FEEDBACK CIRCUITS IN POPULAR USE TO-DAY

RADIO WORLD

REG. U.S. PAT. OFF.

The First National Radio Weekly

654th Consecutive Issue—Thirteenth Year

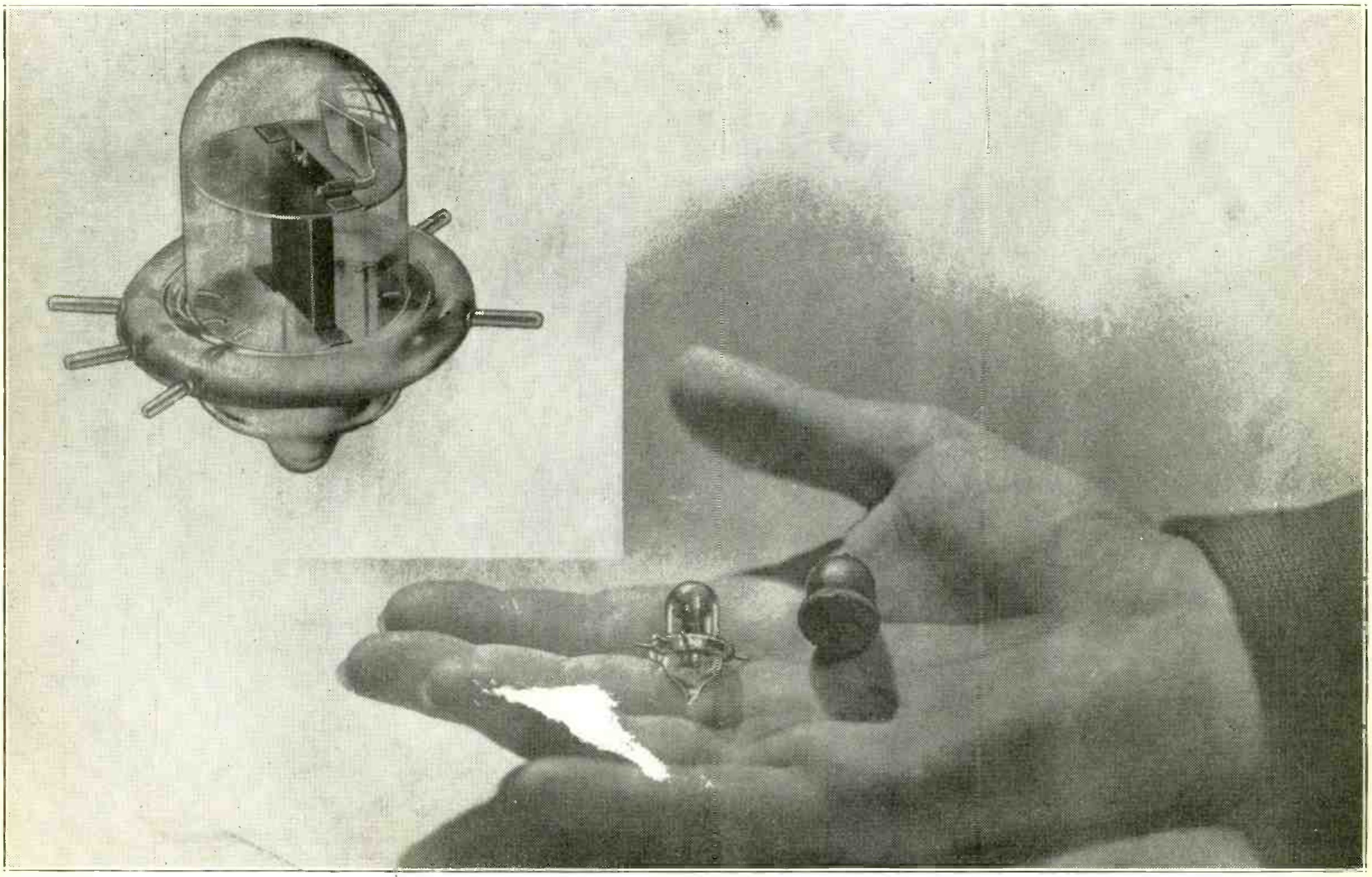
Oct. 6th 1934 15c Per Copy

UP-TO-DATE SHORT-WAVE CONVERTERS

Bridge Measurements

Volt-Ohm-Milliammeter

ULTRA-WAVE TUBE ANNOUNCED



The 955, or "acorn" tube, has just been announced. It is intended for oscillation from 2½ meters down. It is a 6.3-volt model. See page 7.

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INTO ninety-six pages, 8 x 10¼ inches, has been put the very information that all short-wave enthusiasts have been awaiting -- *all* the radio phone short-wave transmitters of the world, listed by frequencies, with equivalent wavelength given in every instance, the call letters, the location, and in many instances also the time schedule being given. So complete and accurate a compilation has never before been published. The compilation was made from official publications of the Bureau de l'Union Internationale des Telecommunications, the British Broadcasting Corporation and the U. S. Federal Communications Commission, as well as from unofficial sources of information. There are MORE THAN 2,400 LISTINGS made by the U. S. Department of Commerce.

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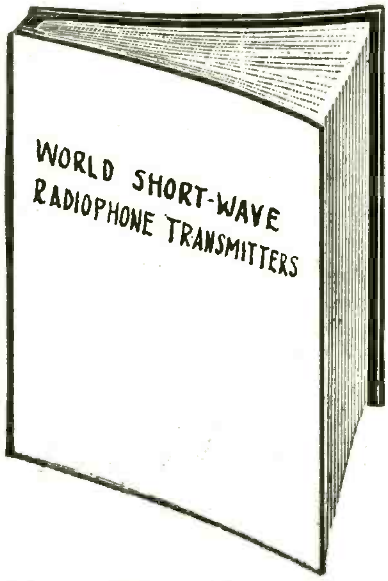

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THE CONTENTS:

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Foreign Alphabetic Pronunciation: How the letters of the alphabet and numbers 1 to 50 are pronounced in English, French, Spanish, German and Portuguese. Familiarity with these pronunciations aids in station identification, that is, knowing what call letters are being announced, or what frequency or wavelength is mentioned.

Short-Wave Broadcasting and Police Radio Stations by Countries: The calls, location and frequencies are given for the whole world. This is a geographical classification and expedites station-finding and identification. It repeats, geographically classified, data found in the main grouping of the 2,400 stations by frequencies.

Distances to Foreign Cities: A textual explanation of how to determine how far any one city on earth is from some other city. A Department of Commerce map gives direction of shortest distances (measured on great circle). This map is right in the book. Besides, there is a table of distances between key cities of the United States for guiding determinations of world distances, as well as a table of world distances for principal cities.

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THIRTEENTH YEAR

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Up-to-Date Converters

Tested Methods Applied for Outstanding Results

By Herman Bernard

THOSE who have broadcast sets and want to tune in short waves naturally turn to the converter. Very excellent results have been obtained from some converters, very poor results from others. It is the purpose of this article to set forth some of the reasons for poor results, apply remedies, and also disclose circuits that yield satisfactory performance.

The principle of the short-wave converter is widely known, but there are always some unaware of it. Hence this exposition:

If a short-wave station is sending a program, that program can not be tuned in on a broadcast-band receiver, because the broadcast-band set responds, say, from 540 kc to 1,600 kc, and the short-wave station is using a carrier frequency much higher than 1,600 kc. Some device is needed that will do some work at or near the frequency of the short-wave station.

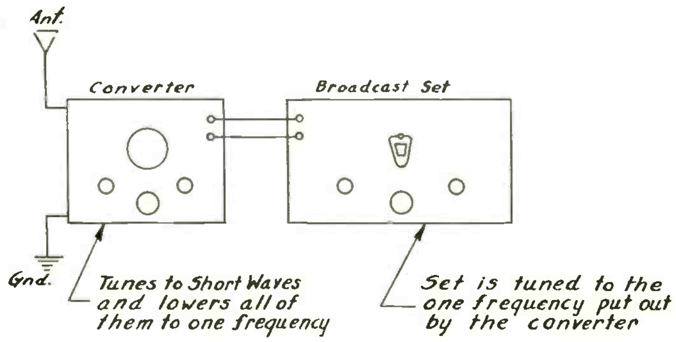

FIG. 1
The theory of the short - wave converter is illustrated. Since the broadcast receiver is tuned to one frequency, the converter lowers incoming short waves to that frequency, for amplification and detection.

Frequencies Examined

Let that device be simply a battery-operated oscillator, as shown in Fig. 1-A. Except for the absence of earphones and any control of oscillation the design would be that of a one-tube regenerative short-wave receiver. But here we are dealing only with radio frequencies, and we want the output of the converter to enable reception of short-wave stations on the receiver's speaker when the converter is connected to the broadcast set.

Now, Fig. 1-A is just an oscillator, let us say, and therefore if we tune it to the frequency of the desired short-wave station, we will have an output equal in frequency to that of the station and of the oscillator, for they are the same frequency, and also we could have an output that is equal to the difference between the oscillator and the station frequency. Of course, this difference is zero, and the reference is just theoretical, but the fact remains that there is or can be an output equal to the difference, and besides, an output equal to the sum. We shall ignore the sum frequency, as it does not figure in converter practice.

It is obvious that so far we have not done anything to enable the reception of this particular short-wave station by using the intended converter in connection with a broadcast receiver.

Now let us assign some frequency values. Suppose the station desired to be tuned in is on 6,000 kc. The oscillator is generating 6,000 kc. Hence, there is no output that is communicated to the broadcast set, in respect to this short-wave station.

Interference Right Away

But the receiver has to be tuned to some frequency, and now let us suppose that the resonant frequency is 600 kc. Also let us suppose that there is a station on the air on 6,600 kc and another at 5,400 kc. Without changing the oscillator frequency, we now have a condition that makes it possible to bring in a short-wave station on the broadcast set, indeed, not only one short-wave station but two short-wave stations, and the two come in at the same time as mutual interference.

The reason we get reception from the 6,600 kc station is that the oscillator is generating 6,000 kc, the station is delivering to the converter a frequency of 6,600 kc, and although the oscillator is lower in frequency than the station carrier, still the difference is 600 kc, and that is the frequency to which the set is tuned, so 6,600 kc is received.

But why do we hear the other station—the one on 5,400 kc? The oscillator still generates 6,000 kc, which is 600 kc higher than the 5,400 kc carrier frequency, so the difference is the same, 600 kc, although in this case the oscillator frequency is higher than the station-carrier frequency by 600 kc, while in the previous example the oscillator frequency was lower than the station-carrier frequency by 600 kc.

