuning-up, and preliminary servicing. This figure may seem to be high, but if we consider that the average family will probably spend $300 or more for a good A-M and F-M radio-phonograph combination in a large console cabinet, and that it will not have the features provided by installations such as these, it seems probable that a large market will be available.

The remaining articles of this series will describe in detail the various units comprising a complete system. In the January issue, we will present the constructional details of the wide-band A-M tuner.

AN EXPLANATION

We promised you a complete Symposium on Test Equipment for this issue, but V-J gave the green light to the manufacturers for civilian production, and they are now able to proceed with new and improved models.

We know that many of you will be buying new Test Equipment as soon as it is available, and we know you will want the latest possible information. So we have held this article for the January issue to make it complete and up-to-date. Look for it again.

In the January Issue

BUSINESS MANAGEMENT FOR THE RADIO DEALER

→ From Page 7

creased labor sales. Again restating, a 50% increase in sales volume should cause only about a 35% increase in cost.

On the premise that the main objective of the radio business man is to establish and maintain a standard of income equivalent to that of any other tradesman or dealer in lines requiring a similar background of experience or education or a similar exercise of management talent, the following suggestions are offered.

The average wage of tradesmen in lines requiring perhaps less technical training but much more brawn is, in the metropolitan New York area, maintained at a general level of $1.75 per hour and up. This is without the additional consideration of general business problems or risk. When the risk and the weight of a business are added, a reasonable percentage of the overall volume must be added as compensation. This is called profit, but actually it should be divided into two categories. Part of it should be considered as profit, and part should be considered as a reserve, and put away as a margin against the slack periods which are sure to come.

The figures for these items are interesting when it is necessary or desirable to bill on an hourly basis for all effort. Note that this composite rate is overall and must be charged for the activities of the errand boy just as surely as it is charged for those of the owner-operator. Any and all jobs must be charged in just this same way.

Promotion

Let it be clearly understood that this is not a recommendation for charging by an hourly rate. It is presented as an academic discussion to show how an hourly rate must be derived, and to determine just how much can and should be spent in the life-line of business—promotion.

In all of these figures, five percent has been included for advertising and promotion. This is generally considered to be the least amount that will keep an operation alive and active.

Business management in any enterprise is always concerned primarily with the overall cost of advertising per unit return. By this is meant simply if an expenditure of $100 in advertising brings in only two sales on each of which the profit is $50, nothing has been gained. If a thousand direct mail pieces are sent out at a total cost of $100, and only two produce returns, it has cost $50 each to make those sales. Of course, a return of only two sales from a thousand broadsides is low—generally a return of two percent is considered a good average—but again this is only used as an example. Costs on this part of the business operation should be broken down for purposes of analysis to show how much profit accrues directly and indirectly from each dollar invested in advertising. There are great differences between the large and small outlets in the conditions of selling radio merchandise. Consequently, planning will vary for different sizes of operation. We will not discuss the planning for the large stores. We feel that the smaller dealers are competing against the greatest merchants in the world when they are working in competition with the large department stores. In many respects the problems in large and small stores are the same, yet each has some advantages over the other.

The department store had the outstanding advantage of having an expert advertising crew at its service constantly to sell radios by the latest methods developed in the science of selling. While this is not a discussion of the respective selling abilities of large and small organizations, these thoughts are presented to demonstrate the probability of equal opportunities for the smaller dealer, who is by far the leader in sales volume in the U. S.

The large merchant cannot give the same quality of service consistently that the small dealer can give to his regular clients. No matter how many times one may visit the large retail store, he usually gets the same treatment—friendly, but without recognition or personal service. The small dealer can practice the policy of considering each customer a friend, and after the second visit, the friend can be called by name. As a famous psychologist says, the sweetest sound in the English language to any person is his own name.

In the operating statements, it will be seen that five percent of the sales volume has been allocated in each case for advertising. In some ways, this amount can be considered as an investment in the future, but it is in reality the very life-line of a business enterprise, as "big business" will testify. This expenditure can be made in many ways, each perhaps more or less successful according to the community and the facilities available for promotion. There are a number of generally accepted promotional methods, such as (1) a good store front and good window display, (2) newspaper and telephone directory advertising, (3) direct mail, and (4) programs of gentle music emanating from the shop. This latter requires exquisite taste in selection of the music, and the highest possible quality of reproduction.

Articles will follow in subsequent issues of RADIO MAINTENANCE on each of the above, but as we are now considering the management of the business, we are at present only concerned with a minimum to spend on each.

