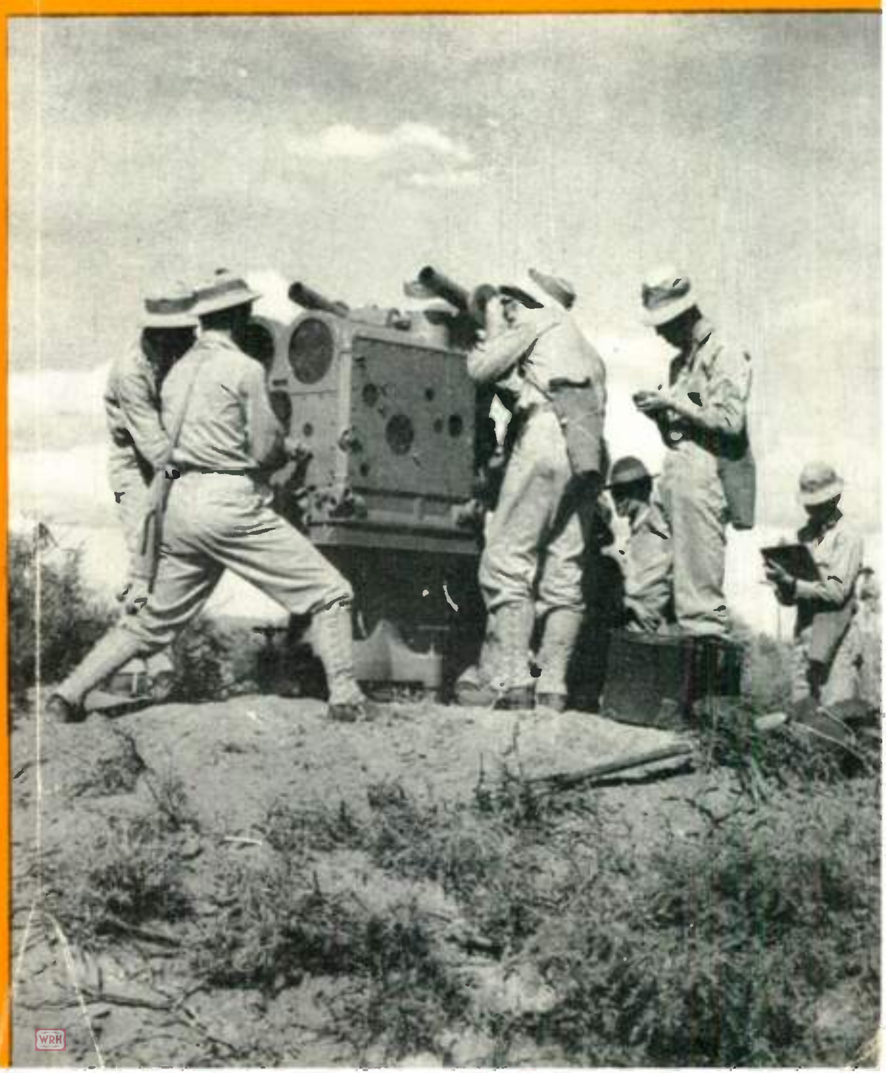
Radio

SEPTEMBER 1942

SERVICE DEALER

This Month



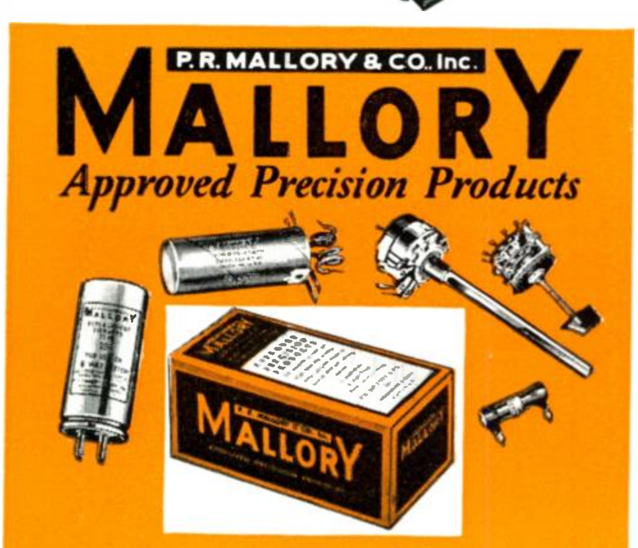
The Book of This Month . . .

The new MYE TECHNICAL MANUAL has received a hearty welcome from radio servicemen, amateurs, engineers, experimenters . . . and in training centers of the Army, Navy and Marine Corps.

But we're calling it "the book of this month," because September is when many business men start planning for the active autumn season ahead. In the radio business, alert men are thinking constructively and reading the best technical literature available. That's why, as you read over the list of chapter headings below, you'll put the MYE TECHNICAL MANUAL on your list of "must" reading . . . as thousands of others already have.

1 Loud Speakers and Their Use
2 Superheterodyne First Detectors and Oscillators
3 Half-Wave and Voltage Doubler Power Supplies
4 Vibrator and Vibrator Power Supplies
5 Phono-Radio Service Data
6 Automatic Tuning—operation and adjustment
7 Frequency Modulation
8 Television—suggestions for the postwar boom
9 Capacitors—how to overcome war shortages
10 Practical Radio Noise Suppression
11 Vacuum Tube Voltmeters
12 Useful Servicing Information
13 Receiving Tube Characteristics—of all American tube types

This manual is as valuable as a voltmeter, according to some of the outstanding servicemen who are using it daily. It contains 392 pages of down-to-earth, practical information. It bridges the gap between radio theory and actual practice. But the supply of MYE TECHNICAL MANUALS for civilian use is limited. Soon copies may be scarce. See your Mallory Distributor today—get your Manual now!



P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA

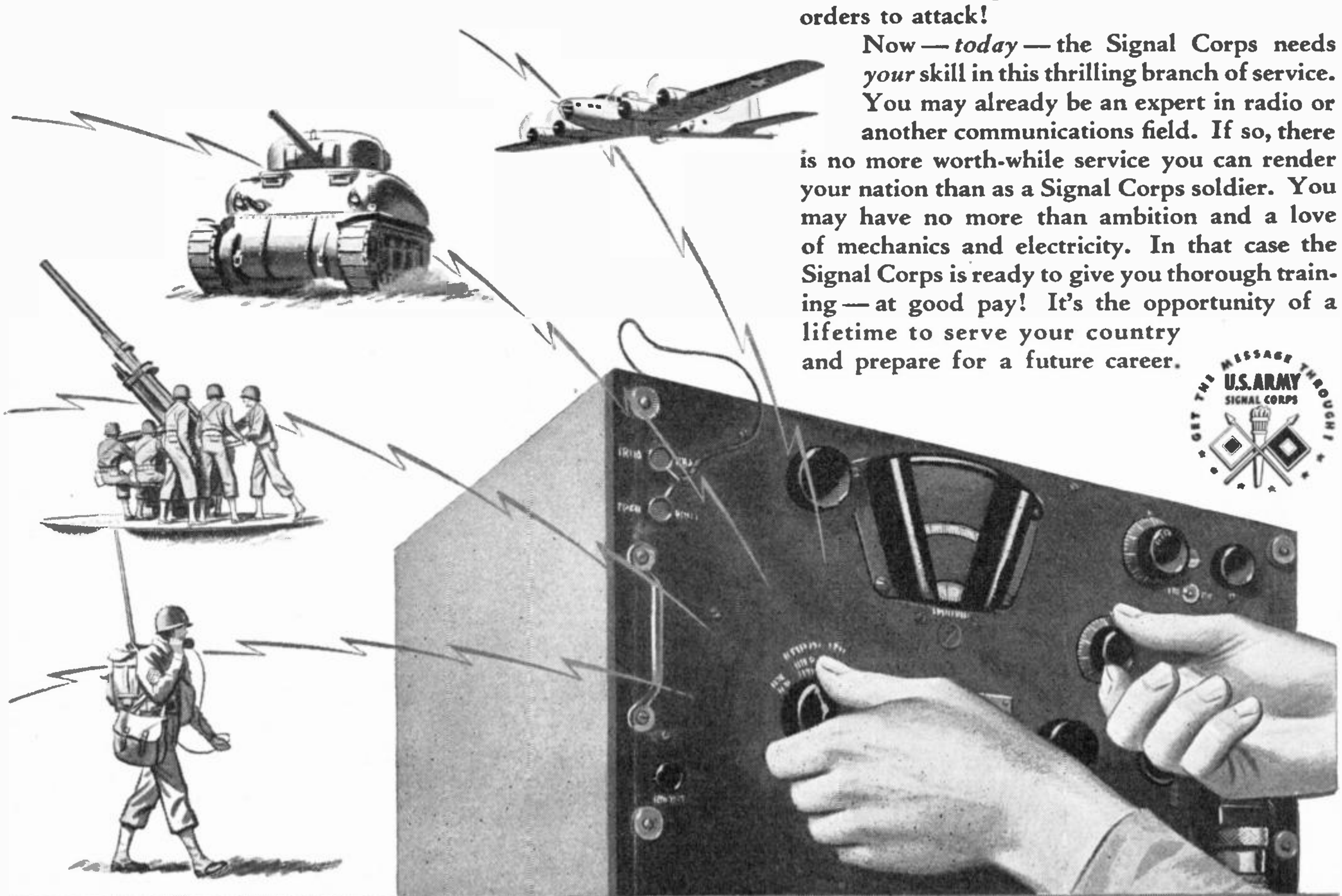
Cable—PELMALLO

The "Nerve Center of the Army" needs your skilled hands TODAY!

THIS is a war of speed — a radio war. Commands and messages must go through like lightning. Never have communications been so vital to victory, or have new devices meant so much.

The whole responsibility for "getting the message through" is in the hands of the U. S. Army Signal Corps. Hands that install and maintain countless thousands of radio sending and receiving sets — hands that adjust the marvelous mechanisms of America's newest and most secret weapons — hands that flash the orders to attack!

Now — *today* — the Signal Corps needs *your* skill in this thrilling branch of service. You may already be an expert in radio or another communications field. If so, there is no more worth-while service you can render your nation than as a Signal Corps soldier. You may have no more than ambition and a love of mechanics and electricity. In that case the Signal Corps is ready to give you thorough training — at good pay! It's the opportunity of a lifetime to serve your country and prepare for a future career.



HOW YOU CAN GET IN NOW

1. ENLISTMENT

If you are 18 to 45 and physically fit, you may apply for enlistment in the Signal Corps or in the Signal Corps Enlisted Reserve.

DIRECT ENLISTMENT: Experience as a licensed radio operator, a trained radio repairman, a telephone or telegraph worker, will qualify you for active duty at once. From Private's pay you can advance rapidly as you earn higher technical ratings—up to $138 a month, with board, shelter and uniforms.

ENLISTED RESERVE: If you are skilled with tools but lack qualifying experience, you may enter the Enlisted Reserve. You will be given training, with pay, in one of the many Signal Corps schools, and ordered to active duty when you have completed the course.

COMMISSIONS: Graduate Electrical Engineers may apply for immediate commissions in the Signal Corps. And special opportunities for training and commissions are open to Juniors and Seniors in electrical engineering colleges.

2. CIVILIAN TRAINING

If you are over 16 years of age, and even though registered for Selective Service, have not received your order to report for induction, the Signal Corps offers you an outstanding opportunity.

If you have ability with tools—if you want to secure training in the vitally important field of communications—you may attend a school in or near your home city. You will be paid not less than $1020 per year *while learning*. And when you have finished your training—in 9 months or less—you can advance to higher pay as your technical skill increases.

Even if you have a minor physical handicap, Signal Corps Civilian Training may give you the chance you've wanted to serve the Army of the United States.

"KEEP 'EM FLYING!"

U. S. Army

FOR FURTHER INFORMATION REGARDING ENLISTMENT — Call and talk this over at the nearest Army Recruiting and Induction Station. Or write to: "The Commanding General," of the Service Command nearest you:

First Service Command	Boston, Massachusetts
Second Service Command	Governors Island, New York
Third Service Command	Baltimore, Maryland
Fourth Service Command	Atlanta, Georgia
Fifth Service Command	Fort Hayes, Columbus, Ohio
Sixth Service Command	Chicago, Illinois
Seventh Service Command	Omaha, Nebraska
Eighth Service Command	Fort Sam Houston, Texas
Ninth Service Command	Fort Douglas, Utah

Or write to: Enlisted Branch, AH-1, A.G.O., Washington, D. C.

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FOR CIVILIAN TRAINING INFORMATION — Call at any office of the U. S. Civil Service or U. S. Employment Bureau.

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SOUNDMAN AND JOBBER
Reg. U. S. Pat. Off.

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Ad Index

Contents

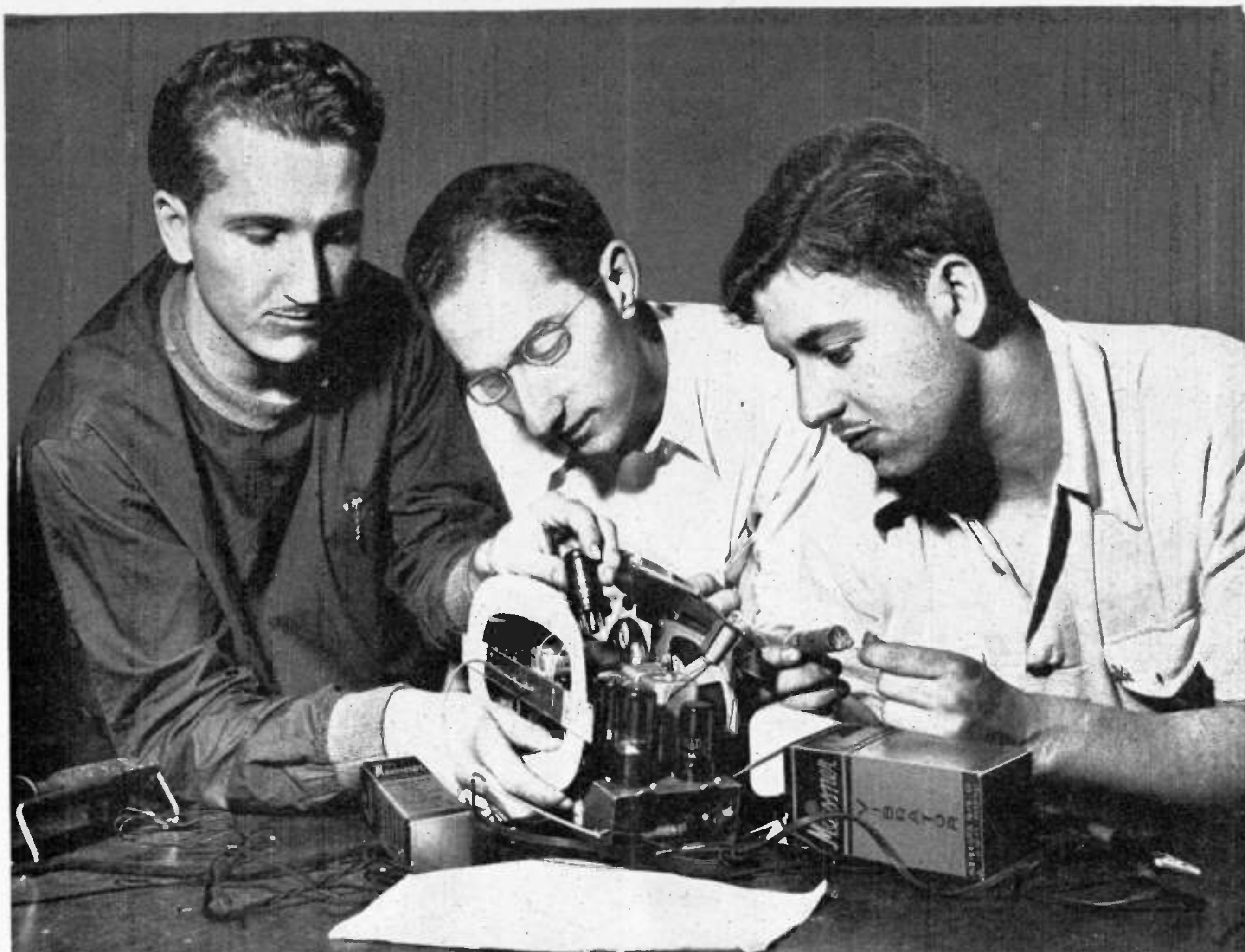
Cover Picture

ANTI-AIRCRAFT DETECTOR

(Official U. S. Signal Corps Photo)

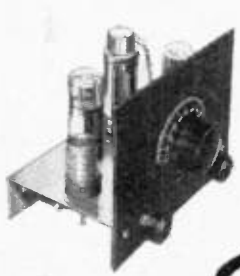
Radio is the "Eyes and Ears" of the mighty U. S. military forces. No technical data may be published.

RADIO SERVICE DEALER, published monthly at 34 N. Crystal Street, East Stroudsburg, Pa., by the Cowan Publishing Corp., Executive and Editorial Offices at 132 W. 43rd Street, New York, N. Y. Subscription rates—United States and Possessions, $2.00 for 1 year, $3.00 for 2 years; elsewhere $3.00 per year. Single copies 25c. Printed in U.S.A. Entered as Second Class Matter October 3, 1941, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.



