1933

MODERN RADIO

EDITED BY ROBERT S. KRUSE

CONTENTS

February Number 20 20 cents

1933 Tank — Circuit Economy

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The tanks—tuned plate circuits—of amateur transmitters have been more costly, and less effective, than seems necessary, possibly because some simple stunts are not well known.

Usually the tuning capacity in the tank is made rather large, in deference

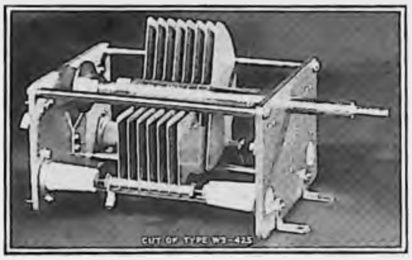

Fig. 1. In either non-crystal oscillators or harmonic-suppressing amplifiers a condenser of .00025 ufds. is sufficient, if well designed. The one shown here is rated at 4000 volts.

to the "High-C" (large capacity, low inductance) scheme of reducing harmonics in an amplifier, or improving frequency-stability in an oscillator of non-crystal type. The coil—perhaps in consequence—is often made with conductor as large as 1/4-inch copper tube, ordinarily spaced much too closely. (With three turns per inch the copper tube is slightly poorer than a No. 10 wire, and becomes rapidly worse as the spacing is made smaller. With less than two turns per inch the tubing is superior.)

The Condenser

The difficulties of the high-C idea are several. First, the losses in a tank tuned by .0005 microfarads can be brought down to those of a tank tuned by .0001 only if the resistance is reduced to ONE-TWENTY-FIFTH—which is almost out of the question. Secondly, the tuning condenser is materially more costly if such a circuit is used at the high-power, or output, end of the set. Even in the oscillator it will be found that at wavelengths around 40 meters there is not a great improvement in frequency stability due to capacities above .00025 PROVIDED that rigid construction is used in all cases. A copper-tube coil supported from the ends or laid on glass rods is not a thing to base a good oscillator on, it wiggles like any spring but becomes better as the turns are reduced and thus lends a false air of improvement to extreme high-C circuits—which could have been gained by a few simple supports. However, a capacity of .00025 in the oscillator is proper enough.

Harmonic Suppression

In the ampifiers harmonics may be satisfactorily suppressed by avoiding extreme r.f. inputs to buffer and other tubes, lowering the bias in proportion. Some "harmonics" are actually semi-blocking caused by leakage of plate voltage from a tank circuit through a coupling condenser to the next grid. This can be avoided by using a separate grid coil inside the tank coil, and biasing by means of a gridleak in series with this coil and by-passed by a .0005 receiving condenser—another economy! No C batteries are needed.

Harmonic suppression also does not improve greatly by using amplifier tanks with capacities above .00015 or at most .00025, provided one has removed the

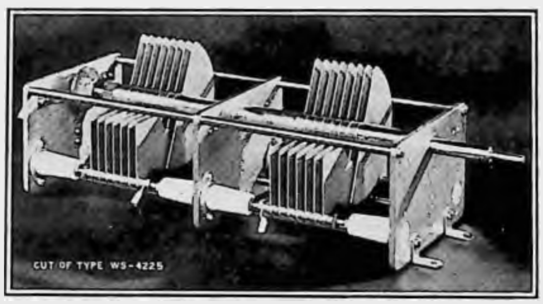

Fig. 2. In push-pull output stages excellent harmonic suppression is possible when using a two-section condenser of about .00025 per section, and with a low-resistance connection from the filaments to the rotor—preferably via a wiper-contact as here shown.

OTHER causes for harmonics—including overdrive of the grids, and grid chokes with resonances at or near harmonics. For this latter reason the bias by gridleak is again recommended—whether grid coupling be as before suggested or not. A gridleak in series with a choke tends to swamp any resonances the choke has.

Push-pull Stages

In push-pull stages the second harmonic is almost wiped out if the tubes are even fairly decently matched. An exact match is not essential. This makes

Fig. 3. While originally intended for neutralization of 852 tubes, this condenser is admirably suited to the tuning of the tanks of harmonic-amplifiers (frequency doublers or triplers). The adjustable stator plate makes possible any rating from 7500 volts at .000010 to 3000 volts at .000025—which covers all needs of such circuits—and most neutralizing needs as well—204A and 851 excepted. For them there is a type WSN 204.

a push-pull stage desirable, but such a stage tends to have a stronger third harmonic than a "straight" or single-sided stage. This can be reduced materially by tuning the stage with a two-section condenser and returning the rotor to the filaments so as to provide a low-impedence path for undesired harmonics. The stage must be quite symmetrical if this is to be done.

Frequency Doublers

By the reverse reasoning—if a harmonic is to be ampified the tank should not *only* be tuned to that harmonic, but should have a low-C high-efficiency circuit, with a capacity as small as practical—tube capacity plus a few micro-microfarads. The tube will then tend to run much color. The points here made are well illustrated by the new condensers of The Wireless Shop, herewith illustrated.

Saw clever stunt recently, tube tester with an extra socket hitched to a couple stages of audio and an antique speaker. Put tube in and pat it on head—no further doubt if it is microphonic. Such a noise!

Monthly weather bulletin. In Kansas we will not admit that it is summer until the mercury hits 90. In Denver tourists are recognized by their umbrellas—the natives just take it. In southern California it is never "generally cloudy"—but there are some high fogs. In Connecticut comfortable winter weather "isn't really healthy," and here 'tis in the fust of the year and we ain't used the tire chains yet.

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Bringing the Amateur Receiver and Transmitter Up to Date
Part 4 The 1933 Antenna*

By Robert S. Kruse

Having found such inexpensive and painless ways to bring the receiver and transmitter up to date it would be a great pity if we could not provide an inexpensive—but improved—1933 antenna as well.

Certainly it is high time to change antenna styles again. It is becoming monotonous to find one station after another wasting its power in charring wooden spreaders in a 2-wire "zeppelin" arrangement like Fig. 1A—and wondering why the antenna tuning changes on wet days!

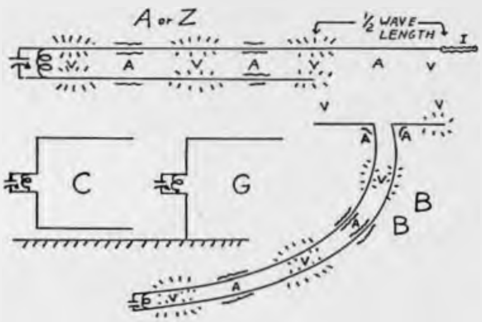

Fig. 1. Test Circuits.

The "Zeppelin" system is nothing but an antenna folded up and working at a harmonic. The so-called "line" has standing waves on it just as before—at all the "V" points in the figure there is high voltage requiring insulation *in every electrical way equal to the insulator I at the end of the antenna.* Nobody dreams of using a dirty stick for insulation at I—but it is expected to stand up at the other V points. And make no mistake—a parafined wooden rod (1906 style insulation) is just a dirty stick after a few months of sun and rain.

* Parts 1, 2 and 3 appeared in the preceding three issues, sent postpaid for 50c. Modern Radio Co., 101 Allyn St., Hartford, Conn.

Before proceeding it is best to emphasize that the "Zeppelin" scheme of 1A, the so-called (incorrectly) "current-fed antenna" of Fig. 1B and the 1920 "antenna counterpoise system" of Fig 2C are really folded Hertz antennas—nothing more. There is no "r.f. line." The whole thing is a tuned system, no matter how it is bent around—and when the two lead-outs are brought close together—look out for losses in the insulation—also look out for unsteady tuning when the wind blows.

Reforming the "Zepp"

If then you *must* use a "Zepp," for efficiency's sake use 10-inch rods of pyrex, mycalex, isolantite or ***high-quality*** bakelite. They can be thin, because the strains are small. I've seen cases where the rainy-day field strength of the antenna was tripled by the change. I realize thoroughly that these things are heavier than dirty sticks—but any *tuned* line should be rigid anyway—not flopping around in the wind. A flapping antenna will not shift the frequency of a modern transmitter or receiver but it most certainly will change the load—and that means unsteady signal strength. Don't take my word for it—let someone listen to a carrier from a "Zepp" antenna and then "flop" the thing with a cord.

The "Zepp" has one distinct virtue—its wavelength is easily adjusted from inside the station—and why not, since the antenna itself comes into the station? This same virtue is shared by the arrangement of 1B which is not really a "current fed antenna" but the same old folded harmonic Hertz antenna—the "line" (!) has high currents and voltages just as before? Again—the line should be rigid and the spreaders of extremely high grade. I used to doubt the need of some of these precautions, but one learns from field engineering.

Better Ways

If the two leadin portions were not so miserably close together—OR—if they were working as a proper feed line (no high voltages or currents) all of these requirements could be washed out—we could stand a floppy wire and dirty-stick insulation.

Let's take the two possibilities one after another.