Suggested Advertising

In the first place, it is advisable to carry at least a one-inch advertisement in the telephone directory, regardless of the size of the business; the bigger this advertisement is, the better. The cost of this will vary in different communities, and in some there will be no classified section. In such districts, a direct mail piece with telephone conveniences should be created, so it will be used near the telephone. For instance, a card telephone directory that the customer may write-in his own often-used numbers can be distributed, carrying the advertising and phone number of the radio shop conspicuously placed. This would serve as a proper substitute for directory advertising, and should cost very little more. If the population coverage is large, the increased cost of mailing it out can be charged against direct mail, as it will be one of the most valuable pieces sent out during the year.

It is suggested that for radio maintenance promotion, direct mail is one of the most effective forms of advertising. It is recommended that forty percent of the advertising allotment be used for this form of promotion. An increased maintenance business will promote more part and equipment sales.

Newspaper advertising is also valuable, especially in drawing customers for specials in both large and small merchandise sales. For each community, it is suggested that the methods of the largest stores be studied, or the services of a reputable advertising agency be secured for the placement of the advertising.

Advertising can be very expensive without sufficient "pull" and, converse-

Business Management for the Radio Dealer

→ From Preceding Page

ly, it can be quite inexpensive and still have a large and attractive pulling power. It will be well worth anyone's time to study the details of copy, art, color, typography, paper, reproduction, layout and other details that go into making quality advertising in newspapers, magazines or direct mail pieces, or the overall effect of quality window displays.

If it is desirable to spend more than five percent on promotion, with the objective of increasing the business still further, it might be worth while to consider how much a better location would cost. The additional cost of renting in a better location might "pay off" more than any other form of advertising. By moving near the large trade centers, you get the advantage of increased accessibility and more people are certain to see and remember your place of business.

In all this, it has been our objective to give suggestions on how to increase the dollar volume of business. Like many other businesses, the war did not bring the radio merchandiser an increased volume of business, but rather has cut his supply of merchandise to the point where the lack of availability of even the most common type of parts has frustrated his enterprise to a large extent. Now, as we look forward in this post-war era which looks up in accord with the national feelings of stabilized employment and plenty for all, we envisage an opportunity to supply a large amount of that plenty to the nation by merchandising and maintenance sales beyond any past dreams. And it is probable that by this same service, we can gain a like prosperity for ourselves.

Of course there will be much competition with other business circles as well as from other fields in which money will be spent. To prepare properly for this era, and to meet this coming competition, it is the purpose of RADIO MAINTENANCE to unite with the radio shop in developing this business into a more profitable profession.

BOOK DEPARTMENT

→ From Page 21

Just out, the fifth edition of this volume which originally came out in 1929 is brought up to date. Written for those with little background in radio who want to know the basis upon which radio communication exists. Begins with fundamentals of electricity, and gradually develops the subject of radio practice. Practical, sound, and recommended. Newly included material comprises u.h.f., and pulses, transients, square waves, etc.

13. **Radio Physics Course,** Alfred A. Ghirardi...... 5.00
972 pp, 6 x 9, Cloth. Murray Hill Books Inc.
Extremely popular training course in basic principles. Widely used in radio schools, civilian as well as Army, Navy, Marine Corps, and Coast Guard, and in employee training courses of numerous radio manufacturers.

14. **An Introduction to Electronics,** Ralph G. Hudson. 3.00
98 pp. The Macmillan Company.
This will be useful to all those who are interested in the field of electronics, aside from the application of these principles to radio exclusively. The field in which the greatest forward strides are due to be taken within the next decade is big, and it is beginning to seem as though anything can be done by electronics.

15. **Basic Radio Principles,** Capt. Maurice G. Suffern 3.00
271 pp, 5½ x 8, Cloth. McGraw-Hill Book Co., Inc.
A simplified manual, approaching radio equipment and theory on a purely practical and simplified basis, omitting all mathematics, physics, formulas, and involved graphs. Especially useful to those who find themselves hampered by a limited knowledge of radio theory.

16. **A Primer of Electronics,** Don P. Caverly....... 2.00
235 pp, 5½ x 8½, Cloth. McGraw-Hill Book Co., Inc.
An especially clear and simple explanation of electronics and electronic tubes and circuits. Beginning with electric current and magnetism, the subject matter deals with electromagnetic radiation, and then takes up the basic elements of electronics. Exceptionally well suited to give you an understanding of how that infinitesimal servant — the electron — works.