Some Questions

Several questions will arise. First, a novice will want to know why it is true that the two stations deliver their carriers to the oscillator tube, although that tube is tuned to a frequency different in each instance from that of the carrier. The reason is that the input to the converter is, in a broad sense, untuned, and all short-wave frequencies are put into the converter. There are two tuning condensers, the main one, 0.00014 mfd. that determines, in conjunction with the secondary inductance L1, the frequency of generation, and the series antenna condenser, which affects the radio-frequency resistance introduced into the tuned circuit, and therefore can be set at a value small enough to keep that resistance low, to support oscillation that otherwise might stop. There is some tuning by this small condenser, but it is of a nature

(*Continued on next page*)

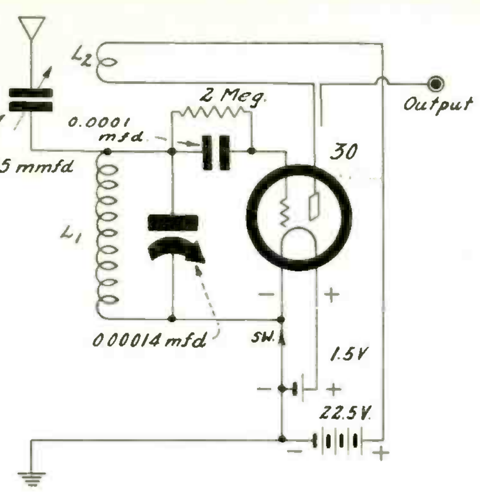

FIG. 1-A

Circuit illustrating the principle of the short-wave converter. This is not intended for actual use, as results are below par

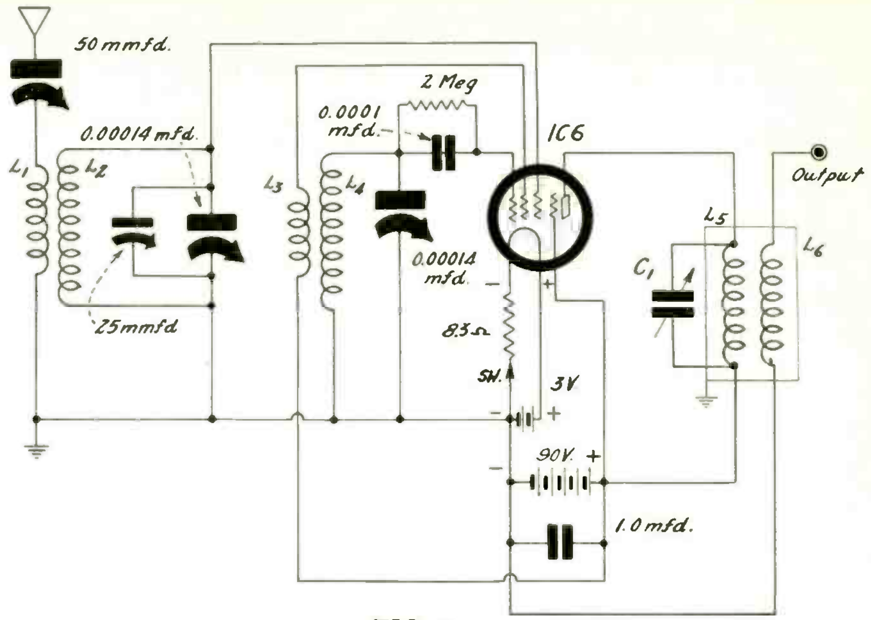

FIG. 2

A practical one-tube converter for battery operation. The new pentagrid converter tube, 1C6, is used. The B voltage may be increased to 135 volts, if desired, for the plate of the pentode. The 90 volts are sufficient even then for the oscillator plate return and for the screen. C1 tunes a broadcast coil's secondary to the intermediate frequency selected, and once set is left thus.

(*Continued from preceding page*)

rather associated with antenna efficiency than with frequency determination.

Another question may be: How does the change in frequency take place? When two frequencies are put into any tube, that tube acts as a frequency changer, and enables taking out the difference between those two frequencies, also the sum of the two frequencies, but we shall forget the sums. The frequency-changing, or conversion, is due to the fact that all tubes distort, even if only a little. A purposeful improvement of the capability of frequency-changing is familiarly known as detection. Hence any detector is a frequency converter. Here we have grid-leak condenser detection, and the conversion is well accomplished.

Image Interference

Another question: Is the device shown in Fig. 1-A any good, since it can bring in at one setting two stations of different frequencies, and provides no means of eliminating one carrier in favor of the other? The answer is that, for practical use, the circuit has no value as a converter, and is shown mainly as an example of the action that takes place, and further to convey the idea that something better than a one-tube device always is required for any sort of satisfactory result. In this sense the duplex tubes would be considered, of course, as two tubes.

Already we have practically found out what all this furor about image interference means. We have noted that two stations, one on 6,600 kc, the other on 5,400 kc, came in at a single setting and interfered, and as we dealt with supposedly real stations, we got strong interference. We also noted perhaps that the condition that brings about this dual reception at a single setting of the converter is that wherein the interfering stations are separated from each other by 1,200 kc, which is twice the receiver frequency. Therefore, we may state that image interference is that form which arises in a superheterodyne when two incoming frequencies are separated from each other by twice the intermediate frequency. From now on we shall call the receiver frequency the intermediate frequency, as it is, for we have constructed something that makes the net result always a superheterodyne; i.f., second detector, and a.f. are in the set; the frequency-changing, and even perhaps some amplification at the intermediate level, is in the converter.

LIST OF PARTS

For Fig. 2.

Coils

Two sets of plug-in coils, four coils to a set, total eight coils; secondary of one of the low-frequency coils to be subjected to turns removal as explained in the text.

One shielded radio-frequency transformer as used for broadcast purposes with 0.00035 mfd.

Condensers

Two 0.00014 mfd. separate tuning condensers, or one gang of two 0.00014 mfd.

One 50 mmfd. antenna series condenser (variable and panel-mounted).

One 25 mmfd. trimming condenser (variable and panel-mounted).

One variable condenser to tune the larger winding on the broadcast transformer, or a fixed condenser and a smaller variable. See text.

One 0.0001 mfd. grid condenser.

One 1.0 mfd. bypass condenser.

Resistors

One 8.3-ohm filament resistor. (This may be a 10-ohm rheostat adjusted until the filament voltage is 2 volts and left thus).

One 2.0-meg. pigtail grid leak.

Other Requirements

One chassis

One cabinet.

One grid clip.

One dial, or two dials if unganged condensers are used.

One six-hole socket.

One 1C6 tube.

Two No. 6 dry cells, to be connected in series.

Two 45-volt B batteries, to be connected in series.

One filament switch.

One antenna binding post and one output binding post.

Phantom Stations

But suppose there is no station on 6,600 kc, but there is one on 5,400 kc, will there still be interference? Now, the novice would not ask that, I admit. But the experienced radioist knows that there is strong likelihood of interference, because, first, including every licensee, there are about 100,000 in the world, and the possibility exists of interference due to the second carrier frequency even if the station that causes the interference is on the other side of the earth. A squeal is heard and it is annoying. Moreover, even if there is no real station on the possibly interfering frequency, there may be some disturbance in the ether at that frequency, including stray generation or static, and the effect is there just the same. And perhaps it is true that there are reasons for image interference that we do not fully understand yet, although the principle is clear enough. What we do know for a certainty is that there are squeals practically all over the dial, and knowing that, we had better do something about it. The stray radiations that cause these squeals are called phantom stations.

What is a remedy?

The remedy, of course, is to reject the frequencies that could cause interference. They may be rejected automatically, in a sense, by having a tuned circuit for acceptance of the desired frequency always lower than the oscillator frequency by the right amount (the difference being the intermediate frequency), which is called tracking and requires nice and permanent adjustments called padding; or we may have a converter where the interference possibly could come in, but could be eradicated by setting an auxiliary condenser. That auxiliary condenser is in parallel with the tuned circuit that accepts the desired frequency.

One R-F Stage Satisfactory

Next question: Is one tuned circuit enough? For general use, yes. This is true because the intermediate frequency is certain to be pretty high—it will be, of course, in the broadcast band—and the

LIST OF PARTS

For Fig. 3.

Coils

Two sets of plug-in coils, four coils to a set, total eight coils; secondary of one of the low-frequency coils to be subjected to turns-removal as explained in the text.
One shielded radio-frequency transformer as used for broadcast purposes with 0.00035 mfd. tuning.
One 30-henry B supply choke coil.

Condensers

Two 0.00014 mfd. separate tuning condensers, or one gang of two 0.00014 mfd.
One 50 mmfd. antenna series tuning condenser (insulate from any metal panel).
One 25 mmfd. trimming condenser (variable and panel-mounted; need not be Insulated from any grounded metal panel.
One variable condenser to tune the larger winding of the broadcast type r-f transformer, or a fixed condenser and a smaller variable. See text.
One 0.0001 mfd. grid condenser.
Two 8 mfd. electrolytic condensers of the bi-polar type (so no harm results if plug is connected wrong way to the d-c line).
Three 0.05 mfd. bypass condensers.
Two 1.0-mfd. bypass condensers.

Resistors

One 2.0-meg. pigtail grid leak (2,000,000 ohms).
One 175-ohm pigtail resistor.
One 0.01 meg. pigtail resistor (10,000 ohms).
One 5,000-ohm pigtail resistor.
One 0.02-meg. pigtail resistor (20,000 ohms).
One 340-ohm, 50-watt resistor.

Other Requirements

One chassis.
One cabinet.
One grid clip.
One dial (or two dials, if unganged tuning condensers are used).
One seven-hole socket (small size) and one five-hole (UY) socket.
One 6A7 tube and one 37 tube.
One a-c cable and plug.
One a-c switch.
One 1-ampere fuse.
One antenna binding post and one output binding post.

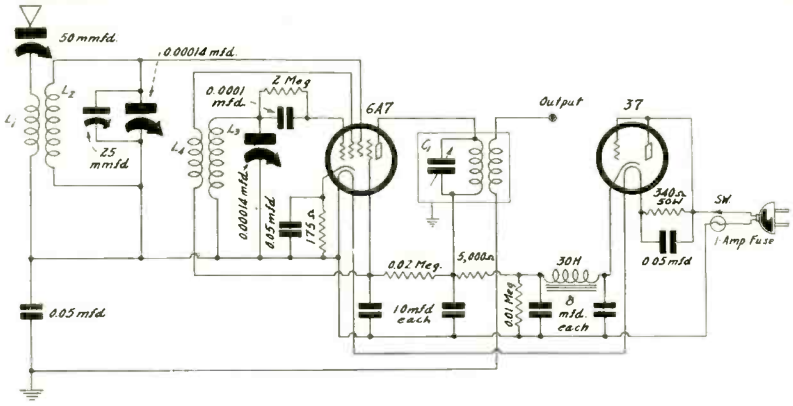

FIG. 3.

The same fundamental radio circuit as in Fig. 2, but this time applied to universal use (90-125 volts, a.c. or d.c.), using two tubes. Note that chassis and ground are insulated from each other. The bypass condenser across the heater limiting resistor is an unusual but valuable precaution. Both Figs. 2 and 3 have a t-r-f stage for aid in image suppression.

higher the intermediate frequency, the less need for extra pre-selection.

A good converter can be built, using one pre-selector stage. This is also called a stage of tuned radio-frequency amplification. For battery operation, the circuit shown in Fig. 2 may be used. This is a practical design. The values of the constants, so far as required, are given on the diagram. The 1C6 pentagrid converter tube is used because it is so much better than its predecessor, the 1A6, but the filament current is twice as great, and therefore the two 1.5-volt cells should be of the No. 6 type. The smallest obtainable B batteries, two of 45-volts each, suffice, as the plate current is small.

The series antenna condenser may be 50 mmfd., since the antenna circuit is removed from the oscillator proper by the high resistance of the oscillating triode part of the duplex tube.

The output of the device is taken from the secondary of a standard broadcast coil, the primary being used for output coupling, the secondary being in the plate circuit. It is necessary to have a good-sized capacity in the plate circuit, to prevent high frequencies from getting by, which would cause trouble, particularly if the receiver proper were itself a superheterodyne. The condenser C1 then would be tuned to any particular frequency to which the set is tuned. It might be advisable, knowing your location, to pick a setting near 600 to 700 kc where there is no local station or any other station that comes in strongly.

The Adjustment of One Coil

Now, the two 0.00014 mfd. condensers may be separate or may be a dual-gang, it makes no difference, as the trimmer condenser of 25 mmfd., which must be front-panel located, takes care of the tracking, after one coil adjustment, and moreover does not change the calibration. In no manner does the response frequency depend on the pre-selector circuit, which performs the function of improving sensitivity and selectivity, but not of establishing the response frequency. That establishment depends solely on the oscillator frequency and the intermediate frequency. Strange as this sounds, it is a fact, and nobody could possibly figure it out differently.

If plug-in coils are used, they might not be intended for converter practice, and it must be said that some of those who have attempted to adjust the inductance for the oscillator have marketed products that hardly could be called successful. An examination was made of four of the principal commercial plug-in coils for receiver intended for receiver use, and a universal factor established that is sufficiently good for general use.

Since the oscillator is intended to generate always a higher frequency than the carrier desired to be tuned in, and since this oscillator frequency is definitely higher than the carrier, being Fc plus Fi, where Fc is the carrier and Fi the intermediate, and since the coils for the lowest band have in general around 70 microhenries inductance, we can compute that the oscillator secondary for this band should have 38 microhenries inductance. Using the factor of 60 turns, often encountered for 70 microhenries, we can strike a general percentage of reduction of turns that works.

Take the lowest-frequency coil, count the number of secondary turns, and reduce these turns until they are 63 per cent of the original number. Example: If the coil had 60 secondary turns, you would use .63x60 or 49.8 turns. The decimal values may be assigned to the nearest whole number. Thus, leave 50 turns. So 50 turns require that 60 minus 50 be removed, or 10 turns off.