Possibility "A"

By unravelling our folded antenna and restoring it to the 1920 form of Fig. 1C

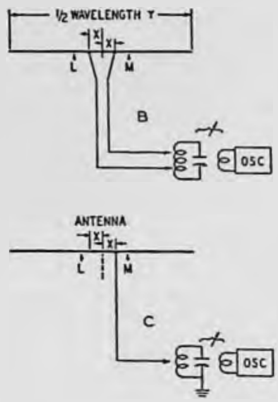

Fig. 2. Antenna performance. Above: A—circle on which test receiver (Fig. 2) showed 50 microamperes. B—effect of reflector. Below: Family of curves like B.

we automatically wipe out the bulk of the insulator losses, but at the same time we increase the theoretical dielectric losses in the house and earth—possibly also we increase the radiation. Attempts to estimate the probable result for average amateur locations were inconclusive. Tests made at amateur station locations gave the following results—all at 40 meters.

First Station

Place—Lawrence, Kansas.

Soil—Deep, loamy clay.

Surroundings—Thick growth of 60 and 70-foot maples—antenna between them.

Antennas: G—1-wire L, 20 meters high, 20 meters long, grounded to buried wire net. C—Same to 3-wire fan counterpoise. Z—Same with dual "zeppelin" lead—no ground or c.p.

Results—Field strength at 1 mile and average of reports from distant observers showed by far the best results from antenna G.

Second Station

Place—East Hartford, Conn.

Soil—Sandy.

Surroundings—Wholly open.

Antennas: G—1-wire 20 meters long, 45 degrees above horizontal, 20 meters high at free end and down lead running irregularly for 25 feet to apparatus. Ground to water pipe. C—Same with 4-wire harp counterpoise. Z—Same with extra lead wire.

Results—G and C equal as to distance effect, G better in gusty weather—same basis as other test. Z inferior by 20 to 50%.

Third Station

Place—Kansas City, Mo.

Soil—Rock (limestone).

Surroundings—Clear.

Antennas: G—1-wire L, 78 feet high, 60 long. Waterpipe ground. C—Same with 2-wire T counterpoise. Z—Dual lead as before.

Results—G decidedly inferior, almost non-resonant. Noisy, transmission poor. C and Z about equal on the average, but Z less good in wind and rain, and slightly better in good weather.

These three are representative tests and seem not to support the reputation of the types A and B too well, the simpler systems C and G on the whole giving a better account of themselves.

"Antenna Amps."

In passing G will usually show the lowest antenna-meter reading, C the next and B or A the highest—"but it don't mean nuthin' " unless B or A are very high in which case it means charred spreaders—assuming dirty-stick spreaders are used.

Possibility "B"—Real R.F. Lines

Or—we may use an honest-to-goodness *untuned* R.F. line—not a folded antenna but a feed-line with *the same* SMALL voltage and current all along it—doing nothing but carrying the power to the antenna. The antenna of course, is always tuned and has fancy voltages and currents and radiates rapidly. Such a non-tuned line can be of *any* length, and can even be used with dirty-wood insulation because the line voltages are low. For the same reason the line can weave by obstructions with much less

(Continued on Page 18)

THE IMPROVED AGS RECEIVER

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Unlike most short-wave receivers the new A.G.S. receiver of the National Company is neither a modified broadcast receiver nor a modified amateur receiver. It differs from multiple-range broadcast receivers in the use of a precision dial and wide tuning-spreads, the provisions for headset reception, c.w. reception, and the switching out of the automatic volume control—and particularly in the use of a construction in which great accessibility is provided for all parts which might need attention in heavy commercial service. It differs from amateur and other specialized receivers in that it uses one control—and one only. There are no other tuning controls whatever — either "vernier" or "bandspread." Bandspreading is instead assigned to coils made for the purpose; with any one set of coils in place there is ONE tuning adjustment to record—and only one. None the less, adequate preselection is provided by the use of two tuned circuits before the first detector. Some of the special circuit features will best be seen in the diagram and the following discussion of the adjustments during manufacture.

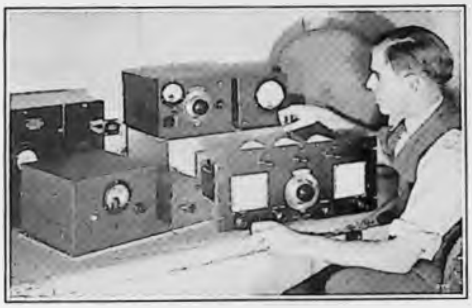


Fig. 1. The testing and adjusting is done in the usual way with a "microvolter" (standard signal generator at left rear), and a shortwave oscillator whose frequency is frequently and carefully checked. The output is either to the speaker or the output meter.

Assembly and Testing

The general arrangement of parts can be seen most easily from the illustrations and need not be described in detail. The interesting part of the process begins when the set has been mostly assembled and wired, so that tests and adjustments may begin. It is, of course, necessary to make sure that each power-supply operates as intended, that is with proper freedom from hum, either of the kind due to imperfect filtering, or "tunable hums" due to r.f. oscillations produced by the operation of the rectifier, or fed in from the supply line. This is of particular importance where "A.V.C." (automatic volume control) is used, together with a second (beatnote) oscillator.

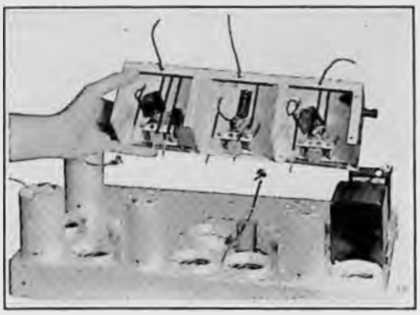


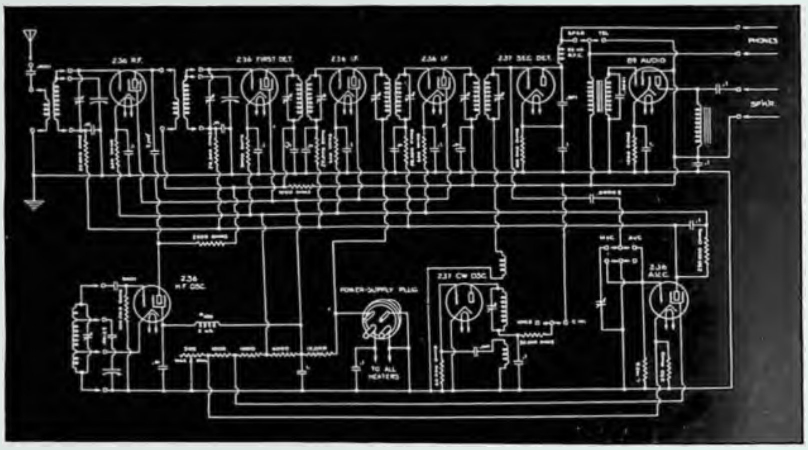
Fig. 2. The tuning assembly removed to show the inductance slide wires. Complete access is possible by removing the flat back plate as shown. The terminal strips at the top permit easy connection to the set terminals which appear on a similar strip to be installed on the chassis.

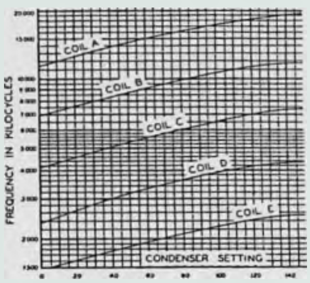
Turning to the receiver proper, the first step is to align the intermediate-frequency amplifier at 500 kc. (Special litzendraht transformers give good gain at 500 kc.) The second is to check the performance of the second detector with particular attention to any tendency toward overloading with signals of either high modulation or very low modulation

An oscillogram showing peaks in the output of a mercury vapor rectifier. These may produce hum or set up r.f. disturbances. An '80 is therefore used in the power supply.

—many foreign signals are of the latter type.

The audio amplifier is next checked, then the first detector and its oscillator, and finally the first R.F. stage. This is all done without any attention to the heater-to-cathode-to-capacity very low and very uniform and check for this in their production checking machines. Also the present tubes have an almost infinite resistance between heater and cathode.





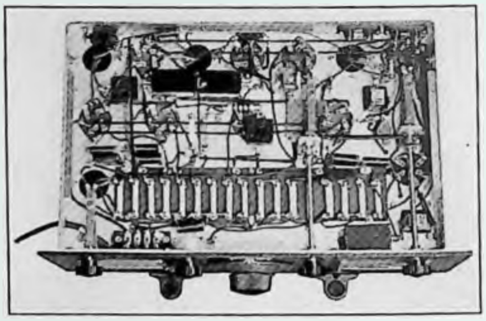


Fig. 3. Serviceman's dream—a diagram with all constants given, a chassis with all parts accessible, and a tuning chart that fits every receiver using standard coils. (The special band-spread coils give much flatter curves.)

ganging—merely peaking tuned circuits at the different test frequencies.

The AVC System

Then the AVC is tackled. This is a rather peculiar circuit in which the grid is operated at ground or chassis potential; the screen at 16 volts above the chassis; the plate at 30 volts above the chassis, and the cathode at 3 volts above the chassis. Such a type of AVC, while exceedingly effective, has only been made possible as a result of the changes in the construction of tubes by RCA and other manufacturers during recent months, as a result of which they maintain the

The volume control circuit is also unusual in that when a switch is thrown for manual control, a biasing or other resistor is not varied in the control grid or screen grid circuits of any of the R.F. or I.F. tubes, but instead the control grid voltage of the AVC tube is changed, which, in turn, changes the plate impedance of the AVC tube and consequently the plate current, which, in turn, controls the biasing voltages on the R.F., first detector and all of the I.F. tubes. This method of procedure makes possible a ready shift from manuaul to AVC control, and eliminates all moving contacts and possible noise producing resistors from the high gain circuits and this has a great deal to do with the extremely low background noise obtained

Fig. 4. A commercial rack-type installation. From the top down—Permanent-magnet dynamic speaker, coils storage rack, AGS receiver for traffic work, 58C tuned r.f. receiver for standby work, and the double powerpack for both.

in the final receiver. This is probably an exclusive feature.