17. **The Electrolytic Capacitor,** A. M. Georgiev...... 3.00
191 pp. Cloth. Murray Hill Books Inc.
A very recent addition to the literature on components, this is a practical book which tells of the design and manufacturing processes, as well as describing methods of detecting troubles, and in emergency cases, of repairing these units. As a complete description of electrolytic condensers, this book is recommended.

Radio Engineering

For the advanced radioman who wants to delve still further into the science of radio, with the engineering aspect clearly of interest, there are many books that are recommended. A listing of the standard texts on these subjects follows:

18. **Radio Engineering,** Frederick E. Terman...... 5.50
813 pp, 6 x 9, Cloth. McGraw-Hill Book Co., Inc.
The time-proven standby in radio engineering texts, comprehensively treating all phases of radio communication from the viewpoint of the engineer. Includes chapters on television, detectors, distortion, wave propagation, with especially complete sections on circuit constants and resonant circuits. Especially recommended.

19. **Fundamentals of Vacuum Tubes,** A. V. Eastman. 4.50
583 pp, 6 x 9, Cloth. McGraw-Hill Book Co., Inc.
A standard text on vacuum tubes, for advanced study in this field. Discusses the principal types of tubes, and fully treats the laws underlying each. Excellent reference material, but not suitable for the beginner.

20. **Radio Receiver Design,** Part I. K. R. Sturley.... 4.50
435 pp, 5½ x 8½, Cloth. John Wiley & Sons, Inc.
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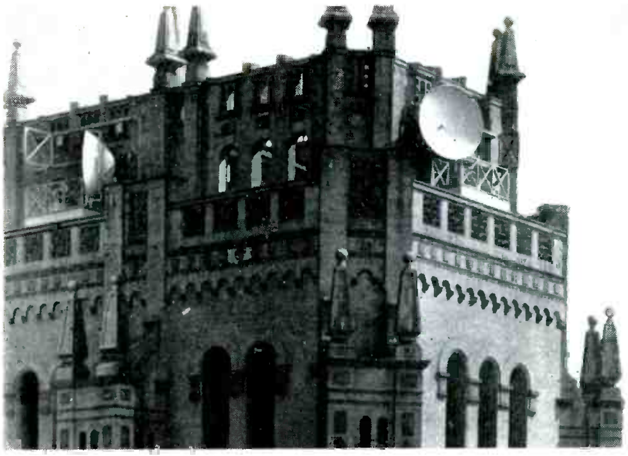

Fig. 1. Antennas and reflectors for micro-wave signals used in P-T-M system resemble searchlights as seen in this photograph of the mounting of two such antennas at the top of the International Telephone Building in New York City.

A-M F-M AND NOW P-T-M

Federal Telephone and Radio Laboratories demonstrate new system of modulation which permits transmission of up to 24 telephone conversations of 12 broadcast programs at once.

By Rex Gilbert

Radio Consultant

ENGINEERS of the Federal Telephone and Radio Laboratories recently demonstrated a new system known as Pulse Time Modulation, which is potentially capable of revolutionizing certain phases of the communication industry.

The system demonstrated was operated on a frequency of 1300 megacycles, and makes possible the transmission of 24 or more two-way telephone conversations or 12 or more different radio programs over the same frequency channel simultaneously.

Federal engineers explain that, in effect, the Pulse Time Modulation system chops the conversations up into small bits and fits together the fragments of each so that they travel precisely in their appointed places over the radio channel. These are the pulses, all of equal amplitude. With no modulation, they are equally spaced on the time base. Each pulse is approximately one-half microsecond wide, and the pulses are separated by five microseconds. The modulation is effected by "wiggling" these pulses backward and forward, varying the spacing between them. The frequency of the modulating signal controls the rate at which the pulses are shifted, and the amplitude controls the amount of the shift. The pulses of energy are so rapid that when they are reassembled at the receiving end, the ear hears a high fidelity signal in each of the many channels. If 24 channels are used, for example, each channel is assigned to a certain pulse, and the modulation of that pulse is done during 1/24th of a cycle, the cycles being repeated 8000 times per second. The character of the pulses is shown in Fig. 2, with a double synchronizing pulse at the left, and with modulation on the second pulse.