This gives you a suitable coil for the low-frequency band. For the other bands, the higher the frequencies tuned in, the smaller the difference need be between the oscillator and station-carrier frequencies, since the absolute difference always is 600 kc, or whatever other receiver frequency is used.

No adjustment of turns need be made for the other coils, because the inductance requirements of the two secondary circuits become progressively more nearly alike, and for the third and fourth bands two identical coils not only suffice, but it would be hard to pad for the difference if one assumed theoretically that they did not suffice when equal. Besides, we have a manual trimmer to take the place of fixed adjustments, and if we ever find that we can not get the t-r-f stage low enough in frequency to give us that state of balance we want, we can use a higher capacity trimmer, say, 50 mmfd.

The sockets used for coil receptacles should not be closer than 6 inches apart, and it is of some advantage to erect a copper or aluminum bracket midway between, something like four inches square.

Unusual Precaution

The universal counterpart of the battery converter of Fig. 2 will be found in Fig. 3, in fact, the two circuits are as nearly the same as they can be, when one considers the fundamental or inherent differences that the tube voltaging requires.

The bypass condenser across the limiting resistor (right-hand side of Fig. 3, under the 37 tube) is something not often found in such sets, but the author's experience has been that the heater circuit is coupled to the r-f circuit inevitably, and the inductance of the limiting resistor sometimes causes dead spots, avoided when the limiting resistor is bypassed. A condenser of 0.05 mfd. is usually sufficient, but the capacity can not be greatly increased beyond that, because if the circuit were then used on a.c. the effective impedance of the limiting circuit would be lowered, and the tubes would get too much heater voltage on a.c., although the right heater voltage on d.c.

Since the capacity across the larger winding of the broadcast-type transformer used for coupling is rather large for frequencies from 600 to 700 kc, it is inconvenient to put in a 0.00035 mfd. variable condenser, so a fixed condenser may be used, of a value less than the required capacity by the capacity of a junior or midget condenser across it. This particular tuning is not very critical, and a 0.00025 mfd. fixed condenser, with a

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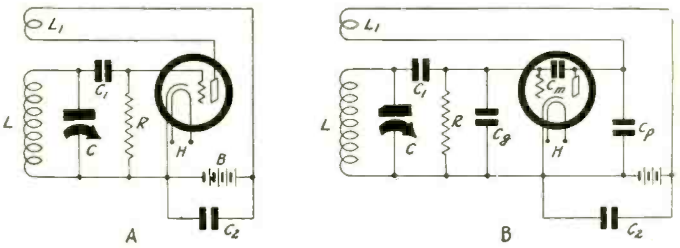
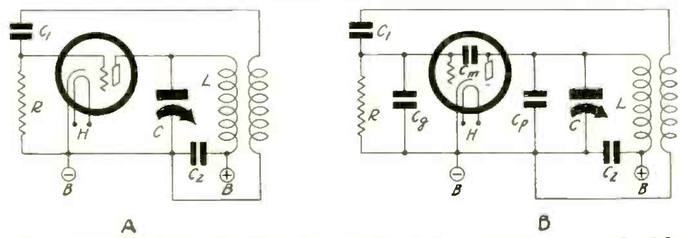
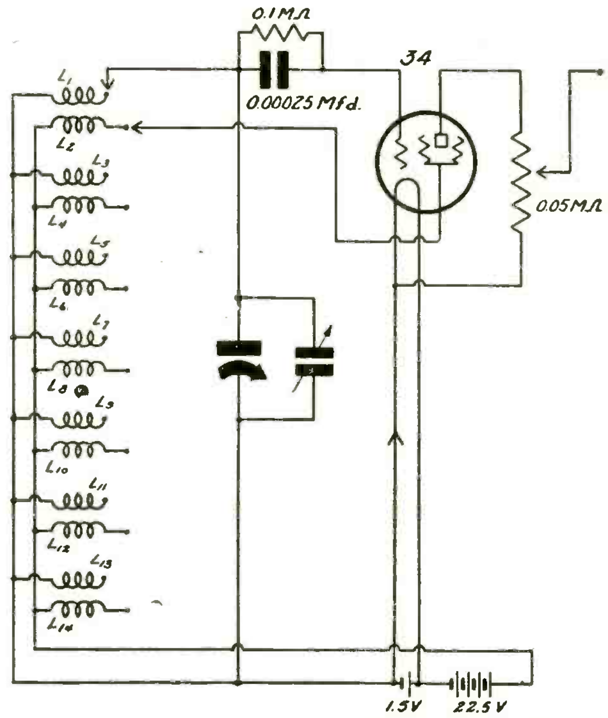
Popular Feedback Circuits



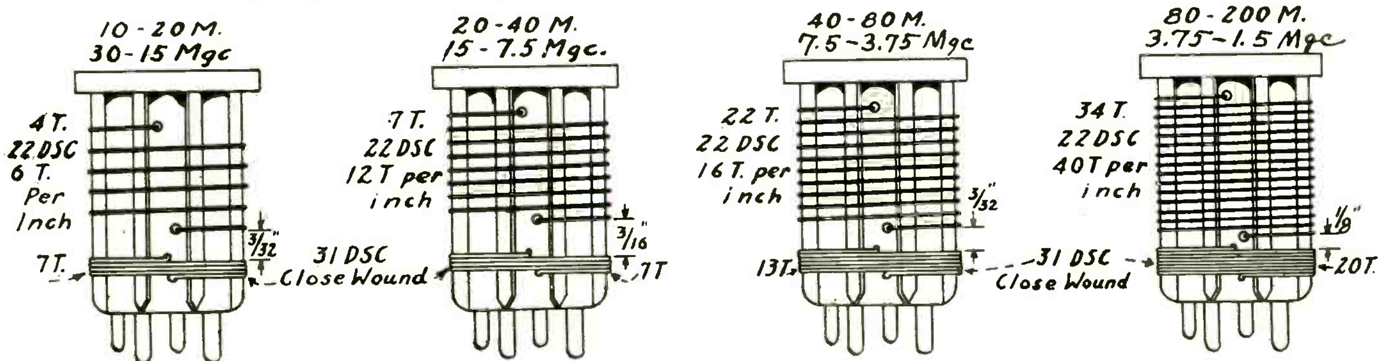
The tuned-grid type of feedback is most popular today. In A is shown the grid-leak type, which is usually fairly stable. Here C1 is the grid stopping condenser, R is the grid leak in parallel with the tuned circuit, C is the tuning condenser, L the tuned secondary and L1 the tickler. C2 bypasses the B batteries and should be 1 mfd. or more. B shows the grid-to-cathode capacity as a fixed condenser, Cg, also the plate-to-cathode capacity, Cp, as such, and the grid-plate capacity Cm.



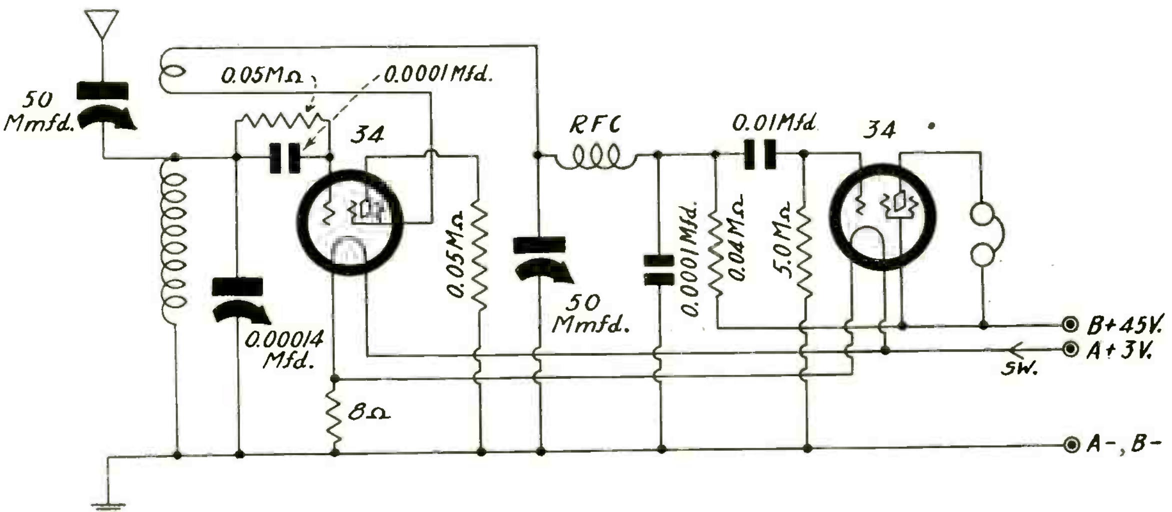
The tuned-plate feedback method is another workable one. In this example there is no direct current through the feedback winding, as the stopping condenser is between the pickup coil and the grid.



The screen as the feedback winding is becoming popular, as it enables the use of the element that would be the plate as a pick-up grid for electron coupling of the output. The intensity of the oscillation may not be so strong as when the more conventional circuiting of a screen-grid tube is used.



For practically any circuit using a two-winding plug-in coil system, the above data may be followed for 1½-inch diameter.