Once the AVC is working properly, then it is necessary to go all over the R.F., first detector, and I.F. again to see that all adjustments made in the AVC tube have not affected the sensitivity of these other circuits.

Ganging

The last and final stage is the ganging. The three tuning condensers are first carefully matched, so as to have the same capacity curves. By means of padding condensers the minimum circuit capacity is then adjusted to a predetermined value. This is done using standard laboratory coils of known distributed capacity and inductance. The tuned circuit inductance is then adjusted, with these same coils in place, to standard predetermined values by means of the inductive slide wires which may be seen in Fig. 2, which shows the inside of the condenser compartments. At the left of each condenser, when viewed in this photograph, will be seen a vertical buss bar to which a flexible lead is soldered. This lead runs from the variable condenser. By sliding this flexible connection up and down the buss wire, before soldering permanently, the tuned circuit inductance is adjusted to the proper value.

Then it becomes merely necessary to adjust the various coils that go with the receiver so that they will have the same distributed capacity and inductance as the standard laboratory coils used in testing up to this point. The inductance of these coils is remarkably uniform and requires very little adjustment, due to their being wound on the NATIONAL R-39 *threaded* coil forms. However, where adjustments are necessary, they are readily made by unsoldering the grid lead to the grid pin on the base of the coil and either pushing it further in or pulling it out, and then resoldering and checking the inductance until exactly the proper value is obtained. Then this wire is clipped off. Being stiff and well protected it does not change thereafter.

Distributed coil capacity is adjusted by means of small padding condensers located inside the coil form. Thus the final result is an absolutely single control receiver with interchangeable coils and one on which no shift of adjustment is necessary when going from one set of coils to another.

Fig. 5. Rear view of the rack installation of Fig. 4.

When a 1-kilowatt broadcasting station increases by 1500 watts the district is charged with a quota increase by the Federal Radio Commission. But if a 25-kw. station is increased by 25,000 watts (which is about 17 times as much)—it doesn't count at all—at all.

THE PERPETUAL ANALYZER . . . NEVER OUT OF DATE

By L. W. Hatry

• • •

It is the purpose of this paper to describe an analyzer that cannot go out of date through tube changes, and to show that such an analyzer can be much simpler than many of the present types, far less costly in the long run—and of course much less of an annoyance to the user.

It is necessary to review somewhat to make clear the advantages of such a type.

The present analyzers are too rigid in makeup, and have gone beyond the sensible region of giving us sensible and necessary facilities—and traveled far into that region where they must be sold on "features"; the more is crammed into the box, the better the analyzer! These complex traveling laboratories are not properly portable, not properly simple, and tend to confuse the user and to make him forget that his work is based on a few simple fundamentals. Incidentally, nothing becomes obsolete more rapidly than an analyzer that has a cut-and-dried test for everything.

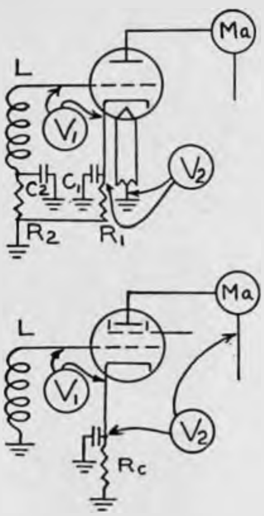


Fig. 1. In most from-the-socket measurements on the common circuits shown the milliammeter may be left in the plate circuit and the voltmeter moved to one of the positions shown. The fact that the cathode (or filament in a d.c. tube) is a common point in these measurements simplifies the switching. These measurements are among the PRIMARY analyzer measurements—those which can't be done equally well with loose meters.

It is about time that we throw overboard the fol-de-rol and extra gadgets, together with the inflexibility that is constantly causing analyzers to become obsolete to the great distress of manufacturers, dealers and servicemen. How? THAT IS THE STORY.

What Is Really Required?

Why do we want an analyzer rather than separate meters with cords and prods—or clips? Would a box full of separate meters be just as good?

This brings us to the main points which are as follows:

1—An "analyzer" is excusable only if it SAVES TIME—and that is the reason for the use of the tube-base plug and its connecting cord; one can get into the TUBE circuits without taking time to cut or solder. This is the PRIMARY business of an analyzer. (See Fig. 1)

2—The analyzer should attempt to indicate perhaps 60% of the ordinary troubles directly by from-the-socket measurements, and some of the rest should be indicated indirectly.

3—It is foolish to attempt to make from-the-socket measurements meet every possible condition. Monstrous cost and complexity result through such attempts to avoid a little thinking, or use of separate meters. Provision must therefore be made for READILY permitting the separate use of the meters with cords and prods. This is the SECONDARY business of the analyzer.

4—It must keep up with tube changes

without using a basketful of attachments—otherwise the high cost of obscolescence, and much time lost in attaching and detaching the extra pieces.

How?

Now then—HOW do we wish to have these things done? Voltage measurements at the sockets have been recommended for this purpose, but alone they do not tell the story. Many circuits are too complex if viewed from the sockets. Furthermore, as many of us know, it is not possible to check all socket voltages with an analyzer containing meters of any reasonable cost. Many of the circuits are of such high resistance that even a "1000-ohms-per-volt" meter will not read voltages correctly. It it, for example, not uncommon to find 500,000 ohms in a grid circuit operating at voltages between 3 and 50, so that the greatest available current is far below a milliampere, and hence not able to operate ordinary voltmeters. The same thing holds in the case of some screen voltages, some power-detector circuits, most space-charge grid circuits and a variety of special and automatic volume control circuits.

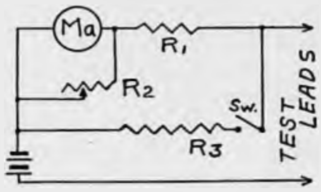
The Main Point

One can right here vastly simplify the whole thing by remembering that in the great majority of cases the vacuum tube is normal if its plate voltage AND plate current are normal. The 245, for example, must be normal if its plate current is around 30 Ma. when the plate voltage is around 250. There MUST be bias or the current would be different. Similarly the 247 shows 27 to 30 Ma. with proper bias, plate voltage being near 250. What if the other voltages are unknown; they MUST be nearly correct or we could hardly have the conditions just named. We carry the tests to the OTHER tube circuits only in order that we shall know that some exceptional and startling thing has not taken place—some thing that can happen once in a thousand cases.

The fundamental soundness of this line of attack makes it essential that the analyzer (as a TIME SAVER) *shall read plate current and plate voltage simultaneously on separate meters.* This is requirement No. 1 of a good analyzer, yet of all the many test kits sold during the last several years only three prominent ones have fulfilled this very important requirement. They were:

Jewel 409
Weston 547
Weston 565

Of these the Weston 565 was, in my opinion, far and away the most useful to servicemen in general. Do you wonder that all other analyzers were "approved" by various Service Managers for manufacturers? I don't. · Those men were thoroughly familiar with their one line of sets, knew what faults to expect in them and could tell all about them with a very few tests—and the kit



Fif. 2. The simple ohm-meter circuit to be used in the analyzer for measurements of resistance. Usually such measurements are not from the socket, and in any case the analyzer plug and cable are not needed—hence this is among the SECONUDARY analyzer functions, which can be done by loose meters also.

happened to make those tests. But you or I must work with all sorts of receivers and other vacuum tube equipment; we can't depend on a few trick tests listed in a manual—we've got to go back to vacuum-tube fundamentals, which are the same in all sets. Our kit will then be SIMPLER, and be useful on any set. But remember that the fundamental vacuum tube effects all require observing a current and a voltage at the SAME time.

The Right Kind of Analyzer

For these reasons my "right kind of an analyzer" has a multi-range milliammeter which might as well be permanently in the plate circuit and it has a multi-range voltmeter which can be connected to ANY socket terminal. This meter arrangement provides for all of the PRI-

MARY analyzer work, that is, it provides for the work which is carried on through a cable and tube-base plug. As will be shown a little later, these things can be done without the usual multitude of "adapters," and both the analyzer itself and the switching arrangement may be so made as to provide for future types of tube bases, or for new and curious ways of connecting tube elements to the base-prongs. Present analyzers do not have this flexibility, nor do most of them provide another of the conveniences of the new analyzer—that the analyzer plug may be left in the set when using the instruments with prods, without the usual risk of "blowing" something, for the meters are completely cut loose from the cable when connected to the binding posts.

The Circuit

The circuit will be described by building it up from its parts, without stopping to give constants at this point.

1—The milliammeter must have several ranges and also be capable of being switched to a pair of posts which permit it to serve as an independent meter with leads. Thus it may have a range-switch and a "position-switch."