Train 'em Faster with MEISSNER RADIO KITS

Signal Corps Schools know that in order to speed up radio training they must use kits that have been specially designed for student training purposes . . . Meissner radio kits are precision engineered for classroom use, saving valuable time for both instructor and student. Meissner pictorial Wiring diagrams simplify construction problems in basic radio training.



Meissner one, two and three tube add-on Kits are ideal for the beginner in classroom work . . . starting with a one tube Kit, students can, with the add-on features, construct two and three tube receivers—available for both AC and DC operations. Six and nine tube kits are available for the advanced student.

See your Meissner distributor for special SCHOOL NET PRICES

Meissner

MT. CARMEL, ILLINOIS

"PRECISION BUILT PRODUCTS"


Tom is meeting familiar faces
EVEN 'OVER THERE'
TOM'S background in radio now stands him in good stead in the Signal Corps. Starting as a "ham", then a communications engineer . . . he knows how to spot and correct trouble. From the day he "joined up" he's been thoroughly at home in his new job. Even the test instruments he works with are duplicates of those in the shop back home. They bear the same name he's always banked on for measurement dependability since he built his first "ham" transmitter. And now that he's abroad, he's surrounded by these same familiar instruments even on the equipment and in the repair depots of our allies. For throughout the allied countries, too, the mark WESTON is the accepted symbol for dependable electrical measurement. Weston Electrical Instrument Corporation, 605 Frelinghuysen Avenue, Newark, New Jersey.
Priority restrictions have necessarily greatly curtailed the supply of WESTON instruments for many industrial needs. Uncle Sam stands firmly at the head of the instrument line!
To the great majority of instrument users not now engaged in war production, however, this has meant little, if any, inconvenience. The WESTONS they now have in service will see them through for the duration and beyond. Long-life dependability is built into every instrument bearing this name.
WESTON INSTRUMENTS
Laboratory Standards • Precision D-C and A-C Portables • D-C, A-C, and Thermo Switchboard and Panel Instruments • Instrument Transformers • Sensitive Relays • Specialized Test Equipment • Light Measurement and Control Devices • Exposure Meters • Aircraft Instruments • Electric Tachometers • Dial Thermometers

TRANSIENTS

MORE GASOLINE

THE WAR PRICE AND RATIONING BOARD of OPA just announced that "radio servicemen employed by dealers are eligible for 'C' gasoline ration books provided they do not use their automobiles to pick up and deliver portable receivers." That is fine! Note however that the Order does not specify that an "Independent Radio Servicing Organization" or an "Independent Radio Serviceman" is entitled to a "C" book. To our mind this is purely an oversight on the part of WPRB or due to a lack of knowledge of the industry's terminology. One way to get around this with your Ration Board if an independent serviceman is this: When asked to name the type of business you are in, state that you are a *Radio Service-Dealer* rather than an independent serviceman or servicing organization. This slight change in naming your type of occupation makes you eligible for a "C" card. If you have any difficulty with your Ration Board advise us at once. We still consider it a part of our job to help fight your battles for you. And incidently, abide by the WPRB restrictions carefully. Insist that owners of portables bring them in for servicing. Don't try to repair cumbersome consoles and heavy jobs in the home. Use your "C" gasoline ration for this sort of pickup and delivery.

RACKETEERS

Until recently only a few radio set manufacturers jobbed their own brand of replacement parts. When civilian set production was stopped a few set manufacturers suddenly recognized that servicemen are their "friends", so, grasping for straws with which to survive, they announced that they would sell direct and through their distributors their own private brand of replacements, especially exact-duplicate replacements for their old models, which they had on hand. Now some of these set manufacturers are making a racket of their replacement parts sales divisions. When a service-dealer orders a part listing at $2 or $4 he is advised that "no orders for less than $5 *net* can be handled." Another subterfuge is to advise men who place small orders that "we are out of that part just now but will fill your order soon" and then let him wait and wait ad infinitum. Don't tolerate such outrageous, racketeering practices! Do business with your regular jobber. If he cannot supply you with a part that will meet your needs, and if you can't fix the set by means of your own ability and substitution, explain all the facts very truthfully to your customer and tell him that he has bought a set made by a racketeering, opportunist manufacturer. Such advertising will put the set manufacturer where he belongs now and later—in some business other than radio.

QST BY UNCLE SAM

Please read page 1 in this issue *very* carefully. It is a paid advertisement by the U. S. Army on behalf of the Signal Corps and refers to enlistment therein. Having read this message we are sure your heart will swell with a certain amount of pride, as did ours, because our Government frankly states, "This is a war of speed—a radio war." You and we are a part of the radio industry. Many thousands of our friends, co-workers, competitors and contemporaries have already answered our Country's call for radiomen of all types. To insure final Victory many more thousands of us must do much more in the war effort. This is *our war*—a radio war—and whether we wear khaki or civilian dungarees makes no difference as long as we each contribute our utmost. Read this Army "help wanted" advertisement again and reflect seriously as to whether or not you can find some means whereby at least some part of your time can be used to good advantage by some branch of the Signal Corps. There are civilian and part-time jobs near home for men who have family responsibilities. There are commissions and active jobs for men with no family ties. All are important jobs. Everything considered, the pay scale is pretty good and you are bound to acquire knowledge about radio and Radar that will be worthwhile in the post-war period.

Servicing By Signal Injection

by JOHN H. POTTS

ELSEWHERE in this issue you will find a discussion of signal tracing and the apparatus used to trace signals. For those who have recently become interested in this modern method of trouble shooting and find it difficult to obtain suitable equipment, information on one of the fore-runners of the signal tracing system may be useful. The method to be described has been termed signal substitution by some writers and, earlier, the oscillator-output meter method. But we believe it is more accurately designated as signal injection, since we do inject a signal into the circuit chosen when using this method.

Fundamentally, the signal injection method is precisely the opposite of present-day signal tracing. In signal tracing, the signal is fed to the antenna post of the receiver under test and traced, stage-by-stage, from the antenna to the speaker. In signal injection, we feed the signal to the output of the receiver first, thence, stage by stage, back to the input. Signal injection has advantages in that it permits dynamic testing with a minimum amount of equipment, but has limitations in that the variety and scope of tests which are possible are limited by the type of equipment used and by practical obstacles in the application of the method itself. Further, it should be remembered that the average signal tracing instrument is equipped to perform other functions besides signal tracing, such as voltage measurements and power consumption tests. However, signal injection, properly used, can supply much valuable information in a minimum of time and, as a means of localizing certain types of defects, is rivaled only by signal tracing.

Testing Inoperative Receivers

The application of this method can be readily understood from a consideration of *Fig. 1.* Here we show the audio section of a typical radio receiver, with various test points numbered consecutively in the order of test. To apply this method, a signal is fed first to the output transformer secondary. Because this is an audio circuit an audio signal must be used, which may be obtained from an a-f signal generator, as shown, or from the 400-cycle modulating voltage used in r-f signal generators. For those who do not possess signal generators which can supply an audio signal externally, this need can be very simply met by using an ordinary filament transformer connected to the 60-cycle line supply. By shunting a potentiometer across the low voltage secondary, it will be possible to adjust the signal strength to any desired level.

When the signal is fed to *point 1* (the return circuit is connected to ground in all cases) the tone should be heard in the speaker. If no sound is heard, then the trouble is immediately localized in the speaker and an examination of the voice coil is in order. However, if a signal is heard, we know that the speaker is functioning and tests may proceed to the next point. This is designated as *point 2,* at the plate of the output tube.

When injecting our audio signal at *point 2,* we are taking in the loudspeaker and the output transformer. Since the loudspeaker has already been eliminated as a source of trouble by the test at *point 1,* any failure of the signal to reach the speaker when injected at *point 2* must be due to some fault in the output transformer. And again the trouble is localized. Note that a blocking condenser is necessary in feeding the signal to points in the circuit where d-c voltages are present. Usually a value of the order of 0.1 mfd will be satisfactory, with a working voltage of 600 d.c. When feeding 60-cycle signals into voice coil circuits, a higher value of capacitance is preferable to prevent excessive attenuation. However, this may be allowed for in making the test.

When feeding the signal to *point 3,* the grid of the output tube, amplification should take place, so the output signal will be considerably stronger than it was when fed to *point 2.* If the set we are testing is inoperative, we are not particularly concerned with the amplitude of the signal; we know that no signal gets through, and the primary object of our test is to find out what causes complete elimination of the signal, not just a reduction in signal strength. So the fact that a response is obtained when the signal is fed to *point 3* is sufficient proof that the tube is functioning properly, if the set is inoperative.

Proceeding further, when we feed the signal to *point 4* it need only pass through the coupling condenser in order to reach *point 3;* so any signal failure at *point 4* must be caused by an open-circuited coupling condenser.

The last points of test in the audio system are at *5* and *6.* At *point 5,* the output signal should be considerably stronger than at *point 4,* due to the amplification of the first a-f tube. At *point 6,* the signal output should be the same as when injected at *point 5.* Again, the coupling condenser is tested when the signal in injected at *point 6.*

In the above discussion, we have assumed that we are testing an inoperative receiver. We haven't concerned ourselves with anything else. It is possible that the set does perform after a fashion, but the signal is weak. In

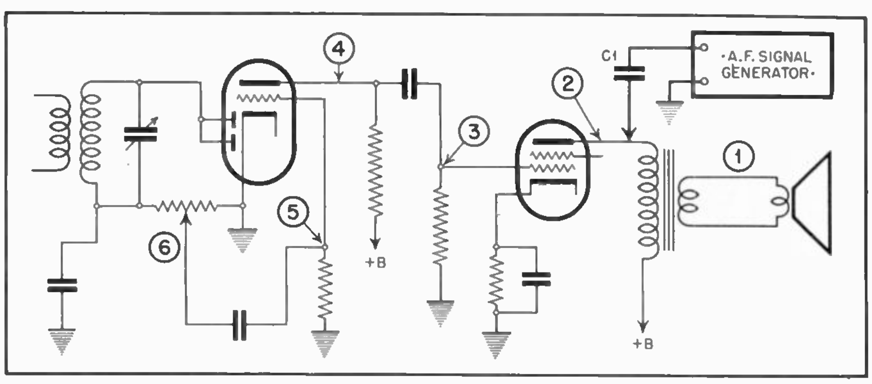


Fig. 1. The audio section of a typical receiver. The numbered points are test points where the audio signal is to be injected.

this contingency, the signal will be heard when injected at each point along the line. But it may be weaker than it should be. Just how strong the output signal should be when a signal of known strength is injected in any circuit depends upon the amplification or gain of the stage or stages between the point where the signal is injected and the output. Typical values are given in *Table 1.*

In the average receiver, the overall gain of the audio amplifier is such that an 0.05 to 0.1-volt signal at the grid of the first a-f tube will produce 1-watt output at the speaker. You can obtain the .05 or .1 volt signal by using a voltage divider across the output of the audio signal source and measuring at a higher level, readable on the a-c voltmeter which every service shop has on hand. A suitable voltage divider is made by shunting a 10,000 ohm potentiometer across the audio output of the signal source. If you adjust the potentiometer so the resistance between moving arm and ground is 500 ohms, the output voltage will be .05-volt when the voltage across the whole potentiometer is 1 volt. Similarly, at 1000 ohms, the voltage output will be 0.1 volt.

Alternate Gain-Checking Method

Another simple way of checking overall gain is to use a phono turntable and record. If the output level is adjusted to give a good, strong signal when fed to the audio input of a normally operating receiver, we can tell by comparison whether the receiver under test gives equivalent output. In the absence of an oscillograph the phone record will provide a valuable signal source for checking for distortion in the a-f amplifier.

The audio output in watts is determined by the formula:

$$W \text{ (watts)} = \frac{E^2}{R} \text{ or } E = \sqrt{RW}$$

where E is the audio voltage measured across the voice coil (or across a resistance similar in value to the voice coil impedance at 400 cycles which has been substituted for the voice coil. This resistance is designated as R in the formula). Thus if the voice coil is a 2-ohm type, 1 watt output is obtained when the voltage across it is $\sqrt{2 \times 1}$, or 1.41 volts.

If tests of the audio amplifier indicate satisfactory performance, we may proceed to check the balance of the receiver. Because we will now have to deal with circuits which are designed for radio or intermediate frequency signals, it will be necessary to use a signal generator capable of supplying signals of the proper frequency for the tests required. Again, as is shown in *Fig. 2,* our tests commence with the last circuit preceding the audio section, rather than the first, as is the case with conventional signal tracing technique. A modulated signal at the intermediate frequency should be applied (through a condenser which need **not** be greater in capacity than .01 **mfd)** starting at the detector stage. This signal will undergo rectification and be produced in the speaker output provided the detector circuit is functioning as it should. It may be necessary, in some circuits, to insert a high resistance in series with the signal generator (about 0.1 megohm) to overcome the loading effect of its introduction into the detector circuit. A very strong signal is required.

If a signal output is obtained from the speaker, tests continue by injecting the signal at *point 2.* If no trouble is evident, proceed to *point 3.* Here the gain of the last i.f. tube will cause a considerable increase in output. The gain may be of the order of 100 in this circuit. At *point 4,* the signal output should again be the same as at *point 3.*

The Output Stage

We are now at the output of the mixer tube. When we feed a signal to the input of the mixer with the signal generator tuned to the intermediate frequency, we check the operation of the mixer as an i.f. amplifier. This is the first test which should be made at *point 5.* If satisfactory output is obtained, the test oscillator signal frequency may be adjusted to some point in the broadcast band, say 600 kc, and the receiver under test tuned to the 600 kc signal. With the test oscillator still connected to *point 5,* it should be possible to obtain an audio output signal, just as was obtained with the test oscillator tuned to the intermediate frequency. If no sound is heard, the oscillator section of the mixer is inoperative . . . or badly off frequency.

A dead oscillator section of the converter is a rather common trouble; it may be checked for immediately by feeding a signal (unmodulated) at the frequency at which the oscillator is

(Continued on page 24)

TABLE I

AVERAGE GAIN-PER-STAGE VALUES

The gain-per-stage figures listed below are average and are based on the assumption that the receiver avc system is not operating. The avc action will reduce the r-f, mixer and i-f stage gains. For comparison purposes, a weak signal should be used or the avc action temporarily shorted out.

In the a-f section, for resistance-coupled amplifiers, the lower gain figures represent average gains for a-c/d-c receivers while the higher gains apply to a-c operated receivers.

R-F SECTION	
Antenna to grid of first tube	2 to 10
Antenna to grid of first tube (auto-radios	10 to 50
R-f amplifier, superheterodynes	10 to 40
R-f amplifier, t-r-f receivers	50 to 100
MIXER SECTION:	
Converter grid to i-f grid (1-stage i-f amp.)	30 to 60
Converter grid to i-f grid (2-stage i-f amp.)	5 to 20
I-F SECTION:	
I-F Stage (1-stage amp.)	40 to 150
I-F Stage (2-stage amp.	5 to 20
BIASED DETECTOR:	
PENT/DES (Types 57, 6C6, 6J7)	
A 1.0 volt rms signal (modulated 20%) at the grid will produce approximately 10 volts rms of a-f at the plate. Higher modulation percentages will produce correspondingly higher a-f voltages. Thus, 40% modulation will produce 20 volts rms of a-f at the plate.	
A-F SECTION:	
MEDIUM-MU TRIODES, RESISTANCE-COUPLED:	
Type 6N7, 6C8 (each section)	20 to 25
HIGH-MU TRIODES, RESISTANCE-COUPLED:	
Type 75, 2A6, 6F5, 6SQ7	40 to 55
PENTODES:	
Type 2B7, 6B7, 6B8	50 to 80
Type 6F6, 2A5, 47, 6V6, 6K6, (Grid-to-plate gain)	8 to 20
TRIODE OUTPUT TUBES:	
Type 2A3, 45, 71A, 6A5G	2 to 5

This table appears in Servicing By Signal Tracing, *by John F. Rider, and is reproduced by permission of the author.*

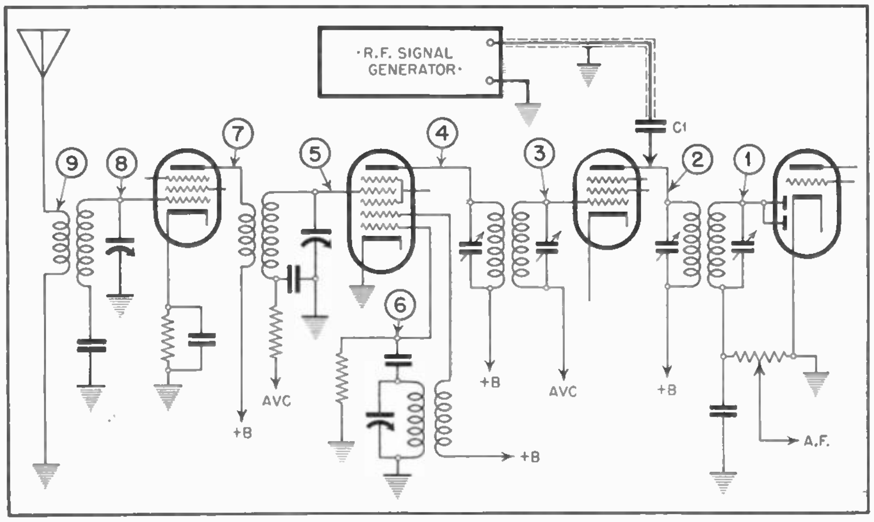


Fig. 2. The r-f and i-f sections of a typical receiver. Testing starts with the last circuit in the i-f section.