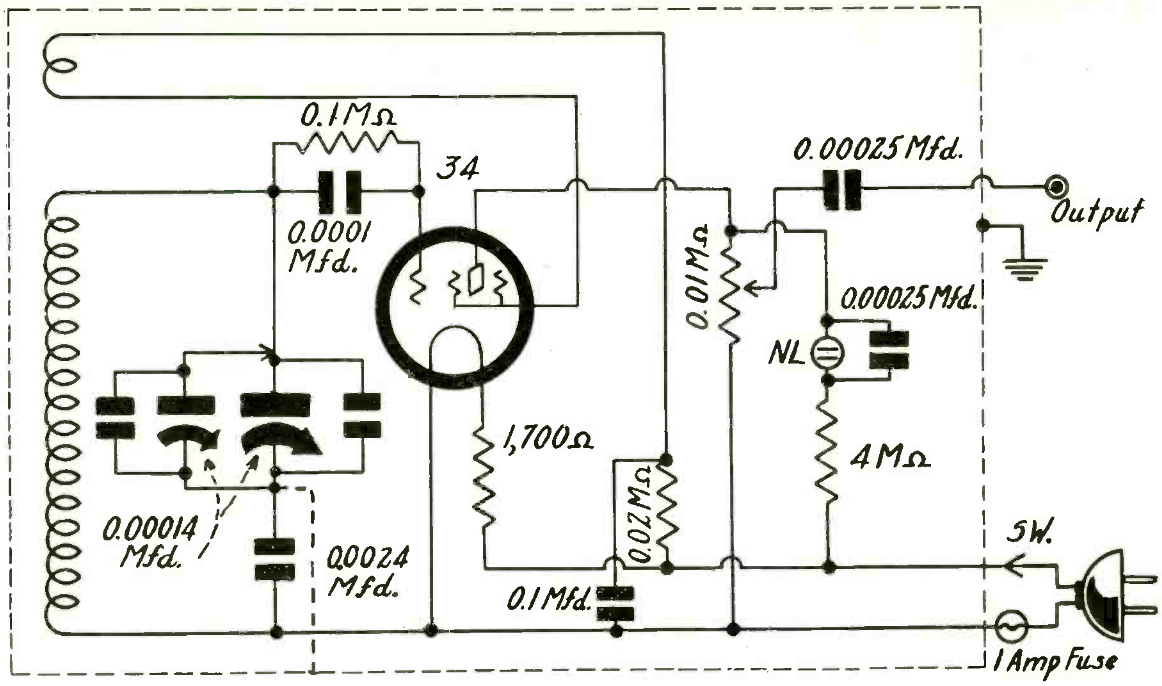


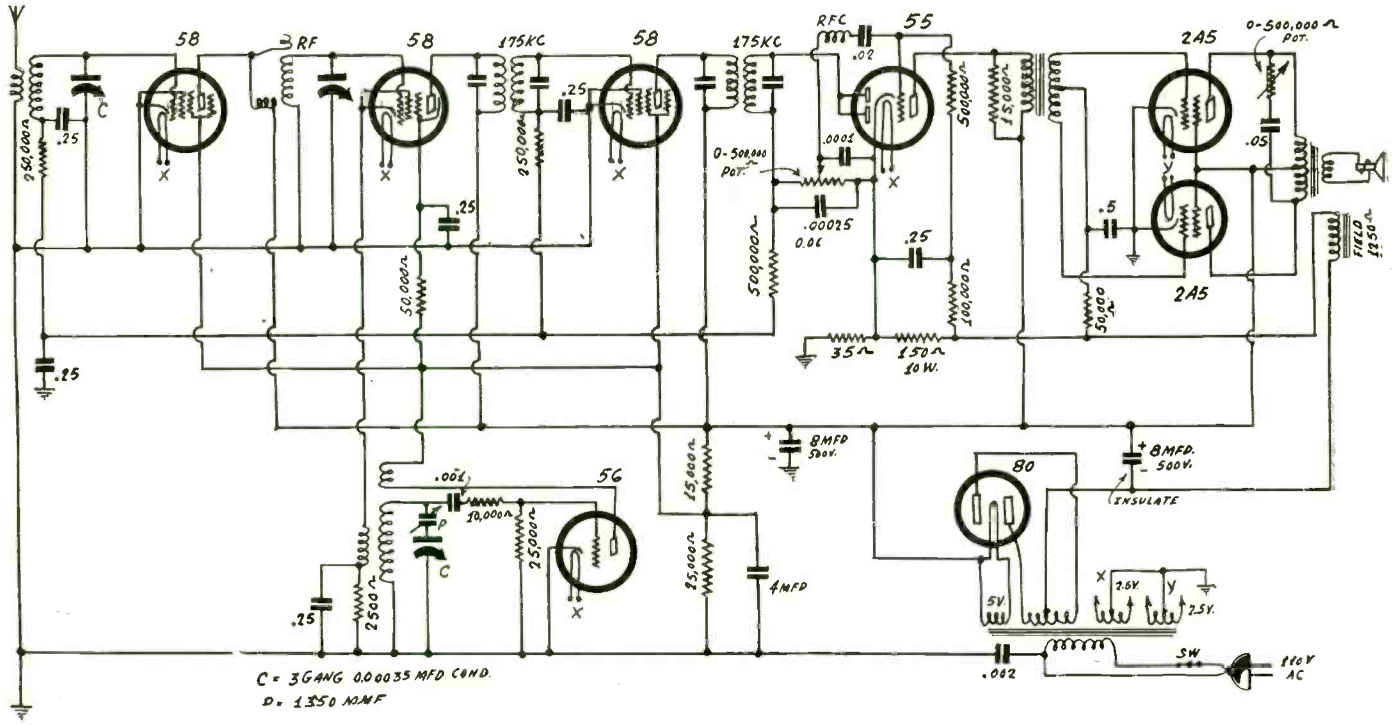
The 34 may be used as a regenerative detector for short waves as shown. Sensitivity is affected by the value of the space-charge load resistor, shown as 0.05 meg. (50,000 ohms). This resistor may be raised until sensitivity declines and a value used that provides maximum sensitivity. Data on the coils on 1½" diameter are given directly above.

WHEN the screen is used for feedback in the 34 tube, and the conventional plate is grounded through a resistor, does the value of this resistor have any effect on performance?

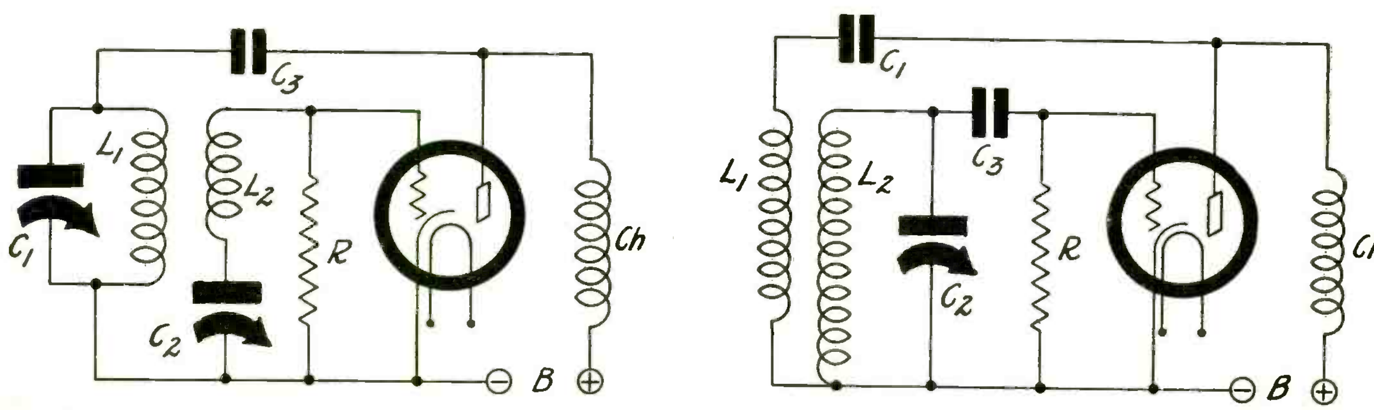
Yes, it does. A value of 0.05 meg. is generally satisfactory. However, higher values may be used, up to the point where the sensitivity of the system is lowered. That is, somewhat more than 0.05 meg. no doubt will improve sensitivity, but a point is reached when sensitivity declines, and it is well then to go back to a value of resistance that affords highest sensitivity. The diagram shows the 34 regenerative detector.

The former example, on opposite page, of screen used for feedback applied to a battery-operated device. In this example the circuit is used on a.c. or d.c., being universal, but there is no change in the feedback on that account. The harmonics will be strong when a.c. is on the plate. This circuit also provides for neon-lamp modulation (an audio tone) when used on d.c. Otherwise the hum is the modulation, on a.c.





Though the tuned-grid type of feedback, with leak and condenser, is fairly stable, many may want to improve the stability, and this may be done by inserting a series resistance between the tuned circuit and the grid. The resistance thus introduced must not be large enough to stop oscillation, but should be large enough to hold the plate current pretty steady as the device is tuned over the smaller capacity part of the spectrum.

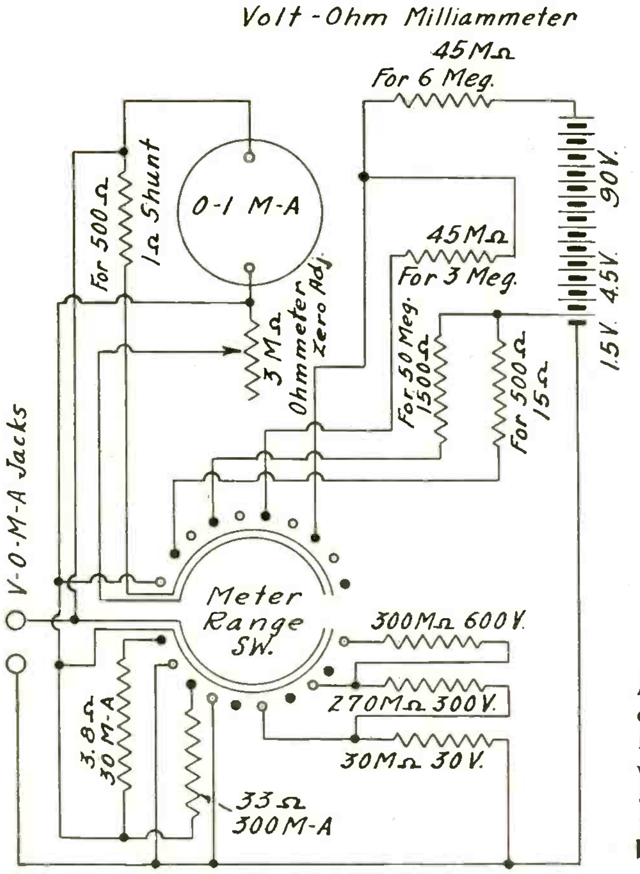


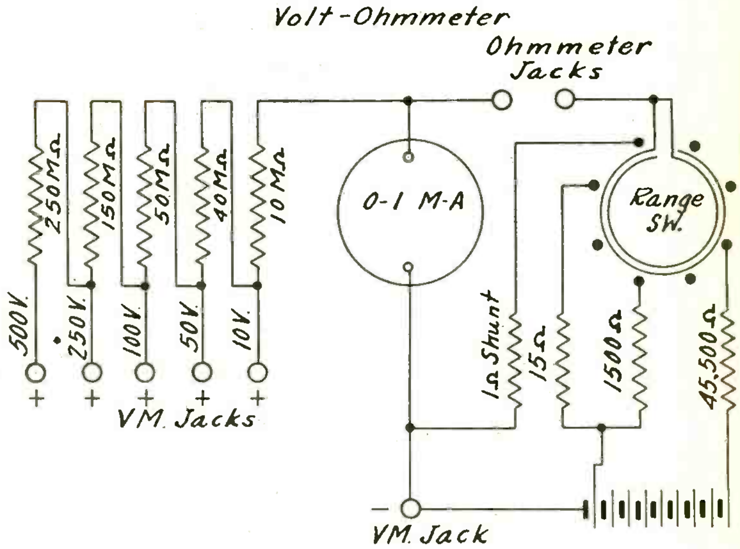
At left is a circuit that has plate effectively parallel-tuned and grid series-tuned. At right the grid is tuned once more, plate untuned, and no d.c. through the plate coil.

SWITCH INSTRUMEN
VOLTS, OHMS AN

General Principles of Circuiting—Provision for A

By Conrad





At left, the circuit for wiring an instrument to read volts, ohms and milliamperes. The words "For 50 Meg." should be read as if "For 50MΩ," that is, for 50,000 ohms. If only voltage and resistance are to be measured, the circuit directly above should be followed. Both of these instruments are of the switch type. The switch should have good contact. The basis of the circuits is a meter of 1 milliampere full range.

THE measurement of voltage, current and resistance is constantly made by radio experimenters and servicemen, and all of them desire to have the best instruments they can afford, but often they find it necessary to use inferior instruments, and know of course that the measurements will not be as accurate.

For measuring current the cheaper instruments do not compare so unfavorably, because current is a thing by itself. Also, in measuring resistance, the comparison is not so unfavorable, either, because the resistance value of the unknown is decided on the basis of current flowing when a known voltage is applied to a circuit consisting of the meter and a series limiting resistor. High resistances can not be measured with low-sensitivity instruments.

When it comes to measuring voltage, the better-grade instrument proves its incomparable worth, because of the large number of circuits in which voltage measurements are made where the current through the device measured is small.

It All Depends On Current

All measurement of voltage, current or resistance, as made with meters used in servicing, depends on current. That is, one may say safely that always current is being measured, nothing else. However, the calibration may be in terms of voltage, or in terms of resistance, besides being in terms of current. Also, the meter may have several scales, so that each calibration is consulted for each particular purpose. Thus the scales might be 0-600 volts, 0-300 volts, 0-30 volts, 0-30 milliamperes, 0-300 milliamperes, and 0-500 ohms, 0-50,000 ohms and 0-3,000,000 ohms, etc.

Since we are always measuring current, and since the needle deflection will be proportionate to the current, the current scale will be linear. Also, since the resistance in the measuring circuit does not change on d. c., the voltage scale will be linear. Therefore it is practical to have a current scale coincide with a voltage scale, that is. 0-30 or 0-300 could serve for milliamperes and for voltage, and also a given resistance scale could be subjected to specific factors of multiplication, by right choice of ascending voltages and limiting resistors.

Thus, some lower-resistance scale (50,000 ohms) could be multipled by 60 (6 meg. maximum reading).

When we are measuring resistance we have a limiting resistor in circuit to start with, and this resistor is such that when the terminals to which the unknown resistor are to be connected are shorted (zero resistance applied), the needle moves to full-scale deflection.

Figuring Out The Limiter

What this resistance should be can be figured out simply, using Ohm's law. The meter's sensitivity must be known. Suppose it is 1 milliampere at full-scale deflection. Then I ma must flow. If the voltage applied is 1.5 volts, then the limiting resistor that will cause full-scale deflection of the needle, or 1 ma to flow when the terminals for the unknown are shorted, is 1.5/0.001, or 1,500 ohms. A simple application to all such meters is this: the limiting resistor should equal the number 1 divided by the full-scale current in amperes, the answer multiplied by the voltage. Thus, 1/0.001 equals 1,000. Hence for 1.5 volts use 1,500 ohms. Therefore if the meter is of the 0-1 milliammeter type, the resistance to add per volt is 1,000 ohms. Therefore multiply the voltage by 1,000 and the answer is in ohms. Eg., 1,000x1.5=1,500 ohms.