2—The voltmeter is under control of three switches: a—A range switch for picking the correct scale; b—A reverse switch to get correct polarity; c—A "tube switch" which throws the voltmeter (set to any range) to any socket terminal, or to binding posts for external use—and which has extra contacts to allow for future freak sockets.

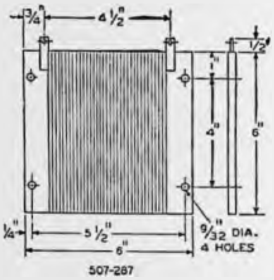
3—The Ohm-meter circuit is the simple but long-range one of Fig. 2. When switched into this circuit the milliammeter is cut free from all other circuits.

4—A socket group, which includes a socket of each present type and has room for new types.

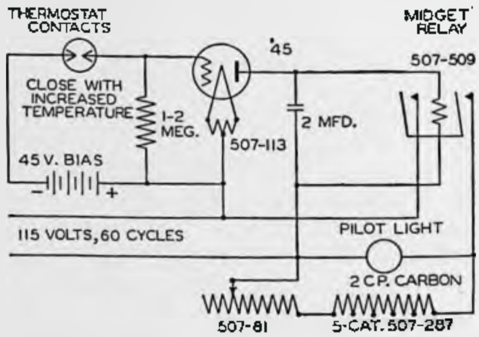
The association of these circuits and parts into a complete analyzer will be shown in the second part of this paper—and you will be surprised at the low—AND FINAL—cost of this type of analyzer.

National Company has just issued a new folder showing 40 kinds of variable condensers for high and ultra-high frequencies. The capacities run all the way down to 15 and the constructions are those found practical in the entire short-wave field, with special types having single bearings, isolantite insulation, particular avoidance of frame designs which act as shorted turns, and special contact devices connecting to the rotor. The folder gives all dimensions, spacings, plate shapes, numbers of plates and details of construction.

Bulletin 507 of Ward Leonard Electric Co. is on their radio products among which appear some new ones. One is a crystal oven-heater unit shown in both



form and use herewith, five are used in series, being placed on the bottom and each side of the oven. Another new device is the familiar vitrohm tubular resistor with a movable contact band

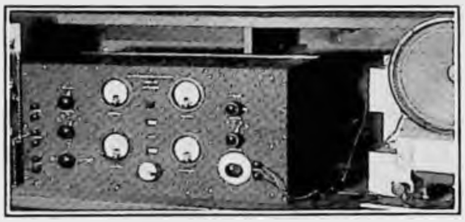


that bears on a bared strip of the winding, facilitating voltage-divider replacements in receivers. Write Mr. H. T. Hayden at the factory—Mt. Vernon, New York.

PRACTICAL TESTS FOR MICROVOLTERS

By Malcolm Ferris*

A microvolter, sometimes called a signal generator, is one of the most useful tools which the radio engineer has available to investigate radio receiver operation.



A Ferris Model 5B Microvolter set up for measurements on the receiver at the right. The upper right hand control is a rheostat for setting the r.f. current through the first attenuator resistor to a standard value marked on the scale of the nearest meter. When this is done the r.f. potential delivered at the output posts (lower right) is controllable from 1 to 500,000 microvolts, the value being read directly from the marking of the right-hand dial and switch which are the attenuator controls. The two lower meters read plate and filament voltage and the central controls are for tuning. When a modulated signal is needed the lower left switch turns a self-contained 400-cycle oscillator on, then the upper left knob is adjusted to make the modulation meter (upper left) read the same as the plate voltage meter. The modulation is then 5, 10, 20, 30 or 40%, depending on the setting of the left-center switch which connects to the tapped modulation transformer coupling the plates of the r.f. and a.f. oscillators. By the use of plugin coils these effects are available at all frequencies between 150 and 7,500 kc.

No microvolter is absolutely perfect. One with no faults would be so bulky, complicated, and expensive that it would be hard to use. However, in actual use, many microvolters are very reliable, but many others have defects which may cause them to give totally misleading results.

It is the purpose of this article to describe some practical tests which can be made on any microvolter, without using special equipment, to find out whether the defects in that particular microvolter are serious, and make it of doubtful value, or whether they are unimportant.

The most important microvolter troubles can be grouped into five main classes:

1. Leakage
2. Inaccuracy
3. Frequency Instability
4. Modulation Troubles
5. Poor "Vernier" for Selectivity Measurements

While leakage and inaccuracy are the most obvious troubles, frequency instability is often a more serious cause of error, and is not always so apparent to the user. Before proper checks for accuracy and leakage can be made, it is necessary to know how much frequency instability exists, so this trouble will be discussed first.

Frequency Instability

A very common type of microvolter is one in which the RF current to the attenuator is varied over a wide range by a rheostat or similar control, to cover the jumps between attenuator steps. In nearly every case this control acts differently with different frequencies—very often to such an extent as to make any one calibration useless.†

To test for this, connect such a microvolter to a receiver in the usual way, at the same time leaving an antenna connected to the receiver. Tune in any broadcast station, and adjust the microvolter until a reasonably low beat is obtained with the station carrier. (This can best be done with the microvolter modulation shut off). Then vary the RF current, and see what happens to the beat note. Shifts of a few cycles, or even a few hundred cycles, are not very serious, but if the beat note shifts several

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† i.e. The attenuator has a tuning effect, and of course it is both undesirable and variable with frequency.—Editor.

thousand cycles, serious difficulties are to be expected.

With a modern highly selective superheterodyne, a frequency shift of several thousand cycles may be enough to cause a great change in sensitivity. It is readily possible to find conditions where increasing the RF current to the attenuator may detune so much that the output from the receiver actually decreases, instead of increasing! If this effect is present, it is of course necessary to retune for every measurement when checking accuracy, or measuring sensitivity. When measuring selectivity this cannot be done, and a microvolter with such a frequency shift is not reliable for selectivity measurements.

With a microvolter using a continuously variable attenuator, and operating with a fixed RF input to the attenuator, frequency instability troubles of the kind just described are practically eliminated, since the RF current is not varied. But with either type of instrument to check and make sure that the attenuator adjustment does not shift the frequency.

A more serious type of frequency instability, and one which is likely to escape notice, unless a test is made for it, is that which causes "wobbulation," or frequency modulation. When the microvolter is being modulated 30%, the plate voltage of the oscillator is being varied 30% above and below its average value at an audio rate. If this change in plate voltage shifts the carrier more than 300 or 400 cycles (from 30% low to 30% high) then trouble may be expected to show up in selectivity measurements of modern receivers. If the shift is one to two thousand cycles or more, selectivity curves on even moderately sharp receivers may be distorted, and very sharp receivers may have their curves so distorted as to actually show a double peak, which is entirely the fault of the microvolter, not the receiver.

The simplest way of testing for this trouble is to obtain a beat between the microvolter and a broadcast station, then increase the B battery voltage 30%, then decrease it 30%, and see what happens to the beat note. This test is very easily made if the microvolter is designed for use with external batteries. If it operates on batteries inside its shield, it will be necessary to remove the shield, and then either move the microvolter some distance away from the receiver, or listen to a very strong station, with the receiver volume control cut well back, to avoid overloading the receiver by stray signal from the unshielded microvolter.

Another type of frequency instability should be mentioned, though it is of much less importance. This is slow drift of frequency. If the microvolter is set to beat with a station, the beat

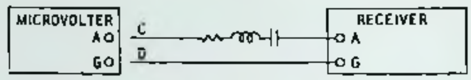


Fig. 1

note should not change over about 100 cycles during a period of several minutes.

In general, the worst frequency instability may be expected at the high frequency end of each coil range, where the value of tuning capacity is very small. At the low frequency end of the range, "High C" conditions are approached, with much better frequency stability. If the coils supplied with the microvolter have generous overlaps, operation at the extreme high frequency end of the range can be avoided.

Leakage

The first test for leakage is to connect the microvolter to the receiver in the usual way. (Referring to Figure 1, connect C to A, and D to G.) Adjust for normal output from the receiver, and then turn the microvolter output to zero. The signal should of course disappear. If it doesn't, trouble exists. This is a satisfactory test if made on a mcirovolter with a zero setting on its attenuator, but is not so satisfactory if made where it is necessary to set the RF current to zero, since this eliminates leakage from the attenuator, and also may shift the frequency enough to detune seriously. (Detuning can of course be checked.)

A very useful test which can be made, even if the attenuator has no zero position, is to connect both C and D to the G terminal. If any appreciable signal is heard with this connection, it is usually an indication of considerable voltage existing between the G terminal and the case or some other exposed part. (In some cases, a signal will be heard with this connection if the attenuator is set for very high outputs. This is unimportant, if the signal so heard is negligable in comparison with the voltage output for which the attenuator is set.)

A still further check can be made by totally disconnecting the receiver from the microvolter, but leaving C connected to D. Even better, an exploring coil of three or four turns about two inches in diameter can be connected between C and D. If any stray signal is heard under these conditions, it is usually a sign of poor shielding, or poor filtering of leads to batteries, external modulation source, etc. The exploring coil can be used to locate the source of the leak. In general, such a coil may be expected to pick up a microvolt or two if held close to the joints of the shielding, but a few inches away no appreciable voltage should be picked up.