FUSES—Simple Devices Embodying Much Science

PART 2

by E. V. SUNDT

Interesting facts which everyone having to do with aircraft and instrument fuses should know

Voltage Rating

Fuses are rated at the voltage which they will break without arcing or bursting. This is generally assumed to be in a direct current system with a theoretically unlimited current supply. Approximately speaking, a fuse will break on two or three times as high a voltage, on commercial 60 cycle a-c, as on d-c; the difference becoming less on higher amperages.

Reliable instrument fuses may be used on 250 volt d-c or a-c. The smaller sizes particularly may be used on much higher voltages where there is considerable circuit resistance to act as ballast. The tendency to arc drops rapidly with (1) the speed that the fuse blows, (2) with increase in resistance and (3) as the current values are diminished.

Standard Fuse Sizes

The standard designations indicating various types and fuse dimensions require some explanation. The term "AG" always indicates a glass-enclosed fuse. The designation system was evolved by the fuse industry over some 30 years and was not planned—therefore the lack of relationship between sequence and size. The following are standard in the United States and Canada:

1 AG—Glass inclosed fuse—⅝" x ¼" dia. Too small for safety except on low current voltages. Used for 4 amp. rating in SFE fuses.

2 AG—Glass inclosed fuse—1 3/16" x ¼" dia. This size obsolete, superseded by the 3 AG.

3 AG—Glass inclosed fuse—1¼" x ¼" dia. Popular size. Used for radios, auto radios, amplifiers, fractional h.p. motors, magnets, etc. Also for 20 amp. SFE fuses.

4 AG—Glass inclosed fuse—1¼" x 9/32" dia. Especially good for aircraft service. High mechanical strength resistance to fatigue and long vibration are their outstanding characteristics.

5 AG—Glass inclosed fuse—1½" x 13/32" dia. Also designed for aircraft. (4 AB and 5 AB fuses are bakelite inclosed; recommended where severe overloads might shatter glass.)

6 AG—2" x 9/16" dia.—not used.

7 AG—Glass inclosed fuse—⅞" x ¼" dia. Seldom used. Largely superseded by 8 AG. Used for 9 amp. rating in SFE fuses.

8 AG—Glass inclosed fuse—1" x ¼" dia. Popular size. Used for the protection of delicate equipment, such as galvanometers, microammeters, radio tubes, etc.

9 AG—Glass inclosed fuse.—17/16" x ¼" dia. Used for SFE 30 amp. fuse.

SFE—Glass inclosed fuse. All are ¼" dia. having a different length for each amp. rating. Lengths and corresponding ratings are as follows:

4 amp. —⅝"—(1 AG)
6 " —¾"
9 " —7.8"—(7 AG)
14 " —1 1/16"
20 " —1¼"—(3 AG)
30 " —1 7/16"—(9 AG)

Industrial Fuses

Most fuses for service in industrial applications of 5 amperes and up, and 250 volts and up, are fibre enclosed (designed as "AB") to prevent shat-

Fig. 16. A Bakelite Enclosed Fuse 4 AB Aircraft Type.

tering of the fuse body on severe overloads. (See National Electric Code regulations outlined in Part One of this article, *Radio Service-Dealer*, August issue.)

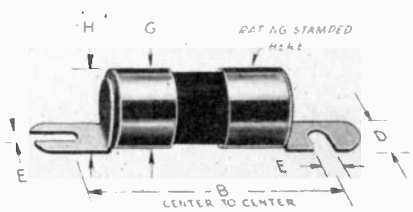


Fig. 17. Army Air Corps Fuse, fibre enclosed type. Drawing shows dimension letters for following tables:

ARMY AIR CORPS FUSES

(Fibre enclosed—non-renewable)

A.C. No. 32084—Rating 125 volts

A.C. No. 32084-B (General Protective Purpose)

AMPERE RATINGS (Standard ratings given)	GENERAL DIMENSIONS B	C	D	E	H
1, 2, 15 Amps.	2¼"	9/16"	½"	17/64"	19/32"
20, 30 Amps...	2½"	9/16"	⅛"	17/64"	19/32"
35, 50 Amps...	3 "	13/16"	11/16"	17/64"	55/64"
70, 100, 120 Amps.	3½"	1-1/16"	11/16"	17/64"	1-5/64"

32084-B General Current Characteristics

Fuse must carry 110% of rating indefinitely. Fuse must blow at 150% of rating as follows: 1 min. 0-30 Amps. 2 min. 31-60 Amps. 4 min. 61-100 Amps. 6 min. 101 to 120 Amps.

AC-32084-C (Protection of Army Aircraft Motor Circuits)

5, 10, 15 Amps.	2¼"	9/16"	½"	17/64"	19/32"
20, 30 Amps...	2½"	9/16"	½"	17/64"	19/32"
35, 50 Amps...	3 "	13/16"	11/16"	17/64"	55/64"
70, 100 Amps..	3½"	1-1/16"	11/16"	17/64"	1-5/64"
150, 200 Amps.	3⅝"	1-1/16"	¾"	19/64"	1-1/8 "
250, 300 Amps.	3⅞"	1-1/16"	13/16"	21/64"	1-5/32"

32084-C General Current Characteristics

Fuse must carry 110% of rating indefinitely—blow 125% of rating in 2 hours—hold 200% of rating for 90 seconds—blow on 200% in 8 minutes.

AC-32272 (General Protective Purposes)

30, 35, 50 Amps.	2½"	9/16"	½"	17/64"	19/32"
70, 100, 120 Amps.	2¾"	13/16"	11/16"	17/64"	55/64"

32272: General Current Characteristics

Fuses must carry 110% of rating indefinitely—blow 125% of rating in 2 hours—hold 200% of rating for 20 seconds—blow on 200% in 8 minutes.

What about VOLUME CONTROL REPLACEMENTS?

Knowing the importance of this question to you,

IRC believes you are entitled to a straightforward answer

divorced from evasions, empty promises and wishful thinking.

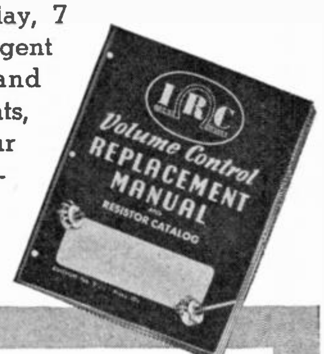
HERE ARE THE FACTS—You can still obtain IRC VOLUME CONTROLS from most Jobbers! But, the chances are they will not be able to furnish exact duplicates in many instances. Due to War Production Board allocations of vital materials and because high-rated priority orders must be filled first, we of necessity have decreased our line for the duration—standardizing wherever possible. This means that you will be called upon more and more in the coming months to use your knowledge and ingenuity in making mechanical and electrical substitutions. IRC Standard Volume Controls, however, are so designed that you can easily adapt them to replace defective units.

YOUR JOBBER WILL HELP YOU—Many months ago we anticipated today's critical situation and adjusted our policies accordingly. Recently announced to Distributors, IRC's new Volume Control stock plan met with immediate approval and a practically 100% response.

This splendid cooperation enabled us to assemble Volume Controls from material on hand and make deliveries in substantial quantities without sacrificing production of essential war orders.

We suggest you continue to use your IRC Volume Control Replacement Manual. Your Jobber has been advised how to make proper substitutions and will gladly help you with your problem if you will consult him whenever necessary.

IRC QUALITY MAINTAINED—You can rest assured that any IRC Volume Control, whether manufactured "before Pearl Harbor" or recently assembled, conforms to IRC Standards of Dependability, Stability, and Accuracy . . . and although IRC is operating 24 hours per day, 7 days a week, to meet urgent Army, Navy, Air-Force and War Industries requirements, we are ever mindful of your important function in keeping home radios in good working order.



INTERNATIONAL RESISTANCE COMPANY

401 N. BROAD STREET *Philadelphia*

High Voltage Sizes

Standard sizes for these fuses for the protection of transmitting equipment, X-Ray apparatus, high voltage rectifiers, etc., are:

1,000-volt, length 3", caps 13/16" dia.
5,000-volt, length 5", caps 13/16" dia.
10,000-volt, length 10", caps 13/16" dia.

These fuses have an amperage rating of from 1/16 to 2 amps, with higher ratings made to special order. All sizes are black fibre enclosed with bright brass caps. Two principles of arc suppression are employed, separately and together, depending on voltage and current rating.

The one principle is that of several small arcs being suppressed much easier than one large arc. This is effected by the multi-break fuse wire which blows at each ½" of its length.

The other principle is the cooling by expansion and conduction of the hot ionized gases which form the arc. This is effected by forcing the arc to pass through the small hole in the ceramic baffle plates. As many as five baffle sections are used in the 10,000-volt sizes.

In nearly all cases, these high voltage fuses may be renewed almost indefinitely by means of the renewal wire available for that purpose. Fuses may be repaired by either returning them to the manufacturer, or the owner can obtain repair materials from that source and do the work himself. The new fuse element is threaded through a fine hole in the ceramic baffles by means of a special needle and the filament ends are soldered to the end caps.

Where expulsion of metal vapor through open fuse ends cannot be permitted, due to close proximity to metal enclosures, etc., closed-end fuses, i.e. non-renewable types, should be specified.

Time-Current Characteristics

When unusual circumstances cause the current in a circuit to become excessive, the fuse must operate *before* damage is done to any other element of the circuit. To express it another way, the fuse must have less "time-lag" than the circuit it protects. How this works out in the protection of widely different types of equipment is shown in the following curves.

As an illustration, see graph below, *Fig. 18*. Because of the fine wires used in it, a typical instrument meter has a very rapid temperature rise characteristic *(Curve B)*. A solenoid, on the other hand, has a relatively slow temperature rise due to its greater mass *(Curve D)*. Thus a very quick-acting fuse is needed to protect the instrument, as shown in *Curve A;* but a relatively slow-acting fuse, as shown by *Curve C* can be used to protect the solenoid, *Curve D*.

Since the fuse operates by virtue of its element temperature, its performance is influenced by the ambient (or surrounding) temperatures. Fuse manufacturers endeavor to make the fusion temperature of the links high enough to be little affected by changes in ambient temperature. From a practical standpoint, the ambient temperature usually is less important than the resistance of the contacts and the conditions of heat conduction through the fuse clips and mounting materials.

Resistance

The resistance of an electrical conductor is that property of the conductor by virtue of which the electrical energy is converted into heat. It depends on the molecular structure of the conductor. Resistance is computed in ohms. Fuse action depends on the relationship of current and resistance.

$$I^2R = W$$

I = Current
R = Resistance
W = Watts.

While W is small for instrument fuses, at the same time I is small: therefore R must be higher than in the larger fuses to produce sufficient heat

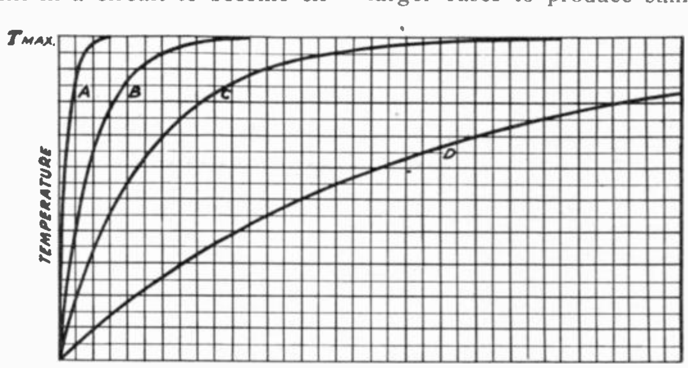


Fig. 18. Curves A and B represent respectively the temperature rise characteristics of an instrument fuse and a meter for a given, sustained current. Curves C and D represent the same data for a 4AG fuse and a small solenoid. The temperature of the fuse must respond more quickly to the current than the circuit it is to protect.

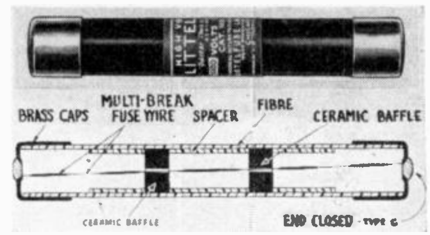


Fig. 19. High Voltage Fuse. From 3" to 10" long for 1,000 to 10,000 volts.

to melt the fuse element. Since the temperature of the fuse elements in low-range fuses varies so greatly with the current carried, the ambient temperature may usually be disregarded.

Fuse Life

Fuses, like all other mortal things, have a definite life. Barring mechanical failure, the most important factor in fuse life is the temperature at which the fuse element is operated.

Fuse life may be conveniently compared to that of incandescent lamp life. A lamp operated below rated current may last for years—at rated current, perhaps 10,000 hours; but then with an increase of only 3% or 4% in current *the life is diminished 25% to 30%*. Similarly, a fuse operated above its rating diminishes in life rapidly, and its element is weakened. The lesson to be learned is—use the largest fuse possible consistent with safety.

Renewable and Non-Renewable Fuses

Where frequent fuse renewals are required in high voltage circuits (due to unavoidable excessive overloads) it is more economical to use renewable fuse links, as it is less costly to replace the link in a cartridge than to replace the entire fuse. Although first cost of renewable fuses is greater than that of non-renewable fuses, renewable fuse links are much less expensive than standard one-time fuses.

Furthermore, the current rating of renewable fuses can be changed within the rating of the fuse body; this is an advantage, if carefully done, since it permits protective adjustment of the fuses to meet changing circuit requirements.

High voltage fuses may be renewed almost indefinitely. (See data under *"High Voltage Fuses"* above.)

Non-renewable fuses are what their name implies—fuses for one-time use, and when blown to be replaced with new fuses. Army Air Corps fuses are non-renewable, but renewables are furnished for certain types of heavy-duty fuses for aircraft. Instrument fuses as a rule are non-renewable.

(Continued on page 27)

CIRCUIT COURT

WITH home receiver production gone by the board, and the future of home reception completely reliant upon servicing, the profession requires the circuits and their breakdown, of the last designs to come off the line. The data on these receivers still comes through, and in the absence of any new manuals, the circuits are worth publication.

SILVERTONE PERSONAL

First on our list is the *Silvertone* Model 7189 three-way portable, shown in *Fig. 1*. The converter is a 1R5, followed by a 1T4 i.f., a 1S5 detector-a.f. and a 3S4 power tube providing .095 watt undistorted and .125 watt maximum output.

It will be noted that avc is applied to the translator section of the 1R5 only. An initial bias slightly in excess of 1 volt for the avc line is obtained from the drop across the tapped filament of the 3S4 power tube, this voltage being applied through resistor *R9*. The 1T4 i-f tube develops its own bias by virtue of the drop across resistor *R3*. This resistor is actually grounded through the #1 filament pin. The i-f signal voltages are bypassed around *R3* by condenser *C8*, and kept out of the 1T4 filament circuit by condenser *C7* which provides a bypass to ground. Hence, the only voltage developed across *R3* is due to contact potential or the flow of grid current on large positive signal peaks, either or both of which develops a negative d-c voltage.

During battery operation, bias for the 3S4 is obtained from the drop across resistor *R14* connected between B minus and ground. During line operation, the bias is obtained by virtue of the voltage drop across the filament string. It should be observed here that during battery operation *all* #7 tube pins and the #1 pin of the 3S4 will be 1.5 volts positive, and all other filament pins will be grounded. During line operation, the voltages will be as indicated in the diagram.

The resistor *R18* tailors the heater of the 45Z3 to the line voltage. During line operation (for which the ganged switches *S2* are set) plate voltage is supplied through resistor *R4* (filtered by electrolytics *C6a* and *C6b*) while filament voltage is supplied through the branch circuit containing the series resistor *R5* (filtered by *C6a* and *C6c*). When switch *S2* is in the battery position, the tube filaments are altered from series to parallel connection.

Switch *S1* consists of two spst units ganged together, one closing the B battery circuit and the other the line circuit. One or the other of these ganged switches is made inoperative by the position in which switch *S2* is set; when set for line operation, for instance, the upper unit of *S1* closes on an open contact on the left section of switch *S2*. The same is true for the lower section of *S1* when the switch *S2* is set for battery operation.

G.E. PHONO-RADIO

The *General Electric* Model LC-679 phono-radio combination shown in *Fig. 2* is, generally speaking, conventional in circuit design, but has some interesting features. Though distinctly of ac-dc design, it is restricted to a-c operation by virtue of the phono motor. Moreover, it uses 6-volt tubes rather than the 12-volt type, but in conjunction, naturally, with a power amplifier and power-supply rectifier drawing the same heater current. The heater string is connected across the line through the ballast resistor *R14* which has a tap for the pilot light.

It will be observed that inverse feedback is used over two stages. Voltage developed across the second low-impedance winding on the output transformer is applied in series with the cathode of the 6J5GT a-f tube, the cathode being grounded through this winding. Bias for the 6J5GT is provided by resistor *R7*. Additional degeneration is applied to the 25L6GT by leaving off the cathode bypass condenser. With the loss in gain occasioned by this degree of inverse feedback an additional a-f stage is required, but the improvement in frequency response, drop in distortion and increase in undistorted power output (2 watts) makes the degeneration worth while.

