RADIO WORLD

REG. U.S. PAT. OFF.

The First National Radio Weekly

649th Consecutive Issue—13th Year

15c Per Copy

SEPT. 1 1934

HOW STYLES ARE CHANGING IN SHORT-WAVE REGENERATORS

—★—

(See Pages 8, 9, 10)

ELECTRON COUPLING USING SEPARATE MODULATOR AND OSCILLATOR

—★—

WHY USE THE ONE-WAY FILTER CONDENSERS TO ENDANGER D-C SETS?

—★—

IMAGES ATTACKED AS SERIOUS EVIL IN S-W SUPERS

—★—

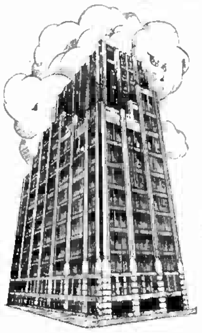
NEW SCANNING METHOD RESONATES CONTROL OF MIRROR

—★—

RECTIFIERS FOR OTHER THAN THE USUAL PURPOSES

—★—

0-1 MA FOR 0-2 OHM TO 5.0 MEG. MEASUREMENTS

Great  News!

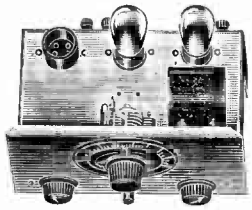
for Every Short-Wave Fan and General Radio Man

We Announce the Opening of Our New Modern Offices

MODERN DISPLAY ROOMS
DEMONSTRATIONS DAILY

AT 130 CEDAR STREET
NEW YORK CITY

PROMPT RADIO SERVICE COMPANY

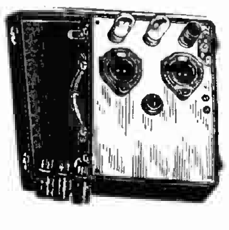


"ROCKET"

TWO TUBE
Battery-Operated
SHORT-WAVE RECEIVER
15 TO 200 METERS

Uses 2-230 type two-volt tubes for perfect and quiet reception. Contains every part for construction.
"Rocket" Two kit of parts, including blue print **$4.50**
"Rocket" Two complete with coils, wired and tested **$5.50**
Set of Sylvania tubes $1.40
Complete set of batteries for "Rocket" Two (2-45 v. and 2-1½ v. dry cells) 2.25
Broadcast coil (200 to 550 meters) .... .49

Handy Two Tube Battery Operated

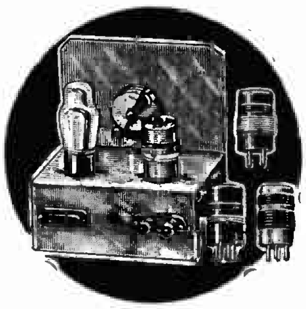


PORTABLE

Short Wave Receiver

The set chassis and batteries are all contained in the beautiful leatherette covered carrying case. Complete kit of parts, including four plug-in coils, carrying case, panel, and blueprints, less tubes and batteries. Sale price,
$10.95
Wired and tested, extra $2.00
Complete set of batteries and tubes for the Powertone Tube Portable. Sale price 3.25

DUO-AMPLYDYNE



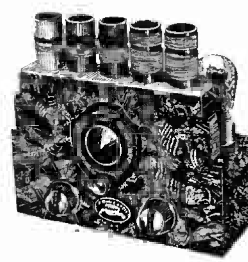
S.-W. RECEIVER

For the Short-Wave enthusiast with a limited finance. Radically new—two-tube results with the new '19 2-volt series tube. Covers from 15 to 550 meters.

Complete kit of parts $4.95
Wired (extra) 1.00
Licensed tube .... .88
Set of headphones .... .95
Broadcast coil (200-550 meters) .39

"COSMAN TWO"

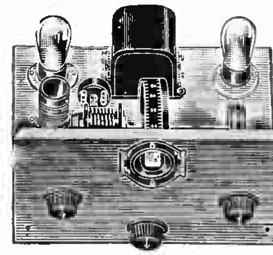
15 TO 550 METERS
Battery-Operated
SHORT WAVE RECEIVER



Its unusual design permits reception on a LOUD-SPEAKER.
Incorporates a 232 and a 233 output pentode.
Kit of parts with 4 Bruno coils **$5.95**
Wired and tested, extra. $1.00
Set of R.C.A. licensed tubes 1.95
Broadcast coil .... .39

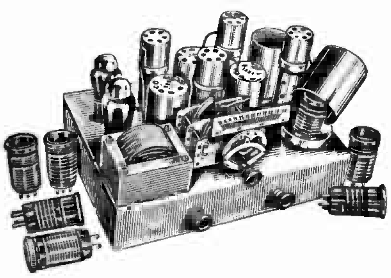
BEGINNERS TWIN

Two Tube "Battery"—15 to 200 Meters
SHORT-WAVE RECEIVER



The "Beginner's Twin" is probably the best kind of introductory set for the beginner, who can readily make changes and improvements on it as he becomes more familiar with short-wave technique.
Complete kit of parts for the "Beginner's Twin" with drilled panel and base, coils, blue print, less tubes **$7.95**
"Beginner's Twin." Completely wired and tested extra **$2.00**
Set of 230 R. C. A. Licensed Tubes $1.40
Set of Batteries (2—45 volt "B"; 2 No. 6 dry cells) $1.95

SIX TUBE "SUPERHETERODYNE"



SHORT WAVE RECEIVER
With Dynamic Speaker
ALL-WAVE

Long-wave broadcasts from 200 to 550 meters possible with an extra pair of plug-in coils. Incorporates every new distinctive feature! Improved super-heterodyne latest type tubes, (1—2A7, 2—'58's, 1—55, 1—80, 1—2A5) A. V. C. single dial operation, low noise level, no background noise, complete tuning of both short and long wave bands. Shipped complete a set of 8 Bruno octo form coils. Everything necessary for construction is shipped, including blueprint, drilled and punched base, knobs, dial, hardware, coils, etc. Shipping weight, 30 lbs.

Complete kit of parts including 8 Bruno Coils and Dynamic Speaker **$24.50**
Wired and tested, extra $5.00
Complete set of R. C. A. licensed matched tubes $4.95
Modernistic Cabinet for Superhet $2.50
Set of Bruno coils covering the 200 to 550 Meter band $1.50

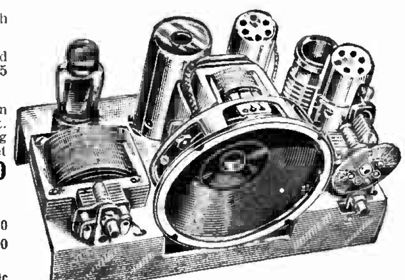
REGENT FOUR TUBE A.C.

Short Wave Receiver with Built-In Dynamic Speaker
15 TO 550 METERS

A complete short wave receiver with built-in speaker.

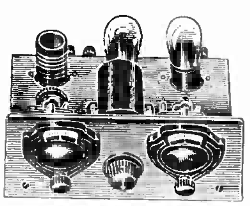
Uses four of the latest designed tubes, 2—'58, 1—'80 and 1—2A5 power pentode output tubes.

The entire chassis is placed into an exquisitely finished wooden cabinet. Complete kit of parts including blueprints and coils, less cabinet and tubes.
Net Price **$11.50**



Completely wired and tested, extra $2.00
Cabinet $1.50
Special broadcast coil (200 to 550 meters) 79c
Set of R C A licensed tubes .. $2.25

DIAMOND of the AIR



Battery-Operated *Short Wave Receiver*

The two-tube model uses 2-230 tubes. Especially designed for headphone reception, although loudspeaker reception may be obtained at ordinary room volume.
Two-tube kit with blueprint. Ship. wt., 5 lbs. Net price **$7.75**
Wired and tested. Ship. wt., 5 lbs. Net price **$8.75**
Complete accessories, including two 230 Sylvania tubes; one set of standard headphones; two No. 6 dry cells; two standard 45-volt "B" batteries. Ship. wt., 22 lb. Net price **$4.50**

Portable A. C.-D. C.

Short Wave Receiver
15 TO 200 METERS

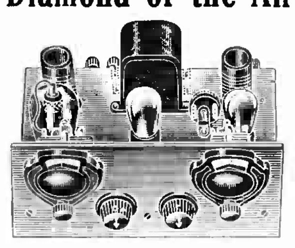
Extremely light in weight and may be carried anywhere. The circuit is one of the most recent types developed. Uses 1-'78, 1-'43 power pentode amplifier tube and 1-25-Z-5 rectifier tube.

Handsome carrying case 13 in. long, 9¼ in. wide and 6½ in. deep, with ample space to carry tubes, shield and coils. Waterproof fabricoid outside covering.

Complete kit of parts including case, metal panel, plug-in coils (15-200 meters) and blueprint. Shipping Weight, 16 lbs. Sale Price **$9.95**
Powertone Universal Portable completely wired and tested. Less tubes. Sale Price **$11.95**

Set of R. C. A. Licensed Matched Tubes. Net Price $3.25
Broadcast Coil for Powertone Universal Portable. Net Price 79c

Diamond of the Air



BATTERY-OPERATED
SHORT WAVE RECEIVERS
Model No. 5022-D. Three-tube kit with blueprint. Shipping wt. 7 lbs. Sale Price **$8.95**
Model No. 5023-D Wired and tested. Shipping wt. 7 lbs. extra **$2.00**
Set of R. C. A. Licensed Tubes (2—'30 and 1—'34) $1.95
Broadcast Coil 39c

PROMPT RADIO SERVICE CO., 130 CEDAR STREET, NEW YORK CITY.

WE DO NOT PRINT A CATALOG. ORDER FROM THIS PAGE. You are cordially invited to visit our showrooms and inspect these S.W. Receivers.

ROLAND BURKE HENNESSY
Editor
HERMAN BERNARD
Managing Editor
OFFICERS
Roland Burke Hennessy
President and *Treasurer*
M. B. Hennessy, *Vice-President*
Herman Bernard, *Secretary*

RADIO WORLD
REG. U.S. PAT. OFF.
The First National Radio Weekly
THIRTEENTH YEAR

Price, 15c per Copy; $6.00 per Year by mail. $1.00 extra per year in foreign countries. Subscribers' change of address becomes effective two weeks after receipt of notice.

Entered as second-class matter March, 1922, at the Post Office at New York, N. Y., under Act of March 3, 1879. Title registered in U. S. Patent Office. Printed in United States of America. We do not assume responsibility for unsolicited contributions, although careful with them.

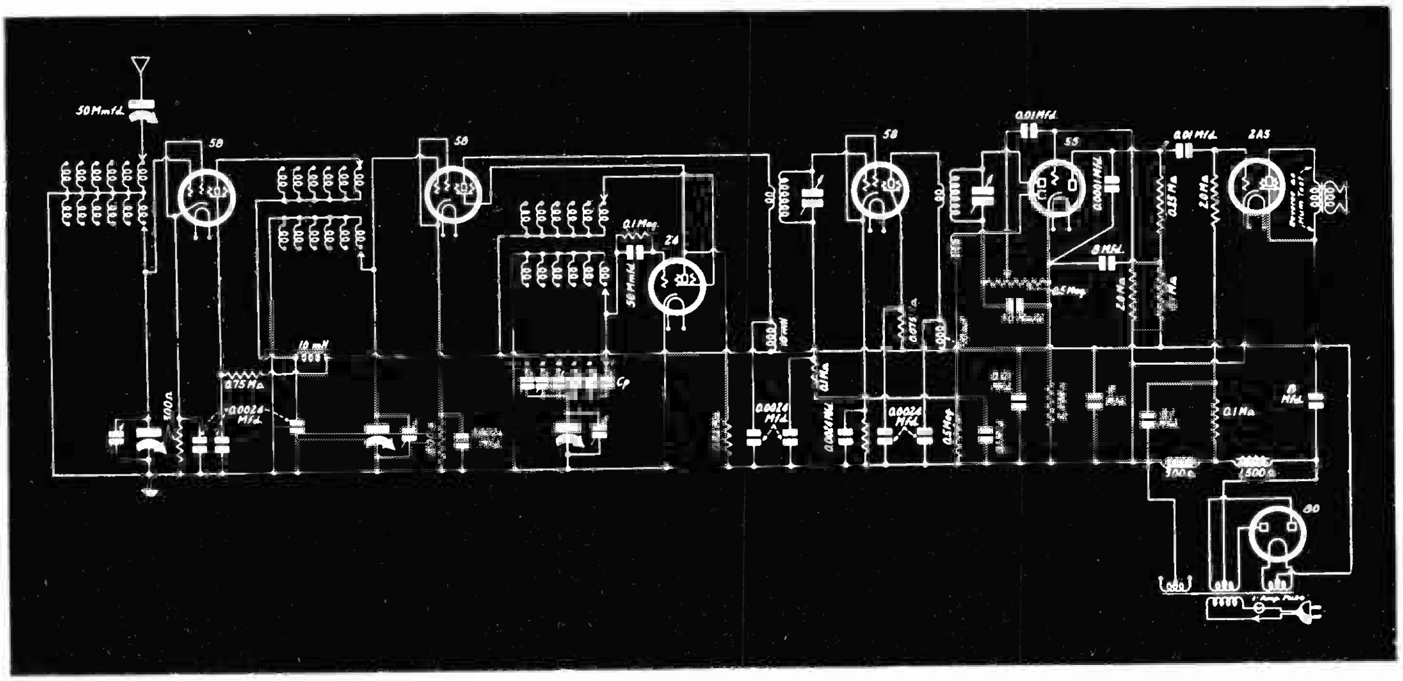
Vol. XXV SEPTEMBER 1st, 1934 No. 25. Whole No. 649

Published Weekly by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y.
Editorial and Executive Offices: 145 West 45th Street, New York
Telephone: *BR-yant* 9-0558

Electron Coupling in Mixer

With Separate Modulator and Oscillator

By Frederick L. Menson



Electron coupling between separate modulator and oscillator tubes. The d-c potential to which the 0.02-meg. resistor is returned (lower center of diagram) largely determines the conversion conductance and the oscillation amplitude.