Even if a microvolter has considerable leakage, it can still be used with less sensitive receivers, or with sensitive receivers by keeping it a considerable distance away from the receiver. The practical test is to make sure that, with the receiver to be measured mounted in the position in which it is to be measured, the leakage must be low enough so that with the attenuator set to zero, or with both leads on the G terminal, no appreciable signal is heard. In making this test, care must of course be taken to see that the receiver and microvolter are accurately tuned to the same frequency.

Accuracy

The most practical test for accuracy is to measure the sensitivity of a receiver on two overlapping attenuator ranges. If the values so obtained do not agree reasonably well, the accuracy cannot be relied on. The exact method of making this test must depend somewhat on the particular type of microvolter used.

The most common type of microvolter has the RF meter calibrated to read directly in microvolts, and has an attenuator switch providing steps of about three times, usually either 1, 2, 5, 10, 20 etc., or 1, 3, 10, 30 etc. With this type of instrument, set the RF meter near full scale, say at 5 microvolts, and the attenuator switch at say 10, giving an output of 50 microvolts, and adjust the receiver volume control to give standard output. (The microvolter being of course carefully tuned to the receiver.) Then set the attenuator to 30, and adjust the RF current until the same receiver output is obtained. The meter should, of course, read 1.67 microvolts. ($1.67 \times 30 = 50$.) If previous tests have shown appreciable frequency shift when the RF current is varied, it will be necessary to check the tuning every time the RF current is changed. By using different receiver volume control settings, similar checks can be made between other attenuator ranges.

If the microvolter is reliable, such readings should check practically as closely as it is possible to read the meter scale. (Note, however, that at one-third scale or less, this is seldom closer than 5%, even with the better meters, having a long scale and knife edge pointer, and *is more nearly 20% with the smaller meters.*)

With the type of microvolter having attenuator steps of 1, 10, 100 etc., and using a fixed input to the attenuator, and a continuously variable slide wire potentiometer calibrated from zero to twenty or fifty microvolts, a more convincing check can be made, since it is possible to check a ten to one instead of a three to one ratio. For instance, set the slide wire to 50, attenuator to times 1, and adjust the receiver as before. Then put the attenuator on the 10 point, and adjust the slide wire for the same receiver output. This should of course come at 5 on the slide wire. The slide wire can usually be read within 5% even at one-tenth scale.

In making such tests, care must be taken to see that the receiver sensitivity is not changing during the test, due to line voltage or other conditions. If trouble from this cause is suspected, the test should be repeated two or three times. The closeness with which the same result can be obtained on several repeats gives an indication of the reliability of the test.

Suppose, in the case first described,

where a reading of 1.67 microvolts would be a perfect check, three repetitions of the test gave values of 1.6, 1.7 and 1.8. (That is, errors around 5%, sometimes positive, sometimes negative.) This could be taken as showing no error in the attenuator, but an error of about 5% in reading the scale, which might be expected.

On the other hand, suppose readings of 1.8, 1.9 and 2.0 were obtained. This would show an error of observation of about five per cent., plus a fixed error in the ratio of about ten per cent.

A number of such tests, made at different frequencies, and at different receiver sensitivities (that is, between different attenuator ranges) will serve to show whether there is any systematic error in the ratios, and also how closely the scales can be read.

In making tests of this kind, a single reading shows very little, but the result of a considerable number of readings gives valuable information. One important piece of advice—watch the receiver output meter, and make the setting. Don't look at the RF meter until after you let go of the knob. Otherwise, you may set the meter to what you think it ought to read.

Modulation Troubles

Modulation troubles, other than frequency modulation which has already been dicussed, are less important, and will be discussed only briefly in this article.

Most microvolters measure the modulation by measuring the a.c. voltage in the oscillator plate circuit. This gives correct results if the input-output characteristic of the RF oscillator is linear. This characteristic can be readily checked by plotting a curve, such as shown in Figure 2, by varying the B battery voltage, and observing the corresponding RF current. (The RF current control must of course not be changed during the taking of this curve.)

The dotted line OBF is the ideal linear curve. The curve actually obtained may look more like EABCD. This will give satisfactory results as long as operated within the region ABC, but operation in the parts of the curve which depart greatly from linearity will not only introduce a serious error in the measurement of modulation, but will introduce harmonics of the modulating frequency.

Other modulation troubles include poor fidelity, due either to poor frequency characteristics in the modulation measuring system, or to cutting of the high frequencies by the tuned circuit. These cannot be readily checked without the use of special equipment.

Poor "Vernier" for Selectivity Measurement

To measure selectivity, it is desirable to be able to measure steps of 5 kc.'s around the test frequencies. In many cases, even smaller steps are desirable, for instance, if the shape of a "band pass" selectivity curve is to be investigated. Many schemes are employed to make such readings possible, such as:

- Vernier scale on condenser,
- Worm gear drive for condenser,
- Use of small variable condenser in parallel with larger condenser,
- Use of "variometer" to give small changes in inductance.

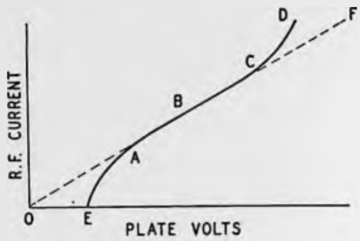


Fig 2

An examination of the apparatus and the calibration provided with it will show whether a frequency difference of 5 kc.'s can be easily read. One test should be made, though—an examination for lost motion. This can be done by turning the dial in one direction until zero beat is obtained with a station and noting the scale reading, then turning the dial in the opposite direction until zero beat is obtained with the same station, and noting how different the scale reading is. If there is appreciable lost motion, this can be largely overcome by always turning the dial in one direction when setting to a frequency.

Other Tests

The tests described above can be elaborated as much as time and available equipment permit. The details given should serve as a guide to enable the experimenter to make more detailed tests if he desires.

While the above tests are written with the broadcast band in mind, many microvolters go to much higher frequencies. In general, any trouble existing may be expected to grow worse as the frequency is increased, and a microvolter which is very satisfactory at 550 kc.'s may begin to be troublesome at 1,500, and totally useless at 5,000 kc.'s. On the other hand, one which is satisfactory at 5,000 or 10,000 kc.'s can be regarded as almost above suspicion in the broadcast band.

Philco's $18.75 receiver contained tubes selling at $9.40.

"Communist Band Shattered by Bomb"—headline. Bandspread—eh?

NEUTRALIZING THE 247

Milton Rubin of W1AKL suggests that the chap with a 247 in his r.f. transmitting amplifier is generally using it because he is interested in economy, and accordingly in zero-cost neutralizing condensers. Such a condenser can be made from a Fahnestock (adv.) clip, a 3-inch length of brass or copper tubing with about ⅛-inch inside diameter, and a 5-inch length of stiff copper wire, frinstance No. 12 or 10. Secure the tubing to an insulating base and solder a connecting wire to the tubing. Then screw down the Fahnestock before the end of the tubing so that the stiff wire will pass through it into the tubing. For greatest ease of neutralizing use a d.c. grid meter and move the wire in and out through the clip until the meter doesn't "duck" as the amplifier *tuning* condenser goes through resonance. If necessary lower the grid bias to get a small grid current.

Mr. Rubin says—"With two such condensers in a cross-neutralized push-pull 247 amplifier I could neutralize completely in 3 minutes. Oh all right—make it 4." (Hint—if there is only one milliammeter around put "closed-circuit" jacks in the various plate and grid circuits and shift meter as needed.)

Mr. H. J. Kayner, formerly Assistant Chief Engineer of United Air Cleaner has joined R. H. G. Mathews & Associates. The organization is now designing a line of small receivers to be made by Toledo Standard Commutator Co., and sold through Wal-Tone Radio Corporation.

The Don Lee Broadcasting system now has on the air a 140 meter, 1000 watt television transmitter signing W6XS. The transmission is in the form of a 60-line picture repeated 15 times per second, as in the case of W6XAO, the smaller shortwave transmitter described on page 3 of our October issue. Look in on them. Both transmitters are at 7th and Bixel Streets, Los Angeles.

How about a jig-saw puzzle using the new radio inspection districts?

(Continued from Page 6)

dielectric loss than would be found for any folded antenna scheme. We have worked up some such simplified information on such lines and hope to present it soon.

Meanwhile here are some simplified rules that anyone can work.

1—Use No. 14 line wires spaced 11 inches or No. 12 wires spaced 14 inches. Theoretically the spacing must be exact—practically a small change in spacing can be compensated at the station by merely moving clips!

2—The "X" distance (antenna center to point of line attachment) is 1/7 of the total antenna length or 2/7 of the half-length. The last line spreader should be twice this distance from the antenna—spread line from there. Use circuit of Fig. 3—also procedure shown there.

3—For a 1-wire feeder—just omit a wire and ground the other clip on L2, Fig. 3.

For Reception

With few exceptions a good sending antenna is also a good receiving antenna. Try yours and see if the reception isn't

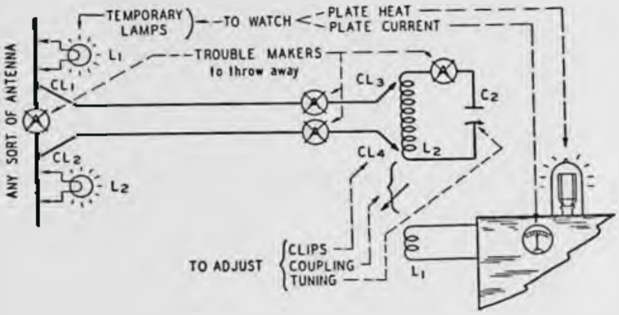


Fig. 3. Method of adjustment.

materially better. Almost invariably the sending antenna has been given the best location and any old wire has been run up for reception. It might not be a bad idea to dust off the old send-receive switch and use the good antenna for both jobs—taking down the other energy absorber. Then again one might put up a second *good* antenna for 1933.