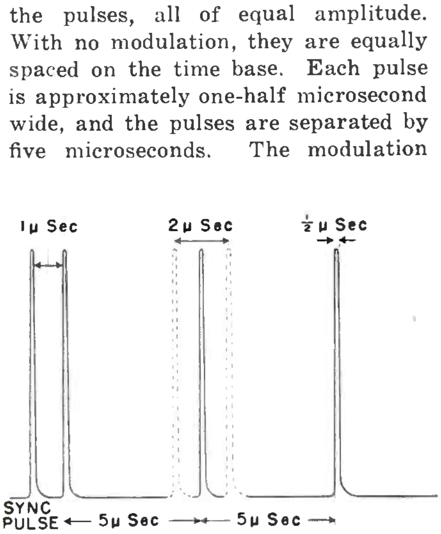

Fig. 2. Synchronizing double-pulse at left, and two pulses of the 24 used for multiplex telephony. Second pulse is shown with modulation which changes the pulse spacing.

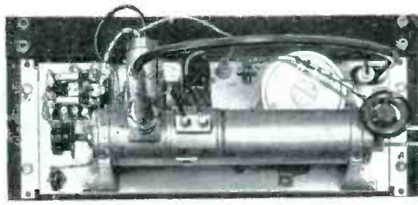

Fig. 3. The R-F end of the transmitter, with typical u-h-f "plumbing." This is a view of the rear of the top panel of Fig. 4.

The equipment is relatively compact. The pulse generating and modulating circuits for 24 channels can all be mounted on one standard rack, and the receiver, transmitter, and necessary power supplies on another rack. The latter is shown in Fig. 4. The power delivered to the antenna is approximately one-half watt, which is sufficient for the 25-mile link to Hazlet, N. J. from the International Telephone building in lower Manhattan. From Hazlet, the signals are relayed to Nutley, N. J., the site of the new Federal Telecommunications Laboratories, and thence relayed back to the IT&T building, a triangular circuit of about 80 miles in all.

The antenna used for these signals is a small dipole mounted at the focal point of a parabolic reflector eight feet in diameter, resulting in a very narrow beam with low power requirements. Figure 1 shows two of these reflectors mounted on the top of the IT&T building. The relay stations at Hazlet and Nutley have similar antennas mounted on high towers. Figure 3 shows a transmitter panel which takes up only seven inches in height on a standard rack. The output is conducted by means of co-axial cable directly to the antenna.

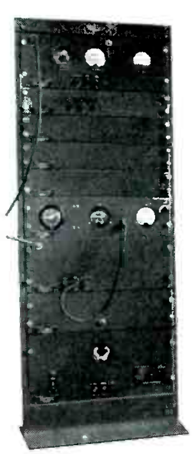

Fig. 4. Transmitter, modulator, receiver, and power supplies for Federal's new system of modulation. Pulse generating equipment for 24 channels occupies another similar rack.

ANTENNAS for F-M and TELEVISION

→ From Page 5

reflection, and these effects are more pronounced when the antenna is low. Height, in this discussion, must be measured from the nearest "ground," which may be the top of a steel and stone building upon which the antenna is located. The proximity of grounded pipes and electrical conduit is ground just as effectively as is the actual earth ground. However, for short distance reception, it is generally sufficient to erect an antenna one-half wave length high, which for the present F-M band approximates 10 feet. A height of one wave length will give improved performance in low-angle reception, which is desirable for the relatively short distances encountered in the primary service areas of F-M stations. However, it is suggested that the antenna be installed as high as possible, and certainly not *less* than ten feet above the building upon which it might be supported. Fortunately, the wave lengths being short, it should not be difficult to get a height of one wave length or more with reasonable expense. It certainly is an advantage from the antenna standpoint that F-M and television broadcasting does not occur at frequencies around 200 kc.

TABLE I. ANTENNA LENGTHS

Present Bands

Freq. (mc)	Use	Total Length of Radiator* ½ Wave	Full Wave	3/2 Wave
44	FM	10' 7½"	21' 9¾"	33' 0"
45	FM	10' 4¾"	21' 4"	32' 3¼"
46	FM	10' 2"	20' 10½"	31' 6¾"
47	FM	9' 11¼"	20' 5"	30' 10¾"
48	FM	9' 9"	20' 0"	30' 3"
49	FM	9' 6½"	19' 7"	29' 7½"
50	FM	9' 4¼"	19' 2½"	29' 0½"
50- 56	Telev	8' 10"	18' 1¼"	27' 4¾"
60- 66	Telev	7' 5¼"	15' 3"	23' 0½"
66- 72	Telev	6' 9¼"	13' 10¾"	21' 0½"
68- 84	Telev	5' 9¼"	11' 10¼"	17' 11"
84- 90	Telev	5' 4½"	11' 0½"	16' 8¼"
96-102	Telev	4' 8¾"	9' 8½"	14' 8"
102-108	Telev	4' 5½"	9' 1¾"	13' 9¾"