ELECTRON coupling may be utilized with separate tubes. Most often it is present in the combination tubes, like the 2A7, 6A7 etc., but since the condition is merely one of unison of the emission current this may be accomplished as shown in the circuit comprising the modulator 58 (second from upper left) and the 24.

The modulator, being a 58, has a transconductance depending largely on the screen voltage, which would seem to be grounded, hence zero, because the screen of the 58 is connected to an element of the 24 and from the common point a resistor of 0.02 meg. (20,000 ohms) leads to grounded B minus. The phrase "an element" refers to the conventional plate of the 24, but which can not be called a plate, because it does not serve any real plate purposes, but may be called a pickup grid, if you like.

It will be noted that the conventional screen of the 24 is the feedback winding and is connected at its return to B plus. Hence the pickup grid will attract some electrons, and there will be a small drop in the 20,000-ohm load.

However, the smaller the drop, the lower the screen voltage on the 58, since the coupling is between the 58 screen and the 24 pickup grid. Therefore if the 20,000-ohm resistor is returned to some higher voltage, the amplitude of the oscillation voltage in the 24 (which tube is really used as a triode) will decline, because the pickup grid will attract more electrons, and fewer will strike the effective plate (conventional screen). Also, as this decline takes place in the oscillator, the conversion conductance of the 58, due to heightened screen voltage, increases. In fact, in the 58, as commonly used, which is in a manner consistent with the diagram, the screen voltage determines the conductance, other quantities being equal.

So the 20,000-ohm resistor may be connected as shown for conditions of high oscillation amplitude and low conversion conductance, or, by returning it to the screen of either of the other 58's (reducing the 75,000-ohm resistor then to 40,000 ohms), the other extreme is reached. Therefore such mutual operating conditions of the oscillator and modulator are established as best suits the performance requirements. That is, the sensitivity may be properly adjusted so that the noise level is not too high, and the amplitude of oscillation may be established at a value 1 volt less than such input voltage to the 58 modulator that would cause grid current to flow.

The circuit is that of a seven-tube superheterodyne, for all-wave coverage, using a switching system, and having a pre-selection stage, for image-rejection: a tuned modulator input and a separate oscillator, with one stage of intermediate-frequency amplification, a diode detector which

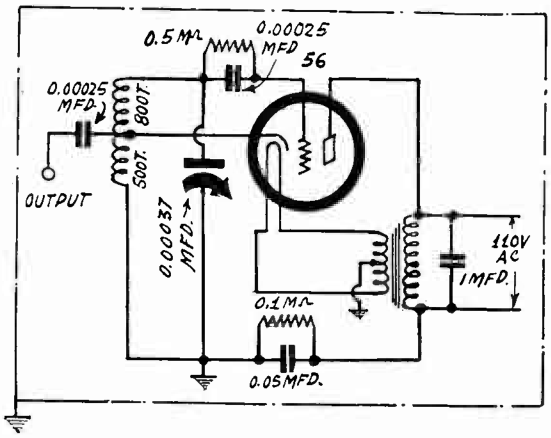
(*Continued on next page*)

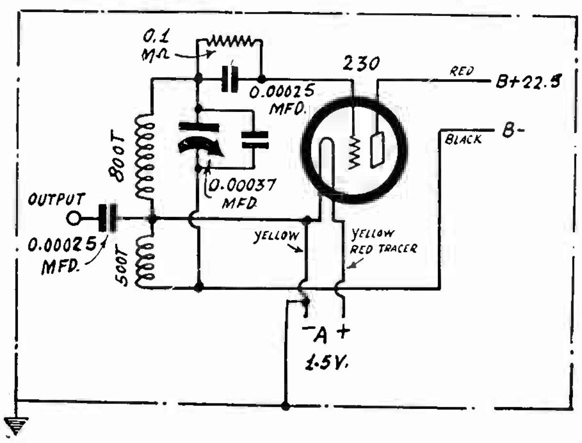
Better Signal Generators

Attained by Simple Adjustments and Precautions

By Leonard Fuller

Two Hartley oscillators. The one at left uses a heater type tube and a filament transformer, for a-c operation. There is modulation always present, it being the hum of the line frequency. At right, battery operation.





SECOND in importance only to the receiver in the radio picture to-day is the signal generator, formerly called test oscillator or service oscillator. Any circuit that provides oscillation can give satisfactory service, but there are some refinements that are desirable to introduce, beyond the mere presence of oscillation.

Experiments conducted on signal generators over a period of two years have shown up some troubles and in most instances solutions were found.

The diagram at left represents a Hartley, heater type tube used, the one at right a Hartley, battery-type tube used.

Feeding Through the Line

The grid leak and condenser at left are of usual values, 0.00025 mfd. and 0.5 meg., and for purposes of largest intensity such a combination is suitable, but excessive amplitude causes trouble. The oscillation is said to feed through the line. What actually happens, however, is not that the oscillation is conducted through the a-c line to the set, but that the a-c cord from oscillator to outlet acts as a transmitting aerial, and of course the receiver antenna acts as a receiver aerial, therefore without any apparent connection the oscillation gets into the set. To check up on the truth of this analysis, disconnect the antenna leadin from the set and there will be no "feeding through the line," because there is no receiving antenna.

If this feeding-through takes place and one were attempting to line up an intermediate channel, with antenna connected where it should be, there would be confusion due to interference. Besides the modulated signal sent through the intermediate channel alone, there might be a modulated harmonic of the i-f, coming from the signal generator, actuating the r-f input. If a hurried remedy must be applied, disconnect the antenna from the receiver when lining up its intermediate channel.

The Effect Analyzed

However, it is not necessary at all to establish maximum amplitude of oscillation. One may use less inductance between tap and ground to cut down the intensity, but, assuming a standard coil, and no desire to tamper with it, the intensity may be reduced and frequency stability also improved by using a leak of around 200,000 to 250,000 ohms, and as a grid condenser the capacity between two pieces of insulated No. 18 wire 5.5 inches long, twisted together closely, and then wound around a pencil diameter to keep the condenser in small dimensions. The capacity is several micro-microfarads, and this helps stability.

The reason it does so is that the instability of the signal generator exists at the higher frequencies of tuning, where there is a serious kink in the curve. If a plate-circuit milliammeter is used (put a bypass condenser across the meter) the needle will jerk around at this region of higher frequencies of tuning. But with the grid condenser made smaller, as stated, the change in needle position over the span of tuning is much less, and by close adjustment of the length of the wire, merely by snipping with shears, the needle can be made to stand almost still. But if the capacity is too small there will be even more serious instability right at the h-f end of tuning, or it is possible if the smallness is extreme that oscillation will not be present. Both these ill effects have to be overcome by use of greater capacity.

The leak may be viewed as a damper on the circuit, and without any grid condenser there would be no oscillation. If the capacity across the condenser is large, the damping effect is practically removed from the resistor. But the instability of the oscillator is shown up by the big change in current through the plate circuit when tuning from one extreme to the other; in other words, alteration of amplitude of oscillation, which in a sense the needle measures, so the high-frequency end, being fractious, has to be tamed. By controlling the damping effect

Inductance Selection for Padded Circuits

(*Continued from preceding page*)
separately supplies automatic-volume-control voltage to the i-f stage; a 2A5 output, with 80 rectifier.

Padding Hints

The intermedite transformer following the modulator may be one of the commercial types with primary and secondary tuned, instead of only secondary tuned, as shown. The second transformer would have to be made by the constructor, or a commercial model converted to this special construction to include the pickup winding. Primary and secondary may be tuned here, if desired. This has about half the inductance of the tuned secondary, and for 465 kc would be about 3/4 inch away from that secondary.

It is advisable to pad the oscillator to frequencies as high as one can, and this limit is reached determined much by the test equipment one possesses. It is assumed that the padding condensers Cp 1, 2, 3, etc., are air-dielectric types, otherwise the padding will not be of enduring value.

For the broadcast band, using 0.00035 mfd. to 400 mmfd. for tuning capacities, the secondary inductance for the selector and the modulator input may be 230 microhenries, while the oscillator inductance is 110 microhenries, Cp 350 to 450 mmfd., being adjusted for the correct value at a signal frequency at antenna input of 600 kc.

Key to Inductances

The inductance for the r-f levels diminishes by the capacity ratio of tuning. Thus, if the tuning for the broadcast band is 3 to 1, as for instance, from 540 to 1,620 kc, then if the first coil is 230 microhenries the capacity ratio is the square of 3, equals 9, hence the inductance for the next coil would be 230/9 or 25.5 microhenries. The same reduction applies all through for the r-f level, e. g., 1-9. In the oscillator the capacity ratio changes, increasing with increase in frequency, but the increase can be closely estimated, and the approximate inductance values derived.

For instance, suppose the first coil has 110 microhenries inductance. The tuning was from 540 x 465 to 1,620—465, hence from 1,005 to 2,085 kc, a frequency ratio of 2.75, or capacity ratio of 7.56, so the inductance for the first short-wave band would be 110/7.56 or approximately 14.5 microhenries.

Get Closer Together

It can be seen that for the broadcast band the r-f inductance was more than twice the oscillator inductance, but for the first short-wave band (called intermediate-short-wave band) the oscillator inductance is about two-thirds that of the r-f level. As the frequencies increase, band to band, the difference between the two inductances decreases, because the frequency difference decreases, and of course so must the capacity difference.

of the leak the current change with change of frequency generated is controlled, until the change is slight, even negligible.

The Extending Stability

When the frequency stability is excellent the generator, when set to generate a given frequency, continues to generate that same frequency, and does not wobble, shift or drift to some other frequency during use or operation.

In general, grid-leak type oscillators are fairly stable. The suggested method is a simple one of improving on that stability by extending it to the higher frequencies of tuning, where it doesn't otherwise exist.

Close coupling between tickler and grid winding is desirable. In the Hartley the grid winding is between grid and tap and the tickler between tap and ground. That is, the tap-to-ground path is part of the plate circuit.

The adjusted grid condenser reduces the amplitude, so that there is no serious trouble due to feeding through the line, and in general, if the tap is well located, there would be no such trouble at all. This provides a real remedy for one of those inexpensive service oscillators, although it changes the calibration, so that any trimmer would have to be readjusted to introduce larger capacity.

In a small signal generator the condenser method just outlined might be used, but for some other purposes the same system could be followed, using an air-dielectric condenser, say, of 15 mmfd., and adjusting it as if it were a trimmer, for it does control the tuning capacity about as much as if the condenser were across the main tuning condenser. However, if the grid condenser is used for frequency adjustment, a compromise has to be made as to stability adjustment, since the condenser can yield only one capacity at one time, and the capacity that is just right for trimming might not be right for stabilization. However, in a test oscillator one is building and desires to calibrate himself, the adjustment would be made for stability only, and then the calibration would be run on the basis of conditions as they exist.

A Step Ahead

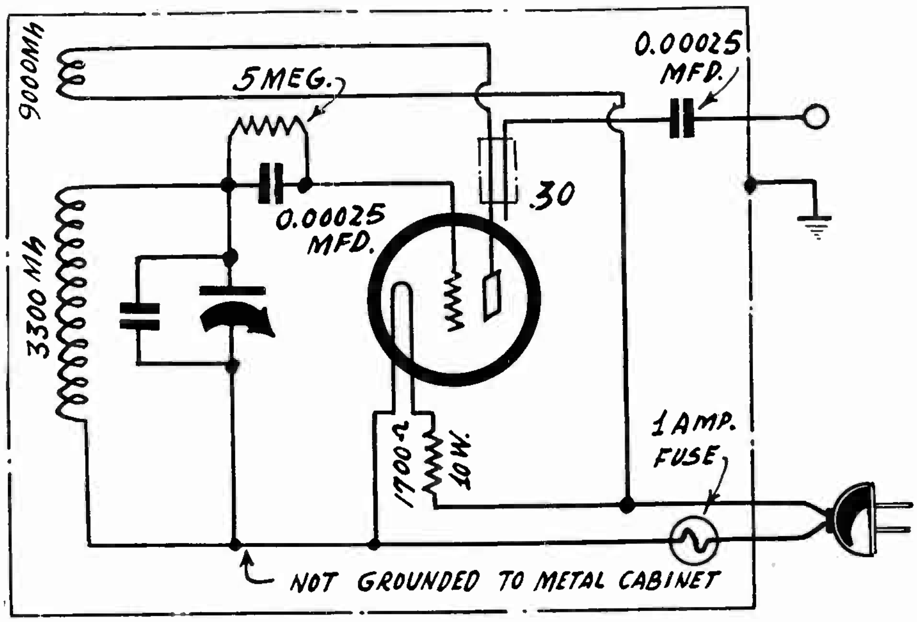
The air-dielectric condenser method of adjustment is suitable for local oscillators in superheterodynes, for stabilizing them. By introducing such stabilization you will be a bit ahead of the times, as the local oscillators in general are used as found, though in a year or so frequency stabilization will be one of the big things in local oscillators, particularly in all-wave sets, for on short waves, and the shorter they are the more important is stabilization, the drift has a detuning effect that produces results comparable to and often mistaken for fading.

In the negative leg of the circuit at left is a combination of 0.05 mfd. and 0.1 meg., which also reduces the oscillation, and is in itself a pretty good deterrent to feeding through the line. Besides, it enables grounding the box to the line without danger of short-circuit.

Grounded Plate

A small filament transformer is used and across the primary is a condenser of 1.0 mfd., mostly for grounding the plate. The grounded-plate method, applicable practically to the Hartley alone, is also consistent with stability.