Since the battery voltage in the cited instance was 1.5 volts, and since the limiting resistor is 1,500 ohms, it is clear that we can not insert a very high value of unknown and get any readable deflection.

Suppose we put 1,000,000 ohms between

NT FOR MEASURING D MILLIAMPERES

-C Tests, Including Relative Output Observations

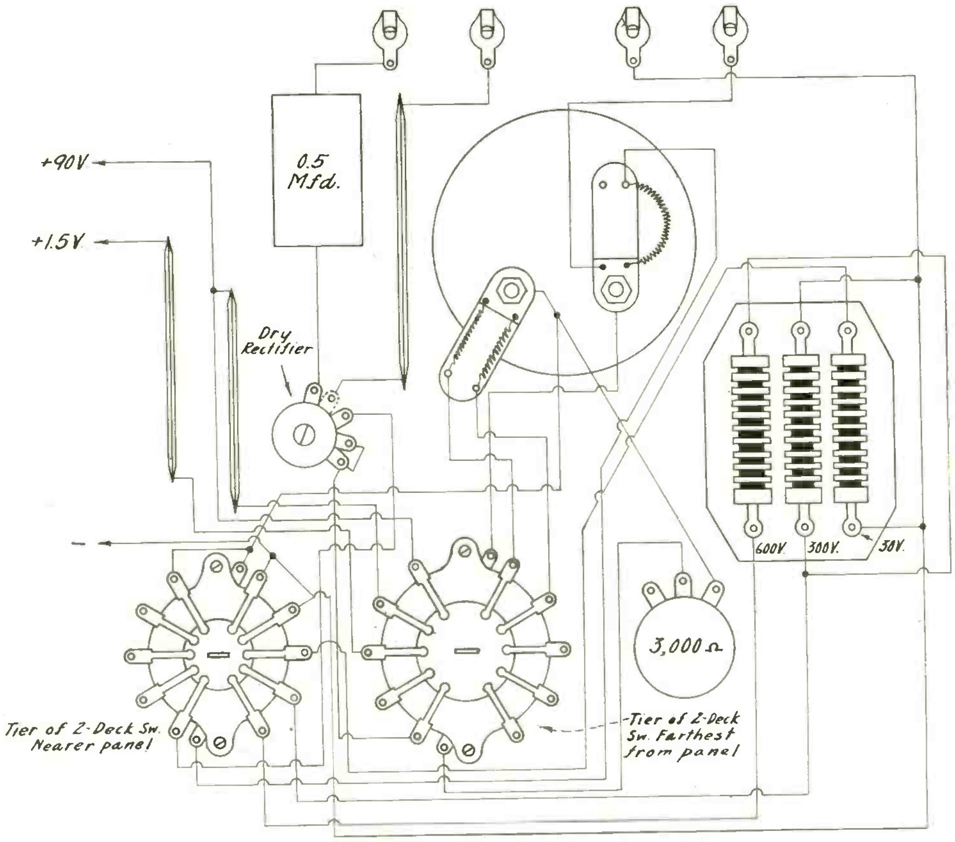
J. Riggles

the terminals for the unknown. The meter resistance is so small it may be neglected, and in this instance the 1,500 ohms of limiting resistance is almost small enough to be neglected. We would get a current "indication" of approximately 1.5/1,000,000, or 1.5 microamperes. Now, this is a current entirely too small to read on a 0-1 milliammeter, and what was stated as an "indication" was a theoretical and not a practical one. In practice the needle may be said to stand still when 1,000,000 ohms are introduced under the circumstances.

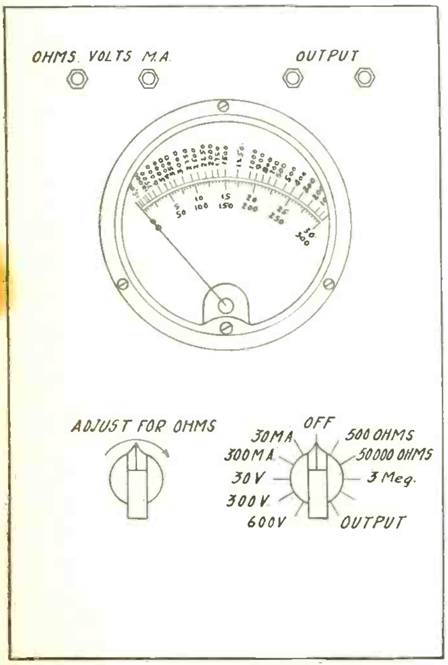
However, we may increase the voltage, and of course increase the limiting resistance accordingly. Suppose we jump the voltage up to 45 volts. Then the limiting resistor will be 45,000 ohms. If we increase the voltage another 45 volts we would have to double the limiting resistance also. Instead of having two resistors, one of 45,000 ohms and the other of 90,000 ohms, we may so arrange the circuit that for 90 volts an extra 45,000 ohms is put in series with the 45,000 ohms used for 45 volts. The sum of the series resistors is 90,000 ohms, and extra expense is avoided because one of the resistors does not have to have so much wire on it.

Appropriate Selection

Now, we can not expect linearity on the resistance scale of the meter, because as the values of unknowns become larger and larger, the percentage of current change becomes less and less. This results in a crowded condition of the resistance-calibration scale, that is, if we attempted to use a single scale with a single voltage and single



Pictorial diagram of a volt-ohm-milliammeter, with provision also for output measurements. A dry rectifier is included, also a series condenser. Otherwise the diagram represents pictorially the circuit wiring shown in the first illustration (extreme left-hand side of this page).



Front panel of the Triplett Model 175 volt-ohm-ammeter.

limiting resistor used for wide-range coverage. But we do not attempt to do that. We select some maximum resistance value that we think can be read well on the scale for the voltage conditions and limiting resistor, and so for 1.5 volts and 1,500 ohms we might say that a satsfactory reading could be obtained up to 500 ohms.

If we want to go higher we use 45 volts and 45,000 ohms, and if we want to read up to 3 meg. or 6 meg. we use 90 volts and 90,000 ohms. Just what the upper limiting of resistance reading should or can be may be disputed, because different persons will disagree as to how closely they can read the scale, or how close the reading should be to the real resistance value.

In the diagram at left is shown the circuit for wiring a Triplett instrument that measures voltage, resistance and current (milliamperes), along the lines discussed. The basis of the circuit is a 0-1 milliammeter. For voltage readings series resistors are used, just as they are used for resistance-measuring purposes, and the relationship is the same. However, instead of the variable quantity being an unknown resistance, the variable quantity is an unknown voltage, so the limiting resistor is made high enough to cause full-scale deflection for the application of the maximum voltage of a given scale, rather than for minimum resistance of the unknown, which applies to the ohmmeter.

The circuit at left measures d-c currents and voltages, and also d-c resistances. Where the designation "Meg" appears the meaning is megohms, or millions of ohms, thus to read to 3 meg. means to read to 3,000,000 ohms, and to read to 6 meg. means to read to 6,000,000 ohms. The Greek letter ω (omega) for ohms, when preceded by M means thousands of ohms, thus, 45Mω=45,000 ohms. In the diagram at left "For 50 Meg." should read "For 50 Mω," meaning for 50,000 ohms.

If the current readings are not desired, then the instrument is a volt-ohmmeter, diagramed in the second circuit.

The pictorial representation of the volt-ohm-milliammeter is shown at extreme right on this page, with the additional provision of a dry rectifier and a series condenser, so that output readings may be taken. As relative values are sufficient, no separate a-c calibration is necessary.

Harmonics Indentified

By a New, Accurate, Triple-Check Method

By Herman Bernard

METHODS of using harmonics of signal generators, with notations on accuracy of determining an unknown frequency, are the basis of the following summation:

1. *Product of two frequencies divided by their difference.*

If a signal generator is lower in frequency than the circuit to be measured, harmonics of the generator may be used for computing the unknown. Use any setting of the generator that supplies a response to the receiver, note the frequency of the generator, turn the generator dial in either direction, note the frequency of the adjoining response position of the generator dial. The unknown frequency is the product of the two frequencies read, divided by the difference between these two frequencies. Example: If the frequencies read are 120 and 128 kc, the product is 15,360, the difference between 128 and 120 is 8, and the unknown is 15,360/8 or 1,920 kc.

This method is useful if the unknowns are not any substantial multiple of the two frequencies read, otherwise the accuracy of the signal generator calibration would have to be far greater than is to be expected, say, 0.05 per cent. The reason is that for measuring high frequencies the difference is an unverified controlling factor, so that if one frequency is just right on the calibration, and some frequency close to it is off 1 per cent., the resultant error becomes enormous.

Possibility of Error

Suppose the frequencies actually generated are 200 and 199 kc. The unknown then is 39.402 mgc. But suppose the generator calibration is accurate at 200 kc, but off 0.5 per cent. at what actually is 199 kc, but which reads 198. Then the unknown would be incorrectly determined as (200 x 198)/2 or 19.9 mgc., almost 50 per cent. off. This is an extreme and unlikely instance. Suppose the calibration is correct at 128 kc, but when 120 kc is generated the reading is 119 kc, which is less than 1 per cent. off. Then the unknown would be wrongly determined as (128 x 119)/9 or 15,232/9 = 1,692 kc, whereas for the true frequencies, 120 and 128, the unknown is 1,920 kc, a difference of 228 kc, or an error of more than 11 per cent. Therefore any determinations requiring use of high harmonic orders is subject to possibilities of serious error, due to the large net effect of dividing by small percentage error differences. The error introduced into the product does not matter so much, but that introduced into the difference, where the absolute error may be 50 per cent. for a 1 per cent. error in the generator calibration, is serious.

Accurate Methods

2. *Determination of Actual Harmonic Orders.*

The formula of product divided by difference is mathematically perfect, but the application is circumscribed by the impossibility of attaining in practice the extremely high degree of accuracy of calibration that would be needed for assurance of scientific results. Therefore it is much better to determine the harmonic order, for when that is known, the frequency read may be multiplied by that order, and the percentage accuracy of the generator is at all times communicated to the measurement of the unknown.

Because the relationships of harmonics and fundamentals are those of numbers related to one another in a definite proportion or ratio, this ratio may be ascertained. Ratios may be developed from the change in capacities necessitated for the consecutive responses, or from the changes in frequencies or equivalent wavelengths. The author has developed a method of determining the harmonic order from the two frequencies read and which can be solved by mental arithmetic. The rule follows:

Where two resonances or responses are obtained in an unmolested receiver due to tuning the generator to two positions yielding consecutive responses, the harmonic orders of these two responses are the summation of consecutive augend and addend producing the sum of the frequencies, divided by the difference.

An augend is a number to which addition is made and an addend is a number added to the augend. For instance, in the case of A + B, A is the augend and B is the addend.

Application of New Method

Take any two consecutive response frequencies as read, say, 128 and 120 kc. The sum is 248. The difference is 8. Divide 248 by 8 and obtain 31. The consecutive augend and addend of 31 are 15 and 16. So the harmonic orders are 15 and 16. The lower harmonic applies to the higher frequencies read, and the higher harmonic to the lower frequency read. Thus, 15 x 128 = 1,920 and 16 x 120 = 1,920. So if the fundamentals are calibrated to an accuracy of 1 per cent. the unknowns are determined to an equal accuracy. As only whole numbers apply in practice, and as the division must produce a whole number that is the sum of consecutive augend and addend, we can get the harmonic order by mental arithmetic, although we might have to use pencil and paper on high harmonic orders to multiply a read frequency by the selected factor.

The identification of the consecutive harmonic orders is very simple, because when the difference obtained between the two read frequencies is divided into the sum the quotient or answer always is an odd number, assuming consecutive responses in these cases. Subtract 1 from this odd number and divide by 2 to get the augend, or one harmonic, and add the borrowed 1 to the quotient to obtain the other harmonic order. In fact, only one harmonic order is needed, and by subtracting 1 from the quotient and dividing by 2 the harmonic order of the higher frequency is obtained. The other or next higher harmonic for the lower frequency fundamental may be used simply as a check.

Further Aid to Accuracy

Incidentally, the ascending order of the quotients is in steps of 2 and as the quotients always are odd numbers, the last fact is useful as a guide to accuracy. Moreover, if any one frequency of generation is known to be accurate, then the accurate frequency value of the other position on the generator scale becomes known, even though the calibration is off.