After all—no one thing will improve a station's sending *or receiving* range so much as a really good antenna.

Good luck to you.

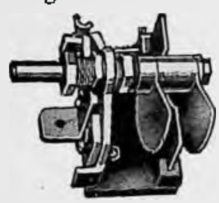
WHATS NEW

Radio Engineering Handbook, edited by Keith Henney, published by McGraw-Hill Book Co., New York. 583 pages, $5.00.

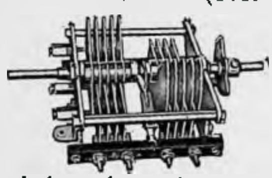
When a technical handbook is extensive enough to be useful, a complete review is impossible, and for that reason one finds it hard to say of Henney's handbook the kind words that it so richly deserves. In 23 sections there are assembled those things that one is forever hunting in 50 different books and pamphlets—not always with success. Each section is by a competent author and the whole has been made coherent and well indexed.

We have had no such thing in radio before, it is good that the Henney handbook has come.

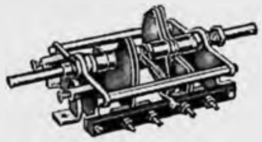
Having been an annoyance to Ray Morehouse for some time because we wanted such a thing, it's pleasant to find that now there is a Cardwell condenser for neutralizing the '52 tube. It is called



No. 519, is insulated with General Electric's home-made stone called "mycalex" and provided with a capable lock. There are also two bandspreading condensers, one of which (No. 516) is



double ended, each section providing 90 μμfds., but only one having a lock in this case. The other type has a through shaft so that both sections turn together.



If called No. 517 the sections are 25 and 50 μμfds., while if called No. 518 they are 50 and 100 μμfds.

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NOTES

1. Keep a copy of your letter, including diagrams, numbering questions 1, 2, 3, 4 and lettering diagrams a, b, c, d.

2. The right is reserved to return remittances for any questions which it is impossible to answer.

3. No attention will be paid to radiograms, telegrams or letters (other than those under class G) which are not accompanied by a remittance. Please use money order—loose cash may not arrive.

4. Address letters, "Modern Radio", 101 Allyn Street, Hartford, Connecticut.

The Practical Advisor

For Serviceman and Amateur

VOLTMETER RESISTANCE

• • •

The serviceman, experimenter and amateur have dozens of occasions for knowing meter resistance—the making of ohmmeters, the checking of resistances with a voltmeter, multiplying voltage scales and so on, require this information. It is not difficult to obtain.

A certain amount of arithmetic is necessary and Ohm's law is the basis of the figuring. The formula that serves the law is the familiar $E = IR$ where E is voltage, I current in amperes and R the resistance in ohms.

Case No. 1

The voltmeter in question is a 150-volt d.c. instrument. You possess a milliammeter of say 25 ma. full scale reading. Any source of voltage may be used but the accuracy of the milliammeter should be doubted at much less than quarter scale. Connect the milliammeter and voltmeter in series as in Figure 1 and connect to the source of voltage. Assuming a 45-volt B battery, a current indication of 7 ma. and the voltmeter showing exactly 44 volts. Then:

$$44 = .007 \times R$$

If I assume you do not know how to get the value of R from this equation, then the next step is to divide both halves of it by .007:

$$\text{(A)} \quad \frac{44}{.007} = \frac{.007 \times R}{.007} \quad \text{or}$$

$$\frac{44}{.007} = R = 6{,}428 \text{ ohms}$$

Then if we wanted the "ohms per volt", the 6,428 would be divided by the 150 range of the meter to give 42.85 ohms per volt. Obviously then, if we were to raise the 150 voltmeter to 450 volts the additional 300 volts would require a resistance of 300×42.85.

Precautions Necessary for Accuracy

Keep both the milliammeter and voltmeter readings at quarter of scales or higher. The nearest accuracy will be obtained from meter observation at full scale on the voltmeter at least. In the case just given that would require 150 volts and a milliammeter capable of showing not less than 30 ma.

In calculating: 42.85 is not the exact result of dividing 150 into 6,428, nor is 6,428 the exact result of dividing .007 into 44 but the latter and former are both accurate within essentially .01%. That is the advantage of carrying a

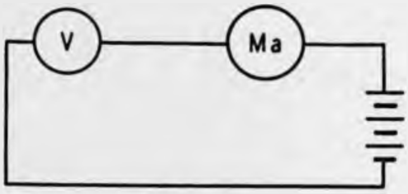

Fig. 1.

figure out to its fourth place. In the case of the 150 into 6,428 calculation, the remainder which would have made the fifth place was 50; i.e., 50/150 or ⅓ of .01%.

Case No. 2

You haven't the milliammeter.

So we must use another scheme which also is simple. It requires that you possess a resistor or two. The accuracy of your result will be dependent upon the resistor used but don't forget the accuracy of the meter involved, it renders important or unimportant the resistor's error.

The arrangement is shown in Figure 2. In this case we first read the battery voltage direct. Assuming the meter to

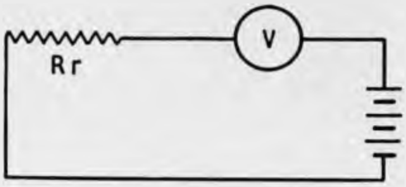

Fig. 2.

be a 50-volt unit, and that the battery shows 41 volts, insert the resistor R. Suppose the resistor is 1,500 ohms and is a standard Electrad, I. R. C., or other 10% accurate resistor. The meter plus the resistor gives a reading of 32 volts. By doing this we have divided E into two parts, Em the voltage of the meter and Er the voltage dropped across the resistor. Also our resistance is in two parts, Rm of the meter and Rr of the resistor. Thus our formula must show up this way:

$$Em + Er = I\,(Rm + Rr) \qquad \text{or}$$
$$32 + 9 = I\,(Rm + 1{,}500)$$

But we don't know two values necessary to clear the equation—we could solve it for one. Hence, we must use a stunt that will give an equation with only one unknown. Accordingly if $E = IR$ then $Em = IRm$ and $Er = IRr$. This is the same as saying the voltage for the meter is equal to the current for the meter times the resistance of the meter, and so on. The meter and the resistor Rr are in series so the same current passes through both. Thus, if we divide

$$\frac{Em}{Er} = \frac{IRm}{IRr}$$

and we have in the last half

$$\frac{I}{I} \times \frac{Rm}{Rr}$$

And since I into I goes once it is 1. 1 times Rr into Rm leaves Rr dividing into Rm without change of answer. Accordingly:

$$\frac{Em}{Er} = \frac{Rm}{Rr} \quad \text{or} \quad \frac{32}{9} = \frac{Rm}{1500}$$

and we have only one unknown left. So we multiply the both halves by the KNOWN part of the half containing the unknown so:

(B) $$\frac{1500 \times 32}{9} = \frac{1500 \quad Rm}{1500} \quad \text{or}$$

$$\frac{48000}{9} = Rm = 5333 \text{ ohms}$$

Once we find the meter resistance as above, the rest is accordingly as before.

There remains the worry as to accuracy. A 10% resistor may be marked 10% above or below its real value or somewhere in between. If you have several "1500" ohm resistors and each gives a different voltage on the voltmeter in the circuit of Figure 2, average the voltmeter readings (5 resistors, for example, would be 5 readings added together and divided by 5) and use the average as the figure for Em. When the resistors are of one manufacture this scheme has worked out within a per cent. but that is an accident—in any case the accuracy becomes nearer in the average.

If a precision resistor can be used (1% or better) one reading is near enough.

If in the case given the meter reading had proved to be 3 volts or some other absurdly low value in place of 32 a lower resistance should be used, sufficiently low in all cases to give about half the battery voltage on the meter. Once the meter resistance is known, the same scheme measures unknown resistors.

Allied Art

MERCURY MAGIC

Shooting Through!

The mercury-vapor rectifier is familiar enough, but some radio men barely know even the names of "thyratron," "phanotron," "inverter," much less the strange things they do.

You recall that in the simple "kenotron" tubes like the 281, 217A and so on, the tube became rapidly hotter with load, and at the same time the output voltage dropped in the disagreeable fashion of curve A of Fig. 1. If the plate of the rectifier tube could stand about 75 watts loss we would find it turning red at something like 250 ma. load, with a voltage drop of something like 300! (Remember how the transmitters "yooped".) With present mercury vapor tubes we can, before wasting 75 watts in the tube, draw about 5700 ma. (nearly 23 times as much)—and the output voltage hardly changes with load—except for filter drop, the tube drop being steady at perhaps 13. See curve B. Now observe the difference, assuming a 1000-volt transformer:

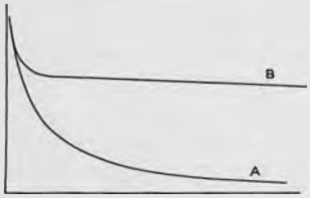

Fig. 1. Poor regulation of an ordinary high-vacuum diode rectifier (A) and comparative performance of mercury-vapor type (B).

