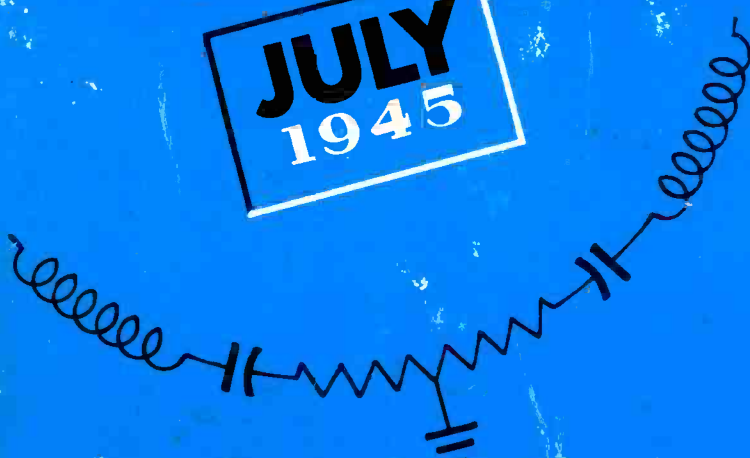
RADIO MAINTENANCE

JULY
1945



A BOLAND AND BOYCE PUBLICATION

Why RADIO MAINTENANCE Magazine was born

THE call for radio maintenance instructional material was urgent and pressing at the start of the war, and as the war increased in tempo this demand became more and more insistent.

The organization launching this publication responded early to the need for instructional material on electronic maintenance for U.S. Naval Communications and the U.S. Army Signal Corps field use.

Naturally, such single purpose application to the problems of modern communications maintenance has equipped our technical staff with a valuable slant on electronic requirements.

It is, therefore, with the thought of making more complete use of this accumulated knowledge that RADIO MAINTENANCE Magazine comes into being.

RADIO MAINTENANCE Magazine will be distributed to those accredited radio and electronic dealers upon whose shoulders rests the responsibility for today's civilian radio maintenance; to airline and airport radio activities; to A-M, F-M and television broadcasting stations, and to manufacturers of radio receivers and equipment. It will not be made available to the general public.

Our editors will obtain articles only of great interest in the actual field of operation where new and improved technique and short cuts are being developed. They will augment this information with the accumulated knowledge of our technicians in the quick and efficient servicing of all general circuits, and in correctly maintaining components for all electronic communications equipment.

We pledge all our energies and facilities to make RADIO MAINTENANCE Magazine outstanding in value to you as a means for keeping abreast of electronics maintenance progress.

BOLAND AND BOYCE INC. PUBLISHERS

RADIO MAINTENANCE

INCLUDING
ELECTRONIC MAINTENANCE

Volume 1 **JULY 1945** **Number 1**

Contents

Departments

Radio Maintenance is published quarterly by Boland & Boyce, Inc., at 295 Broadway, New York 7, N. Y., and distributed without cost to Radio and Electronic dealers and servicemen.

Contributions are invited on Radio and Electronic subjects. Manuscripts will be returned only if accompanied by sufficient return postage. No liability is assumed by the publishers for loss of any material; contributors are advised to retain copies of all manuscripts submitted. Payment for contributions will be made upon acceptance, and covers all right, title, and interest in and to the manuscript, photos, and drawings purchased. Payment will be made at our current rates. All material accepted for publication is subject to whatever revisions, omissions, or additions as may be considered necessary in the opinion of the editors.

Coming

Residence Radio Installations

How to make extra dollars with high-quality built-in systems for the better class homes

Business Methods in the Radio Service Shop

How to increase your net earnings by avoiding the little losses and leaks that eat up your profit

ORGANIZATION -- is that the answer?

Radiomen's Opinions on a type of organization for the radio man

RADIO MAINTENANCE in Aviation

Mr. Eddy's revealing series on the servicing of radio equipment for private and transport planes

Getting the Most Out of Your Test Equipment

Modifications and methods of use to increase your efficiency

Using the Signal Generator and Oscillograph

Covering their use in making receiver response measurements

and others!

RADIO MAINTENANCE

How to Service Airborne Communication Equipment

By Lt. Myron J. Eddy, USN Ret.

NOTE: This is the first of four articles describing the technique and methods of those radiomen who keep airborne communication equipment in top-notch working order. The author has long been associated with these problems, first as a naval aviator and then as an aircraft radio instructor. Mr. Eddy is the author of *Aeronautic Radio,* a manual for aviation radio operators and technicians.

In future issues he covers the servicing of aircraft power packs, bonding and shielding systems and airway station equipment. Don't miss any of these articles; combined, they cover the entire subject of aviation radio maintenance, something every radio technician will want to know about after the war is over.

READERS of RADIO MAINTENANCE, looking forward to the rapid development of post-war aviation well ask "who is going to service aviation radio sets?" It seems certain that we will have many moderately priced, privately owned planes, all radio equipped to fly radio-guarded air routes. It seems equally certain that bigger and better airliners, with more extensive radio installations than ever before, will fill the skies over this country and the waters separating us from our air neighbors.

As to the maintenance of civilian airborne radio equipment in the days of peace to come, private plane owners will turn to the established radio repair shops, wherever possible.

Larger airports already have both privately owned and airline-operated radio shops. These will require more personnel when the skies commence to darken with aircraft again.

American Airlines Photo

An airline company radio maintenance "mech" checking a Western Electric 29A receiver, showing typical receiver test bench

CAA Photo

Installing cross pointer indicating instrument in a Bellanca plane, as a part of the receiving equipment of a radio instrument landing system

IN *Aviation*

Official U. S. Navy Photo

Smaller airports — the ones that will be used by most of the aerial commuters, traveling salesmen, and other itinerant flyers — will have to depend on the nearby small town radio repair shops to keep their plane radios in order. All flights, private and commercial, will be controlled by the Civil Aeronautics Administration, and this outfit requires that all planes flying civil airways be equipped with a radio beacon receiver and with operative two-way communication equipment when using any airport having a C.A.A. air traffic control tower.

This means that when a private pilot develops radio trouble, his trip is held up until repairs are made right where he is, which puts the bee on the nearest radio shop. It also puts money into the pocket of the small town radio shop men who know aviation radio sets. When you stop to think that aircraft radio receivers and transmitters are no more difficult to fix than any other kind it becomes apparent that it will pay you to learn aviation servicing procedure.

The Nature of Aviation Radio Maintenance

Maintenance as a term applied to keeping aviation radio equipment in top-notch condition — and nothing less than this is acceptable in aviation — is a very broad term; so is the term "radio equipment" as it applies to aviation. Radio equipment used in aviation *must not fail* while in service. Every move the radio maintenance technician makes is actuated by this rule; the entire doctrine of an airline radio maintenance department is based on it. This is because the safety of every person who flies may depend, under certain all-too-familiar circumstances of storm and static and darkness, on whether or not the plane's radio continues operative.

It is because of this urgent overall safety element of necessity associated with aviation radio that you must approach the general subject of its maintenance with a special attitude.

You never service or repair an *aviation* receiver as the result of some cash customer's request to "do a cheap job" or "just get it to work for a while." Mostly, believe it or not, you work on receivers that are *almost* all right. I say, "almost"; this is always the case where its known performance falls off and someone, probably the pilot, wants to know why. Summarized, the basic philosophy of this maintenance procedure might be expressed in the words: MAKE SURE. (Check and double check.) More than half your time, if you are in an airline company's radio crew, is spent *proving* that a plane's radio set is okay. And if some part is probably just about due to burn out, you know it, and replace it before that happens. Repairing is a part of maintenance but replacement is more common than repairing. In aviation, *replacing parts is a safety precaution.*

Maintenance means checking, inspecting, calibrating, tuning, testing, replacing and/or repairing parts, cleaning, oiling; in short, anything and everything that has been proved to be effective in the upkeep of radio equipment. And remember, in aviation you have not only several types of radio receivers and transmitters, but also batteries, generators, an ignition shielding harness and the bonding system of the plane. You will find all of these things on every air transport plane and many of them even on private planes.

You may have occasion at some time in your radio career to work on a private plane as an individual, or you may sometime work on an air transport as a member of the communication department of some airline company. Therefore, the best and most commonly followed procedure for the maintenance, inspection, testing and repairing of all the different parts of the radio equipment used in air transport and private flying will be given in this first article.

The first element involved in maintenance is operational practice. That is the procedure involved in operating the sets themselves; the correct use of the apparatus, and how to avoid abuse. A second important element in maintenance is that of periodic routine inspecting and testing. Not only does the operator inspect his set at frequent intervals, but in most aircraft communication systems provision is made for inspection by other radio men at regular intervals. An operator should constantly bear in mind that correct operation combined with intelligent inspection is essential to good maintenance. Pilot operators do not always know exactly what it is that goes wrong because they have many things to watch in addition to their radio, but they can always tell the maintenance man what happened. It is up to you to go ahead from there.

Besides routine inspection, routine tests are also highly desirable. Some

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RADIO MAINTENANCE IN *Aviation*

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of these tests can be conducted by the operator in the plane, if an operator is carried as a crew member; others must be made after the plane's set is removed and placed on the test bench at the airport or taken on a special radio flight test. Some air transport companies require that the operator personally make bench tests before and after each flight; other companies merely require that the plane operator or pilot be present at such tests. In either case the plane operator is given to understand the precise condition of his set, both before and after each flight.

A complete log or record is kept of each piece of radio apparatus and everything that is done to it throughout its entire life. Records are kept of all batteries; the dates of charging and of test discharges (not connected to a set) are entered in these logs. Note the completeness of one airline company's form, Figure 1.

Certain aircraft radio receiver maintenance work is done by actually putting a plane receiver in operation, either in an airport laboratory or shop, or while on a grounded plane. If such pre-flight ground operating tests do not conclusively prove that the receiver's performance is all it ought to be, a flight test is made. The pilot sees to that; he is the one to be satisfied.

Wherever groups of aircraft radio technicians are organized for and assigned to maintenance work on a single line of receivers, a step-by-step system of trouble shooting invariably develops. The system evolved is always the result of experience with the particular receiver being maintained and for the particular service. For example, Army and Navy radio technicians on duty in the tropics find dampness their great enemy; when a set goes wrong they always look first for the ravages of dampness. Men flying in bitter cold climates learn to look for troubles incident to low temperatures, whereas in Texas the arch enemy is dust. The communications departments of domestic airlines set up a trouble shooting program for all their radio men.

Records which constitute a case history of apparatus that has developed trouble are a big help to the trouble shooter. Good trouble shooters are invariably good "theory" men. If you can figure out by deduction the possible cause of the trouble you will save time. The next best method, sometimes combined with the deductive method, is that of elimination. Here you consider each possible cause for the existing trouble and by connecting and disconnecting circuits you prove or disprove the tentative theory advanced as to the trouble. Precise, approved step-by-step examples appear further on, under the heading "A Bench Test for Aircraft Receivers."

TRANSCONTINENTAL & WESTERN AIR, INC.
SYSTEM RADIO MAINTENANCE
RADIO INSPECTION REPORT
W4A EQUIPMENT

PLANE NO.________ STATION________

DATE IN________ OUT________ PILOT IN________ OUT________ FLIGHT IN________ OUT________

PART A

	IN	OUT		IN	OUT		IN	OUT
Power Unit No.			Ants & Spares			T. M. Oprn.		
17A Rec. No.			Jumper & Bea. Ant.			Jack Box Oprn.		
Cont. Unit No.			Emer Bat. Seal			Spch. Mon. 4 freqs.		
Transmitter No.			2 Headphones			All rec. outputs		
W4A Rec. No.			2 Microphones			Dum. Ant. Cur. Day.		
W5DC2 T U. No.			Oprn. of all Relays			Dum. Ant. Cur. Nite		

PART B

	IN	OUT		IN	OUT		IN	OUT
Trans. Ckd. by			W4A Rec. Ckd. by			Cont. Unit Ckd. by		
Frequencies	ED | WD	EN | WN	SW Oprn. (Day-Nite)			Freq. Selector		
Osc. Grid Cur.			LW Oprn.			Vol. Controls		
Doub. Grid. Cur.			T. M. Commutator			Output Meter		
Amp. Grid Cur.			5335 Relay Assy.			Autotyn Calib.		
Plate Voltage			Plugs & Cables			Bea. Tuning Switch		
Total Current			Emergency Dial			On-Off Switch		
Plugs & Cables			17A Rec. Ckd. by					
Rack & Shocks			LW & SW Oprn.			Dial Lights		
5335 Relay Assy.			Calibration			Power Unit Ckd. by		
Trans. Seal Brkn. by			Emer. Bat. Voltage			Plgs. Cbls. & Mtg.		
			Dial Light					

PART C

	IN	OUT		IN	OUT		IN	OUT
Installation Ckd. by			W4A Relay			T. U. Recep. Insp.		
Insp. of all fuses			Fwd. Jnctn. Box Wrng.			All Units Saftied		
			Rear Jnctn. Box Wrng.			License No.		
			Arresters (3)					

PART D

PILOT'S REPORT________

FOUND________

CORRECTION________

IN check by________(signed) at______A. M. P. M. OUT check by________(signed) at______A. M. P. M.

FINAL APRON CHECK BY________ (signed) at______A. M. P. M.

Original WHITE copy—Retain. BLUE copy—Dispatch Daily Maint. Dept., Kansas City, Mo.
PINK copy—Dispatch Daily to Communications Dept., Kansas City, Mo.

Courtesy TWA

Fig. 1 Radio inspection report form used by TWA to insure complete checking of the radio installations in transport planes. With space for a check on each vital point, the maintenance man is constantly reminded to be thorough.

How Private Plane Radio Equipment Is Serviced

Most privately owned planes carry a radio receiver, and many of them have transmitters and radio compasses. If a transmitter is carried, the plane is licensed as a mobile radio station, and the transmitter must be recalibrated periodically. At these times it is customary to bench-test the entire power pack. Most private pilots feel that their receivers should be checked thoroughly at regular intervals; at these times the tubes are tested and replaced if found even slightly impaired. The radio man undertaking this sort of work should attempt to anticipate possible failure of wearable parts such as tubes, dynamotors, vibrators, switch contacts, relays, condensers, and resistors. Various units have different lengths of operating service depending upon their reliability. The service life of each item becomes quite well established by usage. Such items as headphones and microphones will perform

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the radio view of TOMORROW

By Raymond G. Cosgrove

President, Radio Manufacturers Association

THOUGH STILL ENGAGED in a war assignment so important and so vast that very little can be said about it because of security restrictions, the radio manufacturing industry has been able to visualize its peacetime future with increasing clarity. That future holds great promise for employment, entertainment, education and industry; and it holds great promise for the servicemen, as well.

Of the 55,000,000 home radio sets in use before the war, it is estimated that more than 8,000,000 are now silent, while most of the others require service to make them fully efficient. Unquestionably the backlog of service work to be done is very large, and will keep repair shops busy for some months.

When the industry is able to produce an appreciable volume of civilian equipment, the field it will enter will be greatly expanded over the 1940 market. The 8,000,000 silent sets will have to be replaced, and so will many of the others now in use. In addition, there will continue to be the "normal" demand that in 1940 brought the industry a $300,000,000 volume.

These markets, however, are merely the starting point. The great majority of cars now in use will be replaced by shiny new ones — and most of the newer cars will have built-in radios. The suddenly matured FM will not only mean higher priced unit sales involving AM-FM sets but more sets, to augment standard AM receivers still usable. The phonograph market, which was enjoying a pleasant boom before the war, will undoubtedly continue to boom. Many manufacturers anticipate that the great majority of higher-priced sets will be AM-FM-phonograph combinations.

With the people world-conscious and Americans involved in the four corners of the earth, it is likely that short-wave bands will be in demand, too.

Then, of course, there is television. While this will start off modestly, within a few years it is likely that video will be a big brother of radio in sales and maintenance.

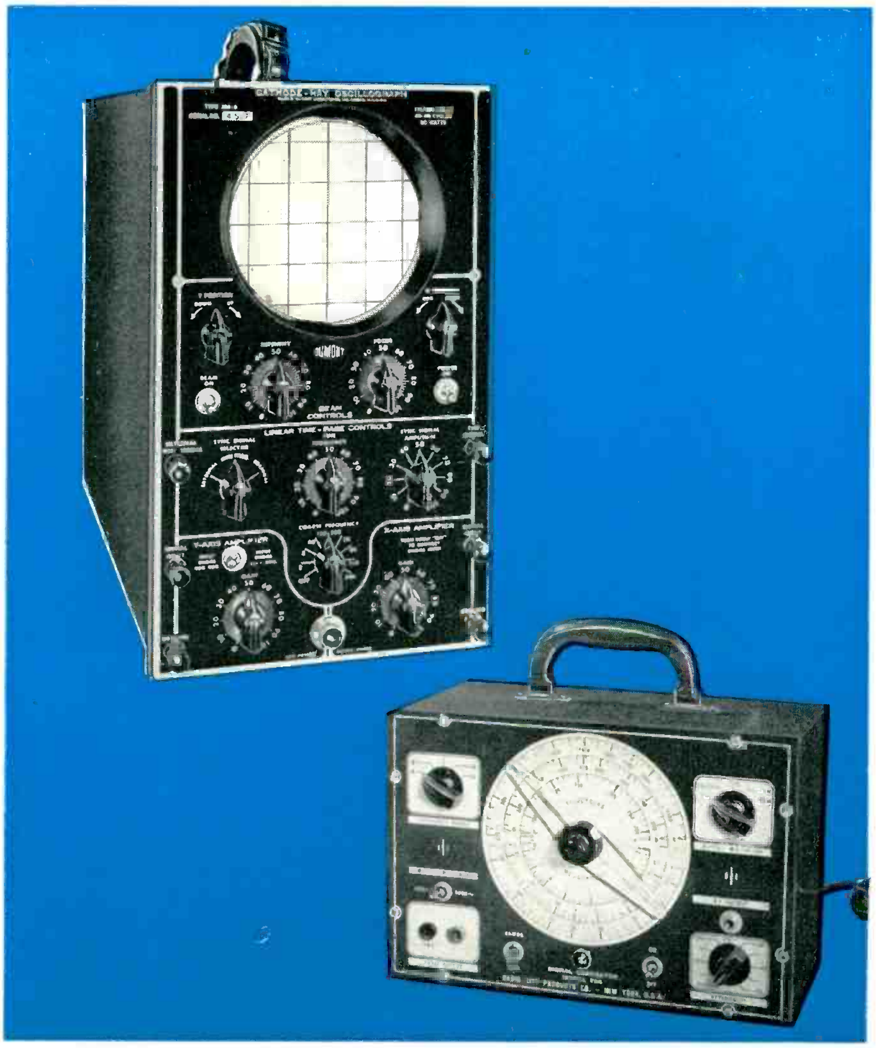
"Citizen radio," adapted from wartime Walkie-talkie and Handie-talkie, will become prominent for taxicabs, railroads, truckers, doctors, in plants and many other places. A whole new field requiring technical skill and maintenance will be created.