The application of the Hartley to battery operation requires a departure from the conventional method of battery connection, the reason being that the filament is the cathode and connecting filament to the tap would result in no oscillation, because short-circuiting the tickler. That is, the coil return is at ground potential, but so is the battery that supplies the filament. Therefore the device is used of putting the minus A connection (if 1.5 volts are used for supply) to the tap and connecting the other end of the coil to B minus. B plus goes directly to the plate, so the B battery is a sort of load on the plate circuit, in addition to the tickler so being; therefore it is plausible to put a bypass condenser across the B battery, say, 1.0 mfd., to negative the r-f effect of any resistance that might develop in the B battery due to age or use.



The 30 tube is not as ready an oscillator as the heater type tubes are, therefore stabilization methods, all of which are consistent with diminishing the amplitude over a portion of the tuning, can not so easily be applied with assurance of full success. But an improvement of considerable magnitude can be attained nevertheless. The grid condenser can not be as small as in the instances of heater type tubes, unless the grid leak is made smaller than 200,000 ohms.

The same methods suggested for stabilizing the first circuit apply to the battery-operated one.

In the foregoing examples the a-c and battery types were differentiated, but in the third diagram a 30 tube is used, with a 1,-700-ohm 10-watt resistor, for "universal" use, 90-125 volts a. c. (any frequency), d. c. or batteries, although use on batteries is wasteful, due to some 60 milliamperes of current.

This is a tuned-grid type oscillator, meaning that there are two inductively-related windings, one in the grid circuit, across which winding in the tuning condenser, the other winding in the plate circuit, being the tickler. Here, of course, the tickler goes to B plus directly. The output is taken through a small capacity, consisting of two insulated pieces of No. 18 wire 3.5 inches long, in a piece of spaghetti small enough in diameter to hold the wires inside tightly. One of the wires is the lead to the plate and connects to the tickler coil. The other is not connected at one end, while at the other end it serves as output. and may be further protected by any condenser, one of 0.00025 mfd. being shown. This condenser is not strictly necessary.

Line Protection

The diagram shows that the rotor of the tuning condenser is not grounded to the metal cabinet. That means the tuning condenser is insulated from the line. If this insulation is to be avoided, a mica dielectric condenser of 0.01 mfd. may be put between stator and metal cabinet, the stator and cabinet being grounded through the line, due to the presence of the 0.01 mfd. condenser, and no connection to the ground post if such a post is present, being made. There will be a little line current through the 0.01 mfd. condenser, and touching ground to the box in one direction (opposite potentials) might cause a slight spark, very slight indeed, but this is due to continuity of the small current and is in no way dangerous.

The 30 tube is harder to stabilize than the 56, and, though the fact was not mentioned in connection with the battery diagram, at least by using the adjusted grid-condenser method. A fair result was obtained, but not comparable to that applying to the heater type tubes 56 and 76.

Moreover, the 30 tube is not nearly so ready and energetic an oscillator as are the heater type tubes, therefore the grid capacity would have to be higher, or the grid leak lower. That is, if 200,000 to 250,000 ohms are used (instead of 5 meg. in the diagram) more wire must be twisted for satisfactory oscillation, or a mica-dielectric condenser of 15 mmfd. adjusted. Such a condenser would have to be insulated at both ends, as both terminals are "hot."

A Precaution

Putting a resistor from the plate return to stabilize the circuit more, and a condenser across the resistor or to negative side (lowest circuit line in the diagram) is dangerous, as the filter increases the filament voltage, by the drop in the filter, hence quite readily would burn out the filament. The circuit should be followed as shown, except for the alternative 0.01 mfd. condenser to avoid isolating the chassis and cabinet from the line by insulation, and of course the grid condenser adjusted for as steady a state of the plate needle as is practical to attain.

The 34 is a battery-operated tube that can be stabilized quite well, and besides enables the advantage of electron output coupling, as diagrammed. The screen is used as the real plate, while the regular plate is the output device. Hence a resistor in the regular plate, slider moving across the resistor, enables attenuation, without changing the frequency of generation, and besides the measured circuit as a load does not change the generated frequency, all due to electron coupling.

Decibel Attenuation

When the circuit is stabilized, using the method already outlined, then the current is practically constant in the output load, therefore in respect to any reference point, here the maximum output, there will be a definite proportionality, based on the amount of resistance between arm and plate. This pro-

(*Continued on next page*)

(*Continued from preceding page*)

portionality can be expressed in decibels. If a straight-line-resistance potentiometer is used, say, 50,000 ohms, but in fact almost any resistance value is just as good, the attenuation can be expressed in decibels.

It is somewhat risky to use the term deci-

Power Basis Used

bels without some statement as to what it means and why it applies. The meaning is that the attenuation is predicated on either voltage, current or power. Here we have chosen power, because the signal generator is to be used with a receiver, and the measurement applies to output of the entire receiver, which is a power consideration. The reason for the application at all has been stated; that is, the current being constant, the output is proportional to the amount of resistance between plate and arm, really compared to the total resistance (50,000 ohms). Therefore a plate may be used that reads for a 270-degree rotation as shown in the figure, for decibels attenuation down from maximum, in steps of 2 decibels from 2 to 24 decibels.

Origin of Term

Decibels attenuation is related to the sensitivity curve of the human ear. One decibel attenuation is supposed to be the smallest difference that the keenest ear can denote. In general, 3 decibels are said to be the smallest difference that the average ear can detect in sound-volume intensity. Strictly speaking, the decibel gives the attenuation per unit of standard cable used in wire telephony. That is how the use originated, and the bel is named for Alexander Graham Bell, inventor of the telephone.

FORUM

EDITOR RADIO WORLD:

A separate C supply of the rectifier type is at all times desirable in an a-c set. I saw one receiver a fellow built where he rectified the oscillator voltage to provide C bias for the power tube, and while this was interesting I can not say that it strikes me as being most favorable, because the oscillator is not steady and sure enough. And if the tube didn't oscillate, where would the bias come from? However, the same may be asked about the signal. I believe that separate C supplies should get much more encouragement than they do. Here's hoping.

WILLIAM J. WOODSTOCK.

The New

Pre-Selection Now Use

from

By Rodney

THE requirements are so stiff in an a ll-wave or short-wave superheterodyne that to get reception without interference it is necessary either to use a high intermediate frequency or to use a stage of tuned-radio-frequency amplification ahead of the tuned modulator. This t-r-f stage is now being called a pre-selector, or, when a separate unit, a booster.

There are difficulties attendant on use of a high intermediate frequency. Suppose 1,650 kc were selected. Then the broadcast band could be tuned from 540 to 1,600 kc. But for a given number of i.f. stages the selectivity there woould be less than if a lower i.f. were used, because the selectivity is greatest when the i.f. frequency is lowest. Also, the reciver would not be a superheterodyne, although that is just a matter of terminology. It would be a sort of infradyne, that term applying to a receiver where the i.f. is higher than the carrier to be brought in. However, years before the infradyne was introduced to the kit-building public, RADIO WORLD printed complete details of the metaformer, which was exacting the same thing.

The High I.F.

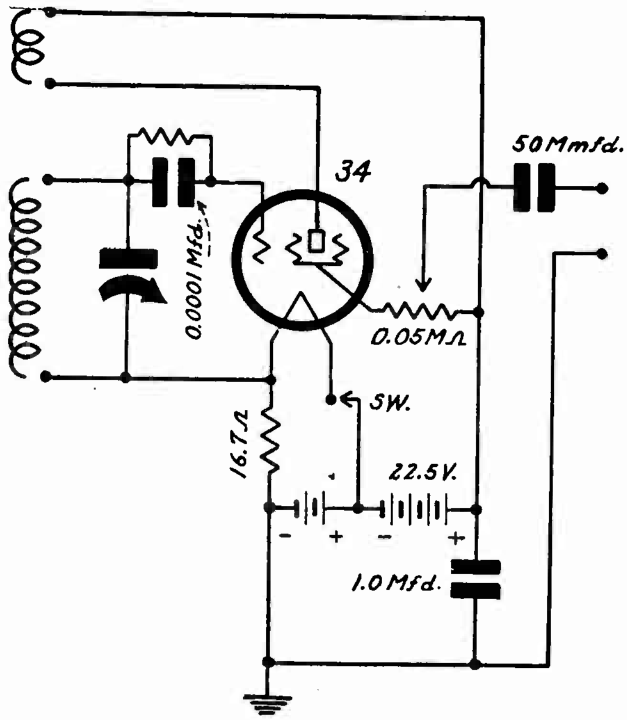
Also, at a high i.f. there would be more trouble establishing stability. Oscillation in the i.f. amplifier might be expected to be a common trouble. Yet the troubles, in all, could be eliminated. The lessened selectity at the i.f. level would be partly offset by the increased differential selectivity at the r-f level. When the modulator frequency is 1,650 kc lower than the local oscillator frequency, naturally the images are wiped out for most of the tuning, anyway. The image is a frequency differing from the intended one, in this example, by 3,200 kc. The r-f suppression may be expected to ge good for 3,200 kc all over the tuning, even to 20 mgc.

There would have to be a blank part or missout in the tuning. It will be noted that with 1,650 kc i.f. the broadcast band topped at 1,600 kc, or 50 kc away, which is fairly close at that, perhaps too close. Therefore there would be no reception from 1,650 to 1,700 kc, since the new band would have to start also 50 kc from 1,650 kc or at a round 1,700 kc. If the carriers were permitted to come through, the whole set would turn into a squeal factory between 1,600 and 1,700 kc, hence the second coil system would start at 1,700 kc and there would be no possibility whatever of getting anything between 1,601 and 1,699 kc.

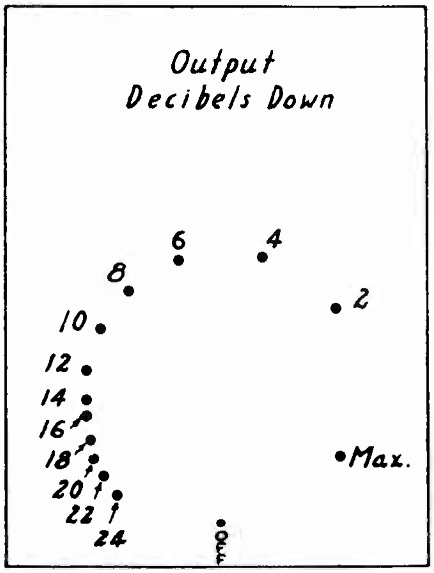
Back to the Low I.F.

Suppose, then, that a low intermediate frequency is used. To-day a popular one is 465 kc. The higher the i.f. the better the image suppression because the greater the difference between the carrier and local oscillator frequencies and the more effective any tuned circuit. That is, any tuned circuit, good, bad or indifferent, affords better rejection of signals 465 kc apart than, say, signals 175 kc apart.

Now, 175 kc is not a bad i.f., but is not particularly suitable for short-wave work, because the carrier and local oscillator frequencies are too close together. They finally become too close together even when 465 kc is used, and some manufacturers have been inchingin toward the broadcast band for i. f., having arrived to date at 480 kc to favor the image suppression as much as possible. Also, leading manufacturers are producing receivers that have three, four and five-gang tuning condensers, there being a commercial set with two i-f stages for the higher frequencies of short-wave tuning. An addition reason for this is to atone for the drop-off in the sensitivity of the set, due to accumulation of losses, when the higher frequencies are tuned, say, 10 to 20 mgc.



With this circuit electron coupling of output is used, and if the circuit is stabilized the current through the 50,000-ohm potentiometer is practically constant, therefore the attenuator can be calibrated in decibels down, rated from maximum.



A straight-line-resistance potentiometer yields this scale of calibration of decibels down, from 2 to 24 decibels, in steps of 2 db, when applied to the test oscillator shown at left that uses the 34 tube.

Iconoclasm

d for Breaking Away "Images"

T. Meeker

So it appears that 465 kc or thereabouts is a good compromise.

The Compromise

Changing the intermediate frequency for each band would be another method, theoretically attractive, but few engineers have the tremendous enthusiasm and purpose necessary for developing a receiver that shifts the tuning bands at the carrier level (troublesome enough) and then besides shifts the intermediate frequencies. Depending on the frequency ratio of the r-f level, the i.f. would have to be increased accordingly. This if the ratio were 3 to 1 the i.f. would have to be lifted to 3 times its previous value for each successive band. However, carrier and oscillator padding would remain intact then for all bands—the oscillator or padding condenser would be merely one and the same for all bands. But this is a silght simplification compared to jumping 465 kc finally to 12,655 kc!

This is hardly practical. And so attention centers on image suppression, with the intermediate frequencies we are likely to use, not the ones we theorize about and then dismiss with a sigh.

The imagoe suppression can be made enough when a stage of t.r.f. preecedes the tuned modulator. Then the oscillator also is tuned, but of itself affords no selectivity. What seems to be the selectivity of the oscillator is only the intermediate-frequency selectivity masquerading as oscillator selectivity. All the oscillator does is generate a frequency, one of two frequencies delivered to the modulator. Or, considering the image, one of thee frequencies.

Analysis of Image

So let us examine more closely into what the image is. Even "popular" advertisements of commercial sets refer to it, in connection with praise of a receiver's performance, by virtue of suppression of this great undesirable. So if the general public is supposed to know a thing or two about images (though it does not, except for the types of images found in museums) at least we should become familiar with the expression and its real meaning.

An image is an interfering frequency to which the intermediate channel is responsive due to insufficient rejection of an impulse at the radio-frequency level.

Let us asign some clarifying frequencies. Suppose we desire to tune in a station operating on 12 mgc., using a receiver that has an intermediate frequency of 500 kc (0.5 mgc.). We follow the usual practice of having the local oscillator generate a frequency higher than that of the desired station. Thus we add the station frequency and the intermediate frequency and get 12.5 mgc. This is the frequency of the local oscillator that will bring in the station, because when the oscillator output is coupled to the modulator that contains the station frequency, the two frequencies mix, the difference between them, 0.5 mgc., being the sole frequency at the output of the modulator, or input to the intermediate amplifier. So the i-f channels amplies this frequency.