	Plain Tube	Mercury Tube
Max. load	250 ma.	5700 ma.
Volts out	700	987
Watts out	175	5603
Eff. %	70	98+

This is what makes high-power air-cooled rectifiers possible. With the old non-mercury tubes the heating would have limited their side.

Thyratrons

But that isn't all. We radio folks must soon become familiar with the thyratron. Putting it into radio terms, the mercury-vapor rectifier is a diode (866) or a double-diode (83) while the thyratron is a mercury-vapor triode with some ideas that never entered the empty head of the high-vacuum triodes.

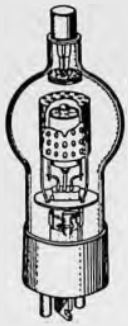

Fig. 2. A General Electric thyratron. Some thyratrons can be used as inverters.

In the high-vacuum triode the grid controls the plate current—always. In the thyratron the grid is like a boy with a frisky team, the control is lost *if things once start.* In other words, if the grid bias is dropped for a moment (or the plate voltage raised), there is instantly a rush of plate current, the plate voltage drops down to the 13 volts familiar in the rectifiers named above—and the grid is lost track of. The team has run away and the boy is helpless until they stop again. Thus the grid is merely a trigger—not a throttle.

Why should anyone want such a nasty and ill-tempered device? That is just the point—we want it to control LARGE alternating currents which would ruin a vacuum tube (remember that 70% efficiency?) but can rush freely through the large gate thrown open by the thyratron—and "thyratron" means "a gate device." For—and here is the plot—between cycles there isn't any voltage

WHERE TO BUY "MODERN RADIO"

CALIFORNIA
Associated Radio Buyers, Oakland
Coast Electric Co., San Diego
I. S. Cohen's Sons, Inc., San Francisco
El Cajon Radio Exchange, San Diego
Electric Supply Co., Oakland
Inter-City Radio Stores Co., Long Beach
Natick Book Store, Los Angeles
Offenbach Electric Co., San Francisco
Radio Manufacturer's Supply Co., Los Angeles
Radio Supply Co., Los Angeles
Sea Cliff Radio & Elec. Co., San Francisco
San Francisco Radio Exchange, San Francisco
Warner Bros., San Francisco
Warner Bros., Oakland
Wenger-Brill Co., Oakland
Zach Radio Supply Co., San Francisco

CONNECTICUT
Hatry & Young, Inc., Hartford
S. S. Kresge Co., New Haven

DELAWARE
Wilmington Elec. Specialties Co., Inc., Wilmington

ILLINOIS
Abbott's Sweet Shoppe, Berwyn
Chicago Radio Apparatus Co., Chicago

MARYLAND
Mattson's, Baltimore
Radio Electric Service Co., Inc., Baltimore

MASSACHUSETTS
T. F. Cushing, Springfield
H. Jappe Co., Boston
Neisner Bros., Boston
Sager Electrical Supply Co., Boston

MICHIGAN
Radio Specialties Co., Detroit

MINNESOTA
Lew Bonn Co., St. Paul

MISSOURI
Burstein-Appleby Co., Kansas City
Stone Electric Co., St. Louis
Walter Ashe Radio Co., St. Louis

NEW JERSEY
Kaltman & Kennyhertz, Newark

NEW YORK
Blan, the Radio Man, Inc., New York City
Gross Radio Co., New York City
Leeds Radio, New York City
Roy C. Stage, Syracuse
Sun Radio, New York City

OHIO
Klodag Radio Sales, Kent
Northern Ohio Sales, Cleveland

OREGON
Northwest Radio Supply Co., Inc., Portland
Guy B. Paine Co., Portland
Wedel Co., Inc., Portland

PENNSYLVANIA
Cameradio Co., Pittsburgh
Hall's, Harrisburg
M. & H. Sporting Goods Co., Philadelphia
Radio Electric Service Co., Inc., Philadelphia
Eugene G. Wile, Philadelphia

UTAH
Felt Radio Co., Salt Lake City

WASHINGTON
General Radio, Inc., Seattle
Spokane Radio, Inc., Spokane
Wedel Co., Inc., Seattle

WISCONSIN
Radio Parts Co., Inc., Milwaukee

FOREIGN
R. C. O'Connor, Tearo Book Depot, Wellington, New Zealand
McGill's, Melbourne, Australia

MORE NEXT MONTH

and we can slam the gate shut again by simply raising the grid bias once more. A thyratron built into a bulb about like the '99 tube can thus control a 1/4 h.p. alternating current motor, acting as a sparkless switch controlled by a circuit that carries only low voltages to the thyratron grid.

Or again we can let PART of each cycle through the gate by using a bias which blocks the tube until the plate voltage has climbed up a ways—and then pops through. The grid then waits until the next zero-voltage comes along and firmly sits on the lid once more. It will, incidentally, serve exactly as well to use a fixed-voltage a.c. grid bias and to shift its phase.

Controlled Rectifiers

Now this performance in no way alters the fundamental rectifying nature of the tube—as before the current goes through in but one direction and we therefore have a "controlled rectifier," that is a rectifier whose output can be controlled by varying the grid bias—for obviously there is less power output if but a small portion of each cycle comes through. The curious waveform that comes out may be smoothed in familiar ways, into either a.c. or d.c. By using two or more of the tube we obtain a full-wave output controllable over a wide range of powers (or voltages—or currents) by means of a modest grid bias.

Inverters

Many electrical devices work both ways. A generator will serve as a motor —and so on. Similarly if we can feed a.c. into the thyratron triode and get d.c. from it we may expect that it is possible to supply it with d.c. and take out a.c.—which is to say we may use it as an oscillator. The advantage over the ordinary vacuum triode will come in the much lower voltage-loss, and much higher output. Such an oscillator (Fig. 3) is called an "inverter," but the circuits are quite different from those of the usual vacuum tube. This is made necessary by the lesser grid control. It no longer answers for the grid to "go negative" *gradually* and thereby taper the plate current down. This isn't possible in the mercury tube. Instead the grid must go negative—very negative—with the greatest speed at the moment when there is no plate voltage, or when it is lowest, and then must STAY VERY NEGATIVE for a good part of the cycle. If the grid fails to regain control at one of the moments of zero plate voltage the instant effect is a disastrous short-circuit, for the d.c. line then simply goes around through several tubes in series with but a 20 or 25-volt drop altogether—and a current limited only by the size of the d.c. generator. The invertor then looks as if it had been hit by the California Limited and the vicinity is full of smoke, noise and questions. This is known as "shooting through"—and sounds that way. In time this unhappy tendency of inverters will be cured, and then we may expect extremely high-voltage d.c. power lines, with rectifiers (probably thyratrons) feeding them, and inverters at the far end again turning the power into the a.c. form to permit stepping it down and feeding it to the ordinary distributing systems.

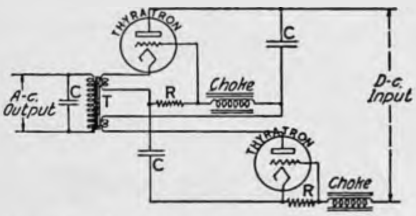

Fig. 3. Self-oscillating inverter using the Sabbah circuit.

Illustrations courtesy General Electric Co.

MODERN RADIO QUIZMATIC

NO. 7

As usual, one year's sub. (or extension) for the most to-the-point answer; six months' to the next four—our judgment to be final. (Winners of a first or two seconds are ineligible until their time is out, but good answers in that time put their names in the KING ROW.)

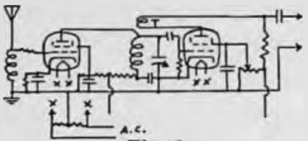

Fig. 1

Part A. This receiver (Fig. 1) had bad habits. What were they? How cured?

Part B. (Not illustrated.) A "40-meter" amateur transmitter had an antenna 30 feet above a grounded tin roof 20 feet high and measuring 20 by 28. The Hartley oscillator of the station, when keyed, would occasionally take large plate current and heat rapidly. What was probably wrong? If this seems like guessing—how would you start to locate the difficulty?

December Winners

First Prize: Herb Walleze, Hazelton, Pa. Second Prizes: S. A. Magnes, Long Island; Ernest Ruland, Natick, Mass.; D. D. Dressen, Los Angeles; David Atkins, Piedmont, Calif.

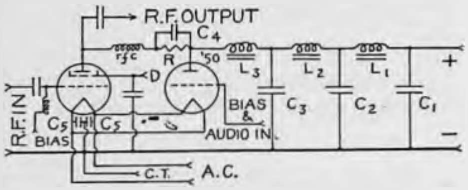

Fig. 2. DECEMBER DIAGRAM

L1 and L2, 30 Hy each.
L3, 5 Hy.
C1 and C2, 4µfd each.
C3, 2 µfd.
C4, 1 µfd.
C5, C5, 0.1 each.
R, 5000 ohms.
Plate supply from an adequate transformer, with center-tapped secondary rectifier—two '66 tubes. 600 volts delivered at load.