Add an increased number of sets per family, including the greatly improved personal portables that may fit into a man's coat pocket or a woman's purse, and the expanded field for radio usage is seen to be very great.

The need of existing sets for maintenance should easily carry the servicemen into the period when the early post-conversion civilian equipment will be brought in for check ups and new tubes. Installations will be important sources of business, especially for television receivers. By the time the new sets have been out a few years and need normal attention, the number of radio units in use will be much greater than in 1940 and the field for service will be enhanced accordingly.

Every sign points to excellent future prospects for the servicemen as well as the rest of the radio industry. And by seeking to standardize some parts, establish standards and disseminate information, the manufacturers are doing everything possible to help the servicemen meet the opportunities. √ √

Using the Signal Generator



Photos courtesy Allen B. Dumont Laboratories, Inc., and Radio City Products Co

1 Receiver Alignment

2 Response Measurement

By C. G. McProud

In two parts — part one

WITH INCREASED PERFORMANCE capabilities of the modern super-heterodyne radio receiver, it is essential that each circuit of the set be in best possible operating condition. This means that in addition to having good tubes in all the sockets, the alignment of the various tuned circuits be optimum. In a set with nine tuned circuits, for example, it is possible that each one is operated at only 90% efficiency. Under these conditions, the overall sensitivity of the set is reduced 61%. In high-fidelity systems, the tone quality may be impaired by improper alignment. These factors demand that the serviceman understand the requirements of a good alignment job, and that he be familiar with the methods involved. Properly aligned, the set will operate normally, and measurements of sensitivity and frequency response will indicate the results of the work done. In this two-part article, methods for alignment will be covered in this issue; for response measurement in the succeeding issue.

Alignment Requirements

A good alignment job requires that every tuned circuit in a receiver be adjusted in accordance with the manufacturer's specifications. This may mean from two to ten circuits in the I-F amplifier, and from two to twenty circuits in the R-F amplifier, first detector, and oscillator. The principles involved are the same in all cases, the difference in the number of circuits being caused by greater complexity due to short-wave bands, tuning indicators, automatic frequency control circuits, and such other refinements as may be included in the design.

Since the principles are the same, it is expedient to select a set of average complexity as an example. Such a set may be assumed to have one I-F stage, with two transformers, both double-tuned; one R-F stage; a first detector; and an oscillator. It has two short-wave bands, covering from 1.7 to 6.0 mc, and 5.9 to 19.0 mc, in addition to the normal broadcast band. There is no a-f-c circuit.

and Oscillograph

for

Equipment Necessary

To do any alignment, some form of signal source and some means for measuring the output are necessary. In simple sets, alignment is often performed using broadcast stations as the signal source, and the ear as an output indicator. Inasmuch as the response of the ear is logarithmic, small changes in volume are not detectable. The minimum volume change discernible to the average ear is about 2 db, which corresponds to ±21% in voltage. Aside from this, the audio modulation from a broadcast transmitter is rarely constant over any length of time. For these reasons, a calibrated signal source with controllable output, and some method of accurately measuring the output of the receiver is required. This latter may take the form of an A-C meter across the voice coil of the speaker; or a vacuum-tube voltmeter from the a-v-c bus to ground; or an oscillograph, which is actually only a voltmeter whose needle has no inertia. For this method of alignment, the signal generator must be so equipped that the output frequency may be varied rapidly from about 30 kc above to 30 kc below the indicated frequency. This is a form of frequency modulation, and many signal generators have this feature built-in. It is accomplished in a variety of ways, the simplest being a small, rotating, motor-driven capacitor in parallel with the tuned circuit of the oscillator. The more modern method of frequency-modulating the oscillator is by means of a reactance tube across the tuned circuit, with a varying voltage applied to its grid. In order to achieve linear variation of frequency, this voltage should have a pyramid or "roof-top" waveform. This wave is developed from the power-line frequency as shown in Fig. 1. This also shows the output frequency of the oscillator under the influence of the reactance tube.

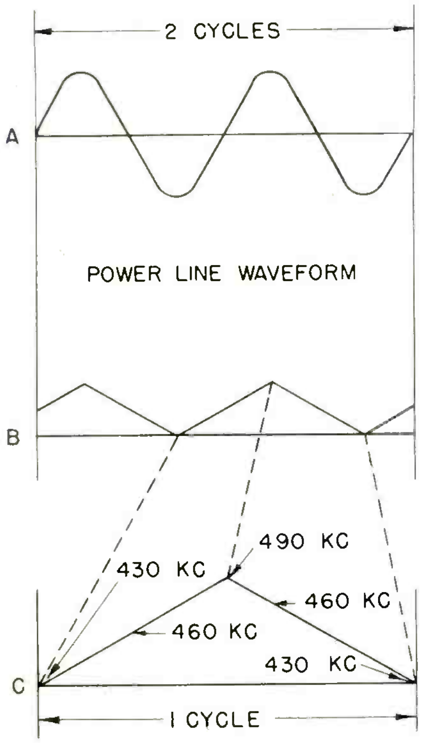


Fig. 1. Pyramid wave, B, developed from power-line sine wave, A; and output frequency variation, C, over one cycle of line voltage.

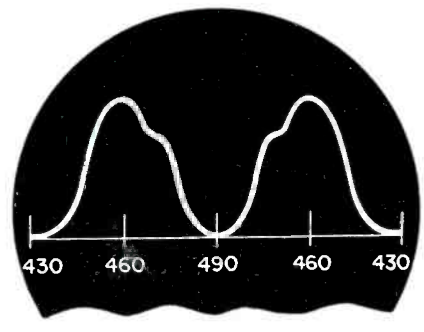


Fig. 2. Appearance of output of improperly adjusted I-F amplifier with oscillograph sweep synchronized at the power-line frequency.

The frequency should be varied rapidly enough so that the traces on the screen of the oscillograph appear to be a continuous pattern. Having a source of power-line frequency available, it is convenient to use this as the modulating voltage, after having suitably shaped the waveform. Several satisfactory sweep-modulated signal generators are on the market, and it is not the purpose of this article to provide the design for such an instrument.

The oscillograph may be any standard unit with high impedance input and means for synchronizing the horizontal sweep with the frequency sweep of the generator.

Let f_0 represent the indicated oscillator frequency; f_1, the lower limit of the sweep; and f_2, the upper limit; and let $f_2 - f_0 = f_0 - f_1 = \Delta f$. In most generators this value, Δf, may be varied from 0 to 30 kc. If the sweep is linear, the signal frequency is made to vary from f_1 to f_2 and back to f_1 during each cycle. As an example, let $f_1 = 430$ kc, $f_0 = 460$ kc and $f_2 = 490$ kc. During the first half-cycle, the sweep is upwards from 430 to 490 kc, and during the second half cycle, the sweep is downwards from 490 to 430 kc. If the horizontal sweep of the oscillograph is synchronized at the power-line frequency, two peaks will appear for an I-F amplifier tuned to 460 kc, and they will be at the one-quarter and three-quarters points of the trace on the screen as shown in Fig. 2. By synchronizing the oscillograph at twice the power-line frequency, the up-swept response will appear on one sweep of the trace from left to right, and the down-swept response will appear during the succeeding sweep, also from left to right. The appearance of the trace on the oscillograph screen will be like that of Fig. 3 for an improperly aligned I-F amplifier. With the double trace method, as this is called, it is apparent that lack

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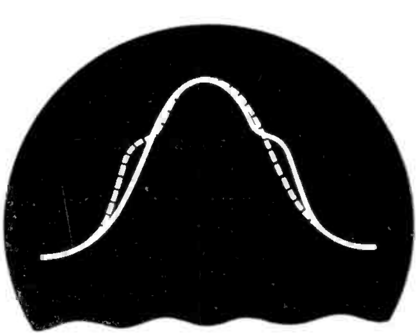

Fig. 3. Same I-F response as in Fig. 2, but with oscillograph sweep synchronized to twice the power-line frequency. The solid line indicates the response for the upswept half-cycle; the dotted line for the down-swept half-cycle.

USING THE SIGNAL GENERATOR AND OSCILLOGRAPH

From Preceding Page

of symmetry manifests itself by traces that do not lie on top of each other; and conversely, if the amplifier is aligned properly, the two output traces become directly superimposed, and appear to be a single line. This simplifies the alignment procedure, removing the necessity of trying to adjust the side-band response of the amplifier by visually comparing the two curves.

I-F Alignment Procedure

In general, this method of alignment provides a visual curve showing the voltage output of the amplifier plotted against the frequency of the input signal, assuming the applied input signal remains constant in amplitude. So far, the requirements of the signal have been discussed, with no mention being made of the means of reading the amplifier's voltage output under the influence of this signal. If the oscillograph were connected across the secondary of the last I-F transformer, the voltage of the signal could be observed on the tube. The signal at this point is an A-C voltage, at the frequency of the I-F amplifier. While this would serve, it has the characteristic of an A-C signal — that is, it varies equally above and below zero; and furthermore, the pattern would give the appearance of a "filled-in" curve, as shown in Fig. 4. For the alignment indication, a more suitable form is a single line indicating either the positive or the negative envelop of the signal. This is available at a different part of the circuit. With a diode detector, for example, the envelop of the I-F signal is available across the diode load resistor, and this same voltage envelop is also available across the volume control in conventional circuits as shown in Fig. 5. Therefore, the high side of the oscillograph input may be connected at A and the low side to ground. In all cases, the low side, or ground, of the oscillograph should be connected to the chassis, or ground, of the receiver to eliminate spurious signals due to A-C voltage differentials between ground of the receiver and ground of the oscillograph.

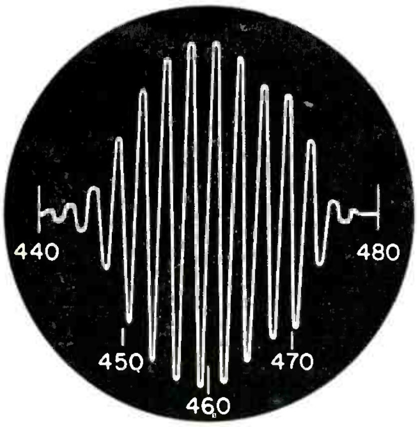

Fig. 4. Waveform appearing across secondary of I-F transformer with frequency-swept signal.

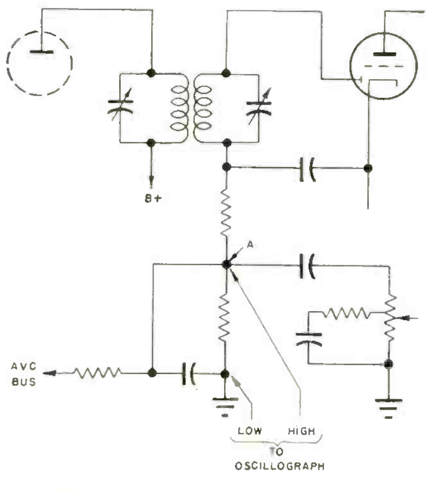

Fig. 5. Method of connecting oscillograph leads to receiver using diode as second detector.

In receivers using infinite impedance detectors, the high side of the oscillograph should be connected to the cathode of the detector, and the low side to ground. In the case of grid leak and biased detectors, the high side of the oscillograph should be connected to the plate of the detector; the low side to ground, as usual. If the plate load for this type of detector is a choke coil, or if the detector is coupled to the first audio stage by means of a transformer, insert a 20,000 ohm resistor in series with the plate, and short circuit the choke or the primary of the transformer in order to eliminate the reactive component of the load. The oscillograph input is then connected directly to the plate of the detector. This arrangement is shown in Fig. 6. It is advisable to connect the oscillograph ahead of the volume control whenever possible, using only the visible output for alignment. The sound from the speaker resulting from this form of signal is a loud hum, and is entirely unnecessary to the operation of alignment.

Connect the output of the test oscillator to the grid of the last I-F stage through a .001 mf capacitor. Tune the signal generator to the intermediate frequency. This value may be obtained from manufacturer's service notes, or from one of the numerous published lists of intermediate frequencies.

Adjust the controls of the oscillograph to give a trace of suitable intensity, properly focussed, with the sweep and synchronizing controls set for this form of alignment in accordance with instructions of the manufacturer of the signal generator. Due to the different methods of obtaining the frequency modulation, exact instructions for setting these controls cannot be given here.

With the horizontal gain control of the oscillograph set at minimum, turn the signal generator on, without frequency modulation; adjust the I-F trimmers to obtain a vertical trace of maximum amplitude. The output of the generator should be kept as low as possible to prevent the a-v-c from flattening the response over the entire sweep. Then turn the frequency modulation on, and adjust the sweep to about 30 kc. Increase the horizontal gain of the oscillograph to give a trace covering the full width of the screen. The receiver tuning dial should be set at some position where no interfering signal is passed on to the I-F amplifier, and the antenna input terminals should be shorted.

The pattern on the screen should now appear similar to that in Fig. 3. Some types of generators will require retuning when the sweep is turned on to make the peaks of the two curves coincide. Reduce the sweep range so that the curve fills about 75% of the entire sweep. Readjust the trimmers of the I-F transformer to make the

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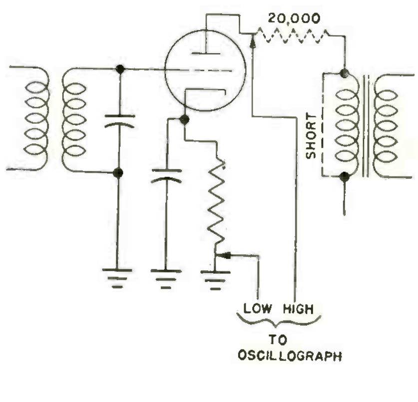


Fig. 6. Connections of oscillograph to biased detector, showing addition of resistor in plate circuit, and short across coupling transformer.

VIBRATORS

By R. M. Ellis
P. R. Mallory & Co., Inc.

(With shortages applying to almost everything necessary to radio repairing, some thought has been given to repairing vibrators. Naturally, the best source of information on this subject is the manufacturer, and the question was put to the engineering department of P. R. Mallory & Co., whose reply follows.)

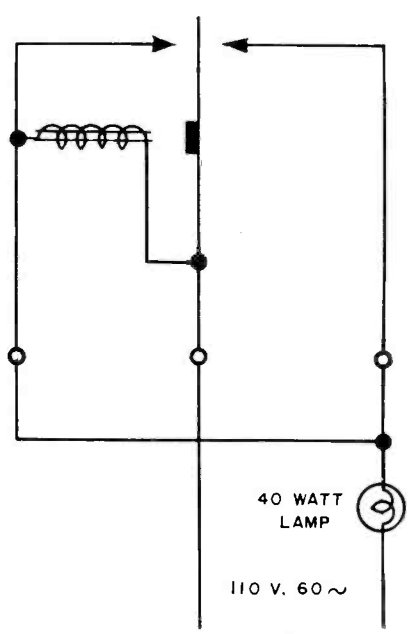
FRANKLY, WITH ONE exception, we do not recommend that our customers attempt to repair vibrators. Our attitude in this matter is based both on sound reasoning and practical experience.

When a properly designed vibrator ceases operation because of contact wear, it will be found that practically all of the tungsten facings on the contacts have been eroded. Any further increase in life obtainable by reducing the contact spacing will be negligible, and certainly not worth the cost and effort required.

Here at the factory, we have to run a regular school for vibrator adjusters. It requires several months of training before a successful candidate can take his place on the production line. A considerable amount of mechanical skill is required, and only a fraction of those who start the course are found to possess the necessary "knack" or inborn aptitude required for this type of work. From this, you will understand the futility of trying to give satisfactory adjustment information in one magazine article.

When the vibrator industry was in its infancy, we sold vibrator repair parts, and issued a detailed manual of instructions on how to overhaul vibrators. Our results on this effort were extremely unsatisfactory. It taught us the lesson that vibrator assembly and adjustment must be done at the factory, with factory assembly jigs and equipment, if any degree of satisfaction is to be secured.

Our experience is that more than 99 percent of so-called vibrator trouble is due to the termination of the vibrator life because of natural wear, or to the use of the vibrator in a circuit which does not have the proper constants, or to damage resulting from the failure of an associated component. The MYE Technical Manual outlines an improved method of servicing vibrator power supplies on page 74, section 4, under the heading of "Important New Service Procedure."