Note that the phono motor switch *S2* is connected to the tone arm shaft (see sketch below diagram). This is arranged so that the motor starts up when the pickup is removed from its rest and moved in toward the record. The phono-radio switch *S3* grounds the diode circuit in the phonograph position; disconnects the pickup and its equalizing resistor *R13* in the radio position and connects the diode circuit to the volume control and avc line. This switch is also actuated by the pickup tone arm, as indicated in the sketch.

SILVERTONE "POWR SHIFTR"

The *Silvertone* Model 4714 "Powr Shiftr" provides "A" and "B" power from a 6-volt storage battery, for any 1.5-volt battery receiver using 4, 5 or 6 tubes. The diagram is shown in *Fig. 3*.

The 1.4-volt "A" supply is obtained by dropping the battery voltage through a No. 81 Mazda auto lamp, a

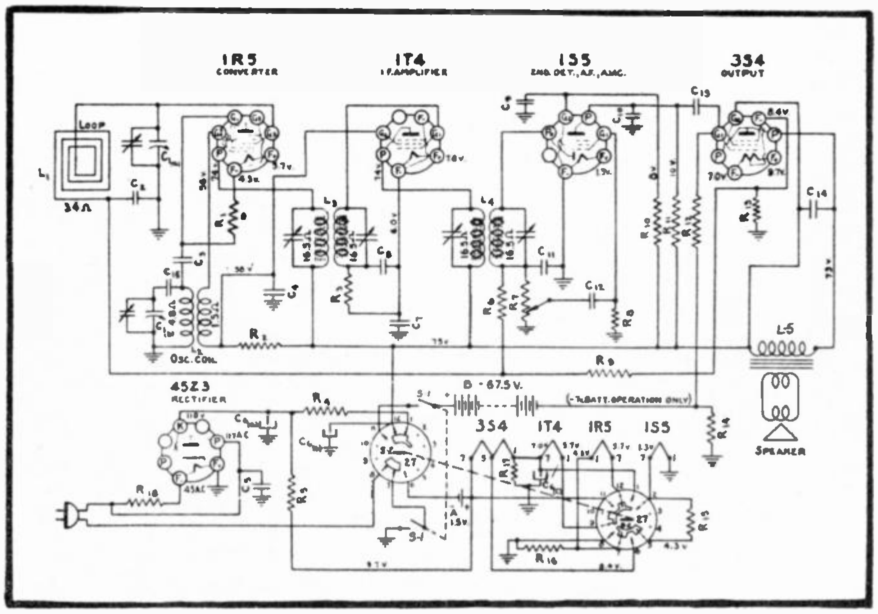


Fig. 1. The Silvertone 7189 three-way portable, with simple line to battery switching system.

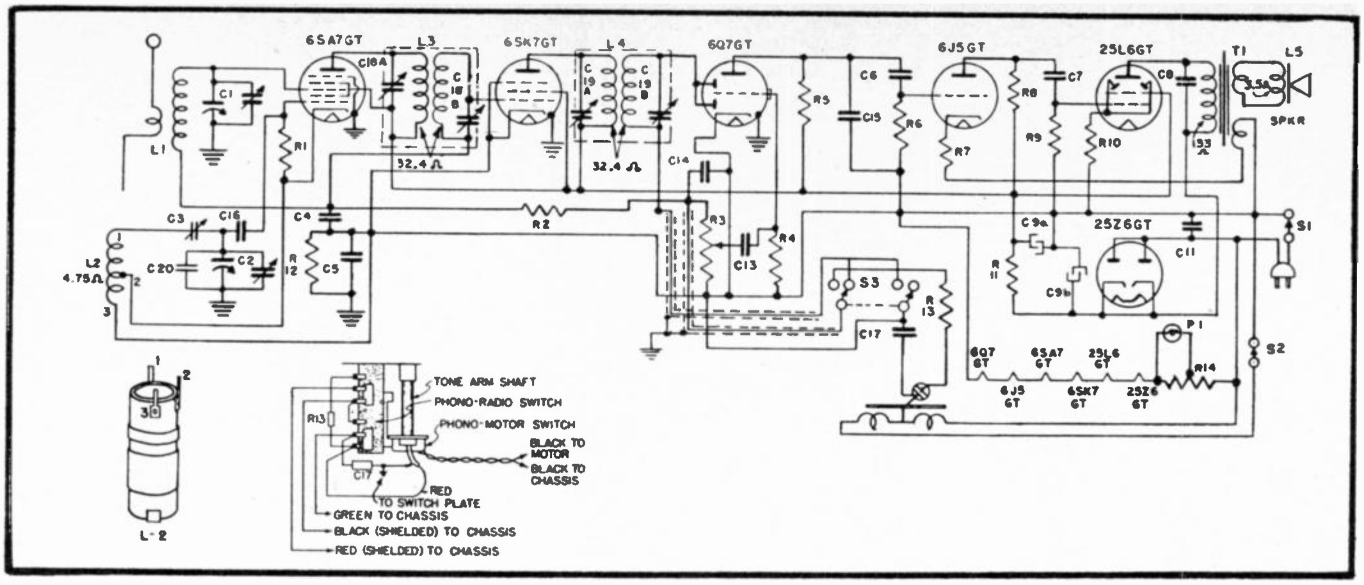


Fig. 2. The General Electric LC-679 uses degeneration over two stages.

choke, *D*, and one of three pre-set resistors, *Q*, *R*, *S*, that can be selected by the *"Tap Changer."* The choke and a 1500-mfd., 3-volt electrolytic, *K*, isolate the "A" supply from the vibrator circuit and prevent any voltage ripple reaching the receiver when the storage battery is being charged. The auto lamp acts as an automatic ballast to further regulate the "A" voltage.

The 90-volt "B" supply is designed with a standard non-synchronous vibrator, and a 6X5GT- rectifier tube which works into a condenser-input filter *G-C-H*. It will be observed that by virtue of the condensers *J* and *F* that the "A" and "B" circuits are not common to each other or to the chassis. This prevents shorting out the bias resistor in some battery receivers.

Servicing

Low "A" voltage may be due to a few minor reasons. The storage battery should be checked first for a terminal voltage of 6 volts. The pin plug position of the Tap Changer on top of the chassis must be in position *4* for a 4-tube receiver, position *5* for a 5-tube set, etc. The auto lamp acting as a voltage regulator ballast will burn dimly without a load on the Powr Shiftr, and the greater the load the brighter this lamp will be. Inside the chassis are three 5-ohm rheostats for factory adjusting the voltage with the correct load at each tap. Rheostat *Q* is set at 3.5 ohms, *R* at 4 ohms, and *S* at 4.67 ohms. A small screwdriver may be used for changing this calibration where required.

The vibrator of the "B" supply is loaded very lightly. Testing for vibrator failure may be made simple by substitution. The 6X5GT tube should be checked in a standard tube tester. The transformer may be tested by measuring a-c voltage across each side of the secondary by removing the tube. The bypass condensers should be tested for breakdown.

A faulty vibrator is a common cause for hash. A good solid ground is required on the ground pin of the vibrator as well as the ground connection of the two 50-ohm resistors *L* and *M*, from the vibrator contacts to ground, for leaking off r.f. Also check these resistors for open circuit, as well as the bypass condensers *E*, *F*, *I*, and *J*.

CORONADO AUTO RADIO

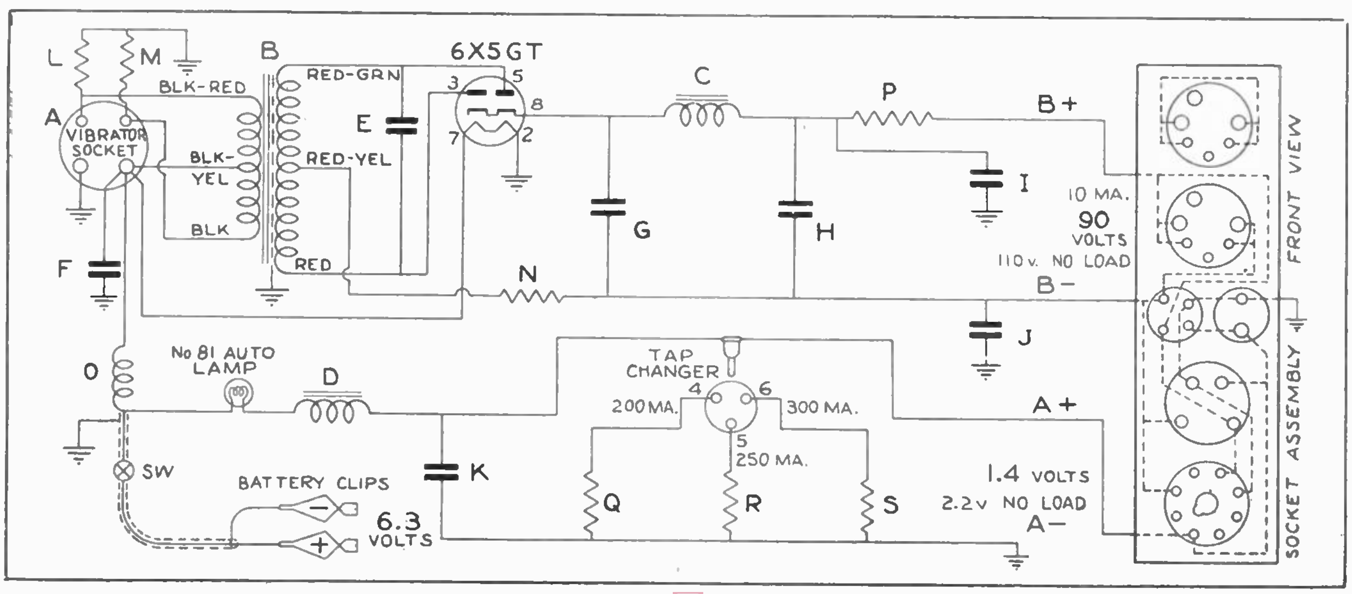
The *Coronado* Model C579 (Series A) auto radio is shown in *Fig. 4*. This receiver requires no spark-plug suppressors. It is of the single unit type, requiring no flexible shafts; and four levers are provided for automatic station selection.

Note from the diagram that the antenna is capacity coupled to the tuned circuit. Condenser *C1* has a capacity value of .00002 mfd., and therefore offers a high reactance to signals in the broadcast range. Condenser *C2* has a value of .01 mfd. and couples to the mid-point of *T1* and *C3*, the latter being the antenna trimmer.

A simple cathode-coupled oscillator is employed. Observe that the suppressor grid in the 6SK7 is given a slight negative bias with respect to the cathode, this bias being equal to the drop across the 50-ohm resistor *R14*. Control grid bias is developed across *R14* and *R16* in series, in the 6SK7 cathode circuit.

The high-voltage supply employs a full-wave vibrator in conjunction with the step-up transformer *T5* and a 6G5G full-wave rectifier. The contacts of the vibrator are grounded through

Fig. 3. The Silvertone "Powr Shiftr" for conversion of dry cell sets to storage battery conversion.



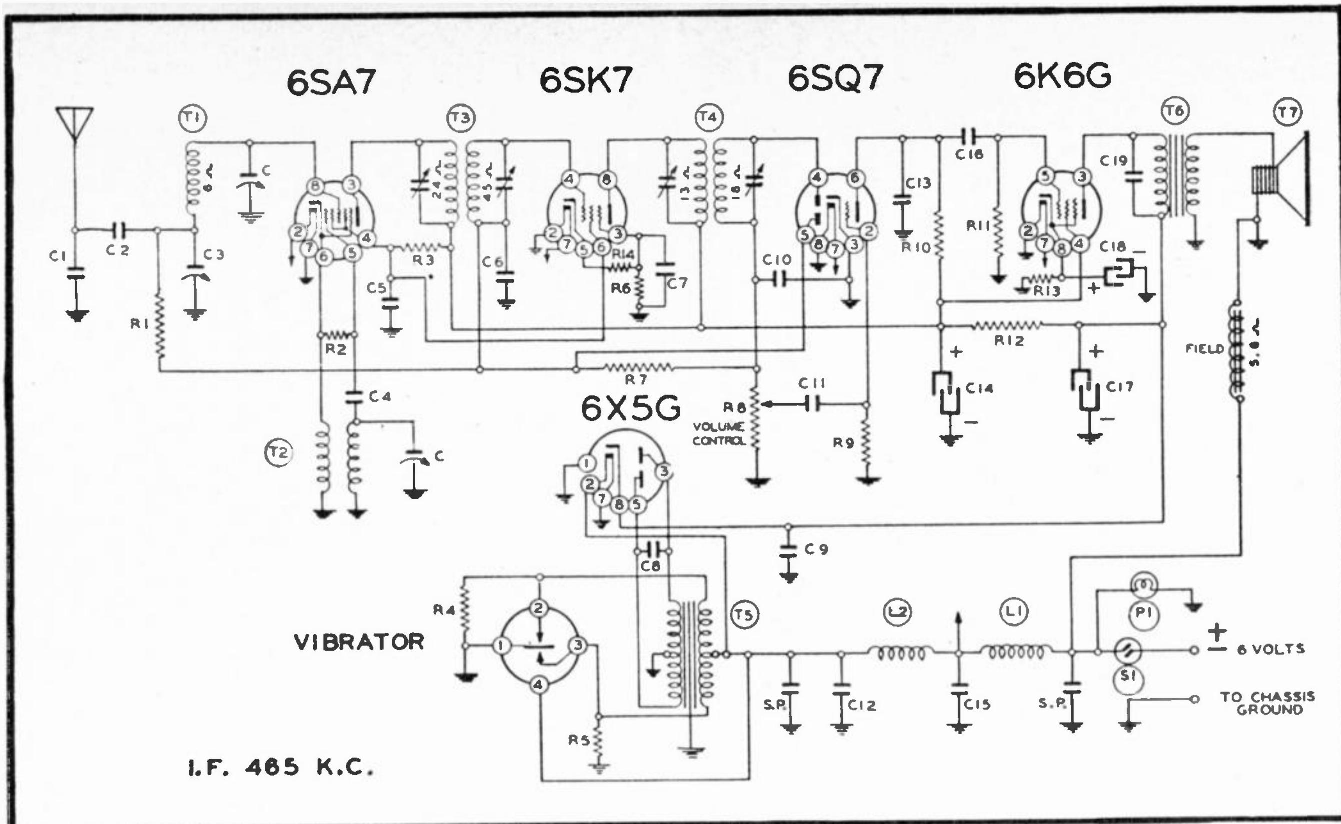


Fig. 4. The Coronado C579 auto receiver. Note negative bias on suppressor of 6SK7.

the hash-suppressor resistors *R4* and *R5*. The "A" line is well filtered by chokes *L1-L2*, and the condensers *C12-C15*.

When first installed, trimmer *C3* should be adjusted for maximum on a weak signal at approximately 600 kc, with volume about ¾ on.