Unlike other months few papers reached the finals, many dodging one of the two problems and few seeing all of the errors in the modulator diagram (Fig. 2) AND KNOWING WHAT TO DO ABOUT THEM.

Here they are:

1—Modulation choke L3 too small; exchange with L1.

2—Condenser C1 only spoiled rectifiers. Remove and put across C3 which is too small to permit full modulation.

3—Increase C4 to at least four mikes. Modulation is now possible but distortion excessive because of fixed screen voltage. Therefore:

4—Reduce screen bypass to .0005 or .001 so audio fed to screen will not be grounded. Then supply MODULATED screen voltage from left end of R through a resistance chosen to give proper "resting" screen voltage.

5—Since C5 C5 are but .01 each they are poor audio return paths for the 50. Several cures obvious.

6—Complete ("100%") modulation is made possible by increasing R or replacing the 50 stage by a push pull pair running normally at 450 volts and transformer coupled to the 65. The price can probably be saved in the filter.

Part Two: The broadcast receiver with screen voltage volume control was cross modulated by the 5 kw. local through r.f. overload. The problem was not to redesign the set, but to cure it. Walleze hits it plumb center: "Fix the screen grid voltage, shift the volume control to the antenna circuit, put in a tuned trap ("wave trap") to soak up the 5 kw. station and maybe chop 100 feet off his antenna."

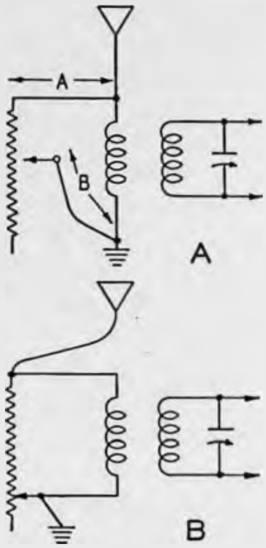

Fig. 3

Procedure: Remove screen pot, set to "loud" and measure with ohm meter, then replace by fixed resistor. In vacant pot. hole install 15,000 ohm reverse taper pot. grounding slider close by and running lead from it to low end of antenna coil. Leave one end of pot. free and from other end run TWO SEPARATE wires to high end of antenna coil and to antenna post. (Fig. 3A is wrong. Fig. 3B is right.) All leads in grounded metal braid. Now retrim with control at one-half. This works on nearly all sets, even for 50 kilowatt locals. For exceptions see page 12 of "Modern Radio Serviceman's Pocket Book," First Edition—provided you can still get one! Use of 58 tube complex and costly—no entrant explained it fully anyway. Use of 35 or 51 tube invariably changes selectivity and sensitivity.

THE KING ROW

?? Who'll Be Here Next Month ??

The Board of Directors of RCA Radiotron at Harrison, N. J., has chosen as vice-presidents, J. M. Smith and J. C. Warner.

Mr. Smith comes from the manufacturing side of the organization, with 19 years of experience at Nela Park and the Ivanhoe works.

Mr. Warner's experience has been in tube research and development at Schenectady and at Harrison for some 13 years preceded by varied teaching experience.

Mr. Smith now heads the manufacturing, and Mr. Warner the research at Harrison. We know only one of the gentlemen—but so favorable that we feel like cheering for both.

Universal Microphone of Inglewood, California, offers an automatic time-switch for radio receivers in the form of an owl containing a dashpot and a piston working in oil. Depending on the distance the owl is pushed down he rises far enough to snap the switch in a time controllable up to two hours. Any battery or 110-volt device may be switched if the power-demand is not large.

The Silver-Marshall parts and special equipment business is being carried on by the Clough-Brengle Co., 1134 West Austin Avenue, Chicago. Incidentally you can not only get the parts your letters have inquired about, but also advice on them as Messrs. Kendall Clough and Ralph Glover go with the organization. Their MODERN RADIO articles are still bringing in letters for the editor to answer. Mr. Brengle, the second member of the firm, was sound engineer at Silver-Marshall. Associated with them is Mr. Leon Worner, former Inspection Engineer of the same firm. The present firm also does consulting engineering, including set design and plant-problems.

THE BAZAAR

Please abide by these rules:

1. 7c per word, payment with ad.
2. Ads for an issue must reach us the first of the preceding month.
3. Used, reclaimed or surplus items must be so described.
4. Please PRINT your name and address.
5. We reserve the right to refuse any part of an ad.
6. Ads designed to stand out cost extra. 10c a word all capitals.

Short Circuits

• • •

The trick type we now use runs about the same number of words to the page as the old Century type, but the "open" appearance makes it easier to read. It is called "Garamond." The table of contents on the cover is in Kabel, and a similar type is called Sans Serif. Radio doesn't have all the funny words.

The woim hereby toins—we deny emphatically that radio is wrong in reducing the loud high notes of tenors and sopranos. A screech sounds terrible in a concert hall—and it sounds terrible by radio—but radio knows how to stop it.

1933 version. A $10 radio set is worth about $9.98—if new.

A loan company offers to free you of your debts by lending you money to pay them.

1933 auto models disclose accentuated streamlines, slant-back radiators, round hoods, roll tops, skirted fenders, and wide flared backs—or are we in the dress department.—New Haven Register.

We never read these stories about setting aside $2,800,00 for this or that. Any sum above $8.75 is hearsay to us. —Buffalo Courier-Express.

Doesn't seem quite fair to call her "Perfidious Albion" when she paid on the due date, and is going without crumpets and tea.

This is the big $250 water cooled National Radio tube used at W6AM. The W6AM alarm clock with the "W" on top and "6AM" below is shown INSIDE the glass bulb of the tube. This tube operates excellently on 10, 20, 40, 80, 160 meters. Long Beach, Calif., city water (ad!) runs through the jacket at a rate of one gallon per minute.

NATIONAL
"AGS"
COMMUNICATION TYPE RECEIVER

NATIONAL'S LATEST AND FINEST

The amateur who is particular about his receiver; who knows and appreciates the little touches of refinement in design that give TOP QUALITY to radio equipment; will welcome the NATIONAL "AGS" Communication Type Receiver.

The "AGS" has been developed in cooperation with the Airways Division of the United States Department of Commerce to meet the exceedingly strict requirements of aviation ground station service. Every latest development has been included to make the "AGS" the very best possible in performance and every day reliability.

NOW AVAILABLE WITH BAND-SPREAD COILS

The "AGS" has band-spread coils for the 20, 40, 80 and 160 meter ham bands either in place of the standard 15 to 200 meter coils or as additional equipment.

ELECTRON-COUPLED OSCILLATOR

Made with electron-coupled oscillator, the "AGS" has maximum stability.

OUTLINE SPECIFICATIONS

1. CW or Voice, by shift of one control.
2. Optional manual or automatic volume-control by turn of switch.
3. Coil change from front of panel.
4. Tuned RF ahead of front detector. Very high signal-to-noise ratio, and high weak signal response.
5. Suppressed image.
6. Single control S.F.L. tuning by 270° precision Velvet-Vernier Dial with German silver scale and vernier reading to 1/10 division.
7. Calibration curves and tuning log on front of panel.
8. Phone or speaker output.
9. Relay rack mounting, extremely rigid construction—front panel 8¾" x 19".
10. Frequency range 1500 to 2000 kc. Band spread coils available.

OPERATED ON AC

NATIONAL Power Units for AC operation. RCA Licensed.

IN THE LEAD
for 4 Years
NATIONAL
SW-58 THRILL BOX

More than four years ago short-wave broadcast listeners heard programs the world over with NATIONAL Thrill Boxes. Each year since then the THRILL BOX has been improved . . . kept in the lead, with new and better tubes and new and better circuit design. Now the SW-58 THRILL BOX offers performance not dreamed of in September, 1928.

THE SW-58 THRILL BOX HAS

Utmost Sensitivity, Extremely Low Background Noise (highest signal-to-noise ratio), Unequalled Flexibility and Ease of Control. "Controlled Selectivity." An en-

tirely new feature, found only in the SW-58, which allows the set always to be operated at the best selectivity consistent with signal strength and reception conditions. Loud Speaker Performance. A Push Pull Stage with 245 tubes for best tone-quality gives fine loudspeaker volume. There is also a jack for headphones.

Full AC or DC. The AC set operates with the NATIONAL 5880 Special SW Power Supply with extra shielding and filter sections for humless operation. RCA Licensed. Battery model also available for use where there is no AC current.

ONE USER SAYS:

"I would like to tell you that the Thrill Box is absolutely the best short-wave set I have heard, regardless of price. I have received stations in Australia, Holland, England, Germany, South America, Central America, all on the loudspeaker . . ."

San Antonio, Texas.
(Name on request.)

This is one of countless similar unsolicited, unpaid for testimonials from THRILL BOX users who bought and paid for their THRILL BOXES. Send for free book.

SEND FOR THIS FREE 24-PAGE BOOK

If you did not get a copy of this book with your November issue of "Modern Radio," send for it at once. Only a few copies still available.

Full and up-to-date information on short-wave receivers, radio time and revised call list of international short-wave broadcasting stations giving wave lengths, call letters and full particulars. USE COUPON BELOW.

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NC

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61 Sherman St., Malden, Mass.
Gentlemen: Please send me your new free 24-page book, WORLD WIDE SHORT-WAVE RECEPTION. I enclose 10c in stamps to cover mailing cost.

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