New Bands

Freq. (mc)	Use	½ Wave	Full Wave	3/2 Wave
84	FM	5' 6¾"	11' 4¾"	17' 3¼"
86	FM	5' 5¼"	11' 2"	16' 10½"
88	FM	5' 3¾"	10' 11"	16' 6"
90	FM	5' 2½"	10' 8"	16' 1½"
92	FM	5' 1"	10' 5¼"	15' 9½"
94	FM	4' 11¾"	10' 2½"	15' 5½"
96	FM	4' 10½"	10' 0"	15' 1½"
98	FM	4' 9¼"	9' 9½"	14' 9¾"
100	FM	4' 8¼"	9' 7¼"	14' 6¼"
102	FM	4' 7"	9' 5"	14' 2¾"
44- 50	Telev	9' 11¼"	20' 5"	30' 10¾"
54- 60	Telev	8' 2½"	16' 10"	25' 5¾"
60- 66	Telev	7' 5¼"	15' 3"	23' 0½"
66- 72	Telev	6' 9¼"	13' 10¾"	21' 0½"
72- 78	Telev	6' 3"	12' 9½"	19' 4¼"
78- 84	Telev	5' 9¼"	11' 10¼"	17' 11"

* Does not include length of spacing insulator at connection to transmission line.

Table showing lengths of wires required for radiator when used as 1/2-, Full-, or 3/2-wave antennas for both present and new F-M and Television bands.

Length of Radiator

Table I specifies the optimum antenna length for half-wave, full-wave, and 3/2 wave length doublets, for the present and future F-M and television bands. These figures were calculated from the formula

$$\text{Length (feet)} = \frac{492\ (N - 0.05)}{\text{Freq. (mc)}}$$

where N is the number of half-waves of length, which indicates that the optimum length for a full-wave antenna is not exactly twice the length of a half-wave doublet, and that a 3/2 antenna is more than three times the length of a half-wave wire. This is occasioned by the difference in end effect. From this formula, it can be deduced that each end of an antenna is equivalent to approximately 2½ percent of the length of a half-wave doublet, regardless of the number of half-waves of length comprising the antenna. Or, in other words, the wire ends themselves correspond to a certain *fixed* length of wire.

When installing a single doublet, it is advisable to select a length suitable for the average of the frequencies of the stations in your locality. If there is a wide divergence of frequencies, it may be advisable to use a double-doublet construction, with one adjusted for each of the frequencies determined by the following formulas:

$$f_1 = f_l + \tfrac{1}{4}\,(f_h - f_l) \text{ and}$$
$$f_2 = f_h - \tfrac{1}{4}\,(f_h - f_l),$$

where f_1 and f_2 are design points for the two doublets, f_l is the lowest frequency in the band, and f_h is the highest frequency in the band. For the present F-M band, f_1 is 45.5 mc, and f_2 is 48.5 mc.

Multi-Doublets

In designing antennas for transmitting, use is made of the features of double-doublets to shape the radiation pattern to conform to the terrain and to the service area it is desired to cover. Double-doublets as generally used in reception use antennas of different lengths to equalize reception over the several short-wave bands, but both of these antennas are in the same plane, causing their patterns to lie on top of each other, yet be effective on the different bands. In transmitting over level terrain, it is customary to use a pattern that is essentially a circle. For such use, two doublets of the same length are used, and their planes are separated by 90 deg. This results in the familiar turnstile antenna, the several pairs of doublets being stacked along a vertical tower to improve low-angle radiation.

Using this as a starting point, it is possible to adapt the same idea to receiving antennas. Let us assume that one station is located due south of the listener, and it is using a frequency of 44 mc, and that another is located southwest of the listener, and broadcasting on a frequency of 49 mc. Optimum reception from one would require a certain length of