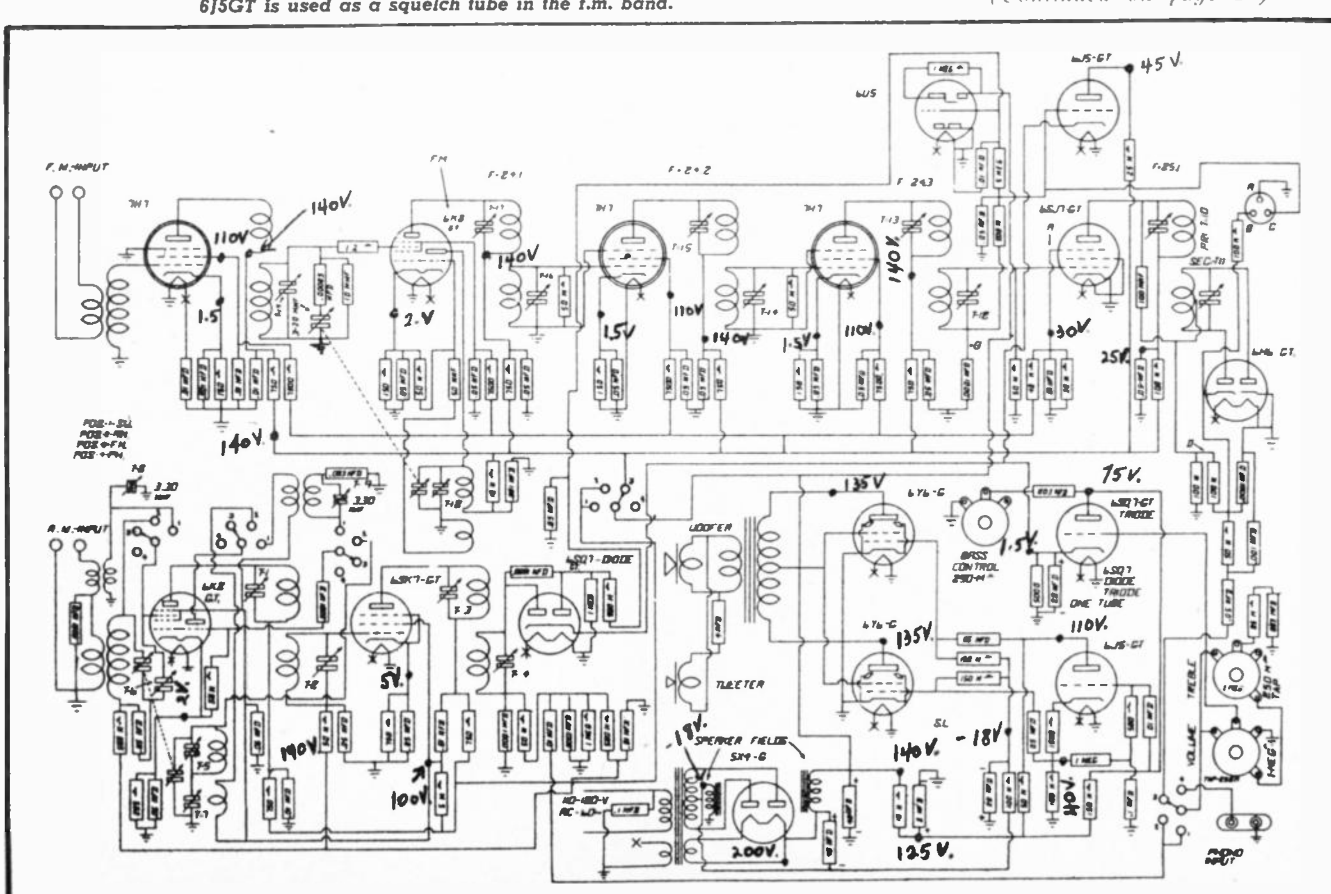
SILVERTONE SW-AM-FM

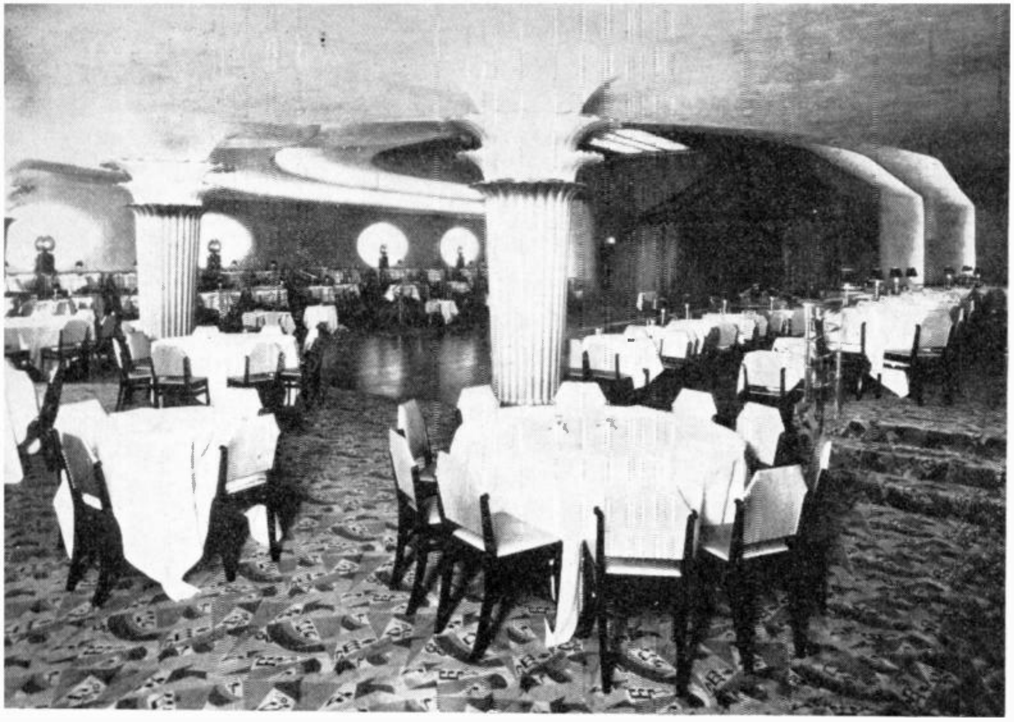
This recent *Silvertone* Model 7099 covers the broadcast band from 540 to 1600 kc., the short-wave band from 6 to 19 mc, and the frequency modulation band from 42 to 50 mc. Some of its features are: separate bass and treble controls, a 5-inch tweeter and a 12-inch woofer, separate f.m. and a.m. circuits, and an f-m squelch tube. The amplitude modulation i.f. peak is 462 kc, and the frequency modulation i.f. peak is 4.3 mc.

The complete circuit is shown in *Fig. 5*. The upper channel is the f-m receiver, and the lower channel the a-m receiver. The f-m channel consists of a 7H7 r-f stage, 6K8 mixer-oscillator, 7H7's in two i-f stages, a 6SJ7 limiter, and 6H6 discriminator. It is entirely conventional with the exception of the 6J5GT squelch tube, the cathode of which connects directly to the cathode of the triode section of the 6SQ7GT

(Continued on page 26)

Fig. 5. The Silvertone 7099. Separate a.m. and f.m. channels are employed. A 6J5GT is used as a squelch tube in the f.m. band.





TOP—*Not every so-called "electronic installation" is "industrial". Here is a Hotel restaurant with lighting effects controlled by Thyraton-reactor. The restaurants sound distribution is handled by separate amplifiers which can also be fed into the hotel's centralized sound system.. Summarized, this is a non-industrial electronic installation.*

BELOW—*A typical industrial installation in which a photo-electric control is utilized to stop vertical lift when tote box intercepts light beam, preventing boxes from piling up. Light beam is placed at an angle to take care of all size boxes.*

ELECTRONIC EQUIPMENT—SALES AND SERVICE

THAT industry now uses electronic equipment for many applications is a matter of record as the several typical "industrial electronic installations" illustrated herein attest.

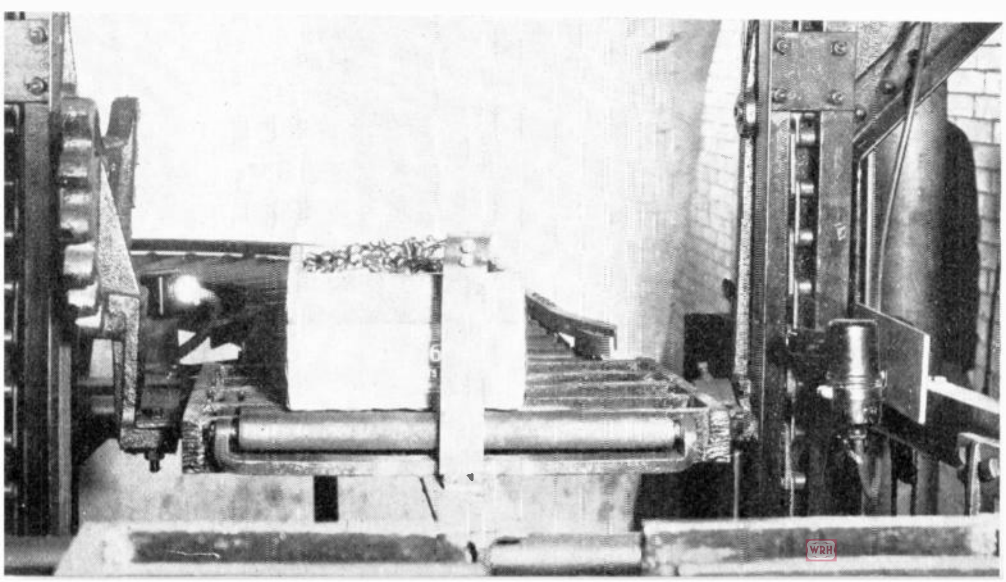
It is an accepted fact that every radio or electronic device will on occasion require adjustments, alterations, repairs, modernization and even replacement of worn or defective parts. To all practical purposes the average radio repairman or servicing organization is thoroughly competent and can handle any such maintenance work, *if he can get it.* The electronic circuits of electronic installations are merely radio circuits about which most servicemen have had years of practical experience. The element of mystery supposed to be included in an "electronic device" simply doesn't exist. Promoters put the mystery in because the word "radio" seemed too elementary, and "radio," for some silly reason doesn't offer the profit potentialities in comparison with the word "electronics." So much for that!

Whether or not the average radio servicing organization will be allowed to do "electronic servicing work" is a moot question as yet but partially answered. We know of several service-dealers and servicing organizations that have flat service-fee-maintenance-contracts with large industrial users of electronic equipment. Likewise we know of many more competent servicing organizations that have tried conscientiously to convince industrials of their ability to service and maintain such equipment to no avail, but primarily because they were "tagged" radio servicing organizations and not electronic servicers.

And we know of industrials that have been forced, in sheer desperation, to call in the *"local* radio serviceman" because their own supposedly superior-minded engineering (sic) force couldn't cope with a problem that proved to be most elementary to the "little radio guy." But, that's the way life is! True ability is seldom recognized until an emergency arises; and the unostentatious radio serviceman generally possesses more practical *and usable* knowledge about radio maintenance work than many so-called engineers, electrical or otherwise.

Having no fixed rule to go by, the average progressive serviceman who is anxious to expand his activities and increase his income by servicing industrial electronic equipment must simply

Illustrations Furnished by General Electric Co.



work hard at the job of *selling himself* and his ability to do the work better and for less money to his prospective customer. In the August issue of RADIO SERVICE-DEALER was outlined a pricing, or service-fee method that has proven practical. The only variable factor is the serviceman's own decision as to how much he must get paid per hour for services rendered on a regular check-up basis.

In trying to get on an industrial plant's payroll you are generally competing with that firm's regular staff of salaried maintenance men, and with the contractor who made the original electronic installation. The former usually loaf half the time, and are less competent and waste much more time when troubles occur in radio circuits and thus are more expensive to keep on the payroll than a local serviceman. Industrials haven't awakened to that fact yet, *but they might*, if you will show them how true it is. The latter group, the contractors, usually include a clause in the contract which provides "service and maintenance in case of breakdown" for a stipulated period. Such Warranties were tried and failed to work in the refrigeration field. Only time will tell whether or not they will prove satisfactory with regard to electronic installations. We feel that the field is wide open for competent, aggressive independent radio service-dealers. Packard car owners find it costs less to deal with the local independent auto repairman, and so will industrial electronic installation owners, in due time.

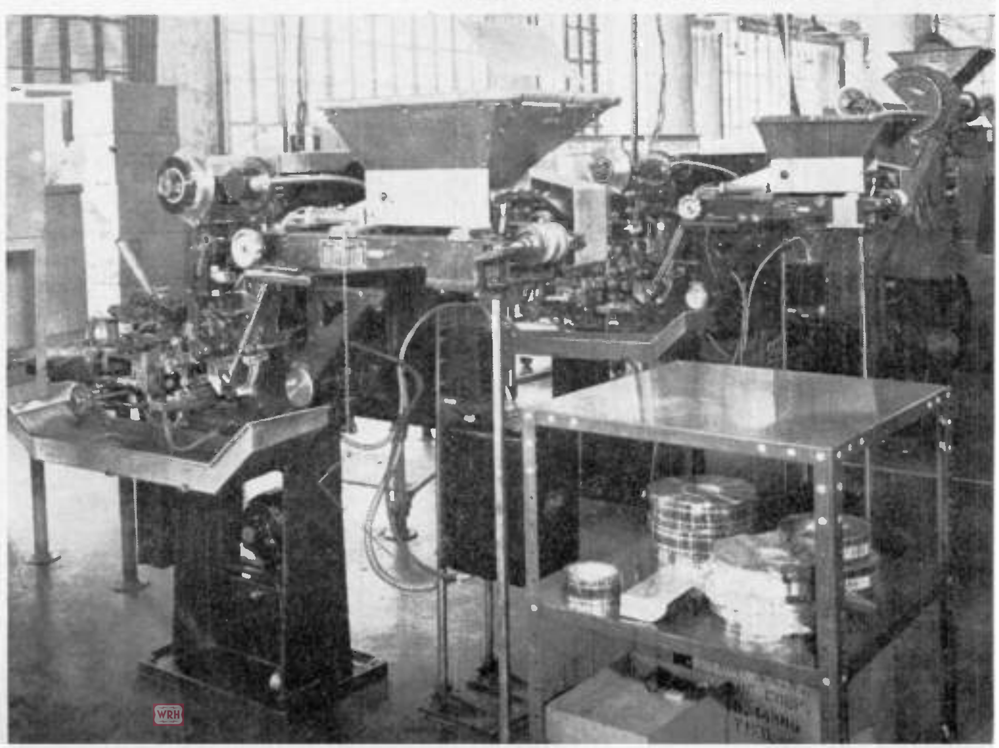
When trying to fix a price for your services remember one important point about which everyone has been grossly misled since the very inception of the so-called "electronics industry." In most electronic installations the radio-electronic portion itself is but a minute part of the installation as a whole. A 50 thousand dollar color-checking or automatic packing device called an "industrial electronic installation" actually and usually consists of 49 thousand 700 dollars worth of machinery and installation time plus only 300 dollars worth of radio-electronic control apparatus. Your service fee must be based upon servicing the 300 dollar part of the installation. Don't delude yourself about the matter! If you believed all you read about the electronic industry being a colossal multi-million dollar affair you could say, in truth, "this is no case of the tail wagging the dog. They're trying to make one hair in the dog's tail wag the tail and dog." Yet such is the "mystery" of electronics because the electrons in a few ordinary radio tubes actuate, through relatively simple radio amplifying circuits, a few relays that in turn control mechanical fingers to accomplish their purpose as "electronic devices."

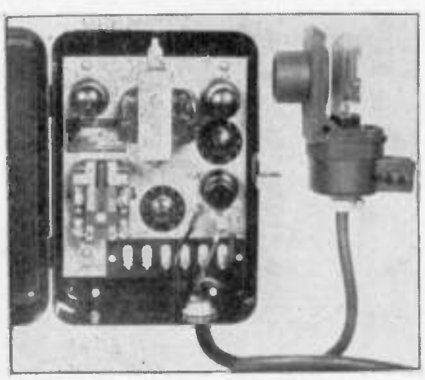
Only 10 thousand radio service-dealers are now engaged in maintaining over 55 million civilian radio receivers. Servicemen are hard-pressed to handle the huge volume of work. No one, we repeat—*absolutely no one* knows how many industrial electronic installations exist and are now in operation. There are many, of course, and more are coming. Canvass the industrial plants in your vicinity. Those that employ, or are about to employ, electronic equipment are your prospects. Try to get these to contract with you to act as their maintenance men. It is *plus* business, a *priority* business, and a *growing* business that some day might become highly specialized with many advantages for those who pioneer in it.

TOP RIGHT—*Chicago trollies pass through a washer that is automatically turned on and off when p-e cell relay beam is interrupted.*

RIGHT—*Doors in factories, stores, railroad stations and restaurants automatically open (like these at the Stanley Works) when a p-e light beam is broken.*

BELOW—*An industrial electronic application. Packaging machines in the American Chicle Co., by means of a G-E p-e actuated relay counter and scanner, put 2 Chiclets in place for wrapping, hold others back until wrapping is completed, then repeats cycle. If cellophane wrapping paper breaks the machine stops.*





Front, open-door view of G-E Photoelectric Relay. At right is the Phototube Holder, cover removed. The mechanism is but a simple raido circuit employing tubes and relays.

More On Transformer Substitutes

by H. F. GULLIVER

HOT, wet weather hastens the breakdown of many audio transformers as well as other radio components. Since audio inputs are getting scarce it is up to us servicemen to make the old units serve whenever possible. They may be more satisfactory and usable than most of us have realized. Take the case of an open-plate winding on an input transformer. *(This does not apply to Class B driver units).* The June 1942 issue of Radio Service Dealer carried the solution by Mr. Warren Anderson given here as *Fig. 1A.* Now note *Fig. 1B* which represents our suggested revisions.

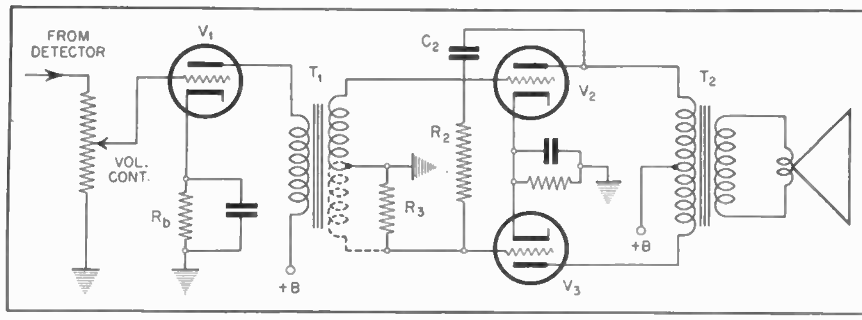


***Fig. 1A.* Common audio circuit, V2 and V3 either triodes or pentodes.**

This circuit has possibilities of being much better than that afforded by the original transformer since the tuning effect of condenser C_1 can be made to resonate the grid inductance to some low frequency, preferably just below the speaker cone resonance. The graphs shown here as *Fig. 5.* list the values used and response curves resulting from several of the older sets which are still quite numerous. The improvement in tone is great enough, in most cases, to warrant the change whenever the customer would appreciate better tone, even if the transformer is still okeh.

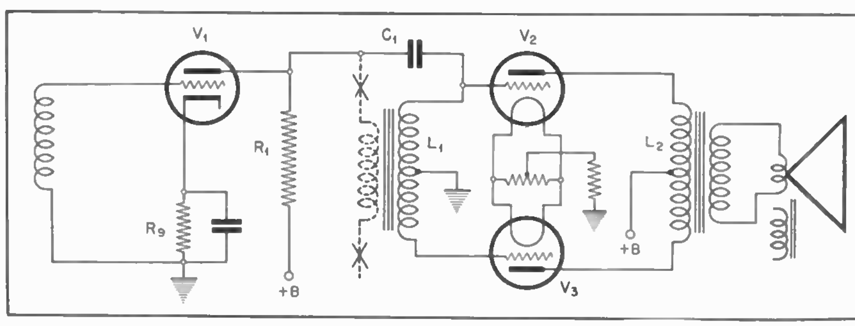


***Fig. 1B.* Condenser C1 resonates the grid inductance.**

Condenser C_1 is, in most cases, about .05 or .1 mfd to produce the best results. However, transformers with extra large cores may resonate at about 50-70 c.p.s. with only a .02 mfd. Too large a condenser will always be better than too small a unit. If too small a capacity condenser is used the resonance will fall too high, say 100 to 160 cycles, and there will be no appreciable bass response over the original transformer. Try to avoid having the resonance hump fall on the speaker cone resonance.