It is true that here a difference is divided into a sum, whereas in the formula first considered a difference was divided into a product and now small absolute differences as between true generated frequencies and calibrated representations of those frequencies could introduce just as large error as in the first example, were it not for the check on the accuracy, resulting from the necessity of the difference being a whole number resulting from the division of the difference into the sum, and moreover a whole number that is an odd number. And besides there are only two consecutive numbers that when added will yield the odd number first obtained. Hence, there is a double check on the accuracy. As a third check, it is obvious that the difference (8 in the example of 120 and 128) is divisible not only into the sum of 120 and 128, i. e., into 248, but of course also into 120 and 128 individually, as verification of the harmonic orders.

Ratio Method

Another method of obtaining the harmonic orders is to read any two frequencies that consecutively produce a response in the receiver, and establish a ratio for these frequencies, which may be a fraction or a whole number, and either way works, depending on whether the higher is divided into the lower or the lower into the higher. The resultant ratio factors will identify the harmonics. In general, this method requires pencil and paper, but may be used as a check on any determination arrived at by the previous harmonic-identification method.

Dividing the lower frequency into the higher, the resultant ratios are apportioned to the harmonic orders in the following a table for accurate disclosure of the harmonic orders up to the 101st:

Harmonic Order of the Higher Frequency Read Is	*Harmonic Order of the Lower Frequency Read Is*	*When the Higher/Lower F Equals This Ratio*
1	2	2
2	3	1.5
3	4	1.333
4	5	1.25
5	6	1.2
6	7	1.67
7	8	1.143
8	9	1.125
9	10	1.111
10	11	1.1
11	12	1.09
12	13	1.083
13	14	1.0761
14	15	1.071
15	16	1.0667
16	17	1.0625
17	18	1.0588
18	19	1.0555
19	20	1.053
20	21	1.05
21	22	1.048
22	23	1.0455
23	24	1.0434
24	25	1.042
25	26	1.04
26	27	1.0385
27	28	1.037
28	29	1.0357
29	30	1.0345
30	31	1.0333
31	32	1.0322
32	33	1.0319
33	34	1.03
34	35	1.0294
35	36	1.0285
36	37	1.0277
37	38	1.027
38	39	1.0263
39	40	1.0257
40	41	1.025
41	42	1.023
42	43	1.024
43	44	1.0234
44	45	1.0227
45	46	1.0222
46	47	1.0217

Harmonic Order of the Higher Frequency Read Is	*Harmonic Order of the Lower Frequency Read Is*	*When the Higher/Lower F Equals This Ratio*
47	48	1.0213
48	49	1.0208
49	50	1.0204
50	51	1.02
51	52	1.0196
52	53	1.0192
53	54	1.0188
54	55	1.0185
55	56	1.0181
56	57	1.0178
57	58	1.0175
58	59	1.0172
59	60	1.0169
60	61	1.0166
61	62	1.0163
62	63	1.0161
63	64	1.0158
64	65	1.0156
66	67	1.0151
67	68	1.0149
68	69	1.0147
69	70	1.0144
70	71	1.0142
71	72	1.0140
72	73	1.0138
73	74	1.0136
75	76	1.0133
76	77	1.0131
77	78	1.0129
78	79	1.0128
79	80	1.0126
80	81	1.0125
81	82	1.0123
82	83	1.0121
83	84	1.0120
84	85	1.0119
85	86	1.0117
86	87	1.0116
88	89	1.0113
89	90	1.0112
90	91	1.0111
91	92	1.0109
92	93	1.0108
93	94	1.0107
94	95	1.0106
95	96	1.0105
96	97	1.0104
97	98	1.0103
99	100	1.0101
100	101	10.1

3.—*Consecutive settings.*

Since frequency differences are concerned in the computation methods, if the fundamental readings can be obtained conveniently for two positions that are 1 kc apart, to cause adjacent responses also, the operation is simplified. In the case of the product divided by the difference, there need then be only one operation instead of three. Simple multiplication suffices, because the difference is 1 and the divisor is 1, and in both instances do not change the result.

For high frequencies of unknowns, responses are numerous on the dial, but with some idea of the unknown, in terms of megacycle steps, as for use in station-finding, when that aid nearly always is present, the generator fundamentals may be selected for any range having 1 kc separation registered, e. g., 100-200 kc. In other words, some inkling to start with avoids the necessity of skipping all over the dial.

Merged Into One

When the responses fall on even kilocycle bars for the 100-200 kc range, the numbers under "Responses on Generator Fundamental" disclose the measured frequency to be that listed under "Unknown Frequency Then Is in Mgc." As all responses on fundamentals are consecutive in kilocycles, and close together, there is danger only of absolute error, scarcely of relative error, therefore the result will be about within the accuracy of the fundamentals, but may be checked by the using harmonic-order method, that is, determining the harmonic and multiplying the read frequency by that determination. The table for adjacent responses 1 kc apart appeared in the September 22d issue.

The foregoing method, product divided by the difference, is expressed as a formula thus:

$$F_x = \frac{F_2 F_1}{F_2 - F_1}$$

where Fx is the unknown, F_2 is the higher of the two consecutive fundamental frequencies of the generator, and F_1 is the lower of the two response frequencies of the generator.

The formula for the harmonic-counting method is:

$$F_x = F_2\,(n) = F_1\,(n + 1).$$

where the symbols have the same meaning as before, and in addition n equals the harmonic order.

In the operation we determine n and add 1 to get $n + 1$, so have both harmonic orders for the two frequencies read. As we are now dealing with frequencies confined to those read on the generator for consecutive responses just 1 kc apart, we have brought the two methods to an identity, or both are exactly the same, because the harmonic order of one frequency read on the generator is equal to the other (consecutive) response-creating frequency read at the next bar. That is, for 10.1 mgc, the 100th harmonic of 101 kc fundamental is used and for 100 kc fundamental the 101st harmonic of 100 is used, and this situation obtains for all frequencies of unknown from 10.1 without limit, although the table terminated at 39.8 mgc.

Just to apply the harmonic-counter method, for 101 and 100 kc fundamentals, the sum of the two numbers is 201, the difference is 1, and since 1 divided into 201 still equals 201, we subtract 1 from 201, get 200, divide 200 by 2, get the harmonic order as the 100th for the higher frequency (101 kc) and 101 for the lower frequency (100 kc). In both instances the answer is 10,100 kc or 10.1 mgc.

Another New Method

So far we have dealt only with consecutive responses, and the bulk of the harmonic technique has been built up in that direction. However, if the frequencies measured are quite high compared to the generator fundamental frequencies, that is, the harmonic orders are high, and there are any misgivings about an incorrect fundamental calibration causing error in the measurement, or some result is obtained that does not check with the methods outlined, while the error results from the application or calibration and not from the method, the peril of error may be minimized by using all the responses obtainable. On this basis a new, accurate method has been developed by the author, as will appear at the end of this article.

Suppose that the generator is set to the lowest frequency that will produce a response in the receiver. If the unknown is high we shall have numerous responses. In previous discussion we dealt with two response points, but only one difference. Now, as we use more response points we must recognize that we are still striking differences. Therefore with a response due to the generator being at or near the low-frequency extreme, say, at 102 kc, we may traverse the dial and count the responses. Only the number of differences counts, therefore, the total responses less 1 is used as the basis. For 10 responses there would be 9 differences, for 11 responses 10 differences, etc. Hence, if we started at 102 and got the last response at 198, total 11 responses, net differences 10, we could use the harmonic-counting formula, or the product-divided-by difference formula, and multiply the answer by 10.

Using More Responses

Since one desires to make the measurement as easily and readily as possible, for high frequencies, it is well to select some generator fundamental on an even kilocycle bar, and turn the dial, counting the responses, until near what is the expected end of the chain, when a halt is made at another even kilocycle bar.

Example: The lowest frequency to yield a response on an even bar is 100 kc, the highest is 200 kc, the number of responses is 11. What is the frequency? Using the harmonic-counting method, the sum of 100 and 200 is 300, the difference between 200 and 100 is 100, dividing the difference (100) into the sum 300 yields 3, and the harmonic orders therefore are 1 and 2, multiplied by 1 less than the total responses, e. g., 10. So the harmonic orders are not consecutive, but are products of consecutives, i. e., 10 and 20, applied to 200 and 100, and the unknown is 2,000 kc or 2 mgc.

It is not necessary actually to have the responses occur at even-bar positions, as estimating between bars does not mar the accuracy, by the harmonic-counter method.

Same Spreadout for All

4.—*Direct counting of harmonics.*

We now come to the very latest disclosure of importance in harmonic technique, as embodied in a commercial test oscillator of the author's design, the 334-A. It is the simplest system of all, and is applicable particularly to the 2-to-1 frequency range of any generator with a fundamental range of 100 kc, though with less convenient practice could be applied to any generator.

This method is not automatic, for all automatic methods result in crowding of part of the dial, and therefore introduce difficulty of reading, hence mar accuracy for high frequencies; it does not use differences calibrated on a dial, but could be applied to a generator that has no calibration, save for the terminal frequencies (100 and 200 kc); and it communicates to all measurements the percentage accuracy of the generator, and besides contributes the same spreadout for any and all frequencies measured. No other system affords equal spreadout for any and all unknown frequencies, for computations based on product divided by difference, or on sums and differences, or automatic systems using these or similar methods, inevitably are constricted to a smaller span for a higher unknown frequency; indeed, the smallness of the calibrated difference is the only measure of the value of the unknown frequency.

Some Examples

Suppose we take concrete examples. The fundamental is 100 to 200 kc, calibrated in steps of 1 kc. We set the pointer at 100 kc. That is what the generator produces—100 kc, plus or minus 1 per cent., if the accuracy is 1 per cent. The 334-A is rated at 1 per cent., but actually has greater accuracy.

Now, we get a response at 100 kc. We turn the dial for the full distance from 100 kc to 200 kc. No other response is heard. Do we know what the unknown frequency is—the frequency of an intermediate amplifier, for instance? If we know it, how do we get that knowledge? We know the unknown is 100 kc, because unknowns of multiples of 100 kc are concerned, and there was a response in the receiver due to generation of 100 kc, and no other response, though we traversed the whole dial to 200 kc. If the frequency of the unknown were less than 100 kc we would not hear any response, or if higher would be a multiple of 100 kc and we would have obtained more than one response.

Suppose the responses are supplied by 100 kc and 200 kc settings. What is the unknown? It is 200 kc, because the second harmonic is 200 kc, and 200 kc itself caused a response in the receiver. No other unknown frequency would satisfy the conditions of two responses for the traverse of 100-200 kc.

Formula is Child's Play

So for 100 kc unknown we got one response when we started at 100 and traversed the dial to 200 kc, for 200 kc unknown we got two responses under the same conditions. As the unknown frequencies increase, the number of responses increase directly. So for 2,000 kc unknown we get 20 responses, for 3,000 kc unknown we get 30 responses, etc.

(*Continued on next page*)

(Continued from preceding page)

Therefore for a 2-to-1 frequency ratio we have this very simple formula:

$$Fx = nF$$

where Fx is the unknown frequency n is the total number of responses heard in the receiver, and F is the generator frequency next lower to the high-frequency terminal of the generator.

The system is most appropriately applicable to high frequencies, since it enables measurements in steps of 100 kc, which at these frequencies would be termed in megacycles: 0.1 mgc. Moreover, the percentage of closeness with which the determination may be made increases with frequency, whereas in all automatic counting systems, including a method devised by the author, known as the Automatic Electric Harmonic Counter, the crowding at the higher frequencies greatly impairs the usefulness, although at relatively low frequencies the application is satisfactory.

No Crowding of Dial

Moreover, any method of attempting to overcome the crowding effect caused by normal tuning characteristics, by using large parallel capacity, reduces the frequency ratio so that the device can be used only as a station finder, and not also as a test oscillator for intermediate frequencies, unless the fundamentals are placed somewhere near the audio range, which is not to be considered.

The answers are in kilocycles, but if instead of multiplying responses for kilocycles, we multiply the responses by 1,000.

Some users will be interested in wavelengths, also, although the general rule is to use the frequency method of designation for the most popular program, amateur, police, airplane and ship channels (1,600 kc to 20 mgc). Also, usually station lists give both frequencies and wavelengths.