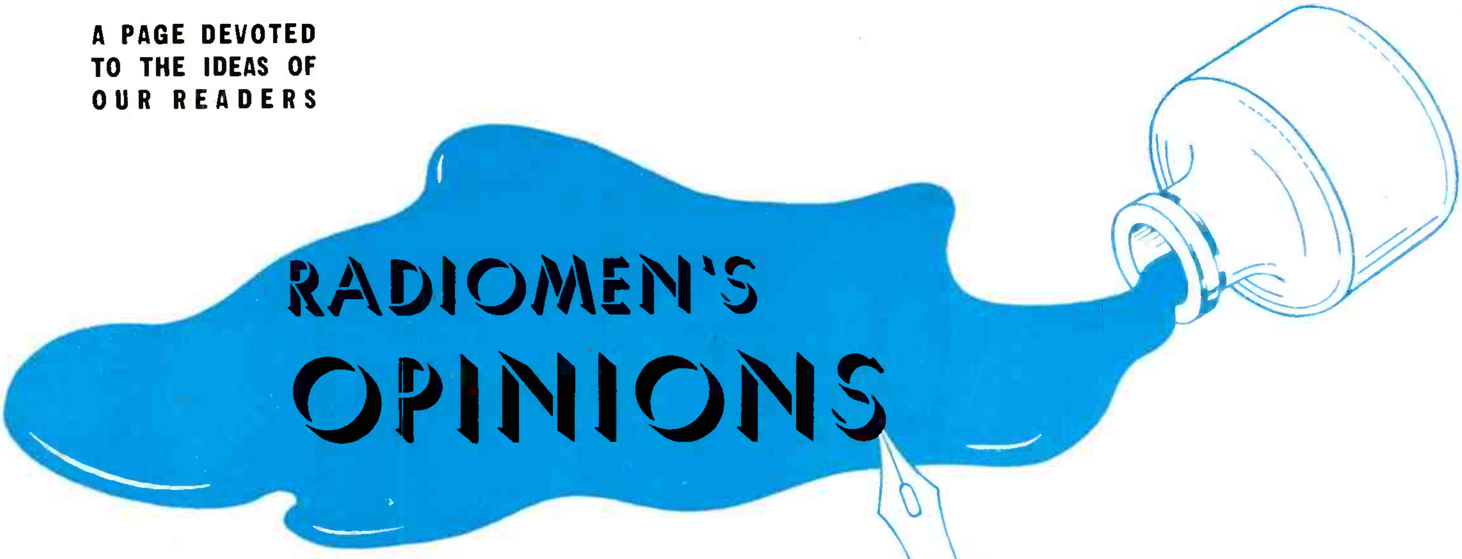
The Exception

The exception mentioned above refers to the cleaning of contacts on bakelite-based vibrators when a no-start condition exists. When vibrators that are not hermetically sealed are stored unused in a moist tropical atmosphere for an extended period of time, a no-start condition may arise from a tungsten-oxide film accumulating on the contacting surfaces. It is easy to remove this film electrically by using the circuit shown in the diagram.

The pulses of the A-C current drive the vibrator reed to full amplitude regardless of whether the driver contacts connect or not, and the high potential plus the mechanical beating from the mating of the contacts will soon place the vibrator in operating condition. A few seconds in the circuit will be adequate, usually, although the vibrator may be left in the circuit for 15 minutes or more without damage if desired. This circuit is adapted to all shunt drive vibrators.

While there is no objection to applying this treatment to hermetically sealed vibrators, there is rarely any necessity for so doing, since the exclusion of moisture by the hermetic seal is an effective guarantee against the formation of film on the contacts. V V

A PAGE DEVOTED TO THE IDEAS OF OUR READERS



RADIOMEN'S OPINIONS

By E. M. Pace

Pace's Radio Service, Vicksburg, Miss.

THE CHIEF POST-WAR PROBLEM of many radio servicemen may turn out to be the problem of survival itself.

I believe we should face this fact squarely, and I further believe that the serviceman who stands the best chance of surviving after the war is the one who puts his house in order NOW and prepares to meet the future with a grim determination to stay in business.

The essential consideration in the successful operation of any business is the CUSTOMER. It is a fact that many of us have been treating our customers all too casually. We have not had to go out and solicit business lately but have had it literally dumped in the shop doors. This condition will not last forever and we will again be confronted by keen and plentiful competition.

According to the military experts it may take from one to five years before we win the final victory over Japan. Personally, I think we can count on one year at least before many new radio receivers will be available, and tubes may be scarcer for the rest of this year than they ever have been. We have, therefore, plenty of time in which to re-establish any personal relations that we may have lost with our customers because of unnatural working conditions produced by the war.

What has been the attitude of many of us towards our customers during the past five years? I could list many instances where the customer has not been given the consideration he has a right to expect and the result is that radio servicemen, generally speaking, have lost a certain amount of customer good-will. It is true that we have been handicapped by an acute shortage of parts and tubes and we have not been able to render the same efficient service as in the past, but that does not completely excuse us. In the rush of business we have too often neglected to take the time necessary to explain to the customer that his radio was being repaired just as efficiently as wartime measures would permit. The chances are that he would have been completely satisfied had we done this; but as the matter now stands he is wondering what has happened to his radio, for it is not performing as he knows it should perform.

Let's take just one example to bring out my point. Every experienced radio serviceman knows that the 14A7 is the poorest kind of a substitute for a 12SA7, as they are different types of tubes, each designed for a different kind of service. I wonder in how many shops it was explained to the customer when this substitution was made, that emergency repairs were being made to his radio, that it was necessary to substitute tubes, and that while the radio would perform fairly well on local stations the overall efficiency of the set would be reduced from 50 to 90 per cent?

Many of us have lost personal contact with our customers as such and while we may or may not be completely at fault the fact remains that we must start re-establishing our customer relationship. It is easier to make personal contacts now than ever before because so many customers are now walking into our shops daily and asking us to repair their radios. Compare this situation with that of pre-war days when we were out soliciting business and asking the customers to let us repair their radios.

The survival of each of us in the post-war period hinges on one thing more than anything else—REPUTATION. In the time remaining between now and final victory the intelligent serviceman will build that reputation to a point where he will have little to fear in the future.

It is estimated that the government plans to discharge approximately one million men from the armed forces within one year from V-E day. How many of these men so discharged will

Mr. Pace, the author of this "Opinion" has given a great amount of thought to the question of organization for the radio servicing business. His plan for such an organization is being considered very carefully, and its salient points will be presented in the next issue of *Radio Maintenance*. Your suggestions and opinions are cordially invited.

decide to go into the radio service business we do not know. It is reasonable to assume that quite a number of them will be former servicemen who were in that business prior to the war and that others will go into the business for the first time. In either case they will have the financial backing of the government under the GI Bill of Rights. These men will be in a position to open modern new shops with the latest test equipment. Under the WPB rules and regulations they will have certain priorities in securing things needed to establish them in business, including parts and a representative stock of tubes.

We will welcome the returning veteran as a competitor, and we offer our sincere co-operation in getting him back on his feet as he rightfully deserves. We know that the public feels a debt of gratitude to him, and we shall do our best to fill the many openings in the service field by lending to him a paternal hand in teaching him our trade. There is plenty of room for many more in the service field to maintain the more and more complicated F-M and television equipments. And we must not overlook the possibility that the veteran who has had opportunities of learning scientific maintenance from the best authorities in the country can show us much from the methods taught by the Army and Navy schools.

The problem of post-war competition leads naturally into another subject that needs open discussion. Have the volume of business, the ringing of the cash register, and the figures on the credit side of the bank book dimmed your memory of the radio servicing business as it was in pre-war days? Refresh your memory for a moment: do you recall the days of free estimates, flat service charges of 25 to 75 cents, the golden period of the screwdriver or shade-tree mechanic, the fellow who replaced parts in radio receivers and charged the customer only the retail price of the part used . . . and so on?

Think back, fellows, to the days when we were all but paying the customer to let us repair his radio. Many of us were just plodding along, doing a professional service for the public but seldom getting paid in terms of professional services rendered. Do we want all that again? I don't think that anyone in his right senses would vote for a return to such times, but the question is — what are we going to do about it?

The answer to our problem is obvious — ORGANIZATION. What kind? I don't know. One thing that I am sure of, however, is that it is utter foolishness to think that the radio servicemen cannot organize. Why can't we? I cannot at this time think of one profession that does not have some kind of an organization designed to benefit and protect each member. In my opinion there is one and only one particular reason why we haven't yet organized, and that is FEAR. Somewhere, somehow, back in the early days of radio, a man that was capable of repairing a radio receiver conceived the idea that all that he knew about the business was best kept to himself. He would not divulge his "secrets" to any one, and consequently there has been some kind of an idea built up among radio men that each of us has his own methods of doing his work and that the other fellow will have to get his own experience in his own way.

Your "Opinions" are of no value to anyone but you if you keep them to yourself. But if they concern the problems of the radio serviceman — and who doesn't have problems nowadays? — and if they apply everywhere in the United States, they should be aired on these pages. We will pay a minimum of $5.00 for every letter published, depending upon its length.

Few of us stop to think that perhaps if we could get together occasionally and talk shop that each would learn something from the other and thereby improve the working conditions of all of us. Where would the medical profession be today if every doctor who discovered something new about our anatomy and its ills and cures had kept his discovery to himself? And is it at all possible that 30,000 radio service men all have their secrets on how to repair radios? Could there be that many ways to locate and replace a shorted by-pass condenser? Certainly not. The only difference that could be thought of would be the manner in which the work is done, and this is determined by whether or not the man doing the work is a good or a bad technician. A radio that needs repairs in Elbow Bend will be repaired in Walla Walla just the same way as it would be in Elbow Bend, make no mistake about that.

Perhaps you agree that we should have an organization; but, you ask — how, when, where? To the first I must admit that I don't know but to the second I can say definitely *now*, and to the last and just as definitely I can say *everywhere*. In order to arrive at some answer to the question of *how*, all I can say is that we must get together, discuss the matter, arrive at a plan of some kind and get started. I have my ideas and you have yours, and if we get all these ideas pooled and then pick out the best ones we are bound to come up with something worthwhile. Local organizations are good but do not cover enough territory, for until the time that every radio serviceman in this country is a member of an organization designed to protect and benefit each individual member regardless of his geographical location we won't be able to demand our just compensation and working conditions.

To start the ball rolling, I would like to offer, briefly, my idea of what we need.

An organization to be effective must be NATIONAL in scope yet flexible enough to permit local units to arrange their own rules and regulations designed to best suit their own needs. The organization should be such as to position the serviceman directly between the manufacturer and his product and the product would be in the hands of the serviceman from the time it leaves the factory, so far as service and maintenance are concerned. Under my plan, service manuals, data sheets or similar information as to service procedure would not be divulged by the manufacturer to any one other than an authorized serviceman. You will ask — how can I define an authorized serviceman? My answer to that would be — how are doctors, lawyers and dentists qualified as such?

There you have my suggestion for a starter. What are your ideas? Remember that we do not want to go back to haphazard pre-war conditions and that each individual serviceman will benefit by the cooperation of all of us. Let's work together to give the term "AUTHORIZED SERVICEMAN" a real meaning. V V

Prepare Ye NOW

NOW is the time for all good radio men to prepare for the future.

By Eugene A. Conklin
Watertown, N. Y.

AT THE BEGINNING of the war, radio servicing was fast developing into a dog-eat-dog affair. Screwdriver mechanics were cutting the throats of their more experienced service brethren, and as a general rule there was very little esprit-de-corps among members of the radio fraternity.

This is rapidly changing. Radiomen have been forced during the wartime era to co-operate with one another in the exchange of needed duties and of set components. They are busily engaged in forming local associations — according to a recent survey the number of such groups has mushroomed to a point where there are over three hundred such organizations.

Perhaps the outstanding achievement of the war has been the price stabilization it has effected. Repairmen are charging from $1.50 to $2.50 per hour without fear that the shop down the street will fix the set for fifty cents. Free inspection for the duration and after seems on the way out. Eighty per cent of the shops offering this service have now eliminated it. Free tube checkups are few and far between — the patron is made to realize that tube testing takes time and should logically be paid for.

Radiomen are becoming communication minded. Of radio servicemen in the armed forces, over sixty per cent have found a haven in military radio. Their experience with F-M, facsimile, and other developments accelerated by the war will stand them in good stead upon their return. Those who have remained on the home front are beginning to realize that when the war is all over they will be expected to install and service walkie-talkies and other communication equipment that will be available for civilians. And a wide-awake serviceman will not overlook the possibilities open to him in the field of private aircraft radio, home intercommunication systems, and other applications of electronics that are certain to appear.

Publishers of radio textbooks advise that the demand for texts on television, frequency modulation, and u. h. f. is mounting steadily. These same publishers point out that they have been receiving requests for books on post-war planning from the standpoint of the radio service operative. Editors of publications for the radio service trade note that readers desperately desire step-by-step lessons in television and F-M technique. House organs are planning special editions devoted to the how, why and wherefore of the video art. Correspondence and resident schools are announcing refresher courses for radiomen home from overseas who were not in the communications branch of the Army, Navy or Marines. They are also preparing courses which will be made available shortly after the war to bring civilian radiomen up to date on communications and television. A communications course for radio servicemen is something new.

During the war, many radio dealers have had to expand their businesses by taking on new lines of merchandise — paints, varnish, gift-ware and such. Many of them plan to retain these wartime products after the war — the demand is very satisfying indeed. But, primarily, they have come to the realization that service is a very important commodity, and that their service shop is as imposing as any other section of their establishment.

Prior to the war, many dealers paid their servicemen as little compensation as the traffic would bear. Because the demand exceeded the supply, dealers have had to raise wages, and after the war will have to depend more and more upon their service departments — both to install and to maintain the radio and electronic items they will merchandise. Among other plans for the future is the intention to modernize the store, and make a model radio service institution out of what has been too often just a necessary evil in the

A timely and concise listing of numerous tried and proven aids for exploitation, personnel problems, and general business methods

dealer's opinion. If dealers are going to sell the public a "package" consisting of a unit *and* the follow-up service, they will need up-to-the-minute facilities to accomplish this task.

From another viewpoint, the serviceman who is not a dealer is beginning to give some thought to his servicing technique and to his business methods. Many of these men are in the armed forces, and are planning new shops, new equipment, and new economic practices. Very important to them is the question of where television and F-M will fit into the scheme of things. According to a survey recently conducted in the Eastern Coastal area, only three out of ten understand F-M sufficiently to service intelligently this type of set. Worse yet, practically all servicemen have a smattering of television knowledge, yet considerable study on television technique will be necessary before they will be able to install and maintain television receivers.

The radioman must realize that after the war there will be a transition period of a year or better before television programs are made available to residents of small communities. There will be a group of experimenters in every town and village who will purchase new video sets as soon as they can. For that reason, the serviceman will do well to start now, reserving an hour a day for the study of television and F-M servicing.

Steps for the Present

In the words of a well-known book on income taxes, there are many steps that may be taken now to insure later success. Some means must be found, and found *now* while the field is still good, to attract favorable attention to the shop. After life returns to a semblance of normalcy, it may be too late to start. The outside appearance of the service shop is of great importance. Even though it may not be possible to build a new shop or to modernize extensively at this time, it is still possible to draw attention by other means. For example, there is nothing more important than a clever and effective window which makes a favorable impression upon the passerby. With the present difficulty encountered in securing adequate personnel and sufficient replacement parts to keep going, many a radioman may be forgiven for evading his window trimming responsibilities. But it is possible to obtain unusually satisfactory effects with surprisingly little time and effort.

First of all, the radioman should emphasize that he is keeping abreast of the progress in both television and F-M. By clipping photographs relating to both subjects and mounting them on cardboard with a short explanatory caption underneath, a series of weekly windowizings can be arranged without undue difficulty. It should not be hard to obtain a dozen or more pictures depicting television sets of the future, F-M sets and transmitters, and so on, which appear continually in trade publications. F-M and television antennas are sufficiently unique in appearance so that they will often attract a glance from people who have not the slightest idea of what they are. Passersby will soon form the habit of stopping and looking at interesting windowizings. In addition, a group of pictures showing radio as it is used in the various branches of the armed services may be offered. To heighten local interest; secure a few photographs of men and women from your community who are in the Signal Corps, or who are engaged in some other interesting phase of wartime activity.

"But darling, — the article says 'an even disposition'."

Another excellent display can be built up by writing a number of radio stations within a radius of fifty to one hundred miles — especially the popular stations of your own area — asking that each station supply three or four glossy photographs showing their own radio stars. In the same window, you may use photos clipped from radio fan magazines. Contact the head of the local Parent-Teachers Association and ask that this group recommend a number of programs for the younger listeners. Extend a similar invitation to the head of a local musical club with regard to recommendations of top-notch musical presentations. Place these in your window, in typewritten form. If you have a mimeograph, make up a quantity of these sheets and use them for give-aways, being careful not to omit your name and business. And be especially careful in preparing such sheets — watch your spelling and punctuation — errors along these lines will detract from the good to be gained, because they indicate amateurishness. If it is worth doing at all, it is worth doing well. This same admonition applies to the lettering of signs in your window — if you cannot letter well, have a sign shop do it, or buy a set of rubber stamps made for display work. Even better is the use of the boards made for home-movie titles.

It is also important that you draw attention to your technical knowledge. Clip out a number of photos showing tube-testers, analyzers, oscillographs, signal generators, and other testing equipment. Accompany these photos with a short, non-technical description of their uses in radio repairing. Many magazines have featured an ideal post-war service shop. They are often practical, generally ultra-modern, and certaihly attention-getters.

These are only a few efficient inexpensive windowizings which do not require any tools, save a generous supply of cardboard, a pair of scissors, and an even disposition. A typewriter and a little glue complete the list of materials.