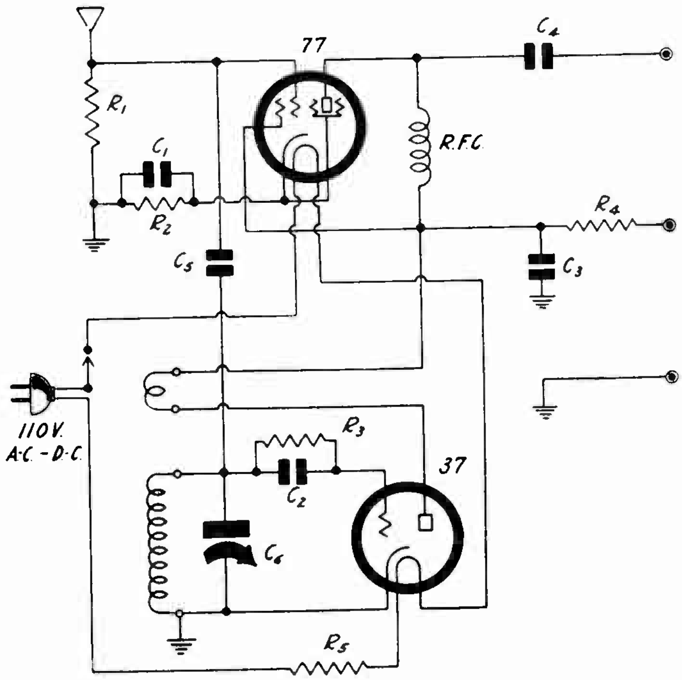
We have referred to "this frequency," but since there is an alternative, let us find out what that is.

The "Other One" Found

If the oscillator generates 12.5 mgc. and is intended to beat with a selected carried of 12 mgc. to cause 0.5 mgc. output to be fed to the i-f channel, is there not at least one other frequency that, when mixed with the local oscillation frequency, will also cause an output of 0.5 mgc. from the modulator?

The oscillator does not change its frequency but stays at 12.5 mgc. The r-f tuner and modulator input do not change their frequency, but stay at 12 mgc. How then can some other frequency get by, and what frequency is it?

We have just mentioned the case of the carrier frequency being lower than the oscillator frequency. That is the typical and intended case. Let us consider a carrier frequency that is higher than the oscillator frequency, and higher by the same amount, 0.5 mgc. Well, the oscillator frequency was 12.5 mgc., so the higher modulator frequency would be 12.5 + .5 or 13 mgc. So the same setting of the local oscillator stokes a frequency just right—or shall we say wrong?—to bring in 13 mgc. Yet the set is tuned for 12 mgc.



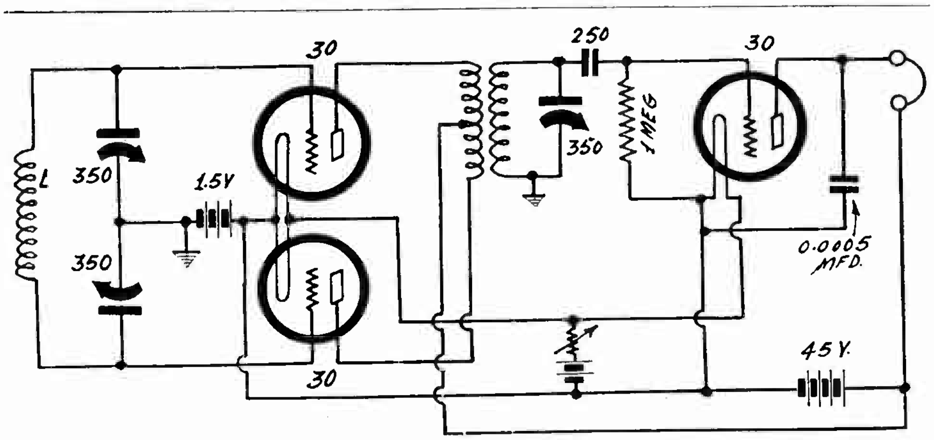
A mixer, as might be used in a short-wave converter, with no pre-selection whatever. This is a condition infrequently met. Usually the input to the modulator is tuned. Now a t-r-f- stage is generally being used also.

Why Must Image Be?

Well, tuning is a matter of degree. The intention is to let in only 12 mgc. But the tuner section would have to be pretty selective to do that, especially as t.r.f. isn't so selective at best, and certainy no better at high frequencies than at broadcast freqencies. Therefore we find that in sufficient selection ahead of mixing permits a second frequency to be received, and the object of pre-selection, and even of double pre-selection, is to kill off the possibility of the second frequeny getting in. And the higher the frequency of the tuner the harder to do such execution.

It will be noted that the image always differs from the intended carrier by twice the intermediate frequency. Numerically above, 12 and 13 mgc. were the frequencies, differing by 2 × .5 mgc., or 1 mgc.

The only remaining question is, how can it be certain there will be image reception, or reception of this second frequency as interference, when it is not certain there is any station on that wave? There doesn't have to be a station. In fact, the reception is sometimes referred to that from "phantom stations." Unfortunately there is enough noise, static, etc., on practically any frequency among these high ones to make phantom reception almost a certainty, unless the selection is of a high order.

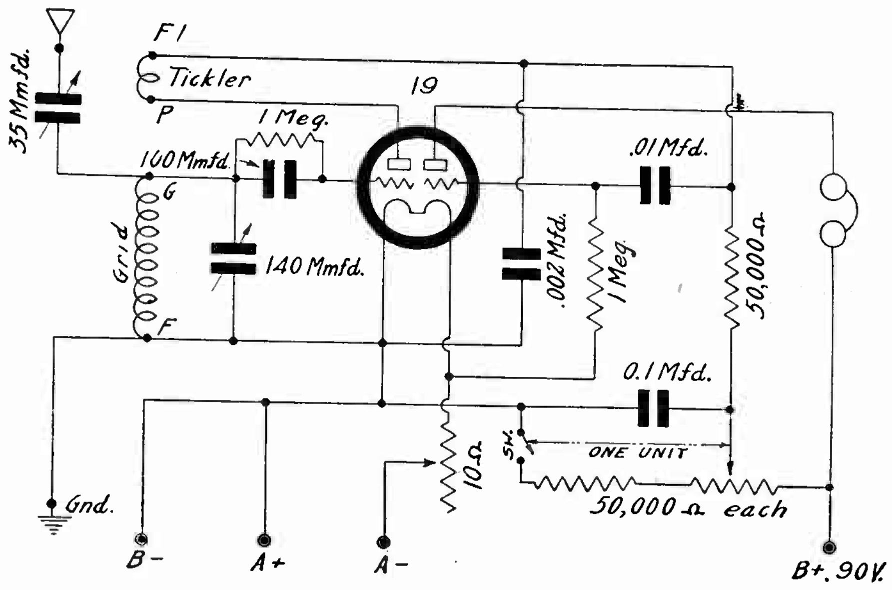


A push-pull radio-frequency amplifier stage and a simple detector. The circuit is suitable for either direction finding or for receiving ultra-high frequencies.

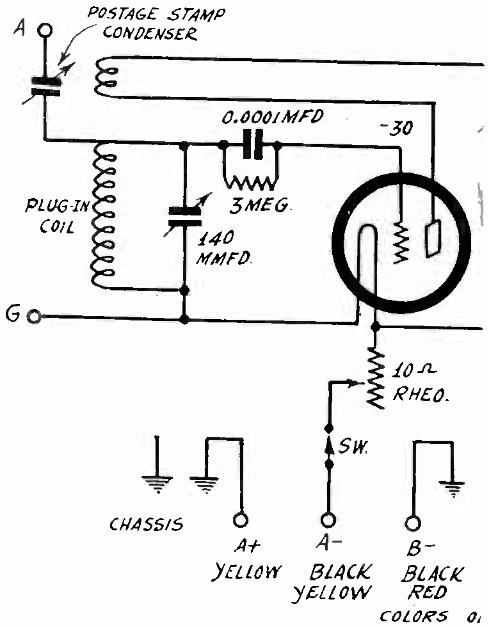
The Styles in Short-

Audio Stage Becoming Standard-

By Thomas



The 19, a new tube, became suddenly popular for short-wave use as detector and amplifier, quite apart from its originally-intended purpose of serving as a Class B power output tube.



This circuit yields about the same pe two separate tubes, both 30's, and perr former advantageously. The first circ ment as the regeneration control. condenser (right-h

SOME audio-frequency amplification ought to be used with the regenerative short-wave receivers. These devices can pick up practically any signal that can be rated as receivable, when one considers reception conditions and compares performance with that of any other receiver.

Of course the response from detector alone in the main is feeble. There is some audio-frequency amplification in the detector, but not enough. A stage of audio should be included, for earphone use, and an extra stage will work some stations well enough for a speaker, yet would not prove too much even for earphone work.

The regenerative receiver is also the simplest to build and the least expensive. In fact, the word expensive scarcely can be appropriately applied. But it is not the easiest to tune. There is no comparison between the ease of tuning a short-wave superheterodyne and the difficulty of tuning a short-wave regenerative set.

Disappointment at First

For any one who never had experience with regenerative sets the type of receiver will prove a disappointment at first, because of this tuning difficulty, but after one has become used to the method, and has learned from experience just what little tricks are necessary to bring in stations, and how patience and some skill must be cultivated, the first impulse when anybody mentions the difficulty is to ask, What difficulty? An experienced user of a regenerative set may say in all truth that he can tune in stations as well and as fast as can a fellow who is operating a superheterodyne.

So the regenerative receiver has its place, at least for a while. Possible, as with broadcast reception, the vogue will veer completely to superheterodynes in the future, especially when some attention is paid to the possibility of interference by radiation due to abuse of the regenerator.

The one-tube battery type is popular, but the signals really could be louder, so a two-tube battery model is likely to be more popular the coming season. Also a-c and "universal" type short-wave sets are in favor. As yet plug-in coils are the rule, but switching arrangements are likely to be perfected for the kit-trade, requiring some initiative by mail order houses and others.

The 19 is a new tube suddenly grown popular in short-wave battery circuits. The reason is that it is two triodes in one. Ordinarily it would be used as a Class B audio output, the intended purpose, but it also suits the other purpose, and has been seized upon for use in the unintended direction. It makes a good regenerative detector, is pretty stable, and of course provides the impedance for a resistance-coupled audio stage. It is hardly practical to use a transformer to advantage with this tube because the transformers would cost more than the builder of such a small set would expect to pay, for they would have to possess extraordinarily high primary impedance.

The first diagram shows the 19 used as regenerative detector and audio amplifier, feeding earphones. The same impedance requirement applies to the phones as would apply to the primary of an audio transformer, if used, and therefore the phones should have the highest impedance obtainable, the author being familiar with types attaining 20,000 ohms. This is by no means enormous when serving as the load on a high-mu tube's output.

Larger Ticklers

While the tube has double the emission of the 30, this is applied to the purposes of two triodes, therefore the individual tube used as detector is like the 30 in emission respect, and for the higher frequencies, especially in view of the low B voltage, would require larger ticklers than usual, often ticklers interwound with secondaries, for that is the easiest way to attain oscillation where difficulties are present.

There was no difficulty attaining oscillation, hence regenerative control, up to 30 mgc, when this circuit was used, although it was noted that the position for operation just below oscillation, the most sensitive point, was considerably different than on lower frequencies. This no doubt is accounted for by the phase shift in the tube circuit as the frequencies became high.

The series antenna condenser in all such hookups is an imperative inclusion, and preferably should be operated from the front panel, as otherwise too many recourses to the rear to get at a postage-stamp type condenser (compression variety) would be required. It is true that one setting will do for one band, and that one does not have to change the setting to get reception, but one does not do only what one has to do. One tries to get the best possible results, and sometimes a slight adjustment (though not a critical one) will greatly improve the volume. This is especially true if any condition is encountered that approaches a dead spot. The series antenna condenser is a dead-spot eliminator.

Aids on High Frequencies

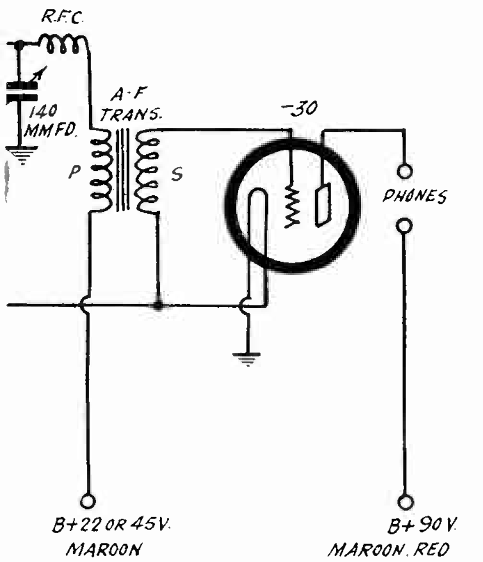
Another factor in favor of its inclusion, and moreover on the front panel, is that it enables the adjustment of the electrical length of the aerial. This of course is related to frequencies, and when the frequency change is most rapid for a given displacement of the main tuning condenser, the adjustments of the series condenser for maximum sensitivity become more numerous.

In this circuit, as in the others, the favorite 0.00014 mfd. is used for tuning, and standard commercial type plug-in coils may be used, or one may wind his own coils, if he prefers, following the data presented in the May 19th (1934) issue of RADIO WORLD.