Since the dial is calibrated 100-200 kc, the numbers 101, 102, 103, etc., to 199 may be read as if 100 were subtracted. Then, since the pointer is of the double type, positions for corresponding wavelengths could be written on a lower scale (below hub). The number 200 would be read as for 100 responses, due to subtraction by 100, but the other numbers on the top scale are pat for the purpose. The traverse permits the gradation of wavelength values from 3,000 to 30 meters, the metrical differences varying according to the exponential term of wavelength compared to frequency.

Higher Frequencies

The case of one response represents 100 kc, hence 3,000 meters, the case of 100 responses represents 10 mgc., read at 200 kc on the dial, so 30 meters. And for higher frequencies or lower waves the number of responses may be continued to be counted, and the equivalent wavelength determined from a chart relating frequencies and wavelength (such as printed in last week's issue, September 29th), or from the 3,000-1,500 meter wavelength calibration of the fundamental on the 334-A signal generator, by determining the unknown frequency, selecting some frequency on the fundamental related to the high frequency by an easily-handled factor, and reading the equivalent fundamental from the dial, and dividing that wavelength by the factor. Thus, for 15,600 kc as determined by the wide-span decimal counting method, read 156 on the fundamental frequency range, note this goes into 15,600 a hundred times, read the wavelength for 156 kc as 1,922 meters, divide by 100 and the wavelength is determined as 19.22 meters. For responses above 100, one may also use the double index, by simple proportion.

Above 6,000 kc

For frequencies above 6,000 kc (waves below 50 meters) the 0.1 mgc difference is indeed close enough, and, as stated, the higher the unknown in frequency, or the lower in wavelength, the smaller the percentage difference the steps bear to the unknown, so by this method the exponential or crowded condition is not only overcome but reversed. Of course the number of responses must be counted, but it will prove a surprise to practically everybody how quickly and successfully this can be done, and especially those whose chief pursuit in these matters is accuracy will appreciate the value and the soundness of the method.

Multiples of Higher Frequencies

The use of the simple system of direct-counting was applied to 100 kc as starting point because of the scale. A possible objection is that if only this method is applied, unknown frequencies not integral multiples of 100 kc could not be measured this way. But the unknown, for any high frequency, is always a multiple of 100 kc or some frequency a bit higher than 100 kc, so get a response from the lowest frequency of the generator, traverse the dial to twice that frequency, count the responses and multiply by the preceding low frequency.

As stated, for high frequencies, say, above 10 mgc., the 100 kc starting point is entirely suitable, and will yield responses or beats for all unknown frequencies, within the 1% accuracy limit, which for 10 mgc. is equal to the starting frequency of the generator, 100 kc, and for higher than 10 mgc. is a difference smaller than the accuracy factor, and from 10 mgc. up therefore always yields results, wherever the set is tuned.

Automatic Method

5.—*Non-computation methods.*

The methods outlined all deal with computation, even that method whereby the harmonics are directly counted. It has been shown that some computation methods are better than others, that is, the preferable solution is to obtain the harmonic order, read a low frequency and multiply this reading by the harmonic order, to have the resultant measurement as accurate as the calibration of the generator.

It will be noticed that the higher the unknown frequency, the greater the number of responses due to traversing the dial of the generator. It follows therefore that the higher the unknown frequency, the closer together will be any two consecutive positions of the generator dial that create responses. This is confirmed by inspection of the table of ratios, which shows that the higher the frequency to be measured, the smaller the ratio resulting from one frequency creating response being divided into the other (consecutive) frequency creating producing response.

It is therefore obvious that an automatic method can be applied for harmonic counting, calibrated as a measurement of the unknown frequency. Since the generator dial positions are closer together the higher unknown frequency, the difference between the generator frequencies creating responses will be a measure of the unknown frequency, though not a direct measurement.

It is not suggested that the automatic method referred to is excellent, for its scope is limited, nor is it stated some other method can not be better.

Formulas Stated

The first response, say, due to the generator's higher frequency, F2, results from that generator frequency being multiplied by harmonic order n. It is unnecessary to know the value of n. The next dial position of the generator (lower frequency) will produce a response in the detector (receiver) on account of the next higher harmonic F_1 $(n+1)$. We have found before that

$$Fx = F_2(n) = F_1(n+1)$$

wherewhere Fx is the unknown frequency, F_2 is the higher frequency to which the generator is tuned, n is the harmonic order of F_2, and F_1 is the next lower frequency to which the generator is tuned to repeat the response.

Therefore we can tell where the response will fall, either starting at the higher frequency of the generator, say, selecting 200 kc for the constant starting point, when the formula is as given directly ahead, or starting constantly at the low-frequency end, 100 kc, when the formula is:

$$Fx = F_1(n) = F_2(n-1).$$

Points Established

We used the direct harmonic counting system, starting at the low-frequency extreme, principally to get 100 kc differences rather than 200 kc differences. Let us determine where some of the positions will fall for specified frequencies in the automatic harmonic-counter system, say, 1.8 mgc to 20 mgc, or at least establish a few points to show the theory.

Suppose we start at 100 kc again. If we got two responses, it will be remembered, when direct-counting was applied, the unknown was 200 kc. Where was the second response? At 200 kc. Therefore if we use a double pointer, on a tier below the hub we can mark a bar representing the same pointer position below as is occupied by 200 kc above the hub, and call that 200. We are ascribing positions for second response-creating points for frequencies spaced 0.1 mgc, so we want to find where 300 will fall. We start at 100 kc and, lacking the simple guidance of the first instance, apply the formula.

For 100 kc of the signal generator 300 is represented by the third harmonic. The next higher-frequency position of the generator dial creating response in a receiver still tuned to 300 kc will be of the next lower order, so we divide 300 by 2, getting 150, and inscribe a bar below in line with 150 kc above, and mark it 300.

Sharp Reduction

So the formula for finding the position that marks the frequency separation between fundamentals, starting with the lower generator frequency, and using two fundamentals, responses due to consecutive positions of the generator dial, is:

$$F_2 = \frac{F_1}{(Fk / F_1) - 1.}$$

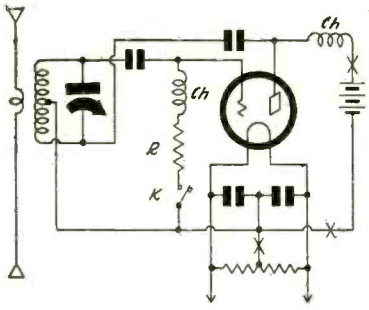
where F_2 is the higher generator frequency, here the unknown, F_1 is the lower generator frequency, and Fk is the frequency now assigned, but in later practice to be the unknown, or frequency to be measured.

So the positions for the second response when the frequency to be measured is 400 kc is 400/3, or 133 kc, and when 500 is to be measured is 500/4, or 125 kc, and when 600 kc is to be measured is 600/5, or 120 kc, etc. Note how sharply the differences reduce.

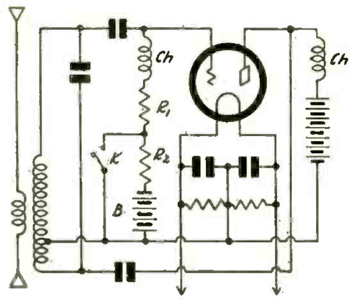
This method, like all other automatic methods that refer to differences on the dial as the measure of the unknown, results in points coming close together eventually, as was found from the fact that from 1.8 to 7 mgc an 0.2 mgc separation was maintained with mechanical ease, from 7 to 10 mgc the separation was necessarily worse, or 0.5 mgc differences, and from 10 to 20 mgc the jumps were in 1 mgc steps. This is what is meant by the exponential nature of the calibration.

Has Some Good Points

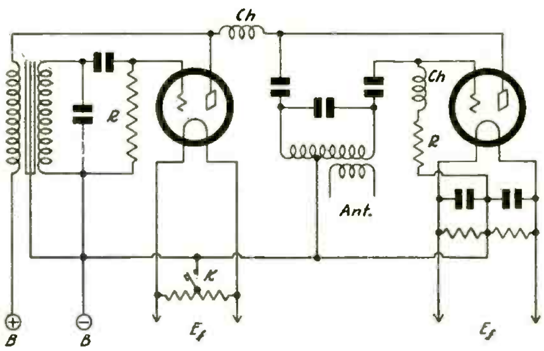
The system applies well enough if the frequencies to be measured are relatively low, compared to the generator, but does not apply well at all when the frequencies to be measured are relatively high, and besides it is a method, like any automatic one must be, has diminishing order of accuracy as the frequency of the unknown is higher, for manipulative reasons. Bars eventually so close together that they are hard to read, or bars separating wide differences of the unknown, are themselves a denial of accuracy.



Keying by opening and closing the grid circuit. A closed key produces an unmodulated wave. Dots and dashes sent out by the above may be received by heterodyne method



This is a similar grid method, though the grid is never open. The bias is too high for oscillation unless the key is closed, when unmodulated carrier results



The tube at right is a Hartley r-f oscillator. The one at left is a tuned-grid audio oscillator. When the key is closed the modulation is put on the carrier. With key open the carrier continues but is unmodulated. Heising modulation is used.

Radio University

Code and Phone Transmitters

WILL YOU PLEASE give me an insight into the keying process for telegraphic transmission, also show some systems of using voice modulation?—L.H.C.

The simplest method is that for telegraphy, where dots and dashes are sent, by stopping and starting oscillation. The grid return may be interrupted by the key, as shown in the first diagram at upper left on this page. When the key is depressed the carrier is sent. When the key is open there is no oscillation. The same condition of presence and absence of oscillation prevails in the diagram second from left, although there the grid never is open. The bias is made so high when the key is open that there is no oscillation, and when the key is closed oscillation takes place. In both these instances the interrupted carrier principle is involved. For reception of this kind of transmission a circuit is necessary that is oscillating near the frequency of the transmission. The difference in frequency between the two determines the frequency of the resultant audio tone. At upper extreme right a separate audio oscillator tube is used, and when th ekey K is depressed the audio tone is introduced into the radio-frequency oscillator, which oscillates continuously. Therefore reception may be had without an oscillating receiver, for the carrier is ever-present. The three circuits so far discussed are telegraphic. The two lower diagrams show phone circuits, at left with Heising modulation, which is a plate-circuit system, and at right a grid-circuit-modulated counterpart of the circuit at left.

* * *

Ultra Frequencies for Fans

IS THERE ANYTHING much that a home constructor can do about the ultra frequencies? These offer very interesting possibilities, but, not being an amateur, what can a fellow do about them?—J. D. C.

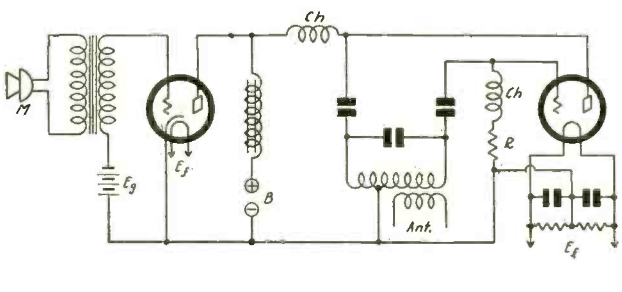
A receiver can be built for bringing in stations transmitting on ultra frequencies. Amateurs can be picked up, and they use phone on the 56 mgc band. Besides, on other related frequencies various experimental efforts are being conducted, including television, and you might want to try scanning some of this. The work in this general band is so much of an experimental nature that even official lists of world short-wave stations include none of these ultra-frequency stations, except eight in Hawaii and two in Argentina. As you know, the reception range, in general, is as far as the eye can see, just as a measure of distance, not of conditions of light and darkness. So there is no hope of your tuning in Hawaii and Argentina. A new tube particularly useful for ultra-frequency circuits, the 955, has been announced. Otherwise rather awkward efforts have had to be made to press regular receiver tubes into service for reception and transmission. Of course the 56 mgs band is not so very far down—or up—being in the 5-meter region, but frequencies much higher are used, and the new tube will work on 2.5 meters and below, and inferentially be of service for lower frequencies, if any wide frequency coverage is to be attempted.