Should too sharp a bass resonance be obtained with a large transformer, by reducing R_1 to 30,000 or 20,000 ohms will flatten it out.

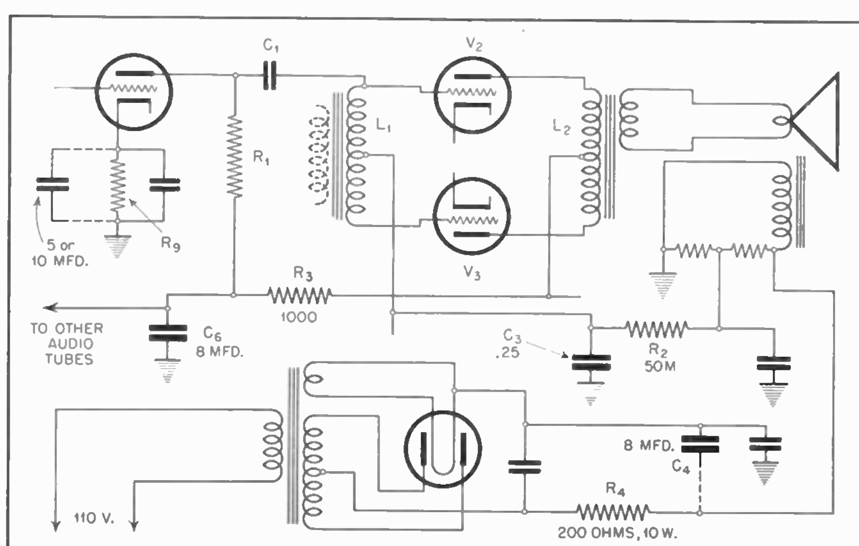


***Fig. 2.* Ripple is avoided by adding R2 and C3.**

Regarding the size of R_1—if V_1 is a power detector tube, as is often the case in the older radios which most often use input transformers, then, in order to function properly the plate voltage must be kept as high as possible. The plate resistance must be kept as low as we can keep it without too much loss of audio voltage, of which we will need plenty to drive the following stage.

In many older sets the power detector drives a pair of 45's. Experience proves that everything will work out nicely if resistor R_1 is about 40,000 or 50,000 ohms for power detectors, and this value is fine for straight audio too. Using this value R_1 not only keeps the plate voltage fairly high, but keeps the resonance peak of C_1 and L_1 from becoming too steep. R_1 forms a shunt for the inductance and tends to flatten the resonance hump. When R_1 is 40,000 or 50,000 ohms no change need be made in the cathode bias resistor, either in audio or detector tubes. If the tube is supplied with fixed bias, a slight reduction in bias voltage may be necessary to compensate for the loss of plate voltage, in R_1.

Several undesirable things may happen when the circuit of *Fig. 1B* is applied. There is a cure in each case:

First — added high frequencies may be heard, and the set may produce monkey-chatter from adjacent stations. This can be cured easily with a small condenser, say .002 to .01 across L_1.

Second — and most important, added hum may be heard. It may come from one or more places. Added low frequency response of the audio system may bring hum through from preceding stages, particularly if there is a detector stage ahead of the tube V_1. The source of this hum must be found and eliminated.

Hum may originate in the output tube grid circuits, if the grid bias for V_2 and V_3 is obtained in a manner similar to that shown in *Fig. 2*. Normally a certain amount of a-c ripple can be tolerated in the grid circuit of a push-pull stage, as long as the two halves of the grid inductance are carefully balanced. When C_1 is added, the transformer grid windings are somewhat unbalanced by R_1 and the tube capacity and resistance. Since balance cannot be easily restored in a circuit like *Fig. 1* we must filter the a-c ripple from the grid bias supply, either by adding a filter to the grid bias lead proper, or to the main filter system. The least expensive method is to add to the bias lead a resistor and condenser. (R_2 and C_3 as in *Fig. 2*.)

(Continued on page 24)

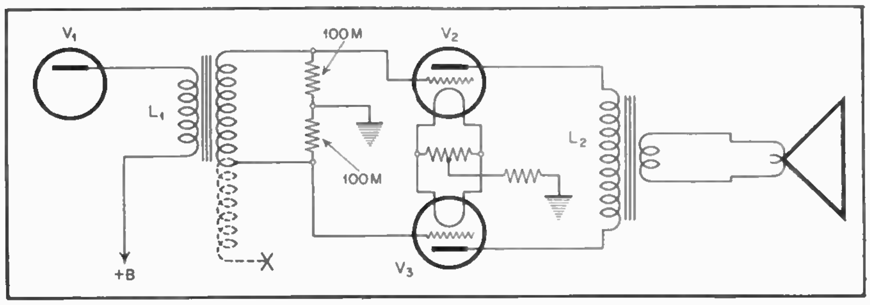


Fig. 3. An inexpensive, not too good a circuit revision.

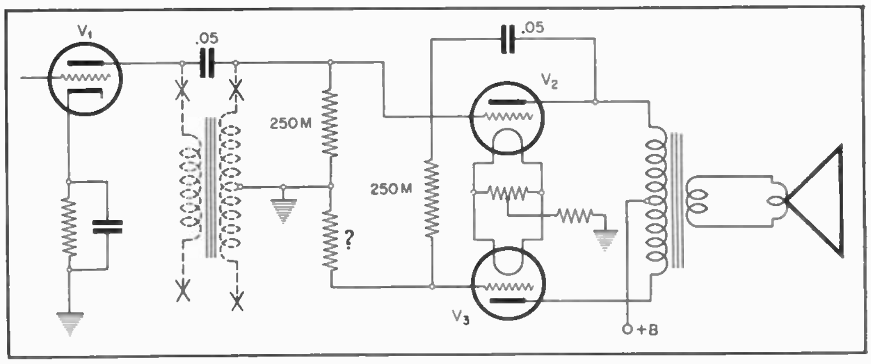


Fig. 4. Probably the most satisfactory corrective method.

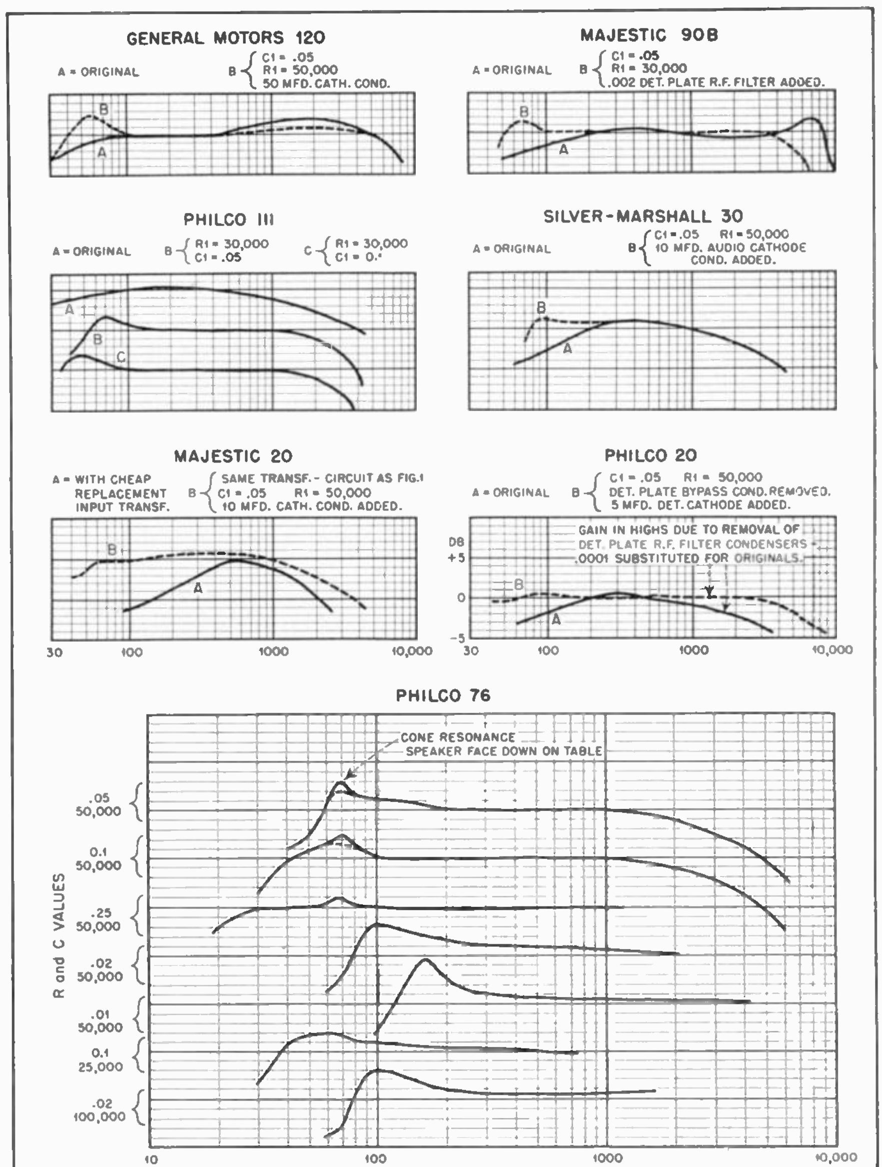


Fig. 5. Actual response curves of many older sets now in use, after being repaired.

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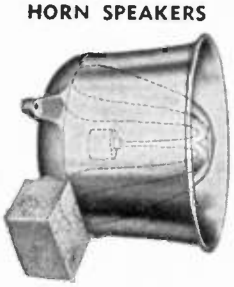

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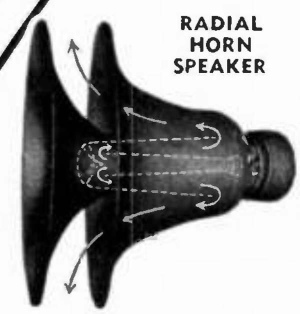

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SECTION XXII

TRACING SIGNALS

FOUR years have passed since signal tracing first made its bow as a modern and most efficient method of trouble shooting. During this period much has been written about the application of this method but relatively little regarding the design details of the circuits employed in signal tracing instruments. Now that first-class signal tracing apparatus is difficult to obtain, and because some of the earlier instruments which have been in service for years may now require servicing, we believe that it will be of interest to discuss in this article the circuit details which heretofore have been but briefly touched upon. In presenting this information, we are not advocating that you build your own signal tracer if you don't already have one, because special coils are required for some of the channels if satisfactory results are to be obtained. Further, very careful shielding and wiring is necessary to avoid oscillation. For those who have no signal tracing instruments, we'll suggest methods of doing the trick without requiring a constructional project.

Preliminary Review

For those to whom this subject is new, let us explain briefly that signal tracing is done by feeding a signal (either a broadcast station signal or one from a signal generator) to the input circuit of a radio receiver and tracing the progress of this signal, stage by stage, from the input to the loudspeaker. If at any point along this line the signal is found to be weaker than it should be, or distorted, or absent, then we know that some defect exists in that circuit where the trouble is first noted, or in a circuit which directly influences the circuit under test. For example, if an r-f coil primary were open, no signal would reach the plate circuit of the tube to which it was connected; consequently no signal would be passed on to any of the stages which followed the stage in which this defective coil was present. Thus signal tracing starts with the very first coil, the antenna coil, in the receiver, and proceeds tube by tube, stage by stage, until the loudspeaker is reached . . . or until the signal becomes adversely affected.

In order to follow the signal along this course, we must have some means of examining this signal at any point in the receiver without affecting the performance of the receiver. This means that we must be able to connect into tuned circuits while the receiver is operating without appreciably detuning them, to measure voltages without loading the circuit under test, and to be able to adjust our test apparatus to the signal frequency so we may be able to identify the test signal to the exclusion of all others. Thus, if we are feeding a 600-kc signal to the receiver under test, our signal tracing device must be capable of tuning to this frequency. Because the oscillator section of a superheterodyne receiver also generates a signal frequency, we must be able to measure its frequency and amplitude. Both these applications call for a device which is essentially a radio receiver, and we find in the typical signal tracer channels which are designed just like radio receivers.

Its Fundamentals

A complete signal tracing instrument will generally be composed of at least five channels, as illustrated in the block diagram, *Fig. 1.* The RF-IF channel is designed for tracing signals over a frequency range of from 95 to 1700 kc and consists of a calibrated attenuator, 3-stage high-gain amplifier and diode detector. Up to this point it is a typical radio receiver. No audio amplifier is included with this channel, since the signal is used to actuate an indicator eye, but phones may be plugged into the output circuit, as may a cathode-ray oscilloscope. This channel has extreme sensitivity, because it must be able to amplify the weak signal from a signal generator to a point where it gives audible power output from the detector and sufficient voltage output to close an indicator eye. Further, it must be usable with a probe which reduces the signal level before it arives at the amplifier input.

The oscillator channel is similar to the RF-IF channel. It is *NOT* an oscillator; merely a single stage tuned r-f amplifier which covers a wide frequency range. Naturally this channel is not as sensitive as an RF-IF channel. It need not be, because the signal strength produced by the oscillator

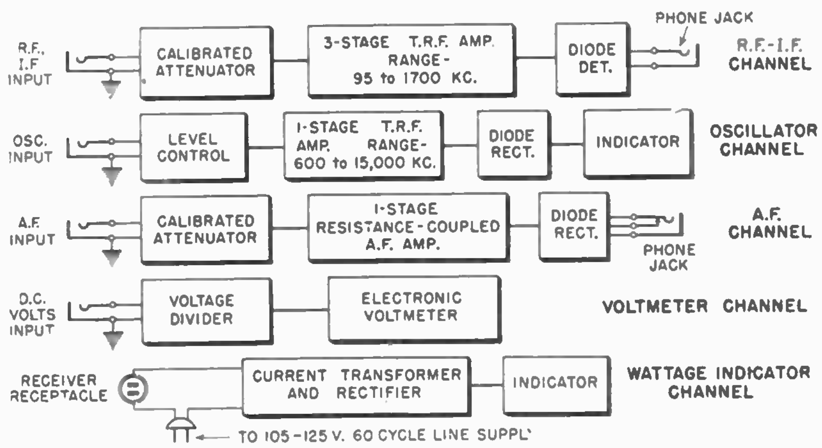


Fig. 1. Block diagram of composite signal-tracing equipment.

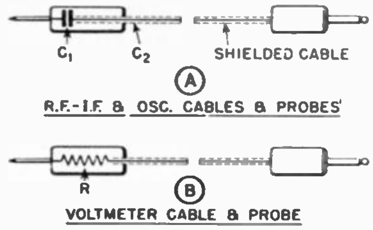


Fig. 3. Special isolating probes are required in signal-tracing work. They place a minimum load on the circuit in which signal- or dc-voltage readings are being taken.

in a superheterodyne receiver (which this channel is intended to test) is very strong—much stronger than that produced by the average signal generator.

For audio signal testing an audio amplifier, consisting of a single-stage resistance coupled amplifier feeding a diode detector, is used. This is termed an audio channel. Provision is incorporated for listening to the audio signal by plugging phones into an output jack. An additional audio stage and speaker may be employed if desired; or a 'scope may be used.

For checking d-c voltages an electronic voltmeter is employed. There is no a-c voltmeter, though r-f, i-f and short-wave signal voltages may be approximately checked with the channels described. Also, the relative magnitude of a-f voltages may be determined with the a-f channel. Some means of testing the power consumption is necessary in order that one may determine instantly whether a serious short-circuit or open-circuit is present in the receiver. This is accomplished with the wattage indicator, which consists, as shown, of a current transformer and rectifier, driving an indicator eye.