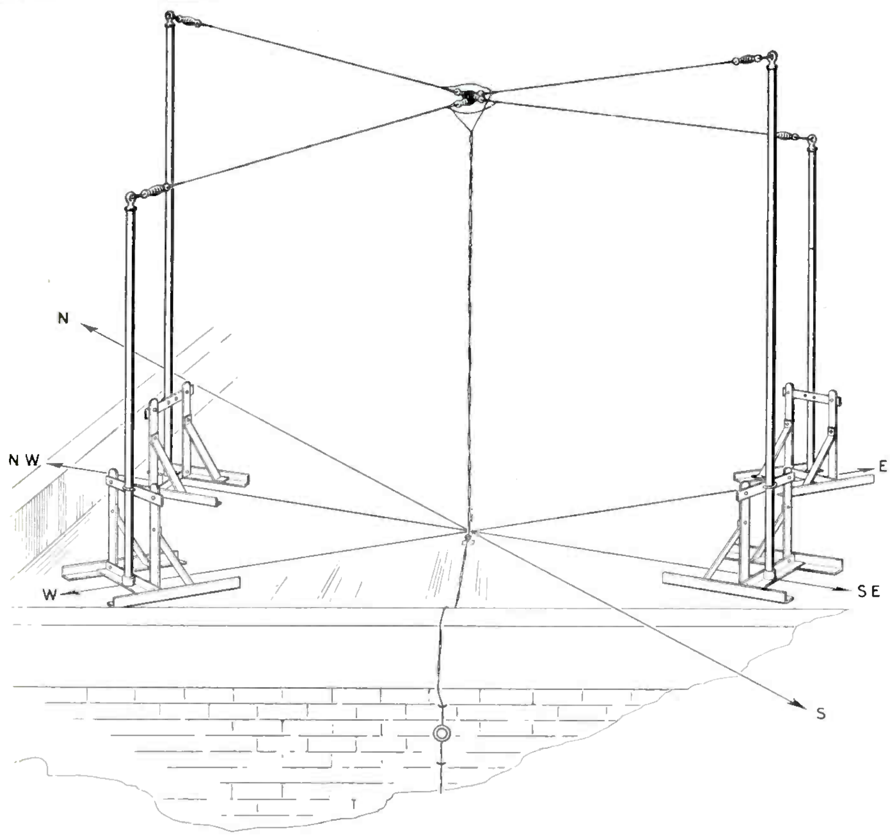

Fig. 6. One arrangement of double-doublet with one section favoring reception from one station, and the other section favoring a second station.

doublet, and it should be installed in an east and west direction. Similarly, the other station would require a doublet of different length, and the orientation should be different.

For such an application, the arrangement of Fig. 6 will fit the conditions best. One doublet of 10′7½″ in length is installed in an east-west direction, and another of 9′6½″ in length is arranged in a northwest-southeast direction, both using insulators in the center, and with these insulators taped together. The wires of the two doublets are connected to the transmission line at that point.

This is only one example of how an antenna can be designed to use its natural characteristics to improve reception. Each installation will differ from every other one, practically, and for the best results, each one should be tailored for its own application.

Reflectors and Directors

In locations where it is necessary to get every last bit of performance out of the antenna installation, and in particular where the direction of all the major stations from which reception is desired is essentially the same, the use of a reflector will give excellent results.

Figure 7 shows one dual-dipole arrangement with reflectors that was available before the war.

In general, reflectors are spaced about one-quarter wave length behind the radiators, and are about 1.02 times the length of the radiators. The optimum length should be determined by trial after the antenna is erected. The reflectors should be rigidly mounted so that the spacing remains fixed.

Directors are but rarely used in receiving antenna installations. However, they may be worth a trial in extreme cases. Their length should also be determined by experiment. Optimum spacing for directors is generally considered one-tenth wave length. The wave length in feet for a radio wave of any frequency is given by the formula

$$\text{Wavelength (ft.)} = \frac{984.25}{\text{Freq. (mc)}}$$

and this formula should be used in determining spacing of the elements.

Efficiency Measurement

In all of these descriptions of antennas, mention has often been made of making adjustment for optimum performance. Improvements in antenna systems may increase performance by only two or three db for each operation, and this is only a barely detectable amount to the ear. When designing an antenna installation, some definite method of measuring performance must be used, if the work is to proceed in an orderly and reliably accurate manner. With the average F-M set, it is generally advisable to insert a microammeter in the grid return of the limiter stage (if two are used, insert the meter in the grid return of the second limiter). Before making any changes in the existing antenna, observe and record readings from each of the stations that can be heard in your locality. Then, begin the antenna improvement program, noting the meter readings after any change is made in the sky wire. Only by this means will you be able to effect improvements and to know just what you are doing. (At this point, it occurs to the writer that manufacturers might possibly install a jack in this grid return circuit for just such a use. One hesitates to recommend much experimenting with the insides of a perfectly performing F-M set — wire placement and trimmer capacities are likely to be critical.)