Wave Regenerators

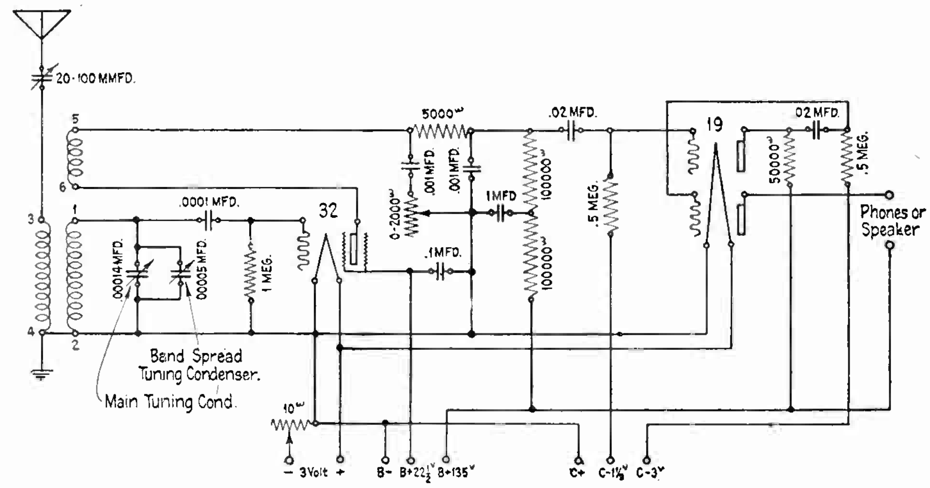
—The 19 Tube Leaps into Favor

C. Coster



: BATTERY WIRES

rformance as the first one, but uses nits the inclusion of an audio trans- :uit had detector B voltage adjust- This one has the familiar throttle and 140 mmfd.)



The 32 as a regenerative detector, with the 19 as two-stage audio amplifier.

The textual information was illustrated by actual coil drawings.

The regeneration is controlled in the first diagram by adjustment of the voltage applied to the plate.

Throttle Condenser

The other and possibly more popular method is the use of the throttle feedback condenser. This is illustrated in the second diagram. The performance is about the same for the two circuits. In fact, the only obvious difference between the two, assuming equal results from regenerative control, is that the second circuit has an audio transformer. This is more favorable to increased volume under any circumstances of low B voltage, and since the maximum specified is 90 volts, it would appear that a transformer would be the better selection, provided of course that one realize sthe total difference is not very large. In any use of resistance coupling the working mu of an audio stage depends considerably on the B voltage, which is not so much true of a transformer-coupled stage.

The practice of having a common rheostat to control the filament voltage of the two tubes is not the best, but is dictated perhaps by considerations of economy of cost. It is always better to leave audio filament voltages at what they should be, and a fixed resistor could take up the slack, unless the rheostat is not on the front panel, and only an occasional adjustment is made, to atone for the changing resistance condition in the A battery, which consists of two No. 6 dry cells series connected.

Pilot Lamp

Scarcely ever is a pilot light shown in a battery-operated set of this kind, but if 90 volts are used, then the voltage is sufficient to cause a neon tube to strike, and a small candelbra type neon tube may be used as indicator. It must be admitted that human beings have been known to leave sets on overnight, and when these sets are battery-operated, and the result of this forgetfulness is that new batteries must be bought, the inclusion of the pilot light that would call to the attention of all and sundry that the set is turned on is advantageous. A call-down for absent-mindedness is preferable to forking up a few dollars unnecessarily for batteries—at least preferable to an avoidable "catastrophe" such as this.

RFC is any radio-frequency choke of 20 millihenries inductance or more. One reason for specifying a high inductance is that these coils are usually universal wound, and the more turns therefore the lower the distributed capacity, as the capacity between turns is effectively in series, though it has been pointed out that for solenoids it can not be said that adjacent turns are in series or in parallel, or any turns in respect to any other turn, in the light of capacity effects, due to unequal distribution of current. Evidently with universal-wound coils (honeycombs) this inequality does not exist. So the smaller the distributed capacity, the larger the effect of the inductance of the coil, otherwise readily bypassed by even a small capacity. The distributed capacity of such a coil—honeycomb—may be only a few micro-microfarads.

Three-Tube Battery Set

The third diagram is that also of what seems to be a two-tube set, though effectively there are three tubes, in that the 32 is the detector, the 19 constituting the first and second audio amplifiers. The 32 tube is a screen grid tube, of the non-suppressor type, and therefore it has a higher internal capacity than has the 34, which it otherwise resembles, though the 34 has a suppressor tied to the filament. So the 34 may be substituted by any who find that the frequency ratio of tuning (maximum frequency divided by minimum frequency for any band) is not as large as expected or desired. Some plug-in coils will not afford overlap with the 32 at high frequencies, when the 34 will supply such overlap. However, the 32 is a good oscillator, but probably no better than the 34, which is a later tube with remote cut-off characteristic.

In this third circuit we have recognition of the undeniable advantage of using more B voltage with resistance coupling. The detector plate voltage is not apparent, as it is cut down by a resistor, but may be taken as a round 90 volts, though the full 135 volts are applied to the two plates of the 19 tube. This is where the greater B voltage counts. It so happens that something less than 135 volts, say, from 45 to 90 volts, gives smoother regenerative action in the detector. Here the regeneration control is effectively a shunt resistor of the rheostat type.

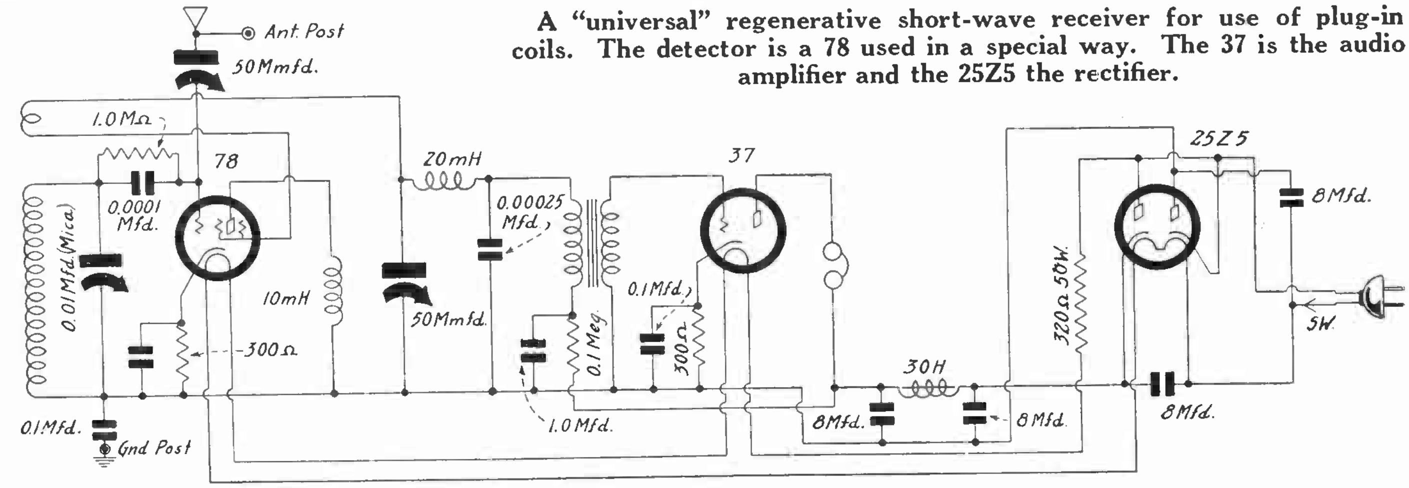
For universal operation the 78 may be used as detector, screen as feedback winding, plate not used as plate but grounded through an r-f choke, or plate and screen may be tied together, if one prefers. This is the fourth circuit. The performance does not differ much, though the conductance of the tube is higher with screen and plate tied together. Really the tube in either instance is a triode and therefore transformer-coupled audio is suitable, and quite a good signal will be delivered to earphones. The 25Z5 is the rectifier, the 37 the audio amplifier. The detector plate circuit is filtered to prevent hum from backing up, and if there is still some hum trouble, put a paper condenser of 2 mfd. or greater capacity ,600 volts rating) in parallel with the 8 mfd. next to the rectifier.

Pictorial Diagram

The fifth diagram is one combing the circuit diagram with the pictorial duplicate, and represents a three-tube a-c operated set, not one for "universal" operation. This is an exceedingly simple circuit to build, and gives excellent earphone results. By adding another tube, say, a 2A5, a speaker could be worked well.

For those who want a 3-tube circuit for speaker operation the 43 tube may be substituted, as in the fifth circuit. This gives more volume than the 37, being a screen grid tube, but is not particularly suitable for earphone output, and therefore quite a few stations that come in loud enough for speaker operation may be enjoyed. These are not confined to locals. Plenty of foreign stations lay down a strong enough signal to actuate the speaker satisfactorily.

(Continued on next page)



A "universal" regenerative short-wave receiver for use of plug-in coils. The detector is a 78 used in a special way. The 37 is the audio amplifier and the 25Z5 the rectifier.

How Styles Shift in Regenerative Sets

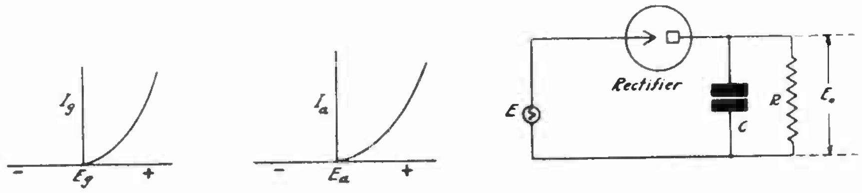
(Continued from preceding page)

The speaker is of the magnetic type and the filter chokes are separate-cored types of of 150 ohms d-c resistance (though the d-c resistance is unimportant), further to improve the elimination of hum.

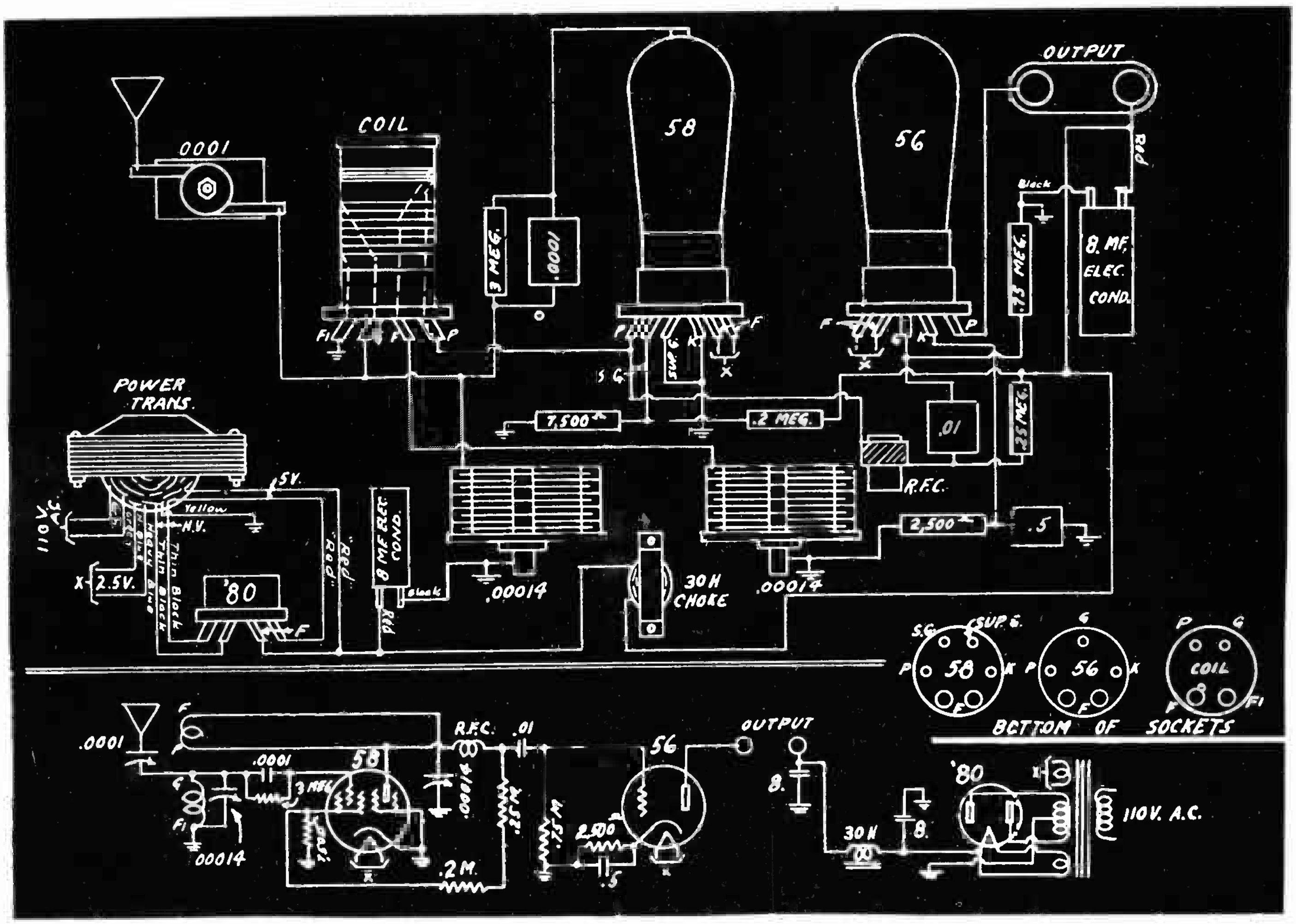
The antenna series condenser should be of the variable type, insulated from any conductive front panel. The capacity is not so important. It may be 35 to 50 mmfd. maximum.

In diagrams of the 25Z5 it is usual to show the cathodes near the heater, as this represents the tube geometry, but the actual socket connections must not be assumed to be in that order, for the plates are next to the cathode outlets on the socket, and the cathodes are at rear.