We have run over these briefly to present a general outline of the signal tracer before studying the schematics, because for those unfamiliar with the system, it is usually rather difficult to grasp all points simply from an examination of the schematic diagrams. As shown in *Fig. 2,* which is a schematic of the RF-IF channel (only one band is shown for clarity, although three bands are included in the instrument) the design is conventional, with the exception of the input and output circuits. Also, coupling trimmers *T1*, *T2* and *T3* are employed in each stage which serve to increase the gain at the high frequency end of each band. The coils used are designed to produce maximum gain at the low frequency end, so by means of the coupling trimmers substantially even amplification over a wide tuning range may be achieved. When properly adjusted, the overall gain is approximately 100,000. This means that a 50-microvolt signal at the input grid will produce a 5-volt signal at the indicator eye—sufficient to close the 6E5. If it were possible to connect directly to a tuned circuit of a receiver being tested without detuning the stage under test we could say that the channel would measure a 50-microvolt signal in a receiver. Such is not the case. No matter how short the leads, some detuning would occur. To minimize this, a special probe is employed in conjunction with this channel, as shown in *Fig. 3A.* This probe has a small capacitance, of the order of 1.0 to 1.5 mmf, built into its end. Actually, this capacitance is formed by simply separating the probe point from the termination of the shielded cable which connects to the plug. Thus the proble and shielded cable, designated as *C1* and *C2* respectively in *Fig. 3A,* form a means of isolating the amplifier input from the circuit under test. Because the probe capacity is only 1.5 mmf, the amount of detuning will be only that which would result by shunting a 1.5 mmf condenser across the

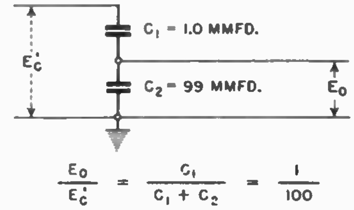


Fig. 4. Demonstrating how a small series capacity in the r.f., i.f. and oscillator probe reduces detuning to a negligible degree.

circuit under test, which, at low frequencies at which tests are ordinarily made, is negligible. The signal, passing through this small capacity, travels along the shielded cable to the amplifier input. Considerable reduction of signal strength occurs due to the capacity of the shield, which will be between 100 and 150 mmf. This attenuates the signal in a manner similar to a voltage divided, as shown in *Fig. 4,* so that the strength of the signal which actually reaches the amplifier input is only 1/100th that at the probe point. However, the great sensitivity of the RF-IF channel makes it possible for a signal as weak as 5 millivolts at the circuit under test to gave 5 volts output after passing through the test probe and cable and, of course, the channel amplifier.

Step By Step

In following a signal from stage to stage in a receiver, the amplification which normally results causes a considerable increase in signal level. If we know how much amplification to expect, we can determine whether or not a stage is performing normally. To measure this amplification, an attenuator is incorporated in the input circuit of the RF-IF channel. Thus, in *Fig. 2,* when the switch *S1* is on point *X1* and the 9,000-ohm level control in the cathode circuit of the first tube is set at zero, the amplification of the

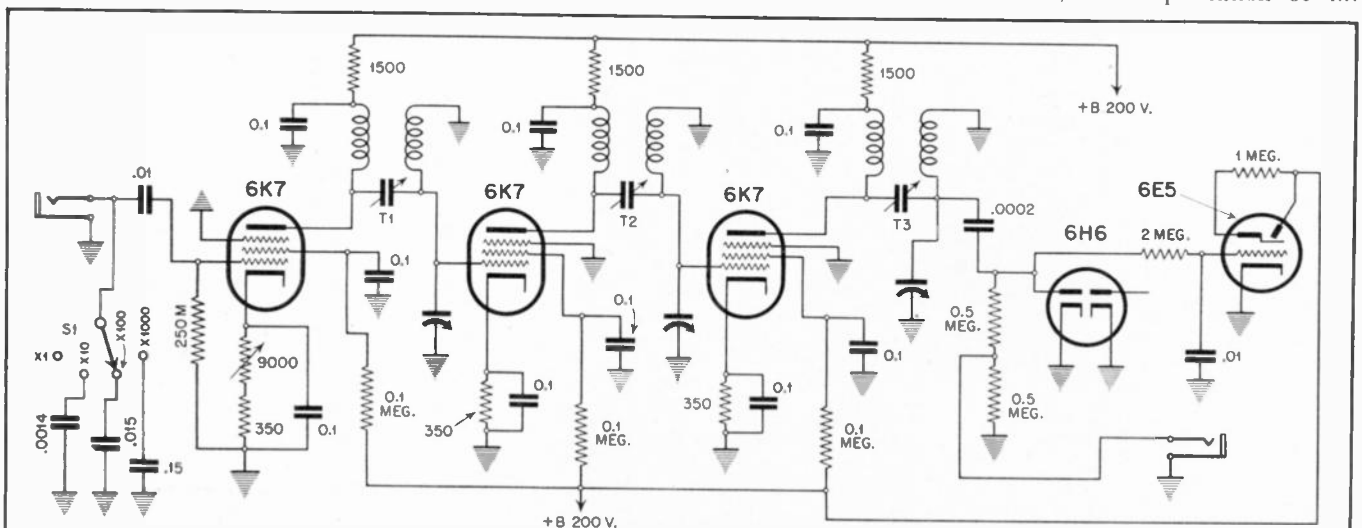


Fig. 2—Schematic diagram of the RF-IF channel of a typical signal tracer.

channel is a maximum. Assuming that the signal which causes the channel eye to close when the channel is adjusted for maximum sensitivity is 5 millivolts (at the probe point) then, when we move the probe to another point where the signal strength is greater, the eye will overlap. To restore the first indication, we must reduce the sensitivity of the amplifier. This is done by varying the 9,000-ohm level control until the eye again just closes. If the amplifier gain is thus reduced to ¼th its original value, the strength of the signal being measured is 4 times that which was present when the full gain of the amplifier was necessary to produce an output sufficient to close the channel eye. By using a calibrated cathode bias control and marking each point in proportion to the amount by which the gain of the amplifier has been reduced, it becomes possible to calibrate the amplifier for variations in signal level up to 10 to 1.

However, the gains encountered in modern radio receivers run up to many thousands, so some additional means of reducing the sensitivity of the amplifier to take care of very strong signal amplification is required. This is furnished by an auxiliary attenuator which operates on the same principle as that shown in *Fig. 4*. Thus, where *C2* is illustrated as 99 mmfd to cause a 100 to 1 attenuation of the signal, by increasing *C2* to 999, the attenuation is increased to 1000 to 1, or 10 times greater. In the channel input, this is accomplished by putting *S1* on point *X10*, which shunts .0014 mmfd across the cable capacity and thus increases the attenuation 10 times. Factors of attenuation of 100 times and 1000 times are similarly secured by placing the switch on *X100* and *X1000*, thus shunting proportionately greater values of capacitance across the amplifier input. For simplicity, the values of capacitance shown in the example, *Fig. 4*, are given in round numbers as 1.0 and 99 mmfd. In actual instruments, these capacitances are of the order of 1.4 and 140 mmfd, but the ratios remain the same.

The probe used with the oscillator channel is the same as that employed with the RF-IF channel. The oscillator channel design is shown in the schematic, *Fig. 5*. Again, only one band is shown, whereas three are employed in commercial instruments. Note that the level control for the amplifier tube is the same value as that employed in the RF-IF channel, and operates in the same manner. No multiplier is used with the oscillator channel, since there is no need to determine the actual ratio of oscillator signals over a wide range. Normally the range of signal level will not be greater than 3 to 1 on any band in a modern receiver.

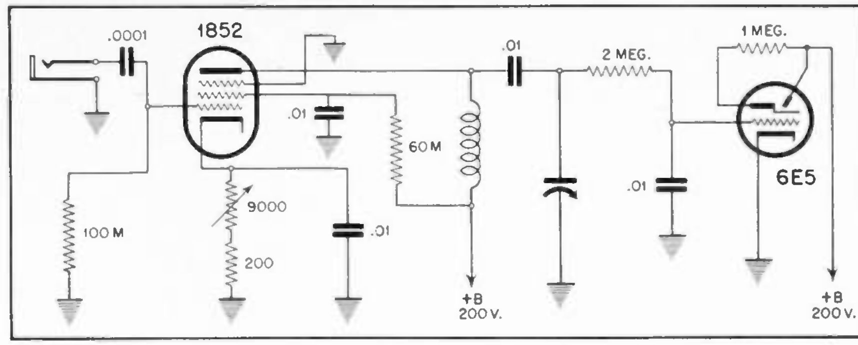


Fig. 5. The oscillator channel of a typical signal tracer. Note that this channel has no oscillator; it is for testing receiver oscillators.

Audio Circuits

For testing in audio circuits, the circuit of *Fig. 6* is employed. Note that the 6Q7 operates with fixed bias. The switch in the input circuit is a toggle type which, when flipped down, cuts in a 2-meg. resistor in the input circuit and attenuates the input signal by a factor of 100. The potentiometer in the grid circuit is also calibrated over a 100-to-1 range, so that audio signals over a 10,000-to-1 range may be measured.

In all the circuits so far discussed a channel eye is employed. In some signal tracing instruments, this eye is replaced by meters, or c-r tubes, or provision is incorporated for using a meter in place of the eye. No matter which is employed, a filter circuit is necessary to prevent flickering due to hum voltages and other a-c voltages which might also affect the accuracy of the indication. In *Figs. 2* and *5*, a 2-megohm resistor and a .01 condenser form the necessary filter circuit. In *Fig. 6*, a 1 meg resistor, preceded by a .0001 mmf and followed by the .01 mf condenser does the trick.

Note that the phone jack connects to a point on a voltage divider across the input circuit of the 6H6 in *Fig. 2*. This is done to avoid detuning of the last stage when the heavy phone load is placed in the circuit, which would happen if the isolating circuit were not employed. To avoid distortion, the diode circuit is opened when phones are inserted in the circuit of *Fig. 6*. When phones are used, it is preferable that they be of the high impedance type, such as crystal types, to minimize further the loading effect.

The design of the wattage indicator circuit is shown in *Fig. 7*. The transformer *T1* is special: it has a very low resistance primary and a fairly high step-up ratio. The 17,000-ohm potentiometer is used for calibrating purposes, which is best done with a fixed, high voltage rating resistor. The instrument is essentially a current-indicating device, but reads approximately in watts by assuming a power factor of 85% in the device being tested. This is about right for the average a-c receiver. This means that the actual power consumption may be figured as 85% of the total primary current times the voltage.

Electronic Voltmeters

The electronic voltmeter circuit is shown in *Fig. 8*. This will be familiar to many readers, since it has appeared in connection with other articles, but for those who have missed it, here it is. This is an extremely useful device

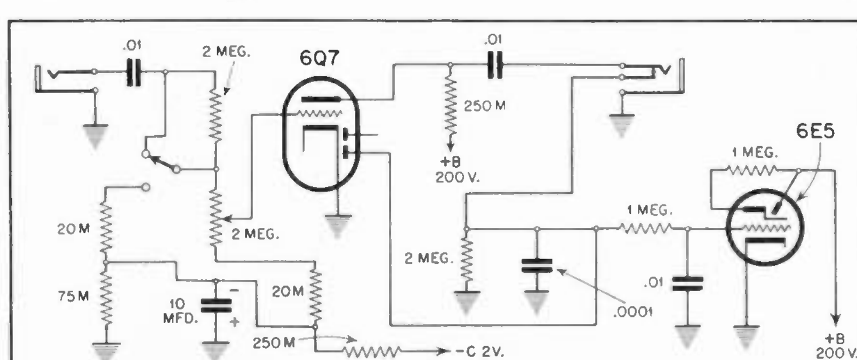


Fig. 6. The audio channel of a typical signal tracer.

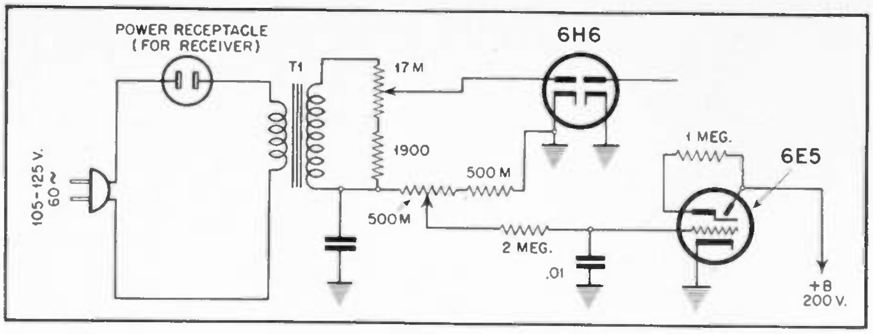


Fig. 7. The Wattage indicator of a typical signal tracer.

which can be easily assembled by anyone, provided a suitable meter and scale are at hand. In operation, the cathode current of the type 76 tube is adjusted by means of the calibrating potentiometer (5000 ohms) and the zero adjustment (10,000 ohms) until the meter reads half scale when the tube is operating. This is equivalent to adjusting the cathode current to 0.5 ma. Now, if a positive voltage is applied to the tube grid, the cathode current will increase and the meter reading will increase in proportion. If a negative voltage is applied, the reading will decrease. Thus it becomes possible to read either positive or negative voltages without interchanging leads. Further, the maximum current which the cathode will draw is about 8 ma, so if the test probe is accidentally touched to a point where the voltage is much higher than was expected, the meter will be subjected to only an 8-to-1 overload, which is can withstand for a short period without damage. In practice, it is possible to apply 500 volts to the input (through the probe) when the voltmeter is on its 5-volt scale, without damaging the meter in any way. When an excessive negative voltage is applied, the meter reading is driven to zero; it cannot read less than zero, therefore no overload is possible.

The probe which is employed with the electronic voltmeter is illustrated in *Fig. 3B*. Note that a 1-megohm resistor is built within the proble handle. This serves to isolate the cable from the circuit where the voltage is being measured so that tests of d-c voltages may be made in r-f circuits without appreciably interfering with the performance of the circuit under test. Actually, it is equivalent to shunting the circuit with a 1-megohm resistor, insofar as r-f circuits are concerned. As for the loading effect on d-c circuits, this is equal to 11 megohms shunted across the circuit under test. This results from the fact that the input voltage divider totals 10 megohms, which is effectively in series with the probe resistor of 1 megohm, making 11 megohms in all. Four scales are available, as shown.

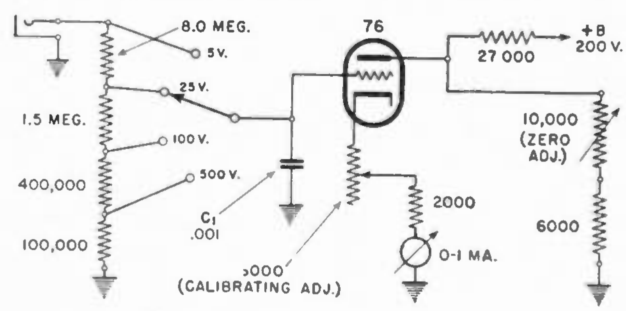
Speech Tests Preferable

In the application of this apparatus, readings are taken at points in the receiver under test, as indicated in *Fig. 9*. The test signal is applied by means of a test oscillator (or a broadcast signal) as shown. It is better to use a test oscillator unless the trouble is simply distortion, because the test oscillator signal is easily controllable to the desired level, while the broadcast signal is not. On the other hand, if we are merely checking for distortion—using phones—the broadcast signal will be more useful, particularly speech, because one can identify distortion more readily on a broadcast signal than on the usual 400-cycle oscillator signal (which already may be distorted).

To test, place the receiver in operation and switch it to the broadcast band. Tune both receiver and test oscillator to 600 kc. Connect the RF-IF probe to the signal tracer and touch the probe to the antenna post of the receiver (to which the test oscillator lead is also connected). Adjust the RF-IF channel to maximum sensitivity and tune to the test signal frequency, 600 kc. Adjust the test oscillator output until the channel eye of the RF-IF channel just closes. This is the reference signal level.

Now transfer the test probe to the grid of the first tube, *point 2*. The signal level should increase, as evidenced by overlapping of the channel eye. Readjust the Level Control of the RF-IF channel until the original reference signal level is restored. The reading of the level control calibration now indicates the amount of gain in the antenna transformer. This will normally be between 2 and 10. A loss indicates a defect in that circuit and will be shown by a weaker, rather than a stronger, signal level at *point 2*. If a gain is shown, proceed to *point 3*, where the gain should be considerable—due to the tube amplification. This will usually be at least 10, provided the avc is not working. Again, a loss indicates trouble and testing should not proceed further until the tube and

Fig. 8. Diagram of a typical electronic voltmeter such as used in conjunction with signal-tracing equipment.



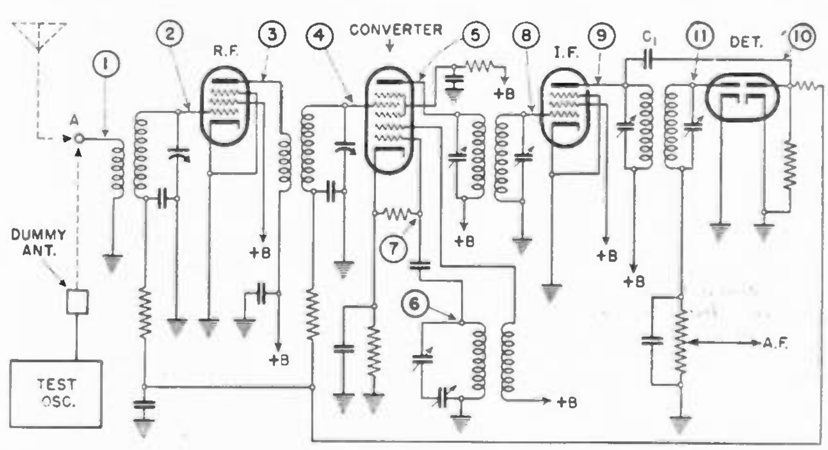


Fig. 9. In servicing by signal tracing, there are only 11 points in the average receiver where readings need be taken—all of them accessible. Ordinarily the fault is located before all points have been covered.

circuit are investigated. It is best to test the tubes in a tube checker to eliminate them as possible causes of trouble. However, it will be occasionally found that the tube checker will not indicate a defective tube; this will be revealed when making the signal tracing test when a new tube is substituted for the one under test. Signal tracing is a dynamic test.