Antenna Maintenance

There is little maintenance work required for an antenna system that has been properly installed. However, with the higher frequencies, it might be especially worth while to include the timeworn caution about properly soldering joints to avoid high resistance connections which are very common in antennas. Watch also for corroded joints, particularly when telescoping elements are provided. After final adjustments to telescoping elements are completed, it is advisable to solder the joints carefully, using a blow torch, 50-50 solder, and

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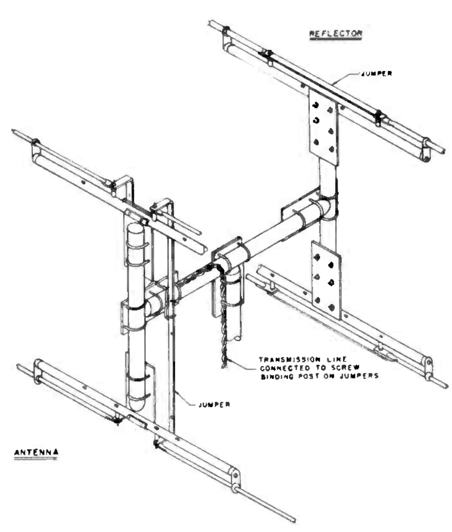

Fig. 7. Mounting of antennas and reflectors as manufactured by Technical Appliance Corp. (TACO) prior to the war.

ANTENNAS for F-M and TELEVISION

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a non-corrosive flux. For this purpose, powdered resin is recommended as the fluxing agent.

Connections to the lead-in must also be carefully made, and it is advisable to thoroughly tape the upper end of the lead-in cable where the wires are fanned out, to prevent water seepage inside the waterproof braid covering. Furthermore, care must be taken to avoid chafing the braid where it passes over the edge of the roof, or past any other part of the building where it comes into close contact.

If co-axial cable is used, it should be well supported, taking care not to make any sharp bends. The minimum radius of bending is listed by the manufacturers of the available co-axial cables, and this figure should be adhered to carefully.

When any antenna is installed in a location where lightning storms are features of the weather, proper lightning arresters should be installed. These are available in several types, and manufacturers' instructions should be followed in their installation. With the higher antennas, it is suggested that an automobile antenna be mounted vertically along the supporting member and extending three or four feet above the highest part of the antenna itself. This "lightning rod" should be grounded with heavy cable to a good ground, such as a six-foot length of pipe driven into the earth, keeping the ground wire well removed from the lead-in. In most cities, there are ordnances regarding the necessary protection when radio antennas are installed, and these should never be violated — you will undoubtedly be fined if you get caught at it, and besides, carelessness is dangerous because of fire possibilities.

Antenna installation will be found a challenging and interesting operation, and it will generally "pay off" in better performance, which means more money in the cash register, more business — in all, an excellent circle. Also there is satisfaction in having satisfied customers at all times, and a little practice and specialization in antenna design, installation, and improvement can easily make this a very profitable sideline.

Using the OSCILLOGRAPH

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6000 cps, beyond which the drop-off is much more rapid, indicating the loss in high frequency response due to side band cutting. This curve, it must be remembered, is that obtained from a good quality receiver, and at the time of measurement, the tone control was at the point of maximum high frequency response. Figure 7 shows the response curve from this same receiver with the tone control at minimum high frequency response position. The response curve shown in Fig. 8 is that of an extremely sharp receiver, which had poor audio quality. The indicating lines for frequency have been drawn in, and the entire drawing was made from photographs which were not sufficiently clear to permit of satisfactory reproduction.

To make use of this method, the serviceman should observe the pattern from several satisfactory receivers, in order to become thoroughly acquainted with the general characteristics of them. Without accurate plotting, the results are only to be used as an indication. After becoming familiar with the system, the effect of tone controls can be observed quite readily in addition to the overall frequency response under optimum conditions.

The Ideal Method

There are many uses for a system of this type, provided that suitable equipment were available. This brings us to a consideration of just what it would take to make such ideal equipment for making measurements of this type.