PRINCIPLE OF RECTIFICATION



The curve at the left shows a change of grid voltage (E_g) causing change of grid current (I_g), representing any triode. The curve is not a straight line, therefore distortion is present. Whenever there is distortion in a tube there is rectification. The curve to right applies to a diode. I_a being anode current, E_a anode voltage. The two curves are practically the same. At right the a-c (ES) is applied to the rectifier. R is the load resistor, C the filter condenser. The rectifier is a "one-way street," hence the output is d. c., or unidirectional current or voltage (E_o).



Wiring diagram and pictorial diagram of a three-tube short-wave regenerative receiver for earphone operation.

A New Scanning System

Vibrating Mirror Uses Resonance for Bright, Large Picture

By William H. Priess

PICTURE quality in television calls for a scanner that will lay down at least a million dots of light a second. It must swing a light beam that will produce a picture of home movie size, quality, and brilliancy. It must be inexpensive and rugged. It must be driven by power of so small amount that it can be kept in step by energy sent over the air.

Nothing like this has existed. The Nipkow system was inordinately expensive and had to use power of such extensive amount as to place it at the mercy of phase variations of the electric lighting circuit. Continuous synchronization between the transmitting scanner and its receiving scanner was well nigh impossible.

Announces an Invention

The cathode-ray system, inexpressibly appealing to engineers because it deals with a substantially inertialess beam, nevertheless is a proven failure.

It can achieve synchronization between transmitter and reciever, but only on a basis requiring an exact and unusual wave form that is most difficult to operate and if incorrect in shape, distorts the picture. Its result at home is bound to be unsatisfactory because its picture is too small. I have invented a scanner that costs about the same as a dynamic speaker and will place the light for a three-foot-square picture in the home.

The advantage of this scanner is that it is inherently periodic. This is all-important, and not duplicated by any other scanning system in television.

Compared to Watch

It can be compared to the working of a watch. In the balance wheel of a watch the time period is controlled by the moment of inertia of the wheel and the elasticity of the spring that is fastened to the wheel. The time period of our scanner is determined by the moment of inertia of the mirror and other attached masses, and the elasticity of the steel rod to which those masses are fastened.

Tells of Solution

Push the balance wheel of a watch and it will oscillate back and forth one a second, its inherent time period being one second. In the line frequency of our scanner, if you treat it likewise, it will swing 5,000 times a second, its inherent time period being one five-thousandths of a second.

This inherent quality of periodicity does not exist in any other television scanning system. Its value is immeasurable, for television requires thousands of home scanners to keep in exact step with a single master scanner at the studio.

The solution, as it has been worked out by my associates and myself, is simple and certain. The light is caused to strike a mirror and is reflected from that mirror to the screen as a spot. The spot is caused to move horizontally by vibrating the mirror in a vertical plane, and simultaneously the lines produced by the vertical vibration are caused to travel up and down by a slower horizontal vibration of the same mirror.

Very Small Mirror

The mirror is a metal 1/4 of an inch square and 1/32nd of an inch thick. It is spot-welded to a steel music wire 8 one-hundredths of an inch in diameter and 3 inches long. One end of the rod is welded into the frame. The other end terminates into a thinned-out section that is gripped by adjustable jaws to provide tuning.

The natural frequency as determinded by the elasticty and moment of inertia of this system is 5,000 cycles a second and it requires a power of only 1/2 watt to attain a 15° light angle. The torsional vibration of the mirror rod system scans the line.

This line system is welded to a steel rod 5/32nds of an inch in diameter and 3 inches long whose axis is at right angles to the first rod and crosses the plane of the mirror. It likewise contains a tuning adjustment.

Claims Great Power Reduction

The second vibrating frequency is the picture frequency and serves to sweep the scanned line from the top of the picture to the bottom and then back again to the top. The picture frequency is a resonant system and is 24 double frames a second and the motion is obtained with but five one-hundreds of a watt. No bearings are used.

The high-speed rod has been used billions of swings without the slighest trace of deterioration. The very use of elasticity and mass in resonance cuts down the driving power four orders of magnitude over what would be required if there were no elasticity and no resonance. Just consider how revolutionary the system is when its principle permits of a power reduction of over ten thousand to one!

Inasmuch as the driving powers are low, they are obtained from the receiving amplifier by a pulse that is sent over the air. This assures the exact synchronization of the receiving scanners with the transmitting scanner.

The wave form of the scanning pulse is immaterial. This is certainly not true of the two other systems, the Nipkow and the cathode ray.

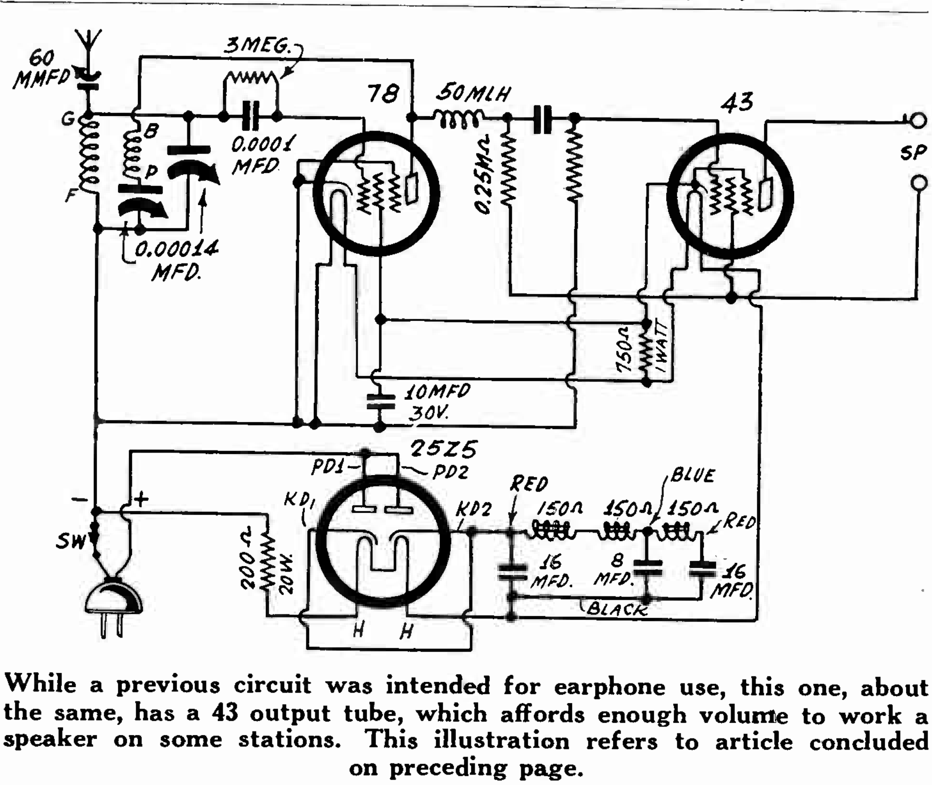
Says Last Problem Is Licked

We have arrived at a practical solution of making television available just as aural radio is now available. All along, for the last ten years at any rate, there has been only one problem remaining to be solved. That was the scanning problem. All the remaining apparatus necessary has been long since proven completely satisfactory; ie., the photo-electric cell, the amplifiers, the screen, oscillators, etc.

It was clear to me three years ago that both the Nipkow and cathode-ray systems would have to be scrapped. These two schools of thought have until now frozen the television industry into two hopeless channels. Millions of dollars have been poured into the attempted development of each, guided by the best engineering talent, and in my opinion, so far as concerns the usability of either system in practical home television, it is just that much water over the dam, for neither can produce a picture of the size, brilliancy and quality of a home motion picture, at a reasonable cost.

Plans Stated

We plan first to arrange for a transmitting schedule in a community of moderate size; preferably less than 500,000 population. In building a dependable scanner we have gotten to the heart of television's problem. It makes satisfactory television certain; just as the vacuum tube insured broadcasting's success.

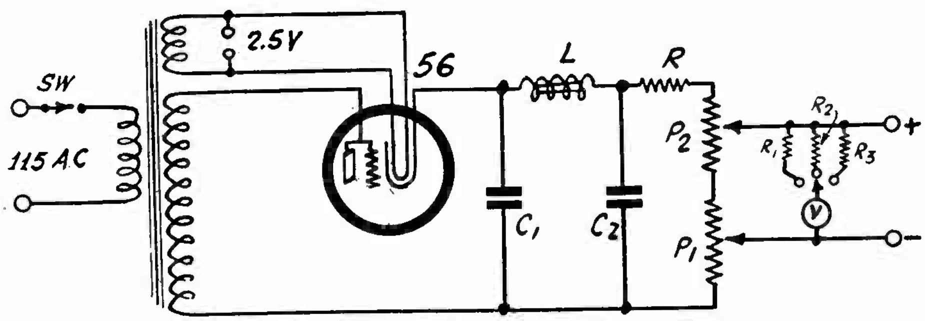


While a previous circuit was intended for earphone use, this one, about the same, has a 43 output tube, which affords enough volume to work a speaker on some stations. This illustration refers to article concluded on preceding page.

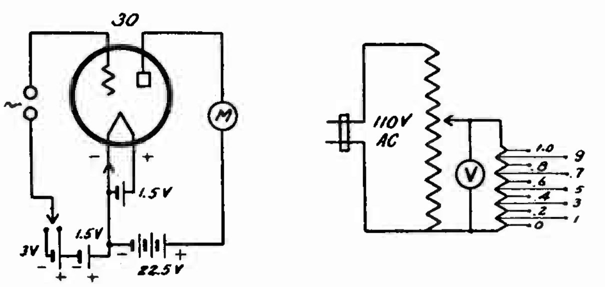
Extending Rectification

Ohmmeter, Vacuum-Tube Voltmeter and Harmonic Analyzer Discussed

By Edgar Traylor



The 56 as rectifier to supply d-c voltage for an ohmmeter.



Circuit for a vacuum - tube voltmeter at left. A method of obtaining low a-c voltages for calibrating the VTVM is shown at right.

THE vacuum tube originated as a rectifier, and there are numerous applications of rectification besides those of changing the line a.c. to d.c. for receivers, or for detecting radio signals. The principle is the same always, but the purposes are distinctive.

For instance, if one desires to supplant batteries in an ohmmeter one may use rectification of the line, measure the voltage each time before a resistance is to be read, in fact adjust the voltage by working the potentiometers, and then has selected the proper resistance for the ohmmeter work. The calibration on the meter scale will hold even if the voltage is not that used originally, provided that the limiting resistor is righly proportioned, but as we have no choice of different limiting resistors for each range we simply adjust for full-scale deflection and are ready to measure.

Circuit Constants

The rectified is a 56. Grid and plate are tied together, the preferable method where line rectification is the object, since the grid as an element alone hasn't enough area. The cathode is positive of the d-c circuit, as always. C1 and C2 may be 1.0 mfd. condensers and L the secondary of an old audio-frequency transformer. R is a limiting eesistance, in case the voltage is too high, found experimentally from one's location. It may be a few thousand ohms, if P1 and P2 are 10,000 ohms each. About 5 or 6 milliaperes will flow in the R, P1, P2 circuit as bleeder, the meter current (never more than 1 milliampere for a 1,000-ohms-per-units voltmeter) being additional.

Thetube as a rectifier is also the basis of the vacuum-tube voltmeter. If a given a-c voltage is applied between grid and filament, and the tube is operating, there will be a change in plate current, denoted by reading the meter M. For a 30 tube this may be a 0-5 milliammeter. Of if a 0.1 milliammeter is to be used, the meter may be shunted so that full-scale deflection exists when the lowest a-c voltage is to be read, or, for a pre-decision, when the open terminals of the grid circuit are shorted.

Calibration Method

The way to calibrate the vacuum-tube voltmeter is to put in various values of a-c voltage, starting from the lowest and gradually and evenly progressing upward to about the value of the bias voltage. Here the maximum bias voltage is 3 volts, so not more than 3 volts a.c. map be read. However, that is a good working range for many purposes applied to radio. The range can be extended, of course, by extending the bias.

The voltage put in is assumed to be a root - mean-square voltage of sinsudoidal form. For this purpose the a-c line may be user, for although the wave form is not exactly sinusoidal, it is so close to it as to be entirely satisfactory for the present purpose. The next consideration is how to acsertain the even values of voltage for running the curve. These voltage may be desired in steps of 10 volts for more extended purposes, and will be desired in steps of perhaps 0.1 volt for the present calibration.

Getting Low Voltages

The method of doing this is shown at right in the second figure. The line voltage is applied across a potentiometer. An a-c voltmeter of the r-m-s type is put between arm and one side of the line. Ten equal resistors are put in series. Now if we slide the arm until the voltmeter reads 100 volts, then the voltage across each of the ten equal resistors is one-tenth of 100 volts, or 10 volts. And if we slide the arm down until the a-c voltmeter reads 10 volts, then each resistor has a drop of 1 volts, and if we slide down to 1 volts each resistor has a drop of 0.1 volt.

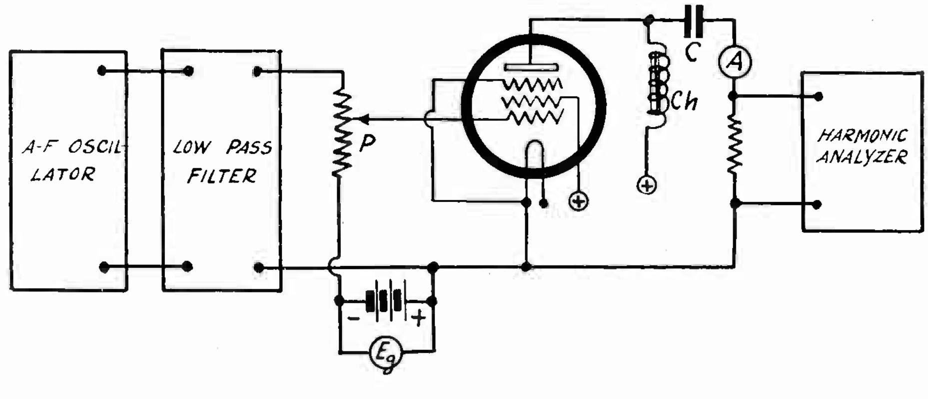
It is difficult to get the low-voltage readings because most meters one has do not provide for them. That is, the lowest voltage may be 5 volts, with nothing on the scale between 0 and 5, though full-scale deflection is only 10 volts. This is usually true of the usual general type of a-c meters used. But one has to get hold of an a-c meter that reads 0-10 volts or thereabouts, or can read 10 volts on the meter on has, put in the series chain and establish 1 volt across each of the ten resistors, and then build another bank of resistors and put this bank across the 1-volt branch. Then the new band has a total drop of 1 volts across ten equal resistors, or 0.1 volt per resistor.