Inside the Shop

You may be one of those who plan to change the interior of your shop very radically after the final guns are fired. No fault can be found with this decision, but why wait? Start now, making such improvements as you can, and do the major renovation when you have more time, and materials are easier to get. First of all, get a couple of used but still serviceable desks. At one, place the shop typewriter and all other office accessories. Place the other where it may be used by customers who wish to write a note to the radioman who happens to be out. Provide a few *easy* chairs, and for good measure, place a few current magazines on a reading rack where the waiting customer may browse through them. You need not wait until after the war to start your merchandising efforts. If you have a P-A system for rent, or if

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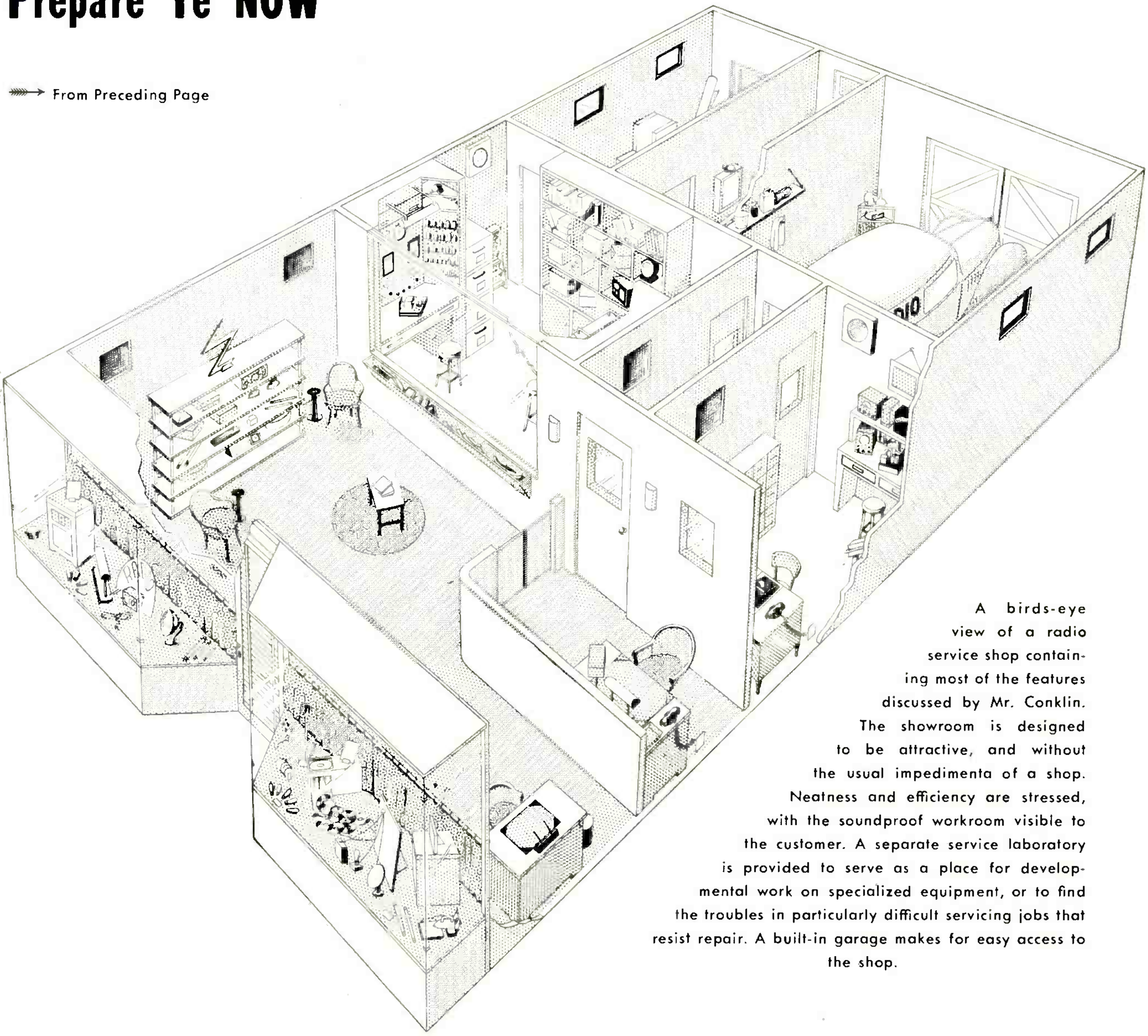
Prepare Ye NOW

From Preceding Page



A birds-eye view of a radio service shop containing most of the features discussed by Mr. Conklin. The showroom is designed to be attractive, and without the usual impedimenta of a shop. Neatness and efficiency are stressed, with the soundproof workroom visible to the customer. A separate service laboratory is provided to serve as a place for developmental work on specialized equipment, or to find the troubles in particularly difficult servicing jobs that resist repair. A built-in garage makes for easy access to the shop.

you have second-hand sets to sell, place them where they can be seen.

The ideal shop should have a soundproof, glass-windowed partition separating the reception room or display room from the service shop. There are at least three reasons for this. In the first place, the noises, squeals, and squawks incidental to radio servicing are not pleasant to the layman. Secondly, the activities of the serviceman are often of interest to a waiting customer. And thirdly, if the shop benches are visible to customers, it will be necessary to keep them clean and neat, which promotes efficiency. Another advantage of the glass partition is that the customer cannot vocally interrupt the serviceman's efforts.

Make the reception room as attractive as your own ingenuity will permit. Perhaps the ex-YL would like to "dress-up" the front end of the store. Unless you have many merchandise items for sale, hang a few inexpensive prints on the walls; possibly some of the more attractive calendar-type art would go well in your locality.

With regard to the layout of the entire shop, the accompanying cut-away depicts a practical layout for a small radio shop. It provides two service benches to be used for the routine service jobs. In a separate shop room, the more difficult operations may be done. If your location is bothered by extraneous noises, make this a screen room, completely enclosing it with copper screen, with electrical bonding at the joints, and electrically tight doors. In very bad locations, it may be well to make it a double enclosure, with two complete screens, about two inches apart, each being separately connected to a good ground.

The suggested layout will allow three separate operations to proceed at the same time, without too much interference between the servicemen. Each of the benches should have all the ordinary items of service equipment — meters, tube-testers, substitute speaker, and such other instruments used in day-to-day repair. For the "laboratory" or screen room — the specialized shop — the signal generator, oscilloscope, and other professional-type items should be placed, assuming there are not enough for each of the benches to be so equipped. This specialized shop, or service laboratory, will find many applications from performing experiments with television and F-M circuits to conducting exhaustive tests on receivers which do not function on one or more wave bands or which possess other idiosyncracies which require considerable work for their correction.

Another desk might be provided here for the serviceman to write up reports of his experiments and to keep records of the more difficult jobs. The lab is sure to be of considerable use in designing, building and testing communication equipment for post-war civilian needs, for you are not going to overlook the field of custom-built specialty items.

Exploitation and Advertising

Now is the time to arouse interest in the community for your shop and the services it offers Every shop has its quota of customers now, and probably does not want any more. But it is a wise radioman who manages, by advertising, to keep his shop in the public eye.

For example, use bus cards in all your community buses. These cards should list your shop operating schedule and urge bus riders to help out by *bringing* their sets in for repairs, and picking them up after they are completed. Keep a list of your clients and, if possible, get their birth dates on this list. Make a point of sending cards on their birthdays. Of course, it really does not make any difference to the customer that he gets a card, but he will have a warm feeling towards you for remembering it.

Have your receptionist call each customer by phone about once every sixty days. Make it a brief but friendly call, but get in a few words about your services.

Personnel Problems

Perhaps no other problem has proved so perplexing to radiomen in general as the personnel problem, and they are getting around it through a variety of maneuvers.

A number of repair shops are asking the high school physics instructor to recommend a group of four or five radio-minded students who have at least a year or two before being called to the armed forces. These embryo radiomen spend four weeks learning the first fundamentals of servicing. They report to the shop three times a week from 7:00 to 10:00 p.m. At the end of a month's instruction course, the most promising students are given employment nights, after school, on weekends, and during vacations.

High school students usually can be sold on the idea that the training received in the radio shop will stand them in good stead if they should wish to enter the Signal Corps or take up radio in any branch of the service.

Another worthwhile plan is that of asking war workers to put in an additional three-hour shift in the shop, and perhaps put in full time on their day off from factory employment. Workers are chosen who have had electrical training, or for whom radio construction was a peacetime hobby. In every community one or two such individuals can be found with a minimum of difficulty.

Of more than passing interest in every radio service shop should be the receptionist. She is, to all practical purposes, the liaison between the radioman and his public. She must possess the tact of Ma Hardy, the poise of a Hollywood movie actress, and, if possible, should boast a well-developed sense of humor. Also she should be able to type, and keep a set of reasonably accurate books. If she has any decorating ability, she can help to make the store look like a professional office, rather than the corner fix-it shop.

A number of shops are using housewives who work a four-hour shift daily — women who, because of children or other commitments, could not cope with full-time employment. Two such housewives could furnish you with full-time receptionist service. Many servicemen plan on keeping a receptionist in their shops continuously during the post-war era, both for convenience and dignity.

Where can such individuals be found? Try advertising in the local newspapers, preferably in those that carry the greatest amount of grocery advertising. Keep your eyes open for women who need full-time employment, but who may not be able to handle factory activity.

"What's up Doc — selling cigarettes in there?"
"No. Conklin just hired a new receptionist."

Prospects for Television

The arrival of television will pose many perplexing questions for the service operative. While it is true that it will require at least a year before much activity can be expected in the television field, the fact of its coming cannot be overlooked. You must be ready for it, and you must know what steps you are going to take after it gets here.

A number of facts can be definitely stated as a result of marketing checkups made by a group of television equipment manufacturers. The ideal living room television receiver will provide a picture in color on a screen about three feet by four. Color will not arrive for some time, but it is a necessity in the ideal set. The controls of the television receiver will be kept at a minimum — a station selector, intensity and contrast controls, and an audio volume control. On the basis of the reports from the consumer front, the video sets will be in use almost constantly — while not actually being watched constantly, they will be kept on, and viewed when the sound program invites interest in the accompanying picture. Because of this constant use factor, the cost of television tubes will have to be reduced considerably. It is certain that if projection tubes are used in the set, their cost will be a large factor in overall maintenance expense.

There is every reason to believe that the customer who is willing to invest from $400 to $700 for a complete set, including television, F-M, short waves, and the standard broadcast band as well as phonograph should not object

To Page 30

THE M

By C. H

IN THE middle of a humid tropical night not long ago — in the autumn of 1942, to be exact — an American ship carrying close to one hundred men was torpedoed in the Tasman Sea. The ship was almost six hundred miles from the nearest land; the explosion completely demolished the engine room, left in the ship's hull a hole big enough to allow the passage of a transcontinental bus — yet neither the ship nor the men sailing her were lost. Quite to the contrary, they were safe and sound in port a week later, recounting their harrowing experience and listening to people marvel at the miracle of their rescue.

To the personnel of the War and Navy Departments the miracle was, however, no miracle. It was explicable in one word — RADIO. To the men actively connected with radio, the inci-

dent was even less of a miracle. To them it was science, plus work, plus effective and thorough co-ordination and dissemination of the knowledge that has made reliable radio communication possible in an astoundingly short period of time.

To these men the incident meant one thing primarily — that the radio stations involved in the rescue were manned by personnel who knew how to *operate* and how to *maintain* the radio transmitters and receivers, the radar, the sonar, and the multitude of other electronic devices which in routine operations provide security and entertainment, and in emergencies save perhaps more lives than any scientific development heretofore known to man.

These men know, as do more and more civilians every day, that science is only as good as its application; that equipment is only as good as the knowledge of the man who uses it; that any device — electronic or other — is only as good as the information supplied with it. They know that behind the service radio renders them and their fellow men — throughout the world in war and in peace—are other men, men and organizations who study every electronic development with a view toward attaining the utmost in service and dependability.

However, even the men whose lives have been saved by these developments know perhaps little of the assiduous research and the staggering amount of work required to produce the Technical Manuals and Instruction Books; books which, even while total war is being fought, have effectively educated millions of men in all branches of the Armed Services in the proper use, maintanance, and theoretical essentials of devices the development of which had not even been dreamed of before the war.

We who have for a long time written, compiled, and published these instructional manuals for the Armed Forces* often wonder how many men and women are aware of this little-heard-of branch of the war organization.

Not that we are looking for garlands of roses — but we wonder. We wonder if telling you about ourselves will not perhaps add another worthwhile drop into the universal bucket of understanding something of how the other half works. So, with your permission, we will tell you:

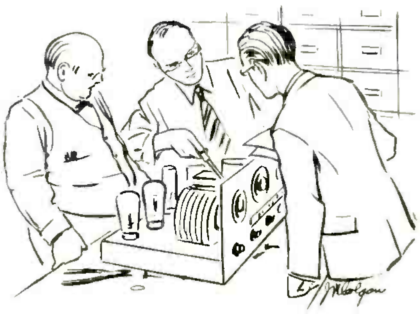
That Technical Manual, that Instruction Book with its illustrations on operation, theory, disassembly, maintenance, reassembly and trouble-shooting, and that list of parts for all the gadgets you use entered the "works" many months before it finally appeared on board your ship, at your shore station, in your repair shop, in the jungle dugout, in the many classrooms scattered throughout the world.

*Boland & Boyce, Inc., publishers of RADIO MAINTENANCE, have in the past served and are currently serving the war effort in this capacity.

Entering the works, for the technical manual, means conferences; the drawing up of plans; research; testing; compilation of engineering data; making of rough sketches; drawing of wiring diagrams and schematics, exploded views and cut-away views; checking for technical accuracy; drawing of final illustrations; photographing; retouching; rendering; inking-in; checking of quality; gathering notes; writing preliminary text; checking; writing second draft; editing for language and clarity of presentation; writing and rewriting final draft; preparing parts lists and other tabulated data; typing, dittoing, mimeographing, and collating text and illustrations; typesetting; proofreading galleys; cutting galleys; making up the "dummy" book; drawing page proofs and checking, drawing final proofs and checking, printing the book and checking again; and finally packaging and shipping.

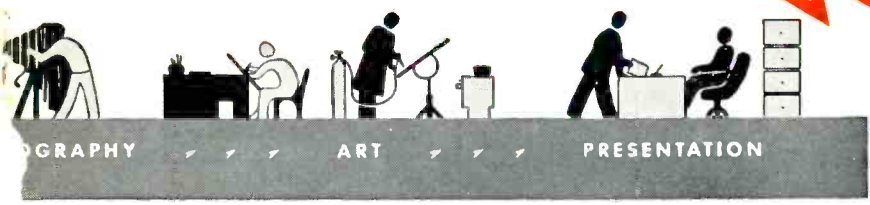
And how does all this get done in the limited time stipulated in most service requirements? The answer is: The right kind of people in the right kind of organization.

To start at the beginning, let us take one typical case: One of the many service branches has heard of a new elec-



IRACLE

Malmstedt



tronic development which bids fair to becoming a vital part of some military operation. The service branch tests the instrument, confirms its earlier beliefs, approves the instrument, issues a letter of intent, negotiates a contract, and the instrument goes into production, with a delivery date fixed.

All would seem to be set. However, the instrument being a completely new development only the designer, the manufacturer, and the approving officers are familiar with it. But its use will be in distant land and sea battle areas — places where men have never even heard of the instrument, to say nothing of having a detailed knowledge as to its proper operation and maintenance. So, an instruction book with adequate text, illustrations, and parts lists must also be ready on the date set for delivery of the instrument.

At the outset the task seems staggering, often impossible to perform in the time stipulated. But work is started without delay. Requirements and specifications drawn up by the contracting branch of the service are studied, analyzed and digested. The job of project director is assigned to a man who has the ability to organize, plus the ability to write clearly and effectively.

The Project Director then further studies the specifications, decides on a plan of work, analyzes that plan thoroughly, and finally decides on what seems the most expeditious approach to the problem. He decides how many men will be required for the job — how many researchers, how many line artists, how many retouchers and renderers, how many typists, how many people for general assistance.

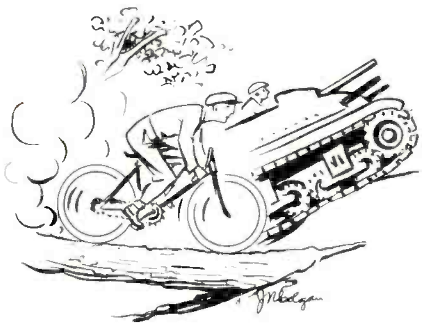
With the planning finished for the time being, the wheels of production begin to turn. The plant manufacturing the new device is visited and it is found that all parts of the instrument have not yet been built.

How do you write about a device not yet built? The problem is solved quickly. In order to deliver the book on or before the deadline, parts of the book must be written from blueprints and tabulated engineering data. Plans are altered accordingly and the Project Director moves on to the next stage — that of gathering all the required information on the device.

With his notes, blueprints, photographs and data, the Project Director settles down to work, either at the plant or at his home office, whichever is more feasible. Here he proceeds to iron out the kinks, revamping his plan of operation as necessary to keep abreast of the job, ordering pieces of equipment for further photography and reference, lining up all available manpower in channels most conducive to efficient production and effective results.

The line-up completed, production begins. An outline of the book is written in accordance with specifications. The outline is submitted to the service branch for approval. Suggestions for improvements are received, and are incorporated in the outline. Simultaneously, the art work for the book is begun. The Art Director is presented with rough sketches, blueprints, photos and data, and is apprised of the requirements for the final product. With all available information on hand, the Art Director faces his own particular multitude of problems. He proceeds to solve them immediately, for it takes longer to produce quality art work than it does to produce quality writing.

While the art department hums with activity of its own, the editorial department uses up pencils and typewriter ribbons at an astronomical rate. A first draft of the text is started by the Project Director. At the same time, research men are sent out to gather information not obtainable on the first



visit to the manufacturer. Other men, and letters and telegrams, hunt up information from a myriad of civil and military sources. Engineers are put to work on problems not pertinent to the design and production of the instrument, but necessary to proper instruction in its use and maintenance.

When all activities are properly coordinated, the first draft of the book is done in record time. But another problem pops up, point blank; last minute tests have revealed a flaw in the production model; a necessary design modification has been made by the manufacturer.