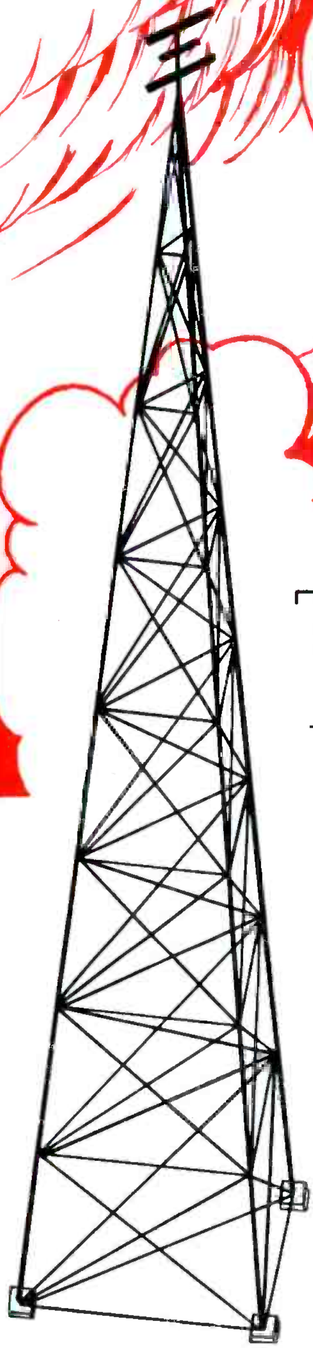
To begin with, an oscillator must be equipped with means for sweeping the modulating voltage over the entire audio range in a logarithmic fashion at a rate of approximately ten times per second, and in contrast to the swept voltage of the alignment oscillator, this sweep should cover the band in a sawtooth manner — that is, the output frequency should increase from 20 to 20,000, jump quickly back to 20, and increase again. There are several methods of accomplishing this, but the simplest appears to be by the use of a motor-driven rotating dual-stator condenser, with especially shaped plates. The use of a dual-stator condenser is suggested so that the sweep might progress over the required range using one set of stator plates, and as the rotor completes its entire change in capacity with this set, a contact on the rotor shaft shifts the circuit to the other stator plate. In addition, the output of the swept oscillator is mixed with that of a fixed-frequency oscillator, and the combined output is fed to the input of the receiver under test. In order that measurements can be made at several points in the broadcast band, refinements must be added to permit of simple switching to provide this facility.

Since the average oscillograph does not sweep in a very linear fashion at rates as low as 1/10 second, a deflection voltage should be supplied for the horizontal plates by the same rotating motor. In addition, a rectifier with logarithmic characteristics should be provided for the output of the receiver under test, so the output indication will be proportional to db, rather than voltage.

Such an instrument is under development at the present time, and it is expected that constructional details will be provided to Radio Maintenance readers in a future issue.

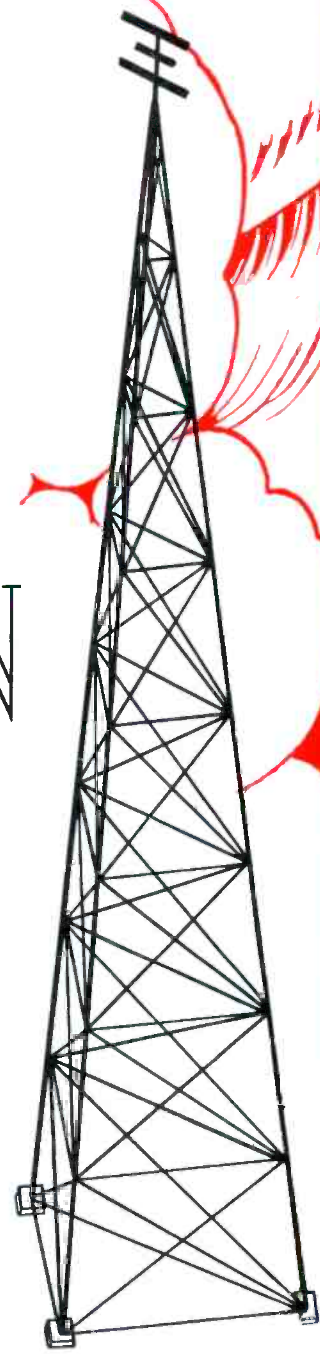
Conclusions

In describing the method of observing frequency response characteristics of a radio receiver, it is not suggested that such a piece of equipment or the use of such a method be considered a necessity for every radio service shop. Far from it, because it is not actually the province of the serviceman to do much work of this character. However, there are certain to be many radiomen whose interest exceeds that of just repairing a defective set. For service use, the simplest of these suggestions may be of interest as a comparison between good sets and not-so-good sets, and as a description of the sort of equipment necessary to do a rapid and efficient job of receiver design.



F-M & TELEVISION

RECEIVING ANTENNAS



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