Harmonic Analyzer

Another purpose of the rectifier tube is to measure harmonics, as shown in the third diagram. Some audio-frequency input is provided. It may be from an a-f oscillator. Then a low-pass filter has the input of the a-f oscillator connected to it. A low-pass filter is a tuned circuit that permits the fundamental and lower frequencies to pass but cuts off higher frequencies, therefore eliminates harmonics from the measuring circuit.

There will be various amplitudes, especially as attenuation is provided by P, which may be 500,000 ohms. Eg is the grid biasing battery. A is an a-c ammeter current

(Continued on next page)

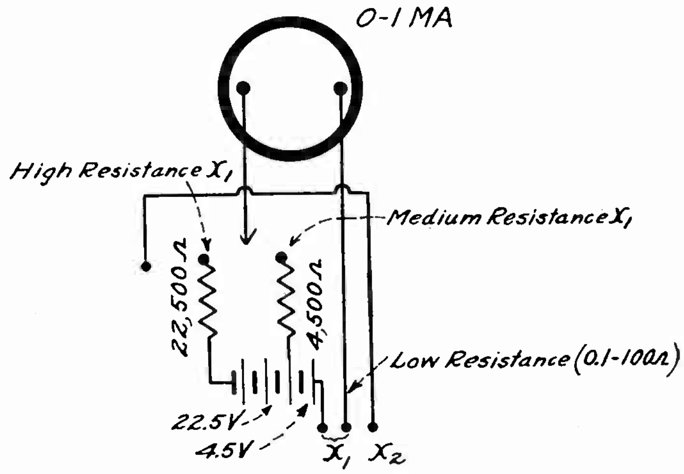


Rectification used in an analyzer of total harmonic distortion.

0.2 Ohm to 5.0 Megohms

Simple Ohmmeter Circuit Uses O-1 Milliammeter

By Leslie L. Barton



Resistance meter of three ranges, to 5 meg. for high-resistance measurements, to 10,000 ohms for medium resistance, and from 0.2 to 200 ohms for low resistance measurements by shunting the meter. It is necessary to close the current circuit.

SHUNTING THE METER EXTENDS RANGE TO THE LOW VALUES

EVERY one interested in the technical side of radio also is interested in meters, and really must use meters. The most popular meter is the 0-1 milliammeter, especially as it is the basis of the 1,000-ohms-per-volt voltmeter. Besides measuring 0-1 milliampers, by shunting the meter measurements of higher currents may be made, as the reading of the meter is interpreted in terms of the current flowing not only through the meter but also through the shunt. Also, by providing the right voltage and limiting resistor the meter can be used for resistance measurements.

The basis of the resistance meter is shown in the diagram. The sensitivity of the meter is known, that is, the full-scale deflection is 1 milliampere. Therefore for any value of voltage applied the value of series or limiting resistor can be calculated.

The resistance required for each volt for full-scale deflection being 1,000 ohms, if we have a source of 22.5 volts we use 22,500 ohms, and if we have a source of 4.5 volts we use 4,500 ohms. At present there are some very small-sized 22.5-volt batteries newly arrived on the market, and as the current drain for the present purpose is so small, these batteries will do just as well as larger ones, in fact, on account of compactness, will serve the purpose even better.

How high resistance ban be read when the voltage is 45 volts for full-scale deflection? That depends on how much one desires to concede on the score of reading possibility. Certainly some few megohms can be read, but the calibration becomes crowded for very high resistances in any range, and the pumps may be in half megohms, so how close you can read, or any one can read, is the dtermining factor. Let us compromise on 5 meg.

We could therefore stop at 1 meg. for the 22.5-volt case, 10,000 ohms for the 4.5-volt case diagrammed and we would cover the resistance range from, say, 100 ohms to 5 meg. But there are resistance values below 100 ohms that we desire to read closely, and what are we going to do about that?

Shunting the Meter

Well, we know that if we have a meter of internal resistance of 30 ohms, and cause full-scale deflection, if we put across the meter itself a resistance equal to the internal resistance of the meter, half the current will flow through the meter and half through the shunt. Therefore since the total current is the same, the meter reads not full-scale now, but exactly half-scale. So we can calibrate the meter in terms of shunting the meter, and this calibration will enable us to read from 0.2 ohm to 200 ohms, and we have gone as far as we desired.

The scales for the 22.5-volt and 4.5-volt conditions for popular meters are generally obtainable from stores, or from the meter manufacturers of the mail-order houses. But the scale for the shunted meter is not obtainable, therefore one has to run his own calibration, and, if he likes, may convey the results to a curve that he consults whenever he has occasion to measure low resistances.

Deflection Provided

The meter-shunting calibration will hold all right even if there is a slight difference in the resistance of the meter itself, as a series resistance can be introduced to take up any slack.

The circuit shows a 0-1 milliammeter with a switch. When the switch is at the upper end of the left-hand resistor high resistances are measurable, when the switch is at upper end of the right-hand resistor medium resistances are measurable, and when the switch is at extreme left low resistances are measurable, bu the binding post at center at the X2 post are used. For higher resistance purposes the central post and X2 post are used. A strap would be used to close or switch either resistance circuit with battery to provide the full-scale deflection.

How Harmonic Analyzer Is Worked

(Continued from preceding page)

meter, which in conjunction with the limiting resistor below it may be treated as a voltmeter.

Method Used

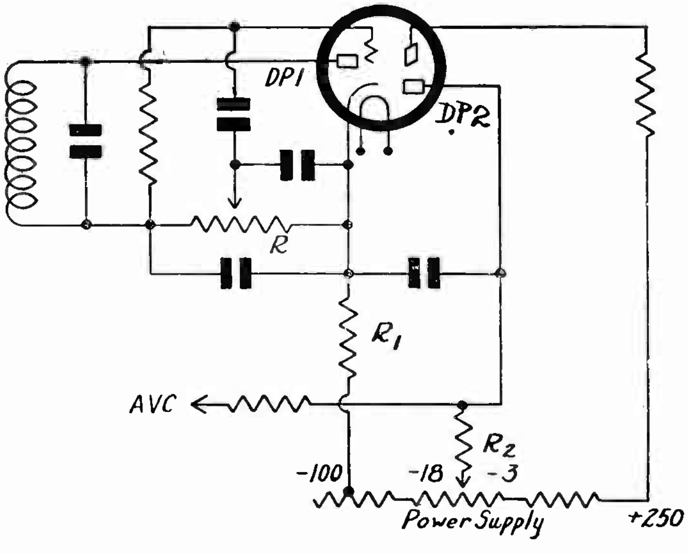
The harmonics are analyzed at the output as follows: The a-f oscillator is set going, the low-pass filter is shorted out, the reading is taken at the output of the rectifier tube. Then the low-pass filter is p cut in. The new reading will be less. The difference accounts for the quantity of harmonic content. This method applies to measurement of total harmonic distortion.

If the filter is altered suitably, the various harmonics of specified fundamentals can be measured also.

A-V-C Circuit

Rectification for automatic volume control must be considered the same as that for "detection," particularly since the detected voltage is the same one, derived from the same load, for supplying the control.

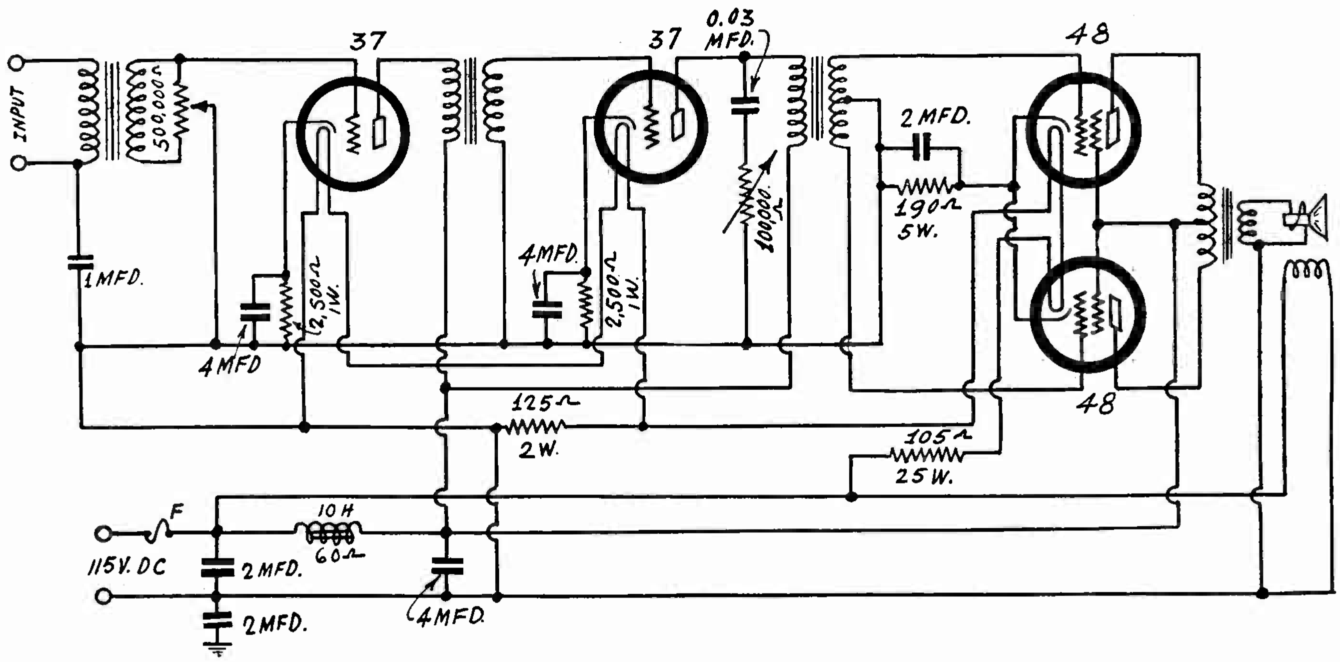
A diode is frequently overloaded. Delay voltage may be introduced by returning the load resistance R to a cathode that is itself returned to some negative potential in the B-supply system. R2 establishes the zero point for d-c potential, and R1



Ending One Nuisance

Bi-Polar Electrolytics or Paper Filter Condensers for "Universal" Sets

By Jack Tully



Electrolytic condensers in "universal" sets always present the danger of ruining the condensers by misdirection of the connection to the line. One remedy is to use bi-polar electrolytics. The other is to use paper condensers.

THE use of electrolytic condensers in "universal" sets has been something of a nuisance, in that a single instance of connecting the line cord the wrong way to the d-c line may cause irremediable damage to the electrolytics. In one instance something popped out and hit the ceiling with serious impact. In several instances fluid emerged from the "dry" electrolytics. Of course, the dry electrolytics are not really dry. They have a paste inside. They are not fluid inside, and not being fluid spells dry.

Therefore, if one desires to avoid this trouble he has his choice between bi-polarized electrolytics and paper condensers. The handy thing about electrolytics is that they yield large capacity in small physical dimensions. Thus it was fortunate that a way was found to use electrolytics that were not damaged in any way whether the line plug was connected one way or the other. All the mischief resulting from a connection the wrong way was that the set would not play, therefore reverse the plug in the outlet and the evening was full of smiles.

Case of Bi-Polars

The capacity is not as large in these bi-polar electrolytics for given physical dimensions. In fact, since both electrodes are polarized, the capacity is half that which would be obtained from the same physical dimensions in the more accustomed process. Another way of looking at it is that a bi-polar condenser of given capacity may be expected to cost twice as much as a uni-polar condenser of the same capacity. The process of double polarizing is costly. The labor charge is moret han twice what it is the other way.

So anyone who wants to build a "universal" type set, meaningone that works on a.c. or d.c., may prefer to select bi-polar electrolytics, not diminishing the prescribed capacity, but rather providing double the number of condensers, to attain or the same number of larger-sized condensers from a physical viewpoint, to establish the capacities shown in the digram herewith, for a small public-address system.

This power amplifier has two 48 tubes in push-pull output, and since the current through the 48 heaters is slightly more than that through other tubes of the 6-volt series, and since the rate of heating of the heater is not as fast, it is practically necessary to use a separate limiting resistor for these tubes alone. Or, as in the diagram, the drop through the resistance serving the faster-heating tubes may be used to produce part of the voltage drop for the 48's, since the 37's are protected that way also.

B Choke Coil

The circuit comprises a three-stage amplifier, transformer-coupled throughout. The volume control (attenuator) is connected in the grid circuit of the first tube, while the tone control is located across the plate circuit of the second tube.

It is advisable to have ta low-resistance B supply choke, and a value of 60 ohms is specified. The inductance should be as high as practical, consistent with the low d-c resistance requirement, 10 henries being minimum. The filtration will be sufficient when 2 mfd. are used next to the line and 6 mfd. after the filter.

The 2 mfd. at lower letf is intended to safeguard the system from actual grounding to the line, but it should be kept in mind that precautions with universal sets are well in order, since some part of the set may be connected to the line and accidental grounding of that part is always a possibility. That is why it is doubly important to include the fuse F, which is of the 1 or 2-ampere type.