This change must be incorporated in the instruction book before it goes too far. Data is exchanged in rapid-fire fashion by phone, telegram and mail; by plane, train and automobile; even bicycles and tanks have been used on occasion. On receipt of the modifications, both artwork and text are revised. The artwork finished in pencil is checked for technical accuracy before inking-in is started. The text is checked for conformity to specification and clarity of presentation. It is edited for language. It is inspected for possibilities of general improvement in content and manner of presentation. Constructive criticism is considered, and

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Initial TROUBLE-SHOOTING

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Checking Power

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Checking Tubes

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Locating Stage

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Checking Components of Stage

By Gordon Edwards

Research

This is "old stuff" to the experienced Radio serviceman. But the newcomer to this field, or those who plan on entering it after the war, will find methods here that are universally used by successful maintenance men. It is generally easy to fix a trouble after you find it.

NO MATTER HOW expensive or how well-built a piece of electronic equipment may be, there are certain to be occasional failures. The more complicated the system is, the more difficult it seems to service it. But all such systems are man-made, and they can be maintained by man — there is no magic in servicing. It may appear that the experienced technician uses a crystal ball to diagnose a trouble, but the only substitute for a detailed, systematic method of checking is a long backlog of experience.

Assuming that some failure occurs, make a complete survey of the system, even if it is a four-tube AC-DC radio set. Ask yourself a few questions: 1. What happened at the time of failure? 2. How did it act before the failure? 3. Are there any visual signs of failure? 4. How much of the system is affected? Then, and only then, begin the diagnosis.

Consider, as an example, a high-grade FM-radio-phonograph combination which has suddenly ceased to play. In most such cases, the serviceman is not present at the time of the failure, so he will have to ask. In answer to the first question, then, it develops that the radio was playing an AM station; a hissing sound was heard, then silence. The set was turned off, and the serviceman called.

How did it act before the failure, you ask. Well, it seems that it was all right until a week ago Tuesday during the Bob Hope show. It made that same hissing sound, the program faded out; then after about two minutes, it came on again. It has worked all right ever since.

The third question must be answered by the serviceman himself. He *looks* at it. He turns it on. Nothing happens. But there *is* a little hum in the speaker, quite normal. He switches to FM; it is too early for any program, but the background noise is normal. So he tries the phonograph. Ah! it works. What has been learned so far?

The dial lights are on, and the set plays on FM and phono, so the power supply must be "OK." The audio system must be all right. The FM section must be all right. The trouble is localized to the "front end" of the AM receiver, either the I-F stages, the R-F stages, the first detector, or the oscillator.

That is only a sample of the way trouble-shooting is done. Localize the trouble to the smallest possible part of the system. If there are 27 tubes in a system, there are probably ten times that many components, any of which could be at fault. It would take hours to check each one individually. If the trouble can be localized to the circuit of one single tube, there will probably be about ten possible places for failure. So it is obvious that a simple, workable trouble-shooting system should begin with localization.

PROCEDURE

on Electronic Equipment

But bear in mind one cardinal principle. *Any* trouble-shooting method should be followed carefully. Do not try hit or miss guesses until your own experience is great enough that the guesses are really only short-cuts. Experience will tell you that a certain type of equipment is apt to fail in a certain place.

Select a method, then, such as is outlined here, and follow it systematically. All electronic equipment uses power from some source, so that is a good place to start. All electronic equipment uses tubes, so that is a good place to check next. Assuming these to be normal, localize the stage at fault, and then determine the exact part that failed.

Checking Power

The first step in checking power is to determine if the source is actually "hot." If the equipment is battery operated, check voltages *under load*, that is, with the equipment turned on. Dry batteries will often test normal with a meter that draws only a milliampere or so, yet the internal resistance may be so high that the available voltage output under load is low. Testing with the equipment on will show up this defect. Low battery voltage will often cause failure of an oscillator tube to function.

For storage batteries, the same conditions obtain, though the method of testing is different. Measure the voltage with the equipment on, and test the gravity of each cell, or pilot cells.

If line-powered, determine if the line voltage is normal. For AC-DC equipment, check to see that the plug is inserted properly on D-C lines so that the positive terminal of the equipment is connected to the positive side of the line.

In permanent installations, some form of indicating device such as a meter or lamps will generally indicate the condition of the power source. After the source is found to be "hot," check the fuses or circuit breakers. In short, take every care to be sure that power is actually reaching the equipment. Many radio service calls have been made only to plug in the line cord and many more, in D-C districts, to reverse a plug.

Checking Tubes

In receiving equipment, tube checking is a simple operation, and immediately removes tubes as a source of trouble. No tube checker is 100% accurate, however, and in certain applications tubes can be checked only by substitution. This applies particularly to oscillators and to noisy tubes, and in such cases, it is well to make the substitution if a spare is available.

Transmitting tubes are more difficult to check. Few users have the facilities for regular checks of the characteristics of transmitting types. On the other hand, the manufacturing tolerances of these types are much more rigid.

Tube testers take many forms. A simple check on the electron emission of the filament or cathode is effective in about 90% of all tube defects. This type of tester is simple and generally inexpensive. With increased complication, testers are made which will measure the "dynamic output" of a tube, and depend for their operation on the change in plate current caused by applying an A-C voltage to the grid. This type of tester is not expensive, and gives reliable results on about 95% of failures. The more complex and expensive mutual conductance testers will show up perhaps 99% of tube faults, and are of the best type for general use, provided the additional expense is justified. But even with the best possible tube testing apparatus, some tubes will test satisfactory, yet fail when placed in service. No tube test can be considered 100% accurate, and the technician must resort to substitution for final and certain surety of performance.

One necessary check for tubes is that of leakage. Modern testers have facilities for "short" checks that will show up shorts of as high as two megohms resistance between elements. There are two reasons for such a check: (1) It protects the meter in case of leakage between high voltage elements and the grid, which would cause high plate currents; and (2) in many circuits, any leakage between elements may disturb element potentials beyond operating limits. Cathode-heater leakage is often a source of hum, and will render many circuits inoperative.

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Initial TROUBLE-SHOOTING PROCEDURE

From Preceding Page

The "gas" test is not furnished in all testers but is a valuable adjunct. If introducing a high resistance in the grid circuit causes an appreciable change in plate current, the tube is gassy, and should be replaced.

With all these doubts, however, a thorough check of the tubes is a necessary operation, and must not be overlooked in a trouble-shooting system. It must be appreciated that no electronic apparatus can function unless the tubes themselves are functioning properly.

Locating Stage

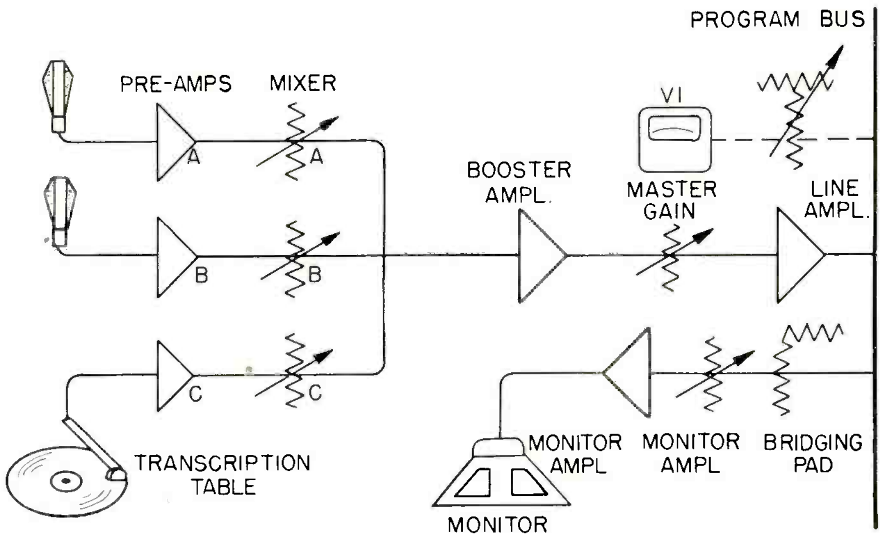
Assuming the power source is checked and is found to be normal, and that the tubes all test satisfactory, the next step is to locate the stage in which the failure has occurred. This can be done by various methods. In receiving equipment it is easy to begin at the last tube and check by touching the grid terminal of each tube with a metal object. A characteristic sound will be heard as each grid is touched. If there is a sound when touching the grid of the fourth tube in the set, but none for the third, it may be assumed that some component associated with the third tube is defective. In more complicated systems a different procedure is required.

The block diagram shows a simple system suitable for a small broadcast installation. Suppose the control operator hears a crackling noise in the monitor speaker. His first check is to close the mixer dials. If the sound stops, it must be in one of the pre-amps, or the input circuits.

If the noise continues, he should close the master gain control, which would stop the noise if it originated in the booster amplifier. Next he should close the monitor gain control, eliminating the line amplifier as a source. If the noise stops, it must have been in the line amplifier. If the noise continues, it must be in the monitor amplifier.

A volume indicator on the program bus would show up immediately whether the noise originated in the program circuit or in the monitor circuit. If the noise were in the monitor amplifier, it would cause no deflection of the VI; but if it were in the program circuit, the VI would indicate it.

This is only a simple example of the type of analysis required to locate a faulty stage. Familiarity with any system is required to determine a checking method for it which eliminates as many elements as possible as the source of trouble, but the principle of localizing should be understood and adapted to the equipment being serviced.



Checking Components of Stage

Having determined which stage is at fault, it becomes a simple matter, in most cases, to locate the defective component. In low voltage equipment such as receivers, voltage and resistance measurements at tube sockets should suffice; but in transmitting equipment, safety precautions eliminate voltage measurement as a suitable method.

Well organized maintenance material on electronic equipment should provide complete tables of voltage measurements at all socket terminals, and at any other critical points in the circuits. No voltage at a given terminal indicates an open circuit or a shorted capacitor. Low voltage at a plate terminal indicates high resistance, defective capacitor, or high plate currents. Low voltage at a cathode indicates low resistance from cathode to ground, a defective capacitor or low current. High voltages at plate terminals indicate open bleeders, low plate currents, or low resistance series circuits. High voltages at cathode terminals indicate high plate currents. Taken together, these measurements can be used to determine the source of the trouble, and further continuity and resistance measurements are necessary to locate the faulty component.

Maintenance material should also provide resistance measurements between various tube elements and ground and between these elements and the plate supply. After making the voltage readings, measurements should be made of the resistance between various points and these results considered carefully. In most equipment, it should not be necessary to disconnect any parts for these measurements, until a very definite indication is obtained. Parallel resistors and capacitors must be separated to make final checks, but most circuits may be analyzed completely without this procedure.

Transmitting equipment is generally provided with sufficient metering to enable the technician to locate the source of trouble, though perhaps not the definite component. In such cases, individual resistance measurements on the components should be resorted to.

Capacitor checking can be done fairly accurately by means of an ohmmeter. Naturally, a shorted capacitor gives an indication of its condition, but "opens" are more difficult. With a capacity of .01 mf or more, a "kick" is

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RADIO MAINTENANCE IN *Aviation*

From Page 4

reliably over much longer periods than dynamotors and other apparatus having moving parts; consequently they only require servicing and checking perhaps semi-annually as against monthly or quarterly periods for others.

You will find at almost all large airports a commercial radio service shop equipped to do business with the itinerant pilot. Some of these shopmen sell a routine overhaul service at a fixed fee. In that case they check all apparatus as to sensitivity, calibration, etc., after all component parts have been very closely serviced. All tubes, dynamotors, vibrators, headphones, microphones, and similar parts are serviced with the idea in mind that there is a certain wear and tear, either electrical or mechanical, on all parts and that each unit must be in condition to give reliable service until the next routine service period.

How Transport Plane Radio Equipment Is Serviced

Airlines require that operating radio equipment be inspected both before and after each flight by a radio mechanic appointed to that duty.

Even when an airliner lands at an intermediate airport, a quick check is made of the radio equipment and any troubles are remedied. The American Airlines rules require what they call a Turn-Around Inspection at this time. Here are the instructions covering this inspection, given as a typical example of the nature of work done by an airline radio mechanic:

1. As the period of time that an airplane remains at a station may be brief, it is essential that inspection and tests be made immediately upon arrival. Tools and spares shall be available and the work shall be a continuation of the preliminary inspection.

2. Inoperative equipment shall be inspected at once and the cause of the trouble investigated. Repair or replacement of units should be made. If the cause is not immediately apparent, substitution of a unit known to be in an operative condition will aid in determining the location of the fault. Use a logical and orderly procedure, examining first the most obvious and probable sources. Blown fuses, open tube filaments, broken headset and microphone cords, faulty plug and jack connections, broken antenna connections, poor relay contacts, and similar troubles head the list. Failure of the radio wiring in the airplane is one of the rarest cases of trouble.

3. Visual inspection shall be made of antennas, receiver and transmitter mounts, headsets and microphones, volume control panel, power unit and connections.

4. An operating check of transmitters and receivers shall be made, testing by calling a company station. Listen to the company transmitter, checking both day and night frequencies. Listen to several radio-range stations on standard beacon and auxiliary receivers.

Maintenance of Aviation Radio Receivers

Receivers are probably the most important single item of radio equipment installed on airplanes, and in servicing them you must be guided by known flight conditions and required safety rules. When inspecting them you must follow a set routine.

When looking for causes of trouble in a receiver aboard a plane, as in a "flight" or "ground" inspection test, always look for the simple causes of trouble first.

Many good airplane sets have been damaged by internal alteration made by a trouble shooter when the trouble was really due to a faulty cable, plug, or tube, or to the power supply. Aircraft radio receivers are more dependent upon their design, workmanship and adjustment for proper operation than upon frequent replacement of integral parts. Trouble shooting and repairs on the sealed interior of this equipment should be done as a last resort, and only after it is certain that the fault is not to be found outside the set enclosures. The interior work is known as service work and is done in a radio shop, whereas checking and inspecting is done with the receiver still on the plane.

Probably the most common cause of poor radio reception in high sensitivity airplane receivers is "static," or electrical disturbances of both local and atmospheric origin. Operators and technicians alike should learn by experience to identify those noises in the telephone headset which indicate faults in the apparatus or installation. Such identification by ear will greatly facilitate the correction of the fault. The following may be used as a guide:

(1) Atmospheric (static) and external man-made interference should be identified with the plane on the ground, engines stopped. The familiar crashing type of static found on broadcast receivers and other receivers operating below 20 megacycles is not ordinarily present on the 110-megacycle band. However, interference due to man-made static such as corona, ignition noise, diathermy machines, and telephone dials is generally found to some degree, and the identity of the source can usually be determined by its characteristic sound in the headset. Disconnecting the antenna transmission line will usually indicate these sources of interference. If the noises disappear or are greatly attenuated by removal of the antenna plug, they must be coming from outside the set.

(2) Dynamotor noises should be identified on the ground, engines not running; the pitch of this sound varies as the power is tuned on and off while listening to the interference in the head-set.

(3) Intermittent contact in phone cord, plug, or contacts in the telephone headsets should be identified on the ground, engines not running. A loose bond or terminal plug on any of the set cables should be identified on the ground, engines not running. Sometimes it can be located by jiggling the cord.

(4) Ignition noise should be identified on the ground, and appears immediately on starting the engines. Trouble source can be localized further by switching between magnetos.

(5) Generator noise should also be identified on the ground, with the engines running, by advancing the throttle to the point where the generator cuts in. If the noise originates in the generator itself, it will be a characteristic "machine noise." If it is coming from the voltage regulator it will probably be intermittent and appear only above a certain critical engine speed. Noises originating in the generators and voltage regulators can be distinguished from ignition noise by the fact that generator and voltage regulator noise is usually suppressed by opening the airplane main line switch.

(6) Vacuum tube noise can be detected on the ground; it usually has a crackling or ringing sound. It will sometimes appear under sustained vibration, although not heard at all when jarring the receiver by hand.

(7) Intermittent contact in an internal circuit of the receiver may usually be identified by shaking or jarring the receiver by hand. Disconnecting the antenna plug and vibrating the receiver is not necessarily a test because some noises of this character may be increased to audibility by a strong incoming signal.

Sometimes a radio serviceman, not connected with an airline company or an airport radio shop — with their attendant maintenance facilities and equipment histories — is called upon to either flight-test or bench-test a

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private plane radio receiver. In these cases careful questioning of the pilot as to past performance and faults will be helpful right at the start. Also, in helping such a pilot maintain his receiver in flight it is well to be able to set up for him certain instructions as to operating procedure. As an example, point out to him that a careful, watchful operator can help maintain his receiver at the highest degree of efficiency by simply noting the receiver performance under varying conditions. The service demanded of an aircraft receiver over a certain run from day to day is about the same. The general receptivity of the set may change somewhat due to weather conditions but comparing one average day's run to another, the pilot-operator should be able to detect at once any reduction in the signal strength or any undue interference. He probably learns, sooner or later, that poor reception may be due to interference from outside as well as inside the receiving set, and his ability to interpret this interference is very important in describing his troubles to you. Sometimes he blames the transmitting operator for faults which can really be remedied by himself. For example, correct tuning is an important part in maintaining efficient receiver performance.

Good tubes, properly selected, probably will do more to assure good reception than any other thing about the receiver and for this reason you should use a *good* tube tester if you doubt the fitness of the tubes used.

If during a flight it is suspected that tubes are defective in any way, new ones should be substituted immediately. If the performance of a set is materially improved by this change, the faulty tube or tubes should be replaced as a part of service procedure. Remember, in aviation work it is not necessary that a tube completely fail to function before it is discarded. When replacing tubes, the pilot must turn off all filament currents first. In carrying spare tubes aboard a plane, a suitable rack should be provided that will prevent damage to the tubes while in flight. Also, headphones occasionally cause considerable trouble, and it is always wise to have a spare set aboard the plane for this reason.