Oscillator Frequencies

Testing continues at *points 3, 5, 8, 9* and *11* with the RF-IF channel. At *point 6,* the oscillator frequency is being checked. This is done with the oscillator probe and channel, tuning the channel to the oscillator frequency. Normally the oscillator frequency will be equal to the frequency to which the receiver is tuned plus the i-f amplifier frequency used. Thus, if the i.f. is 465 kc and the receiver is tuned to 600-kc, the set oscillator should operate at 1065 kc. If the oscillator frequency cannot be picked up on this setting, or thereabouts, the oscillator may be checked for operation by placing the electronic voltmeter probe on *point 7.* When the oscillator is functioning, a d-c voltage is developed across the oscillator grid leak, which may be checked at *point 7.* This will normally be of the order of several volts and will be negative with respect to the converter tube cathode. If the oscillator is inoperative, the reading may be slightly positive with respect to the converter tube cathode.

If the converter is functioning properly, the i-f signal is checked by retuning the RF-IF channel to the i-f. and placing the probe on *point 5.* Thence the signal is followed through the i-f amplifier. At *point 10,* the rectified i-f signal, which is used to apply avc voltage, is checked with the electronic voltmeter.

For checking in audio stages, the audio channel is used as indicated in *Fig. 10.* The audio signal, which will be a 400-cycle tone if the modulated test oscillator signal is fed to the receiver under test, will appear first across the diode load and may be checked by placing the AF channel probe on *point 1.* This signal then passes through *C1* to *point 2,* without amplification but will be amplified considerably at *point 3.* Other test points appear at *5, 6, 7,* and *8.* At the last named point, a strong signal would indicate that the bypass condenser across the cathode resistor was not working as it should. A considerable reduction in signal level would be expected from point *5* to points *6* and *7* because there is a normal step-down in the output transformer which is proportional to the square root of the impedance ratio. Thus a 10,000-ohm primary and a 10-ohm secondary would indicate an impedance ratio of 1000 to 1 or a step-down ratio of about 33 to 1.

This covers the signal tracing in principle: a complete book has been written on the subject and the writer suggests those who are interested in delving deeply into the subject to consult such a text. The point we want to make is that signal tracing is done largely with instruments which resemble conventional radio receivers. It follows that a regular radio receiver may be used for signal tracing; not, we hasten to add, with all the features

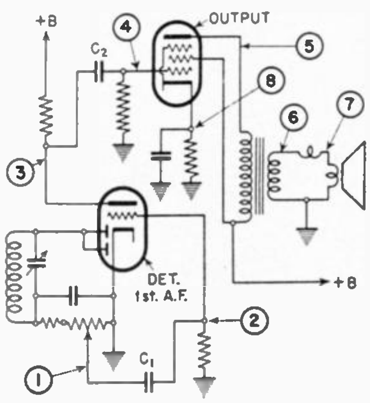


Fig. 10. The points in the circuit of an audio amplifier where the signal should be checked. Explanation of procedure is given in text.

which are obtainable in channelized instruments designed especially for the purpose, but insofar as tracing the signal, without regard to gain measurements, it is possible to use an ordinary receiver. This is done by simply connecting a wire to the input circuit of the receiver which is to be used as a signal tracer and placing the wire close to, *but not directly in contact with,* the circuit to be tested. Otherwise, the operation of the signal tracer and the receiver used for the same purpose is identical. In audio circuits, the audio amplifier of a receiver might be used, with a regular shielded probe for tracing purposes. All these variations are somewhat make-shift in character, but can be used in a pinch when no more efficient substitutes are available.

Servicing Signal Tracers

Regarding the servicing of signal tracers, much information is given in instruction manuals which accompany such instruments. Most of the troubles which you are likely to encounter are similar to those which occur with high-grade radios; perhaps the replacing of a level control, or changing a tube, or a condenser. The 10 mfd electrolytic in the audio channel may have to be replaced after a long period. If the image on the indicator eye becomes fuzzy, this is the most likely cause. A 25-mfd, 25-volt electrolytic is a preferred replacement. The power supply (not shown) will likewise require similar attention. Very little servicing is normally required, because these instruments operate at low voltages — 200 volts is maximum — and all parts are chosen with a wide safety factor.

The instrument we have been discussing is the pioneer one of its type—the Rider Chanalyst. There are many others, but in principle they are all the same. Insofar as their application is concerned, the technique is identical to that described in these pages.

★

MORE ON TRANSFORMERS

(Continued from page 17)

If hum seems to come from the speaker field and output plate supply, first try added capacity across C_4 in *Fig. 2.* If that fails R_4 and C_7 may eliminate not only the bias hum but also the field hum and any other type of plate supply hum.

Hum may be coming through the V_1 plate supply. If it still persists after the above corrective means have been used, add R_5 and C_6 to filter the plate supply of this tube, using the added filtering for any other audio tubes ahead of V_1.

Then there is the very rare case of hum from the cathode of V_1. It can be cured by adding a 5 or 10 mfd, 100-volt condenser across R_6. This will also add to the very low bass response. A new tube may also eliminate this type of hum.

If one side of the secondary goes open, and you cannot make the other side open with a surge of d-c through it, the transformer will probably stay in service for a considerable length of time, with the changes shown in *Fig. 3.* In this circuit the gain is reduced, probably the same amount in *Fig. 1B,* but the grid is not unbalanced, nor is the tone changed much from the original. Only two ¼-watt resistors are needed. We feel that this is definitely a cheap system, adding nothing to the original performance, and slightly reducing the gain. It is our impression that adding a few more parts, as shown in *Fig. 4,* would be better from a performance standpoint since improved tone can be obtained. Hum difficulties may need to be solved.

A word about audio transformers in general. It has been our experience that these open windings are nearly always the result of acid eating the wire. This acid is most frequently found either in the paper wrap, the tape around the splice, or in the form on which the winding is started. As a general rule audio transformers are wound in such a manner that the primary may open up without there being much danger of the secondary opening later. The plate voltage in the primary also seems to hasten the acid action, possibly by electrolysis due to the small leakage current to the frame. When the primary is entirely disconnected as in *Fig. 1B,* electrolytic action should cease and the transformer last much longer than otherwise.

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SIGNAL INJECTION

(Continued from page 7)

supposed to operate to *point 6.* Thus, if the set is tuned to a local broadcast signal—it is best to pick out a strong local and connect the antenna to the receiver under test — having a frequency of 700 kc and the i.f. amplifier of the set under test is 465 kc, then we simply tune the test oscillator to 700 plus 465 kc or 1165 kc and inject the signal at *point 6.* There it will beat with the incoming broadcast signal to produce the required i.f. of 465 kc. This assumes, of course, that the converter tube itself is OK, even though the oscillator section is inoperative.

Testing in the r.f. stages is made by injecting at points *7, 8* and *9* a signal of the same frequency as that to which the set is tuned.

This, then, is the routine to be followed in trouble shooting by the signal injection method. We have referred, as you have noted, to gain-per-stage tests during the progress of this work. To be of value, it is necessary to know what stage gain should be expected and, further, of the technique of making the measurement. Actually, in general trouble-shooting, it is not necessary for an experienced serviceman to know precisely what gain should be obtained. He soon gets to know this by comparative tests of receivers. And, further, the nature of troubles usually encountered is such that a very great reduction in gain occurs when a part becomes defective, while minor differences in gain are usually merely the result of receiver misalignment, which will readily be corrected in the process of servicing. But it is interesting to know how these measurements are made, and what gain should be expected.

Gain Measurements

To make a gain measurement, an output meter should be connected across the voice coil and a signal level selected which will produce a readable deflection well above the noise level but below the overload level of the receiver. Then a signal is fed to the output of the stage under test. For example, in *Fig. 1,* to measure the gain of the first a-f stage, the signal is fed to *point 4* and the signal level adjusted (by means of the attenuator on the audio oscillator) until the output meter reads, say, 1 volt. Then the audio signal is injected at *point 5.* If the signal has been amplified, the output meter should increase. So we reduce the audio signal by readjusting the attenuator on the signal generator until the output meter on the set reads 1 volt, as it did originally. Now if we know what signal level was fed to *point 4* and *point 5* we can readily determine the gain. Thus, if the signal level were 1 volt when feeding at *point 4,* to produce 1 volt across the voice coil, while 1/20th volt fed to *point 5* produced the same output meter reading, it stands to reason that the signal has been amplified by the ratio of 1 volt to 1/20th volt, or 20 times, between *points 4* and *5*

Naturally, to make such measurement requires an attenuator which is calibrated in ratios over a considerable range. This is not hard to do at audio frequencies but is quite difficult at radio frequencies. Thus, signal generators with calibrated attenuators are far more expensive than the run-of-the-mill service test oscillator.

Why, you might say, need one require a calibrated attenuator? Why not keep the signal level the same as we inject from one point to another and merely note the difference in output meter reading? Wouldn't the ratios of the output meter readings serve just as well to indicate gain? The answer is no, except for very small gains, because if we start with an initial output meter reading above the noise level we will find that the gain in even a single stage will be sufficient to increase the reading to a level near the overload point or where the output is no longer linear. That is, when the output meter is connected across the voice coil, where it usually must be for audio gain readings.

R-F Circuits

In r-f circuits the same methods apply. Here, in addition, we must make certain that no avc or other control circuits which affect gain are operating if an accurate gain measurement is to be made. However, it is possible to use a v-t voltmeter across the diode load as an output meter and measure small values of gain by the change in readings of the voltmeter for a constant signal input level. But this method is admittedly makeshift; to do the job right you need the proper tools.

A further precaution in making stage gain measurements is to make certain that all tuned circuits are properly aligned. This seems obvious but is often overlooked.

Output meters which may be used as indicators for these measurements are the copper-oxide type of a-c voltmeter, with which we are all familiar, a vacuum-tube voltmeter, or a cathode ray oscilloscope. The last named will serve the dual purpose of indicating distortion when the signal character is affected by some defective condition in the stage under test.

Overloads

Lastly, make certain before applying any signal circuit tests that no major overload exists in the receiver under test. This may be done by a wattmeter check of power consumption or, more simply, by measuring the resistance from the high side of the power supply circuit to ground. This may be most conveniently done by removing the rectifier tube and checking the resistance with an ohmmeter between the heater or filament of the rectifier tube socket and the chassis. A low resistance—below 5,000 ohms—means that an overload exists due to a short somewhere in the receiver. An open circuit means danger also; in all probability the condensers will be severely overloaded if an attempt is made to operate the receiver before correcting this trouble.

★

Clarostat Brings Murphy East—Frank Murphy has been transferred to the Brooklyn offices, from which he will answer correspondence, although he will continue to travel his Chicago territory. Clarostat's large volume of war work necessitated the move.

CIRCUIT COURT

(Continued from page 13)

a-f voltage amplifier. The grid of the 6J5GT squelch tube connects to the grid circuit of the 6SJ7GT limiter tube. When an f-m station is being received, a high negative voltage is developed in the grid circuit of the limiter. This biases the 6J5GT squelch tube to cut-off. However, when the receiver is being tuned between stations, no negative voltage is developed in the grid circuit of the limiter. Under these circumstances no negative voltage appears on the grid of the squelch tube with the result that it draws plate current. This plate current flows through the cathode circuit of the 6SQ7GT a-f triode in which there is a 5000-ohm bias resistor. The increased current through this resistor increases the bias on the grid of the 6SQ7 to a point sufficient to reduce the gain of the tube below the noise level.

The lower channel in the diagram is the a-m receiver. This is also conventional, but note that the diode second detector is the diode section of the 6SQ7GT, the triode section of which is used as the a-f voltage amplifier.

In the audio amplifier the treble control is associated with the volume-control circuit, whereas the bass control is in the plate circuit of the 6SQ7 audio tube. This tube feeds a single 6J5GT which is employed as the phase inverter, with half the audio voltage being picked off the plate circuit and the other, opposite, half being taken from the cathode circuit. These opposed-phase voltages are applied to the grids of a pair of 6Y6G's in push-pull. Bias for these tubes, it should be noted, is obtained from the voltage drop across the field of the tweeter loudspeaker, which is connected with the negative leg of the power supply. The woofer field is used as the filter choke in the power-supply output circuit.

The frequency-dividing network in the speaker circuit is nothing more than a 4-mfd. condenser connected in series with one of the leads to the tweeter voice coil. This condenser offers a progressively higher reactance to frequencies as they become lower. The very low frequencies, therefore, take the path through the woofer.

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"E" Citation to Hallicrafters—The Hallicrafters Company, Chicago, was awarded the Army and Navy "E" on September 9th, for "high achievement attained in the production of war equipment."

FUSES

(Continued from page 10)

Fuse Clips and Mountings

Along with the fuses, fuse-clips, mountings and extractor posts, have of necessity had to keep pace. Clips and mountings are just as important as the fuses, and are as constantly a field of special development and design. Fuse performance vitally depends on these. The Be. Cu. (Beryllium Copper) Fuse Clip may be taken as an outstanding achievement as clips of this new alloy of beryllium and copper have remarkable properties. Its tables of performance show high fatigue resistance, tensile strength, modulus of elasticity, heat-, corrosion-, and vibration-resistance. These Be. Cu. Clips have the spring quality of steel and triple the grip of best phosphor bronze.

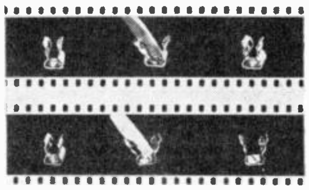

Fig. 20 Top—Cinema photo of screwdriver test shows Beryllium Copper (Be. Cu.) Fuse Clip's instant return to perfect form. Fig. 20 Bottom—same test of phosphor bronze fuse clip. Observe deformed condition of clip after test.

Some practicable suggestions on the care of fuses may not be amiss in a discussion such as this.

When A Fuse Blows

The presumption is that the "blow" was caused by an overload of current. The blowing of a fuse is a *trouble* signal. It is probable that the blowing was caused by an overload of current above the rating of the equipment. But it may have been caused by one or more *other* troubles.

Before inserting a new fuse, look for the trouble. Do not replace the fuse until the trouble is found and corrected. If the fuse is of the right size and kind, it is not the fuse's fault. Under proper operating conditions a good fuse will last indefinitely. With all the information at hand in the fuse literature usually furnished, there never need be an error on size and kind of fuse.

Look for poor contact: On the fuse, near the fuse, or if a renewable fuse, *in* the fuse. Contact must be tight at all points. Clips must be bright and clean, and must grip fuse tightly. Pressure is required to insert fuse in good clips. Contact must be tight at all points on the fuse block. See that the clips are not warped nor misshapen.

Look for starting trouble. If the fuse blew on starting, trace to current source.

Test the temperature near the fuse. If the fuse is at a point of high ambient temperature say 150° F or more, it cannot carry its rated load. If temperature cannot be reduced, give all the air circulation possible.

Look for temporary overloads. If nothing can be done to correct this trouble, change the wiring and fuse block.

Do not over-fuse.

Look for short circuit. If this blew the fuse, correct the cause, see that the line is cleared before putting in new fuse.

★

G. E. Ups Ray and Mandernach—it is announced that F. A. Ray, manager of the Musaphonic Division since its inception, has been named Eastern Regional Sales Manager of the Receiver Division at Bridgeport, Conn., and will assist A. A. Brandt, sales manager. H. J. Mandernach, G. E. district radio representative in the central west for the past six years has been named a member of the headquarters staff in the Tube Sales Division of the Television and Electronics Department, Bridgeport. He joined G. E. in 1936, was headquartered in Chicago until this new assignment brought him to Connecticut.

F. A. Ray

H. J. Mandernach

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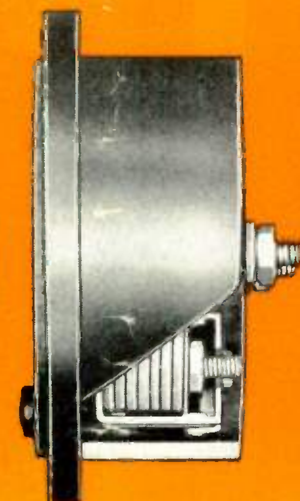

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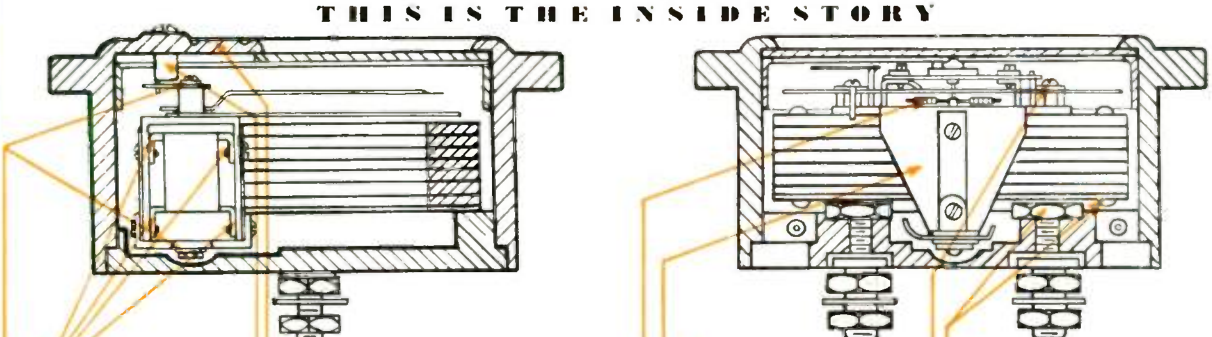

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