Hum-Bucking Coil

The winding pointing upward at right, toward the speaker, is a hum-bucking coil, serviceable principally on apc use. Since this is across the line, it has a very high d-c resistance, so that only small current flows through it on d-c use. As a matter of course the current through it on a.c. will be smaller, on account of the inductance of the winding. That is, the coil has a high impedance to the line frequency.

Radio University

Is a "Bad" Coil Best?

REGARDING the stabilization of oscillators, a subject about which you print considerable, does it not appear from articles you publish that, at least by inference, that a bad coil is better than a good coil, for this purpose? Also that stabilization is a form of loss?—I.H.

The general impression is that stability is best served by an excellent coil, one having the proper shape factor, with spacing adequate and distributed capacity low. However, our opinion is consistent with your surmise, although running counter to the accepted theory. The reason we believe that what might be termed a "bad" coil is consistent with frequency stability is that a "good" coil has low radio-frequency resistance to such an extent that the oscillation intensity stays greater at the higher frequencies of tuning any band than at the lower frequencies. Therefore, since a levelling has to be accomplished, the only practical way is to take something away, that is, reduce the intensity at the higher frequencies of tuning. When this reduction results in an even amplitude throughout, the oscillator is stable. Therefore, any means of creating this effect of levelling is frequency-stabilizing. The coil you call "bad" really would not be that, but would have a fairly low r-f resistance for low frequencies and a comparatively higher resistance more effectively present than otherwise for the higher frequencies, so that the higher resistance would overcome the rising characteristic of the amplitude. The effect on the circuit would be a constant resistance for all the tuning. Considering the effect of the circuit outside the coil, or the coil alone, seems to us inadequate treatment. The example must be treated as a unit. There is, as you say, a "loss," in the sense that there is reduction of amplitude, purposely introduced, but any system of stabilization may be so regarded, and no importance attaches to the actual value of the amplitude, as it is easily too high under normal conditions, and thus there is plenty to spare.

* * *

Extension of New System

YOU ANSWERED a question about the Bernard system of harmonic counting, but I do not grasp the significance completely. Is the system based on harmonic relationships established in some new way, or is it only a mathematical treatment applied to a dial scale, and how about the accuracy?—H.B.N.

Explanations of systems of harmonics are not easy to follow, and it is no surprise that the significance is not fully appreciated at a mere reading of an explanation. It is necessary to make a study of harmonics in order to understand and appreciate a statement of relationships. The Bernard automatic electric harmonic counter is based on a tuning system covering a relatively low band of frequencies, applying the harmonics to the measurement of higher frequencies. The same harmonic system with which all are familiar is used, for there is only one system, that of integral multiples of fundamentals constituting the harmonics. The method has been applied in a station-finder so that fundamentals of 100 to 200 kc are used for measurements of from 100 kc to 39.8 mgc. Thus in reality the device is an all-wave signal generator, for measurement and peaking of intermediate channels, as well as determining higher frequencies, up to 39.8 mgc. The primary basis of operation, already explained in answer to a recent question, is that the highest frequency of the finder is generated first (200 kc) and a response heard in a receiver. Then the finder dial is turned slowly in the direction of lower frequencies, until another response is heard. Since the harmonic of the high-frequency fundamental was n, the harmonic of any lower fundamental would be greater than n. Also, since the next adjacent harmonic response is being considered, it is the harmonic order $n + 1$. Thus, if the scale is calibrated at first simply on its fundamentals, the location of the next adjacent response points may be determined by computation, and this computation calibrated on the scale, using another tier. If a response is heard at 200 kc and not again until 100 kc, then obviously the unknown is 200 kc, striking the fundamental of 200 and the second harmonic of 100. Hence for the starting point, the high-frequency end, of 200 kc, the harmonic order is 1. The lower frequency that also yields a response is $200/n + 1$, or $200/2 =$ **100**. Thus selecting the frequencies one desires to inscribe on the scale, 200 is divided into them, 1 is added to the dividend, and the new number divided into the unknown, for the second response points. Hence for 400 kc the process is: $400/200 = 2$, $2 + 1 = 3$, $400/3 =$ **133.3**; $600/200 = 3$, $600/3 + 1 =$ **150**, and so on to, say, 25,000 kc, when the case is that of $25{,}000/200 = 125$, $125 + 1 = 126$, $25{,}000/126 =$ **198.5**. It is practical from the tuning characteristic to encompass frequencies in steps of 200 kc from 100 kc to 4,000 kc, and in steps of 1,000 kc from 5,000 to 10,000 kc, and in steps of 5,000 kc from 10,000 to 25,000 kc. The limiting factor on the possibility of using closer frequencies for high-frequency readings is the tuning characteristic of the fundamental. This much explains the automatic electric harmonic counter. Besides, a system is introduced which is semi-automatic, for accurate determination of high frequencies and thus atoning for the wide sweep of frequencies above 4,000 kc. The dial scale fundamentally is 100 to 200 kc, and there are 100 bars, the separation between bars accounting for 1 kc. Therefore to ascertain accurately some high frequency, where crowding results when using the automatic method, the dial is turned until a response is obtained in the receiver exactly on some bar of the finder scale, and the frequency is noted. Then the finder dial is turned until another response is heard exactly on another bar. The unknown for adjacent responses is the product of the two frequencies read. This method is exceedingly accurate, that is, just as accurate at the fundamental calibration, which is 1 per cent. Also, the 1 kc separation as represented by the finder bars eliminates two operations, one of subtraction, the other of division, in determining the unknown, and makes necessary only the single operation of multiplication, and this only for very high frequencies.

* * *

Finding the "Sense"

KINDLY SHOW a diagram for a single-sided input to the 19 tube and a full-wave output, also the basis of a direction-finder for determining the "sense" as well as the direction.—T.H.G.

These diagrams are given herewith. The one at left is self-explanatory. The direction-finding method requires not only that the direction be obtained, as running from north to south, or east to west, for instance, but whether the point from which the signal comes is north or south in particular, or east or west in particular, instead of leaving the matter undecided. This particularization is known as finding the "sense" as well as the direction. The method shown in one of phase opposition to balance out one component and reveal that the other is the one being read.

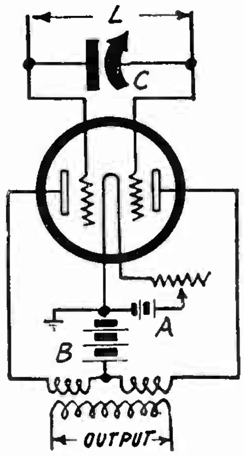
* * *

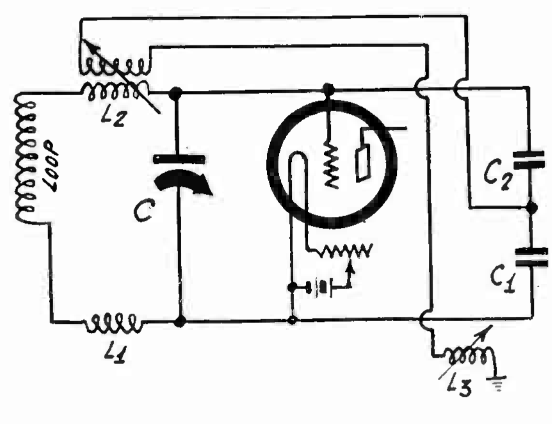
Change in Reception

WHY IS reception from Great Britain not uniform for different times of the year, and why is there trouble contacting the Byrd expedition? Is it because Ad-

(*Continued on next page*)

Determining the "Sense" In Direction-Finder





At left, the 19 tube as a full-wave-output radio - frequency amplifier. At right, fundamental of a direction finding circuit, where the "sense" as well as the direction are obtained.

Radio University

(*Continued from preceding page*)

miral Byrd has been ill that this difficulty has arisen?—

The changes that take place in meteorological conditions account for the non-uniformity of reception of particular frequencies at different times of the year. The same explanation applies not only to both cited instances, but to all reception short-wave. The illness of Admiral Byrd of course had nothing to do with the changes. The long winter is ending in the Antarctic, the sun is beginning to come up, and the night-time wavelengths used perhaps have been retained longer than desirable, resulting in attenuation of the signal, or weaker reception. Higher frequencies for daylight conditions become imperative. The frequencies used have been from 6,000 to 9,000 kc, but now from 11,000 to 13,000 kc will be used, and better results are to be expected, although there is non-uniformity of light and darkness conditions in the intervening expanse of the earth. Thus Buenos Aires, the relay point, formerly in favorable darkness when the programs were picked up by Buenos Aires for transmission to the United States for night-time chain features, will be in darkness while there is twilight or even sunlight of greater magnitude in the frozen territory of Byrd's activities. Hence a relay station may be used that is more favorably located, for instance, in the Argentine, or in Hawaii. At least, the waves will be shorter, and such other accommodations provided for improving results. You can see that more than a mere shift of frequencies is required, and these other activities require much preparation, which has been made, with the result that improved reception may be expected. The British condition is due to the considerable amount of daylight between England and the United States during the Summer, when the 19-meter band was retained by the transmitting station, because transmissions were mainly instituted for the benefit of Africa. The British 19-meter channel that was used during part of the summer is about to be abandoned temporarily for the longer waves of 25 and 31 meters more favorable to the conditions of darkness, and therefore the United States may benefit.

* * *

Tube Shield Use

CAN A TUBE shield be used that requires connection to the cathode of a heater type tube, although the cathode is not directly grounded?—H.B.M.

It is possible to do this, of course, but not desirable. The tube shield should be at chassis potential, and not at cathode potential, unless the two potentials (chassis and cathode) are the same, that is, cathode is directly grounded, which is seldom true.

Station Sparks

By Alice Remsen

THE FALL SEASON is almost upon us; nights are growing longer, and days seem to be growing shorter faster—if you get what I mean; however, sponsored radio programs are multiplying. A lot of the old ones are coming back, which speaks well for the advertising value of radio. . . . Glad to see Leonard Joy is returning to the NBC air waves. Len will conduct the orchestra on a new Sunday afternoon program sponsored by the Malted Cereals Company; he will share time with Dale Carnegie, celebrated author and lecturer, who will present "Little Known Facts About Well-Known People" each Sunday at 1:00 p. m. NBC-WEAF network. . . . "Mrs. Winchell's little boy Walter" will return to the air on September 2, for his old sponsor, the Andrew Jergens Company. Sundays 9:30 p. m. NBC-WJZ and network. Walter will dish out his old line of chatter about this, that, these and those. . . . Ralph Kirbery's commercial starts on September 6; each Thursday at noon and Sundays at 2:00 p. m. NBC-WEAF. Sponsored by Mohawk Carpet Mills. He will be supported by an orchestra under the direction of Harold Levy. Martha Lee Cole, well-known interior decorator, will talk on home decoration. . . .

The Texas Cowgirl no longer rides the trail alone. Margaret West, producer and heroine of the NBC Western sketches, "The Rafter S. Riders," walked into the Little Church Around the Corner, in New York, on August 7, and when she walked out a few moments later she was Mrs. William Lee Comerford. However, there will be no honeymoon for the Texas bride, for she has launched a new series of her cowboy sketches over WEAF, each Monday at 5:30 p. m. . . . Gloria La Vey, NBC soprano, sang her first featured role recently in the Palm Olive Beauty Box production of "Pinafore." . . . The Billy Batchelor series is back on the air for Wheatena; each evening except Saturday and Sunday, at 6:45 p. m. NBC-WEAF network. . . . Ruby Mercer, who won the Walter Naumburg Foundation prize some time ago, is the new featured soprano on NBC's "Two Seats in the Balcony" program, which is broadcast each Wednesday over WEAF at 2:00 p. m.

Frank Black, NBC music director, is back from his vacation looking fit and ready for a strenuous season. . . . Danny Malone, the young Irish singer, is red-headed, tall and slight, with a thin, finely modeled face. He sits on a high stool, with his feet curled around the rungs while broadcasting. . . . Those hardy annuals. Parker and Fennelly, are being featured on yet another program. The Western Clock series, each Sunday at 4:45 p. m. over an NBC-WEAF network. . . . Ivory Soap will bring to the microphone the first original musical comedy series ever written exclusively for radio, when it commences broadcasting on September 15. The story will be written by Courtney Ryley Cooper, and the lyrics and music by Howard Dietz and Arthur Schwartz. Titled "The Gibson Family," the show will run for a full hour and will be heard each Saturday at 9:30 p. m. . . .

Jack Benny starts with a new sponsor in October—General Foods; the series will run until Spring, then he'll be back again with his present tire sponsor—lucky boy! . . . Carolyn Rich, golden-haired songstress formerly heard over NBC networks, is now singing over Columbia with Ferde Grofe's band—and doing a good job of it, too! . . .

"Whispering Jack Smith" returns to the air on September 11. Over CBS; sponsored by Ironized Yeast, three times weekly—Tuesdays, Thursdays and Saturdays, at 7:30 p. m. Arnold Johnson's Orchestra will supply the music. . . . H. V. Kaltenborn, the explosive speaker, is back on CBS for his seventh consecutive season of broadcasts, each Friday at 6:00 p. m. . . . It took Rowene Williams, Minneapolis soprano, to win the final CBS "Hollywood Hotel" audition—and so, Rowene will journey to Hollywood and a high weekly salary; and perhaps a chance in pictures—who knows! . . . More bands have been added to the already crowded roster of WMCA's dance parade—Charles Barnet, from the Park Central; Bud Fishers from the same source, and Eli Dantzig from the Hotel St. George. . . . Ten different voices are created by George Ried in his "One Man Minstrel Show," which is broadcast from Washington, D. C., over WMCA and the ABS network. . . . Vilma Rafael is looking for a new name—if you have one to suggest send it along to Vilma in care of WMCA.