There are many sources of radio interference in any aircraft which may cause undue noise in the receiver. Some are in the receiver itself, and some are in the apparatus connected to it, even including the plane. The first two sources of interference to be considered are the bonding system and the shielding system. If noise decreases or disappears when the receiver is connected to a ground at an airport instead of to the bonded plane, the bonding is inadequate or defective. If there is far less noise in the receiver when the engine is not running, the trouble is in the shielding system. Therefore, these two tests for noise are usually made first, while the receiver is in the plane. A bench test usually follows.

A Bench Test for Aircraft Receivers

To conduct this bench test, remove the receiver from the plane and connect it to a regular ground and aerial. Sometimes this immediately discloses the fact that the plane batteries were weak or had loose connections. Under any circumstances, with a reliable source of "A" and "B" supply connected, search first for defective parts —tubes, tube sockets, resistors, and condensers.

If a tube tester is available, all tubes should be checked before making any checks on receiver circuits. After tube trouble is eliminated by replacing any defective or microphonic tubes, proceed to check all connections and circuit components. Occasionally you will discover a momentary short circuiting of the plates of the tuning condenser, or the insulation of the fixed condensers may be found to be defective. Loose connections and broken wires are found much more often than in broadcast receivers. Dirt is usually found in the sets and this you carefully blow out while searching for defective parts.

Next, connect the headphones and tubes and note the presence of static. This can be reduced to a minimum by using small testing antenna but it cannot be eliminated entirely. Next, note the filaments. If they flicker it is evidence of a loose connection, so look at the "A" battery terminals, the spring contacts in the tube sockets, the tube contacts themselves, and the filement rheostat. If a filament fails to light, there is an open circuit, either at one of the places just mentioned or in the wiring itself. A dim filament means too low "A" voltage; but if the "A" voltage is checked with a voltmeter at the beginning of the bench test, a dim filament would indicate high circuit resistance.

Now test the ground connection. Tune in the "whistle" of some station and then touch the ground binding post. A poor ground will cause a decided variation of the pitch of the whistle when touching. In this case, since the ground used with the test bench is known to be good, the connections should be cleaned and fastened more securely. This same method can also be used to detect loose connections or faulty wiring in other parts of the receiver. Once satisfied that the receiver wiring is in good condition, the quality of reception is determined by a listening test.

Weak reception is as common a complaint as noisy reception. If this is accompanied by a rasping, scratchy sound, the cause may be a headphone, or an open or intermittent coupling condenser. To remedy this, try connecting the grid return of the detector to the positive filament terminal. In the case of an oscillating receiver, there may be too much feed-back even with the control dial set at minimum. In this case, less "B" voltage to the detector tube should be tried; also less filament current. If more, instead of less feed-back is desired for a trial, more turns of the tickler coil should be used, or a larger plate variometer or coupling condenser, whichever it is most convenient to change. Sometimes the volume decreases as the tickler coupling is increased. This indicates that the tickler coil connections are wrong and should, therefore, be reversed. A grid condenser of improper capacity for the tube used will also prevent proper oscillation, as will also a defective tube.

If too much capacity or too little resistance is utilized in the grid leak and condenser unit in an attempt to strengthen signals, the scratchiness first heard may disappear, but a dull muffled tone may appear instead. This sound also shows up as the filament voltage drops below its specified value. In the case of weak signals (or none at all) with a humming noise of low pitch, an open in the grid circuit is probably the cause. The grid terminal connection, the grid leak resistance, the grid return lead, the tuner coil secondary, and the tube contacts should then be examined. Excessive current through the tube will cause a sound like water flowing. By reducing the filament and plate voltages, this can be corrected. The use of a "C" battery will also reduce this sound.

There are a number of cases of reception of normal strength accompanied by objectionable noises. One of these noises may be described as a hissing, frying, scratching, or crackling sound. Sometimes this dies down to a hum, often interrupted by a series of intermittent clicks. These noises suggest "B" battery trouble to the experienced tester.

Practically new batteries should always be used while testing an aircraft receiver, but the quickest way to discover whether this noise is caused by the "B" battery or not is to try a new battery, or one that is known to be good. Care must be taken to see that the "B" battery connections are also good. If in doubt as to the "B" battery itself, it can be tested by connecting a pair of headphones across its terminals. If a boiling or frying sound is heard, it is proof that the battery is defective and should be discarded entirely.

Sometimes an aircraft receiver is reported after a flight as having been noisy when tuning. When the dials are moved and noise occurs, it is probable that the fault is a mechanical one. Check the grounding contact fingers to the stator plates, and see to it that the dial and other control mechanisms are working properly. If they are, remember that a vacuum tube will often become noisy when the rheostat controlling the tube voltage is varied. This will also occur when the receiver is subject to vibration. For this reason, most airport radio laboratories have some means of mounting a receiver so it can be vibrated by a motor, the usual method being to have an eccentric shaft on the motor with a connection that will rock the receiver on its mounting.

Excessive hum in an A-C receiver usually indicates an open filament center-tap resistor or an open connection on the center-tap of the plate supply secondary. Leakage between heater and cathode causes hum, and the tube should be replaced. Infrequent causes of excessive hum are open filter or bypass condensers in power supply circuits. An open grid circuit sometimes causes hum, accompanied by weak output and distortion. In regenerative receivers, a periodic clicking with poor sensitivity indicates an open detector grid leak or one of too high resistance. Replace with one of lower resistance.

If filaments light but receiver is dead, check "B" supply voltage and connections to output stage. With no signal there should be strong clicks when the speaker or headphones are connected and disconnected. If output stage is normal, check each circuit component (condensers, resistors, and coils or transformers) for opens, grounds, and shorts, going through each stage in receiver.

A shorted filter condenser in the power supply is indicated by low or no "B" voltage and a very hot rectifier tube. In the 80 type rectifier, a blue glow will show inside the plates when a filter or plate by-pass condenser is shorted. A blue glow in mercury-vapor rectifiers is characteristic of the type, but it will be more green in color when overloaded by shorted condensers.

Open audio transformer or choke windings will cause weak signals. Open or inadequate cathode by-pass condensers on audio tubes will cause poor bass note response or a "tinny" quality.

Keep in mind these facts: that circuit components consist of resistors, condensers, and coils (inductances), and that there is no D-C continuity through a condenser, but that in some circuits condensers are paralleled by resistors or coils which will indicate continuity of such a circuit unless disconnected.

Single-dial control on tuned R-F receivers of two or more stages necessitates trimmer condensers in parallel with tuning condensers to compensate for inequalities and differences in wiring of such circuits. This type of receiver will show considerable lack of sensitivity when t-r-f stages become misaligned.

Poor sensitivity and broad tuning in superheterodyne receivers also indicate misalignment of R-F and I-F stages. Do not attempt the alignment of circuits unless the proper tools are available consisting of a good modulated signal generator, an output meter, and insulated screw-driver.

Maintaining Air Transport Receivers

You can't stop an airliner in mid-flight to change receivers so the maintenance work done in connection with air transport receivers is of necessity tied in with airline operating procedures. These procedures vary somewhat in accordance with the shop facilities of the terminal airports and the working plans of the various airline companies.

Airlines require that operating radio equipment be inspected by a radio mechanic assigned to that duty both before and after each flight.

At this time microphones are checked by either operating them on the interphone system or by modulating the transmitter and listening to the side tone. The mikes are then wiped off with a solution of 70% alcohol and stowed away, not hung up in the cockpit because they would become damp there. See to it that the headphone caps are tight; then clean them, polish the plug, and replace frayed cords. When soldering, make certain the braid carries the tension, not the wires. Then hang them up in the cockpit where the cords will not become tangled.

In testing the receiver on the plane a small signal generator is sometimes set at a given level. In flight tests, tunable receivers should be set to several different stations as a check of the accuracy of the calibration and operating efficiency.

In addition to these check-ups, the receiver is periodically removed from the plane for cleaning, overhaul, tube replacement and test.

When receivers are tested on a bench, a signal generator is always used and sensitivity limits set for the minimum performance acceptable. Limits must also be set for plate current and voltage and instruments for measuring these values must be a part of the bench equipment.

Use a shielded conductor between signal generator and receiver and select the proper dummy antenna. See to it that the signal generator is tuned to the exact frequency desired (using a crystal standard if possible) and adjust the sensitivity control for maximum sensitivity. Use a minimum of signal, turning down the generator output as you approach alignment of the receiver.

This series will continue in the next issue, with information relating to transmitter maintenance, showing how you can handle radio repairs on planes carrying two-way communication equipment. √ √

"Traffic to patrol — make that Cub pull over to a cloud and stay there until he fixes his radio — he can't fly around this airport that way. Over."

"Patrol to traffic — Roger, wilco. Out."

Getting the most out of your Test Equipment

The RCA VoltOhmyst Jr.

By Rex Gilbert

Radio Consultant

MODERN, EFFICIENT, time-saving servicing procedure practically demands the use of some form of instrument that will measure stage gain, in R-F, I-F, and audio circuits. This application is probably the most important function of any of the various channel analyzers or signal tracers on the market today.

However, not every service bench is equipped with such an instrument. A much more common piece of test equipment is the Volt-Ohmyst, which has received very great acceptance. The Volt-Ohmyst can be modified easily to permit its use as an A-C voltmeter, which greatly increases its usefulness. There are three requirements to be met: the normal use of the Volt-Ohmyst should not be disturbed; the scales of the Volt-Ohmyst should read A-C volts directly, without reference to calibration charts; and the completed instrument should not load the circuit being measured.

These conditions may be met by the addition of a rectifier to the input circuit, using the basic Volt-Ohmyst as a means to measure the D-C voltage of the rectified A-C signal.

Considering the circuit of the Volt-Ohmyst, it will be noted in Fig. 1 that the input circuit for D-C measurements consists of a 10-megohm voltage divider, with the arm going to the grid of the metering tube. In addition to the 10-megohm divider, there is a resistance of one megohm in the probe for the isolation of cable and circuit capacities. With a maximum sensitivity of 3 volts, the voltage applied to the grid of the tube is

$$Eg = \frac{10}{10 + 1} \times 3.0 = 2.73 \text{ volts}$$

Therefore, for a 3-volt sensitivity, it is necessary to put a D-C voltage of 2.73 volts at the top of the 10-megohm voltage divider, and if this condition is met, the range switch will function for the various ranges of A-C voltages just as it does for D-C measurements.

The input circuits of the General Radio type 726-A vacuum tube voltmeter perform a function for that instrument similar to the one we desire to obtain for ours. Figure 2 shows a simplified schematic of the General Radio voltmeter circuit. With a voltage Es at its probe, the tube V-1 rectifies a portion of the signal, developing a negative potential at the junction of R-1 and R-2. This potential is applied to the condenser C-2 and the grid of V-2 through the isolating resistor R-2. After the first few half-cycles, C-2 becomes charged to this potential, and thereafter current is drawn from the source only at the peak of each cycle. It is only necessary to supply enough current to compensate for leakage off C-2 through R-1 and R-2. Since R-1 is 10 megohms and R-2 is 50 megohms, this leakage is very small. Although this instrument *measures* peak voltages, it is calibrated to *indicate* RMS voltages, and the indications are accurate so long as the input voltage approximates a sine wave.

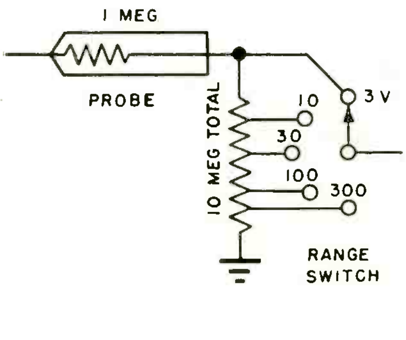

Fig. 1. Simplified input circuit of RCA Volt-Ohmyst.

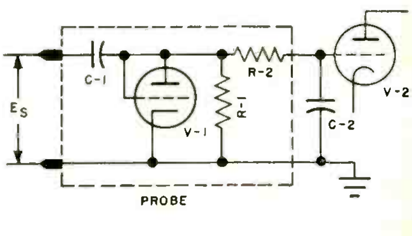

Fig. 2. Simplified input circuit of General Radio 726A vacuum tube voltmeter.

How to increase the usefulness of the Volt-Ohmyst by modifying it to serve as an R-F voltmeter of very high input impedance

Inasmuch as it is desirable to use the voltage divider of the Volt-Ohmyst in its present form, and to change the instrument as little as possible, the General Radio circuit must be modified to some extent. In Fig. 3, the 10-

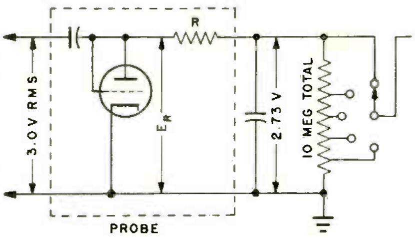

Fig. 3. Simplified input circuit for modified RCA Volt-Ohmyst.

megohm voltage divider of the range switch is retained in the A-C instrument, and another resistor, R, is added, together with the condenser C-2. The rectified voltage is developed across the two resistances, 10 megohms and R, which constitute another voltage divider. C-2 serves the same purpose as in the General Radio meter.

To determine the correct value for R, a little mathematics is resorted to. One of the initial requirements is that the scales be the same as for the D-C meter, and it is desirable that the A-C meter read RMS volts. Referring to Fig. 3 again, the peak voltage Er will be 1.414 times the RMS voltage; therefore, for an input voltage of 3.0 RMS, Er will be 4.24 volts. Requiring 2.73 volts at the top of the range switch, the value for R may be determined by the equation

$$R = \frac{(4.24 - 2.73) \times 10 \text{ meg.}}{2.73} = 5.55 \text{ megohms.}$$

A 5.6 megohm resistor of the preferred value series can generally be found that satisfies this requirement.

In order to eliminate the effect of contact potential, which approximates 0.9 volts when the 955 is used as a rectifier, the cathode of V-1 is returned to the arm of a potentiometer which constitutes a portion of the bleeder system, and across which about 2 volts is developed. This gives a good range of adjustment, and permits the meter to be set at zero with no signal applied to the rectifier probe. In order not to disturb the voltage distribution of the Volt-Ohmyst, a 0.22 megohm, ½-watt resistor is paralleled across R-30.

Figure 5 shows, in complete form, the circuit diagram of the Volt-Ohmyst as revised in this fashion, with heavy lines indicating the changes. Using a 955 tube for the diode rectifier requires a little ingenuity on the part of the technician making the changes because there does not seem to be a complete ready-made probe available for the purpose.

However, for the original model of this conversion, a single-cell bakelite flashlight case was found that served admirably. In order to mount a tube, socket, resistor and condenser in the probe, the following procedure is recommended. Procure a piece of bakelite tubing (such as an old R-F coil form) that will just fit inside the probe case, and cut it to about ½ inch long. Bend the lugs of the five terminal clips accompanying the 955 tube at right angles, very carefully and not too sharply, so as to avoid breaking them off. Then, eyelet the five clips around one end of the form, using the 955 as a guide in marking the holes. Then mount a soldering lug on the other end of the form, also by eyeletting, locating it approximately under the cathode terminal. Connect the 5.55 megohm resistor between the soldering lug and the plate terminal, and, with a three inch piece of #16 bare hookup wire, connect the plate and grid terminals together, leaving the extra length of wire extending upwards from the socket. Connect the cable leads to the heater terminals, the cathode terminal, and the soldering lug. Thread the cable through the cap, using tape to make a collar on the end of the cable to prevent its being pulled through. Take a soldering lug and solder a 6-32 radio nut flat to it, with the large hole in the lug concentric with the hole in the nut. It will probably be necessary to tap the hole out after the solder cools. Solder the lug to one lead of the .02 mfd condenser, so positioning it that the hole in the lug is over the center of the condenser. (See Fig. 4)

With the 955 tube in its socket, solder the other lead of the condenser to the extending piece of hook-up wire with the condenser about ¼ inch above the top of the tube. Drill a #25 hole in

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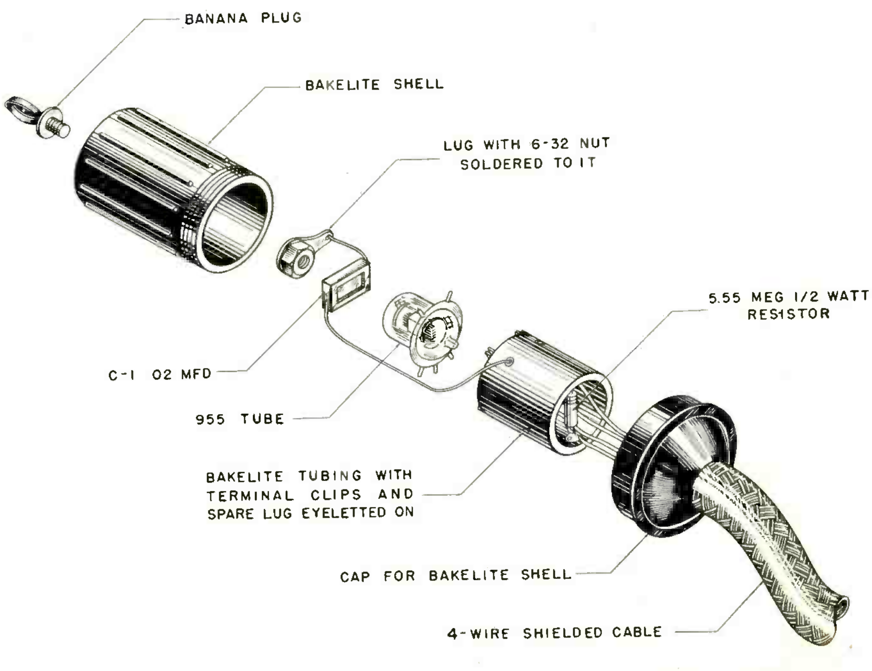
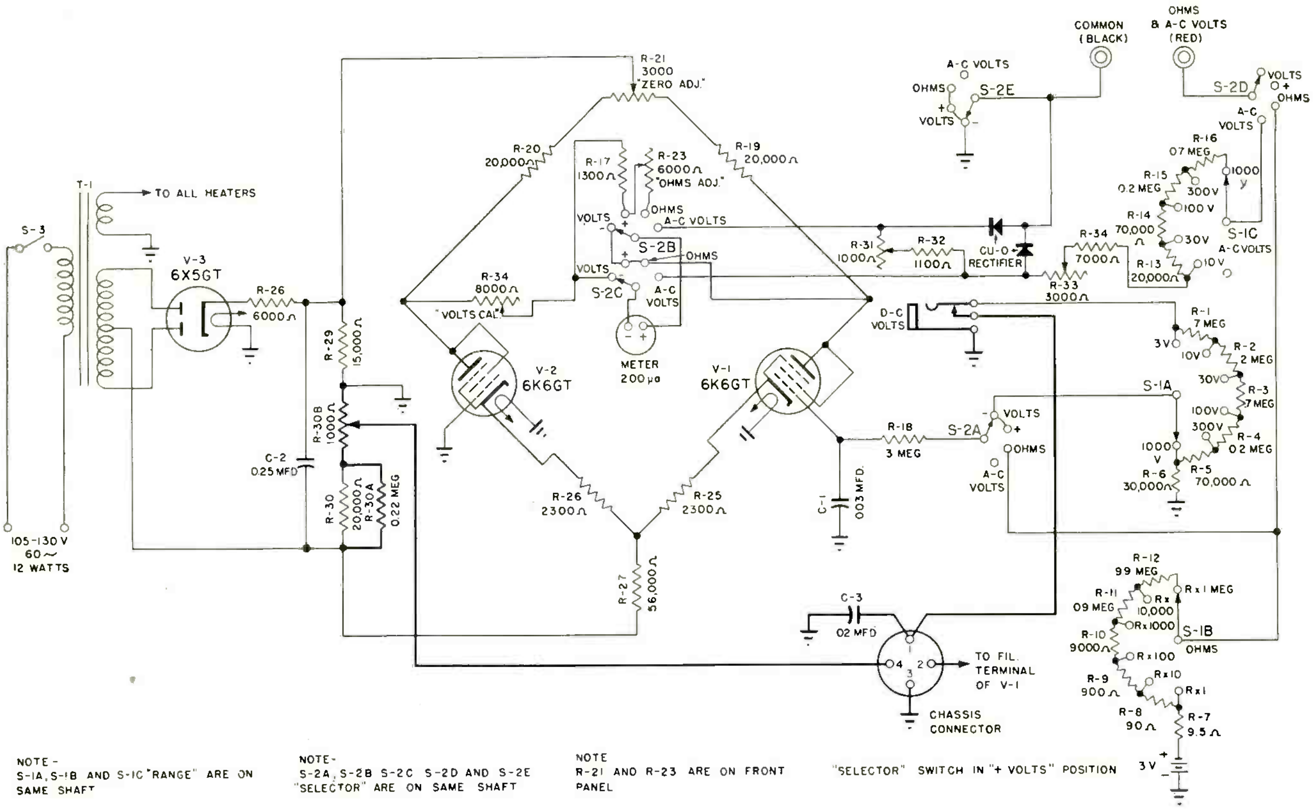


Fig. 4. Exploded view of probe showing construction for use with 955 tube.

Getting the Most out of Your Test Equipment

From Preceding Page



Courtesy RCA

Fig. 5. Complete circuit of RCA Volt-Ohmyst as modified for use as high-frequency A-C voltmeter.

the center of the end of the bakelite case. Now, insert the condenser, tube, and socket into the case, and screw the cap onto the case, thus enclosing the probe completely. If this is carefully done, the soldering lug with the nut should be in such a position that the banana plug may be screwed into place. Connect the cable to the plug, and the probe is completed.

Remove the Volt-Ohmyst chassis from its case, and drill a hole in the side for the chassis connector. Remove the single-circuit jack from the front panel and replace it with a closed circuit jack, as indicated in Fig. 5. Disconnect the grounded end of R-30 from ground, and connect it to one side of the 1000-ohm potentiometer, R-30B. Connect the 0.22 meg resistor, R-30A, across R-30. Run six-inch leads from the filament terminals of V-3 to terminals 2 and 3 of the chassis connector; from the contact of the closed-circuit jack to terminal 1 of the connector; and from the arm of the 1000-ohm potentiometer to terminal 4 of the connector. Connect a .02 mfd condenser from terminal 1 to ground at the connector. Plug in the probe, and turn the instrument on, making sure that the D-C probe is not plugged into its jack. Set the selector switch at "— volts" and the range switch to "3 volts" and allow the unit to warm up for at least 15 minutes. Then, with nothing touching the probe, adjust the 1000-ohm potentiometer for zero reading on the meter. Turn the power off, and replace the front panel.

To use as an A-C meter, it is only necessary to plug in the A-C probe, remove the D-C probe, and set the selector switch to "— volts." The readings should be well within ten per cent accuracy for audio, I-F, and R-F measurements in the broadcast band. No checks have been made on higher frequencies due to the lack of a source of known voltages in these bands.

The uses of such an instrument will naturally suggest themselves to the serviceman as he becomes familiar with it. Remember that there is a limit to the maximum output voltage of any stage, and be careful not to apply too large a signal to the grid of a tube when measuring stage gain.

There are a number of other tubes equally, or possibly more, suitable for the probe tube. Immediately suggesting themselves are the 9002 and 6C4. It is certain that the miniature type of tube would be much easier to design a probe around, but the basic principles remain the same, and the circuit should be followed closely, to avoid a lot of experimental work. It is believed that the constants furnished here will be equally applicable to the miniature tubes mentioned.

The material required for this modification is as follows:

1 Amphenol PC4F chassis connector
1 Amphenol MC4M cable plug
1 955 tube
1 socket for above (see text)
2 .02 mfd mica condensers (postage stamp)
1 1000 ohm wire-wound potentiometer
1 5.55 meg, ½ watt, resistor ("preferred value" 5.6 meg, selected)
1 0.22 meg resistor, ½ watt
4 ft 4-wire shielded cable
1 banana plug
1 Mallory A2A closed circuit midget jack
1 probe housing (see text). V V

NEARLY—CONSTANT-IMPEDANCE-PADS

By E. S. Cross

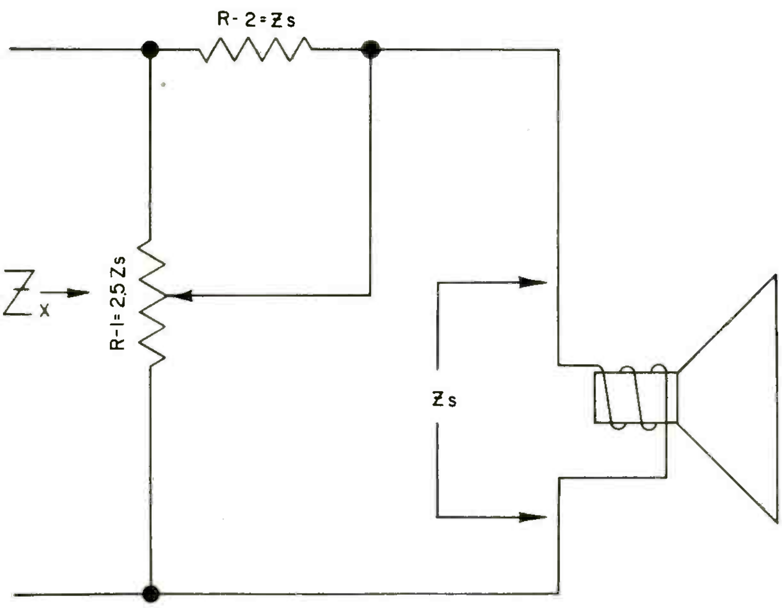


Fig. 1 Method of connecting simple wire-wound potentiometer and additional resistor to make a pad which approaches constant-impedance characteristic.

OCCASIONALLY a need arises for a volume control in a loudspeaker circuit for multiple speaker installations. In order to obtain the best results from an amplifier, it is generally advisable to maintain the impedance of the output circuit at a constant value. This necessitates the use of controls of the "constant-impedance" type, or some form of control in which the impedance variation is kept to a minimum. This requirement can be met easily by the use of "T-pads" or "L-pads," or even the more complicated "ladder" network. However, these controls may not always be available, and in any case, their cost is somewhat greater than an ordinary potentiometer. Having the problem of selecting a control for this use, and having several wire-wound potentiometers at hand, the following method was developed.

After a number of combinations were calculated, the circuit of Fig. 1 was decided upon, and it has been used in a number of installations since. The control is a simple wire-wound potentiometer, and the network is completed by the addition of a resistor, equivalent to the impedance of the speaker, across the upper part of the potentiometer. With the speaker across the lower part of the control, the impedance of the circuit, with the speaker connected, varies from .715 Zs at the ends of the control to 1.11 Zs at the center, where Zs is the impedance of the speaker. Assuming that the control would normally operate in the central portion of its range, this gives fairly good impedance match.

For example, when using a speaker of 6 ohms impedance, the control, R-1, should be a 15-ohm unit, and the resistor, R-2, should be 6 ohms. In this case, the impedance of the circuit is 4.3 ohms at the ends, and 6.7 at the center.

The insertion loss of the control when set at the maximum position is 1.58 db, calculated from the formulas for loss due to a shunt impedance. For multiple-speaker installations in residences and for small P-A systems, this loss is acceptable. However, for high power sound systems, the unit is not recommended, since the power loss is too great for economy. The control used should have a power handling capacity of approximately 30 per cent of the rated capacity of the speaker, and R-2 should have the same rating as the speaker.

Figure 2 also shows the attenuation provided by this type of control. For remote speakers, the required variation is generally not large, the custom being to set up such a system with the normal operating level of the speaker about 6 db below the available maximum from the line. Such being the case, the control operates at about the center of its scale, giving a variation of 4 db up and 7 db down over a range of 80 per cent of its total rotation.

The advantages claimed are low cost, and a reasonable approximation of constant-impedance characteristics. The main disadvantage is the insertion loss. For small systems, this may be readily overlooked, as sufficient power is generally available. √ √

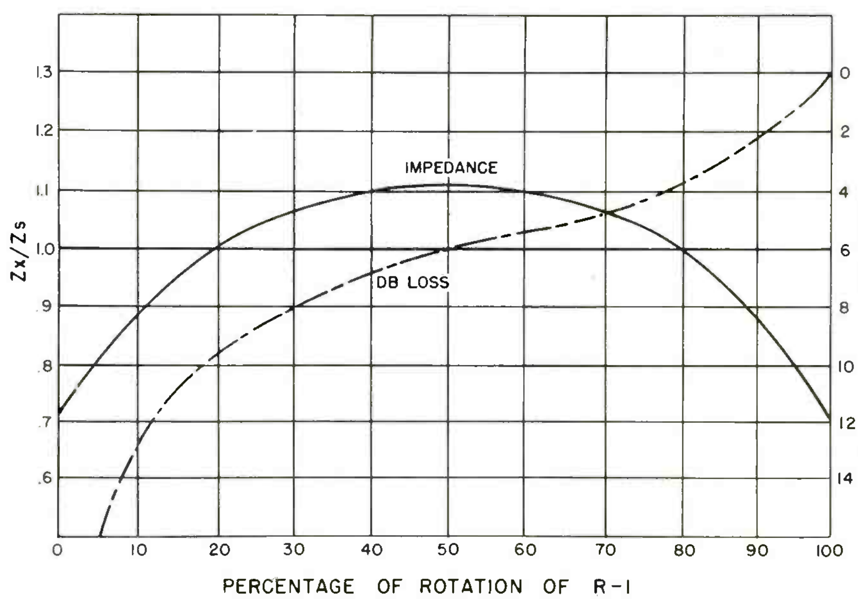


Fig. 2 The impedance ratio, Zx/Zs, is shown by the solid line and the loss in db is indicated by the dotted line, for various settings of the potentiometer.

Using the Signal Generator and Oscillograph

From Page 8

two curves of maximum amplitude, and as symmetrical as possible. When properly adjusted, the two traces appear as one line.

Reduce the output of the generator, and shift the generator connection to the grid of the first detector, or mixer tube. The pattern should change its appearance, becoming narrower and more peaked. Adjust the trimmers of the first I-F transformer for maximum

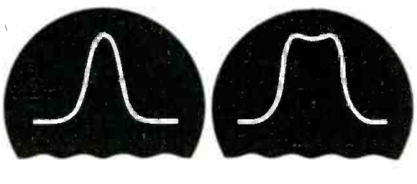


Fig. 7. Response traces for different degrees of selectivity; sharp (left), and broad (right).

amplitude, retaining the symmetry of the two traces. If the I-F amplifier has variable selectivity, make these adjustments at the sharp or maximum selectivity position; then check the curves at the broad or minimum position. Fig. 7 shows the relative appearance of the traces for these two conditions. By reducing the sweep range so that the entire trace shows only the portion of the curve between the lines marked BAND WIDTH, this value is indicated by the setting of the sweep range control. The exact value for a specific set should be found in the manufacturer's service notes.

R-F Alignment Procedure

Upon completion of the I-F alignment, the signal generator connections should be removed from the grid of the first detector. Leave the oscillograph connected as before.

In most super-heterodynes, trimmers are provided across each section of the main tuning capacitor. These trimmers adjust the tracking at the high-frequency end of the band for R-F, first detector, and oscillator circuits. The tuned circuit of the oscillator is also provided with adjustments for the low-frequency end of the band. This facility is not provided for the R-F and first detector circuits, so some other method of adjusting these stages must be used. The following procedure will produce good results.

Set the signal generator at 600 kc, with the frequency sweep off, and connect the generator to the antenna terminals of the receiver through a dummy antenna. The standard dummy antenna is shown in Fig. 8, and is furnished as an accessory to most signal generators. It is a simple device to construct, if none is available. Turn the horizontal gain control on the oscillograph to minimum. Then while tuning the receiver slowly with one hand over the range from 580 to 620 kc, continuously vary the setting of the oscillator low-frequency padder until settings of the tuning dial and padder are found which produce a trace of maximum amplitude. The dial should indicate 600 kc at this position. If it does not, loosen the set screws, and reset the dial to this point, without changing the position of the tuning capacitor. This procedure will fix the setting of the tuning gang at the point of maximum response to 600 kc for the R-F and first detector circuits. Increase

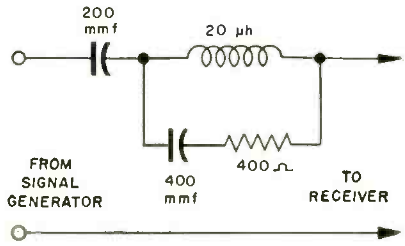


Fig. 8. Circuit of standard dummy antenna.

the horizontal gain of the oscillograph to obtain a suitable trace. After checking or resetting the dial position, tune both the generator and the receiver to 1400 kc, and adjust the oscillator, first detector and R-F trimmers, in that order, for maximum response. Then repeat the 600 kc adjustment as outlined, and follow with a final adjustment at 1400 kc. These steps should make the receiver dial track accurately at both

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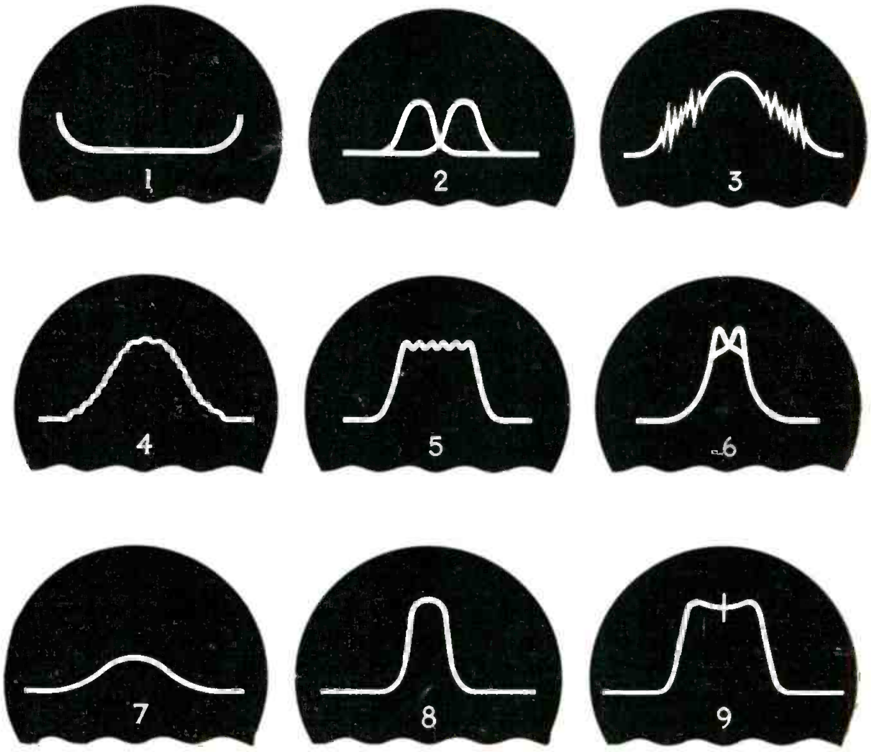

Fig. 9. Typical patterns observed on the oscillograph screen. (1) signal approximately 20 kc off resonance of I-F amplifier. (2) signal approximately 5 kc off resonance. To correct (1) and (2), be certain signal generator frequency is right, then adjust trimmers to make curves coincide, as in (8). (3) shows presence of spurious signal from external source. (4) indicates oscillation in I-F amplifier. While (5) has good selectivity, as shown by steep sides of curve, ragged top indicates overload of oscillograph or I-F amplifier. Reduce output of signal generator. (6) shows unsymmetrical alignment. These two curves can be made to coincide by suitable adjustments of trimmers. (7) shows broad curve, such as is generally obtained from first step of the alignment, with only one tuned I-F transformer. Increase the vertical gain of oscillograph to obtain higher curve, for greater ease in observing results of adjustments. (8) shows good curve for I-F amplifier. Top of curve is fairly broad, and sides are steep. (9) shows double peak effect for higher fidelity. Curve is symmetrical, both peaks of equal amplitude, and equally spaced from frequency of resonance. Sides are fairly steep, a condition indicating good selectivity.

THE MIRACLE

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if agreed upon is incorporated in both text and illustrations. Illustrations are considered again. Has every vital point been adequately pictured? No? Well then, how about a pointed cartoon or two? Agreed. Cartoons are sketched, the most applicable chosen and inked-in. The point is reached where the preliminary art and text are ready for inspection by officers and enlisted men of the interested branch of the service. Another problem arises: a corporal recently returned from a war area has an idea, another use to which the new instrument can be put.

A conference is held by the military representatives. Their findings, as related to the instruction book, are made known. The new use for the instrument has been approved. Its description must be included in the book.

More research. More gathering of data. More revision of illustrations. More drawings added. More conferences. More phone calls, more trips to the manufacturer's plant. Every item of information must be checked, every activity co-ordinated, every wire in every diagram checked and double checked — and the manuscript is ready for typing into second draft.

The office hums with activity. The rat-tat and purr of electric typewriters, the hiss of airbrush machines, the click of camera shutters, the incessant hubbub of technical talk that would spin the head of even Buck Rogers and Superman.

Weeks of this, and a fresh, clean copy appears — copy complete with glossy, intriguing, yet simply explanatory pieces of artwork. Copy ready for technical and quality check by the Production Manager of the manual publisher, and subsequently by the engineers and directors of the equipment manufacturer.

Days pass. More last-minute information is received, more last-minute tests are made. The necessity for a revision arises. It is promptly taken in stride. The text and illustrations arrive with the manufacturer's corrections and suggestions. They are incorporated in the book. Its size swells.

Parts lists are checked against schematics and wiring diagrams and with the equipment itself. Additions and corrections are made. Symbol numbers are affixed. Gaps are filled in, and the book continues to swell. It is edited and checked again — and is ready for final approval.

With final service approval obtained, the book is ready for typesetting, mimeographing, or offset — whichever reproduction process is specified. If it is typeset or offset, galley proofs arrive. Engravings are ordered for the illustrations and their proofs arrive and are checked. Galleys are proofread and checked immediately and in a day or two the corrected galleys are returned to the typographer. The production staff goes to work on cutting the galleys and "dummying" the book. Strip after strip of galley is cut and pasted-up in the form in which it will appear in the final book. The engraver's proofs are pasted in, captions affixed, Army and Navy symbol numbers added, explanatory legends and footnotes arranged in proper places, and the paste-ups are ready to go to the printer. What a relief for the staff!

But only for a few days. Then the page proofs begin to arrive. Another round of checking takes place. Letter by letter, figure by figure — for an oversight at this point may be an oversight not again open to correction. Every page is checked, and checked again. Every table and every illustration is checked. The keying of each illustration to the text, and the cross-referencing of every symbol in the parts list and text come in for their share of minute scrutiny. Finally the Production Manager sticks his neck out and puts his "OK" on the proofs — the book is ready for printing, and the staff of engineers, writers, and typists ready to collapse — ready for another job on another book — ready and glad to look forward to hearing of another life-saving "miracle." V V

Using the Signal Generator and Oscillograph

From Preceding Page

the 600 and 1400 kc points, and these settings should be at the points of maximum sensitivity at both frequencies. No means of adjusting the tracking is provided for 1000 kc, but the original design must be assumed to be correct for this frequency.

Short Wave Alignment

The procedure for aligning the short wave bands is similar to that for the broadcast band, except that the receiver dial is not readjusted on the capacitor shaft. For the bands covered by the receiver used as an example, the low frequency padding adjustments should be made at 1850 and 6450 kc. These padders are not adjustable in many receivers, so that the only adjustments that may be made are at the high-frequency end of the bands. Service notes for the receivers generally specify the alignment frequencies, but when this information is not available, it is safe to set the dial so it indicates 600 and 1400 kc respectively on the broadcast band. One precaution is necessary when aligning the high-frequency end of the highest short-wave band: Two settings of the oscillator trimmer will be found for maximum output; select the one with the lower capacity of the trimmer.

Refer to manufacturer's service notes for specific instructions for alignment of band-pass I-F circuits, a-f-c circuits, and any other adjustments that are out of the ordinary. There are so many different circuits that it is impossible to cover all of them in one article.

Oscillograph Patterns

Fig. 9 portrays several different types of patterns that may be observed on the screen of the oscillograph. In all cases, the sweep range was set at 30 kc, and the traces may be interpreted by inspection. Patterns (1) to (6) show incorrect conditions. Patterns (7) to (9) are satisfactory.

Although this method may appear to be somewhat complex, it is actually quite simple. After the first three or four times it is followed, considerable proficiency is acquired; and after using an oscillograph with the frequency-swept signal generator, no other method will ever be considered satisfactory. As soon as the technician learns to interpret the traces, he will save much time in alignment and in general set servicing.

Response measurement with an oscillograph is also quite simple, and will be described in the next issue. It presents a visual picture of the overall fidelity of a radio receiver V V

INITIAL TROUBLE-SHOOTING PROCEDURE

From Page 4

noted when ohmmeter prods are touched to the terminals. Reversing the prods will then give a larger kick of the meter needle because the charge across the capacitor caused by the first checks acts as an additional voltage in series with the ohmmeter battery when the test prods are applied the second time. After this initial capacity-type kick, the ohmmeter should return to infinity. Any reading other than infinity indicates leakage, and in coupling capacitors, this condition demands replacement of the part. In filter and bypass applications, some leakage is tolerated, and, in the case of electrolytic capacitors, is always present. This leakage is in the order of 0.1 ma per microfarad at the rated operating potential. A low-voltage ohmmeter will not show this leakage accurately, but will indicate it to a certain extent. Capacity measurements are rarely necessary in servicing operations, as change in capacity is improbable. In electrolytic filter or bypass capacitors, aging is normally accompanied by loss of capacity, particularly where large A-C voltage components are present. Loss of capacity in filter circuits will cause increased hum, but seldom causes complete failure.

Transformers offer a problem in servicing when shorted turns develop. This fault, which is often occasioned by poor insulation, manifests itself by increased heating of the unit in plate and filament transformers. In audio-frequency transformers, poor frequency response and lower power-handling capacity will be observed. D-C resistance measurements will be affected but slightly, and insulation resistance from winding to winding or from winding to core is not necessarily affected at all. The only safe remedy in the case of a suspected transformer is to replace it with a spare. Inductance measurements on the windings will show up the defect, and if facilities are available for such a check, it should be made, provided the correct value is known.

In any kind of maintenance work, the technician should never lose sight of the safety requirements — even 115 volts can cause death. Before working on any high-voltage equipment, open line switches and tag them, remove fuses, put grounding wires on the danger points, and discharge capacitors. The slogan "Always Be Careful" is an easy one to remember. And remember also that "Death is so Permanent." √ √

Is your copy of RADIO MAINTENANCE addressed correctly?

If it is, you need not read this. If it is not, please use a penny postcard to advise us of any errors in name or street number, your zone number if located in cities where postal zones apply, or any change of address.

To be sure of getting the next issue, be sure we have your correct address

Prepare Ye NOW

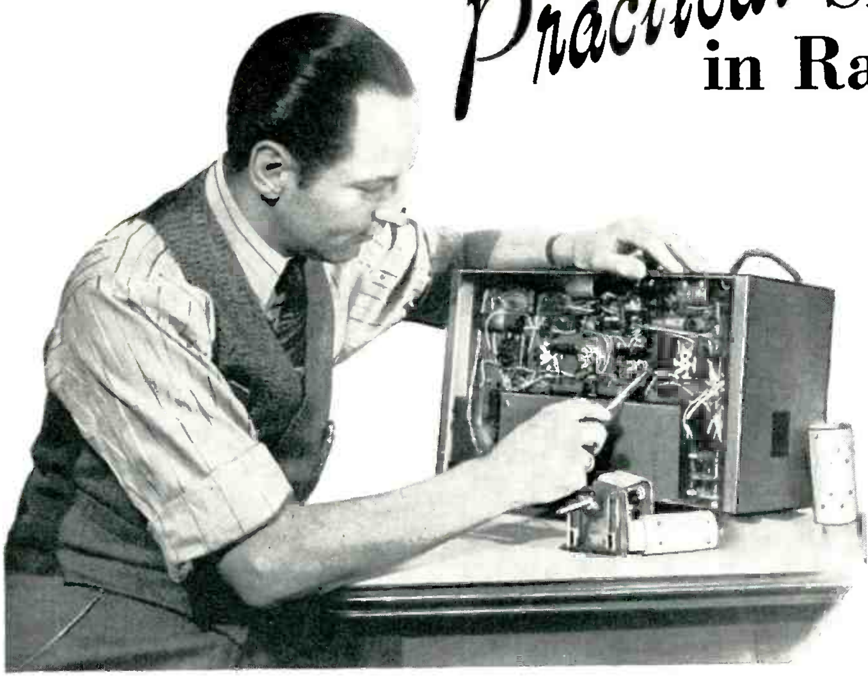
From Page 15

to paying a flat fee of $50.00 or so for the erection of a proper antenna, adjusting the set to maximum efficiency, and instructing the customer in its use. This flat fee may seem a bit on the high side, but bear in mind that the services of a helper will be necessary in erecting the television antenna. In some instances this installation fee may be included in the purchase price quoted by a television dealer, in which case the dealer will pay a serviceman to handle the installation proceedings.

Hourly rates for servicing television receivers will naturally have to be higher than those quoted for repair work on pre-war and immediate post-war sets. Under present conditions, a service charge of $4.00 per hour is not exhorbitant when it is considered that such work will have to be performed by two men working together. Shop servicing will be possible only after a preliminary examination in the home to determine that faults in the performance of the set are not due to local conditions. Essentially, this means that shop route-men must be trained radiomen who can make the preliminary check-up without difficulty. Veterans with radio knowledge would make excellent route drivers, since they might be better satisfied with outdoor work. If a set needs shop attention, it is probable that it will be a two-man job to load it into the truck, and when ready to return, the two-man team is again necessary.

Summing up, there are a number of lines in which the radio serviceman must make definite plans now if he intends to make a success of the next few years. He must become technically proficient in all the new devices that are on the horizon of radio — television, F-M, facsimile, civilian radio communication — and other electronic applications. He must conduct his business on a sound economic basis, watching the outgoing pennies and the incoming dollars as carefully as a banker. He must find ways of attracting new business, of handling the business he gets, and of keeping all his old customers satisfied. A big job? Yes, indeed, but one in which there is a lot of personal satisfaction, a lot of enjoyment to the serviceman who is genuinely interested in radio as a hobby as well as a business, and the certainty of a good income as long as there is radio and the long list of allied arts. But to enjoy these benefits, the serviceman must get ready, and get ready NOW! √ √

Practical SHORT CUTS in Radio Servicing



THE servicing problems that come up daily in each repair shop and are solved right at the bench are naturally the ones of greatest interest to the practical serviceman. However, each repair shop is isolated from the next one; the question is how to make available to hundreds of servicemen the special procedures and time-saving methods developed by others.

Realizing this, and realizing also that people who make their living fixing radios are the ones best qualified to tell about it, RADIO MAINTENANCE is offering a prize of a $100 War Bond with each issue for the best and most practical servicing short-cut submitted to this department.

Elsewhere in this issue, Mr. Pace, of Vicksburg, Miss., writes, "In the early days of radio, a man who was capable of repairing a radio receiver conceived the idea that all he knew about the business was best kept to himself." Most of us do not hold with this attitude, although there are probably still some servicemen who follow that policy.

Actually, this prize offer is not made to flush that type of serviceman out of his cover. We think that pooling service ideas and suggestions is one good way to help each other.

Another point is that servicing problems will vary somewhat with locality, or with climate. The radio man in Riverside, California, may have a different set of problems from those faced by the man in New York City. For example, there are no D-C power lines in Riverside so he does not make a service call just to reverse a line plug. On the other hand, Riverside happens to be on the fringe of the ground wave service area of most of the big Los Angeles stations, and fading between ground and sky waves gives rise to a peculiar type of distortion.

Repairmen facing these special problems are probably more apt to devise new and effective methods of servicing. However, the yardstick for measuring the value of a servicing short-cut will be its general interest to repairmen everywhere and its widespread application; in other words, will the servicing method suggested apply to a similar breakdown in various makes of receivers operating almost anywhere in the country?

Even if you do not win the War Bond prize, it is possible that your suggestion will be of sufficient interest to warrant publication here. If so, you will be paid for it at space rates. If you have a longer story of general interest, send it in too. Remember that schematics and diagrams take up space, and furnish sufficiently clear sketches to enable them to be suitably redrawn for reproduction.

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.

$100 PRIZE CONTEST

For each issue **RADIO MAINTENANCE** *Magazine* will award a **$100 WAR BOND** to the Radio Repairman who sends in the best and most practical Servicing Short-Cut idea to this department.

RULES

1. All entries must be received by the 15th of the second month preceding each issue. 2. All entries should be accompanied by diagrams where required for clarity. 3. Decision of the publishers is final. 4. Winner will be announced in this column, and winning entry becomes the property of Radio Maintenance Magazine. Any entry considered of interest will be accepted at current space rates if used.

DEPARTMENTS AND FEATURES IN THE NEXT ISSUE

October, 1945

HOW DID YOU GET THAT WAY?

How did you get to be a radio serviceman? Were you an engineer or a "ham," or did the Signal Corps or the Navy introduce you to radio? Be your own press agent — get some publicity for yourself and your shop. Simply send us a biographical sketch telling your background and what started you in radio, together with a good glossy photo of yourself, and others of your shop, service bench — anything you think of interest to other servicemen. We'll write the story around your sketch, and pay $10.00 for each one used, to offset the cost of the photos. In addition, we'll send you the cuts after the magazine is printed.

SYMPOSIUM ON TEST EQUIPMENT

Gathered together in one place, complete data on meters, tube testers, signal generators, oscillographs, signal tracers, and other test equipment, will simplify selection for your post-war shop. Many of the items listed may not be available for some time, but complete information, priority requirements, delivery time, and date of readiness for new items will all be listed. Look for it in the next issue of RADIO MAINTENANCE, out October first.

SEEK & OFFER DEPARTMENT

For those hard-to-get replacements, that out-of-stock condenser bank, that unusual power transformer — and as a way to get rid of those surplus parts from dismantled sets now taking up valuable shelf space, we offer a new service. Here's how it works: Make a list of your needs, and a list of your surplus items — parts, tubes, and test equipment — and send it to Seek & Offer Department. We will cross-check them, and notify the seeker by postcard of the offerer of desired items. In addition, we will compile weekly a list of these items and circulate it through New York's extensive Radio Row, where millions of parts are available. No charge for this service — just send your shortage and surplus lists and we will do the rest.

BOOK DEPARTMENT

A fairly complete list of radio books, with a brief description of each, will be a feature of the next issue. Beginners' books, servicing books, experimenters' books, builders' books, engineers' books, scientists' books, hand books, pocket books, reference books, big books, little books, pamphlets, circulars, data sheets — anything that will aid the radioman. Author, editor, publisher, price — everything you need to know about radio books, compiled in one list.

ANTENNAS FOR F-M and TELEVISION

What kind of antennas will give the listener or looker the best reception — and how to install them. Design data for multi-lobe antennas to permit best reception from several stations, simple dipoles, transmission lines — another "how" article to enable you to make more profitable installations and to create more customer satisfaction. Look for it in the next issue.

Is your copy of RADIO MAINTENANCE addressed correctly?

See Page 30

THESE 10 CONTROLS REPLACE 95%

N. U. *Sav-a-Shaft* VOLUME CONTROLS

If you haven't already put in a stock of N.U. Save-a-shaft Volume Controls . . . order yours today from your N.U. Distributor. Here's a real time-saver he can deliver fast! Minimum investment in stock of only 10 types is all you need to get going. NATIONAL UNION RADIO CORPORATION, Newark 2, N. J.

7 REASONS WHY

1. 10 types handle over 95% of your volume control replacement needs.
2. Eliminates shaft sizing and knob fitting.
3. Adaptable to any standard shaft.
4. Controls are complete with switch.
5. If no switch is needed, use same control but don't pull switch lug.
6. Individually packaged with instructions.
7. All sizes $1.00 list price.

NATIONAL UNION RADIO TUBES AND PARTS

Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs

To those who wonder why we need still bigger War Loans

In the 7th War Loan, you're being asked to lend 7 billion dollars—4 billion in E Bonds alone.

That's the biggest quota for individuals to date.

Maybe you've wondered why, when we've apparently got the Nazis pretty well cleaned up, Uncle Sam asks you to lend more money than ever before.

If you have, here are some of the answers:

This war isn't getting any cheaper

No matter what happens to Germany—or when—the cost of the war won't decrease this year.

We're building up a whole new air force—with new jet-propelled planes and bigger bombers. We're now building—even with announced reductions—enough new ships to make a fair-sized navy. We're moving a whole war half around the world. We're caring for wounded who are arriving home at the rate of one a minute.

Furthermore, there will be only 2 War Loans this year—instead of the 3 we had in 1944.

Each of us, therefore, must lend as much in two chunks this year as we did last year in three. That's another reason why your quota in the 7th is bigger than before.

The 7th War Loan is a challenge to every American. The goal for individuals is the highest for any war loan to date. The same goes for the E Bond goal. Find your personal quota—and make it!

THE MIGHTY 7th WAR LOAN

ALL OUT FOR THE MIGHTY 7th WAR LOAN

BOLAND & BOYCE, INC.

PUBLISHERS