* * *

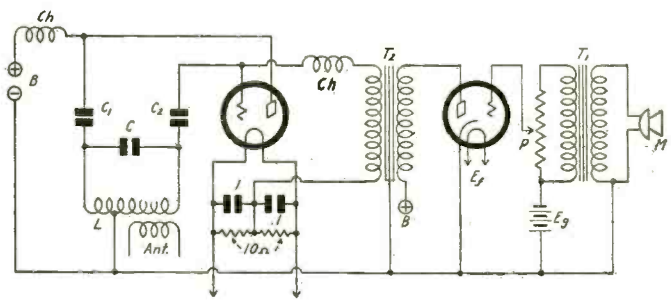
Too Much Volume

PERHAPS YOU NEVER before ran across this one. My receiver is too sensitive and I cannot turn down the volume to a comfortable level on local stations. This must be annoying to neighbors late at night. In fact, it causes me some annoyance. The detector I use is a 55, which has a negative bias for the triode, the diode load resistor being a potentiometer with arm slid across the total resistance to pick off as much voltage as the operator desires—except that he can not pick up as little as he desires! There is indeed a change in volume as the control is manipulated, but the minimum volume is

(Continued on next page)



This is a system for phone transmission. The Hartley r-f oscillator at right sends a carrier continuously. Sound modulation results whenever the microphone M is excited



Heising modulation previously shown is a plate-circuit affair. The above circuit uses grid modulation, otherwise is substantially the same as the circuit at left. Above, the tube at left is the r-f oscillator

QUALITY PUT FIRST IN SETS AT N. Y. SHOW

While the radio-electrical exposition in New York City, which recently wound up twelve days of activities, was not devoted exclusively to radio, there was much of interest in the radio exhibits and in what the manufacturers' representatives had to say.

Chiefly the all-wave sets drew attention from the crowds, and for the first time all radio manufacturers exhibiting at the show had such models. There were many refinements, including several sets that illuminated only that part of the dial where the frequencies being tuned in were concerned. One manufacturer had a time-clock system for pre-setting the mechanism to tune in up to 14 stations in periods of 15 minutes or multiples. Remote tuning controls were practically absent, and refinements of a worth-while nature were stressed.

Going In for Quality

Prices were somewhat higher, averaging about 20 per cent. advance, not for the same relative products as last year, but for products worth at least 20 per cent. more, because of the extras included. Instead of making sets as cheaply as possible, manufacturers in general seem to have gotten around to the idea of making them as well as possible.

The universal midget set of the $10 class was in the background, having been lost in the trend to better things. There were midget sets, of course, but these ordinarily would be classified as table model receivers, and included all-wave and skip-band sets. The skip-band set is one that tunes in the broadcast band, omits the police, amateur and other bands, until the principal foreign-station bands are reached, tuned in as a rule from about 15 to 50 meters at one switch setting.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, 145 *West 45th Street, New York, N. Y.*

Robert J. Murphy, 22 Griffin Street, Skaneateles, N. Y.
Albert Tatkin, 1115 Laurel Ave., St. Paul, Minn.
Arnulfo Gutierrez, 126 Hamburg St., Mexico D.F., Mexico
Frederick W. Smith, Box 254, Waterville, Maine
J. R. Floyd, 515 E. 8th St., Houston, Texas
Q & N Electric Service, 751½ Chartiers Ave., McKees Rocks, Pa.
Pasqueal Cozzi, 202 Franklin St., New Haven, Conn.
F. W. Madaris, 910 Dueber, S.W., Canton, Ohio
Ernest W. Hull, Craig, Colo.
John Rudnick, 3136 N. Monticello Ave., Chicago, Ill.
W. E. Morehouse, Jr., 21501 Roscoe Blvd., Canoga Park, Calif.
Frank J. Barney, 2215 Russell Ave., Youngstown, Ohio
Nick's Radio Service, 1130 Chelsea, Memphis, Tenn.
Guy B. Bierman, 622 Gordon St., Reading, Pa.
Rufus P. Turner, 11 Wellington Street, Boston, Mass.
Billy Finney, 1407 Putnam Ave., Plainfield, N. J.
Edwin J. Ryan, 273 West 10th St., New York City
Alan H. Rice, Stuarts Draft, Virginia
Fredr. Frieke, 422 Marshall Str., Muskegon, Mich.
L. C. Clark, 939 E. 1st St., Santa Ana, Calif.
Mason E. Redman, 1822 W. 108th Place, Chicago, Ill.
S. Carleton, M.D., 75 Whitestone Ave., Flushing, N. Y.
R. O. Young, 720 Haight St., San Francisco, Calif.
Thos. Hill Nicholl, 1779 Middlehurst Road, Cleveland Heights, Ohio

Latest Official Corrections of Broadcast List

Latest alterations and corrections to "Radio Broadcast Stations in the United States," published by the Federal Communications Commission, follow:

Call Letters — Studio Location — Alterations and Corrections

KGEK, Yuma, Colorado. C. P. T. and Studio Sterling.
KIEM, Eureka, California. Licensee, Redwood Broadcasting Co., Inc.
KSD, St. Louis, Missouri. S. A. Exp. 500w additional night, quota units 0.99.
KSO, Des Moines, Iowa. Power 500w-LS.
KWYO, Sheridan, Wyoming. C. P. covered by license.
KXL, Portland, Oregon. Power 250w-LS.
WALA, Mobile, Alabama. T. Mobile.
WBAA, West Lafayette, Indiana. Frequency 1400 kc, power 500w, S. A. frequency 890 kc, power 1kw-LS.
WBBZ, Ponca City, Oklahoma. S. A. Howard Johnson to operate station.
WBHS, Huntsville, Alabama. Licensee, Virgil V. Evans.
WCAL, Northfield, Minnesota. Power 2½kw-LS.
WDGY, Minneapolis, Minnesota. Power 2½kw-LS.
WFAS, White Plains, New York. Call letters WJBI changed to WBRB.
WFEA, Manchester, New Hampshire. C. P. covered by license, strike out S. A. Exp.
WGBB, Freeport, New York. Call letters WJBI changed to WBRB.
WGCP, Newark, New Jersey. Call letters changed to WHBI.
WGNY, Chester Township, New York. Call letters WJBI changed to WBRB.
WHDF, Calumet, Michigan. T. Laurium.
WJBI, Red Bank, New Jersey. Call letters changed to WBRB.
WKBF, Indianapolis, Ind. S. H., S. A. U.
WKBV, Richmond, Indiana. Licensee, Knox Radio Corporation.
WLEY, Lexington, Massachusetts. Call letters changed to WLLH, C. P. Lowell.
WNEW, Newark, New Jersey. Call letters WGCP changed to WHBI.
WQBC, Vicksburg, Mississippi. D., quota units 0.5.
WSPA, Spartanburg, South Carolina. C. P. frequency 920 kc, power 1 kw, D., quota units 0.5.
WTRC, Elkhart, Indiana. Licensee, Truth Radio Corporation.
WWRL, Woodside, New York. Power 250w-LS.

Miscellaneous.

KECA, Los Angeles, California. Add, California.
KGFF, Shawnee, Oklahmoa. Add, Incorporated.
KWCR, Cedar Rapids, Iowa. Add, Iowa.
WBBZ, Ponca City, Oklahoma. Add, Oklahoma.
WFBE, Cincinnati, Ohio. Power 250 w-LS.

Corrections to Frequency Book

Page 11, after KIEV, add 860 kc. Clear.
Page 27, after KTW, add 1,230 kc. Regional.
KWSC, Pullman, Washington. Power 2 kw-LS (1,220 kc).
WDAG, Amarillo, Texas. C. P. 2½ kw-LS (1,410 kc).
WRDW, Augusta, Georgia. U (1,500 kc).

Corrections to State Book

WCAU, Philadelphia, Pennsylvania. T-Newtown Square (Zone 2).
WPTF, Raleigh, North Carolina. Add, Exp. to operate to 8 p. m., P. S. T. (Zone 3).
WTOC, Savannah, Georgia. Strike out L. S. on C. P. (Zone 3).
WDAF, Kansas City, Missouri. Quota units 1.25 (Zone 4).
Missouri. Quota units assigned 13.04.

WORTH THINKING OVER

THE COLUMBIA BROADCASTING SYSTEM isn't complaining that business is bad. How could it in face of its recent announcement that the corporation cleared $923,794 in 1933, after operating and other expenses had been deducted. This amount was equal to $8.21 a share on 112,444 shares of combined Class A and Class B stock.

All of which indicates that perhaps the daily press might possibly assert that this means another leg to stand on when the publishers of the daily newspapers of the country want further muzzling of radio in an effort to increase their own income. In the meantime, the public looks on and doesn't care a rap so long as the newspapers are interesting and radio helps to make life more bearable.

ACE ADVISES ON HOW TO GET IN AS ANNOUNCER

William H. Andrews, chief announcer of NBC's San Francisco studios, epitomizes the requirements of an announcer:

Age: twenty to twenty-five years. Education: college preferred, but not necessary, though basic knowledge of at least two languages is necessary. Voice: trained in both music and drama but NOT theatrical in tone. Experience: artistic and technical, in radio. And—most important of all—ability to sell.

Andrews said:

"The announcer is the salesman of every program he presents, particularly on commercials—is this true, for on sponsored programs the announcer not only has to present the entertainment itself but often discuss the product being advertised."

Must Work the Buttons

On a high table in each studio is a box containing channel switches operated by buttons. By pressing the various buttons the announcer standing by connects and disconnects the other stations on a network as the schedule requires. He must do this at exactly the right second, many times a day, with mechanical perfection.

Astonishingly small is the number of applicants who can meet the pronunciation test devised for announcers' auditions. The list includes such words as inimitable, oceanography, cacophony, jugular, sacrificable, inquiry, carburetor, and isolate—all taken out of actual continuities. Not one candidate out of ten pronounces them correctly, Andrews reports. In a recent audition at which twenty men were tried out, eighteen failed on the announcing test and two were barely fair. The final arbiter so far as NBC pronunciation is concerned is Webster's International Dictionary.

Tells How to Start

Auditions for announcers are held only when a prospective vacancy on the staff develops. Applications are then sifted down to those of persons who, inexperience and general qualifications, might do. The position, frequently is awarded to some announcer from a smaller station who already has proven his ability on the air or to somebody employed in another department at NBC.

"This seems hard on young chaps who want to enter radio and have no experience", says Andrews. "But at a big broadcasting station nobody has time to teach a beginner. The wisest action for the inexperienced boy who wants to be an announcer is to get a job at the first small station which will employ him. The all-around work he will do at such a station is the best possible preparation for a specialized job at a big station, later."

Independent Code Is Nearer Adoption

Arrangements negotiated by the Radio Manufacturers Association code committee with the National Industrial Advisory Board and NRA at Washington for independent code operation for the radio manufacturing industry were approved by the RMA Board of Directors at the Commodore Hotel in New York City. President Leslie F. Muter presided and nearly all directors attended. The RMA Board also tentatively made new plans for a national radio sales promotion campaign this fall and early winter.

Captain William Sparks of Jackson, Michigan, and Bond Geddes detailed an agreement reached between RMA and NEMA, in recent conferences with the National Industrial Advisory Board, providing for an independent code status and code authority for the radio industry. The details are to be worked out by the RMA code committee in early conferences with NEMA and the Washington authorities.

Wholesalers Object To Being Eliminated

Direct selling to dealers, instead of through jobbers, was the rock upon which leading radio wholesalers as well as manufacturers divided sharply at the NRA hearing on the radio wholesalers' supplemental code. Over a hundred leading radio manufacturers and jobbers attended the hearing which lasted the entire day and was an entirely new procedure of the NRA, to examine rulings of a code authority.

The NRA, through Deputy Administrator Frank H. Crockard, heard scores of witnesses on the dispute and took under advisement the rulings of the radio wholesalers' code authority which proposed application of the wholesalers' code, its trade practices and possibly code assessments to radio manufacturers who sell direct to dealers. The wholesalers' code authority regulations are in part suspended and in part remain in effect pending the final decision of NRA.

No Trade Show in 1935

There will be no radio industry trade show in 1935, according to a decision made by the Radio Manufacturers Association Board of Directors at their meeting in New York City. The former annual RMA trade show was discontinued in 1933 because of the sharp reduction in sales during the months immediately preceding the trade show and the RMA Board this year decided for this reason not to plan any 1935 trade show. The question of holding public shows under RMA sponsorship or auspices was continued for further consideration.

Roosevelt's Voice Popular Abroad

Hitler and Mussolini may be spellbinders, but Europe's favorite American radio voice is that of Franklin D. Roosevelt.

So John S. Young, National Broadcasting Company announcer, reported on returning to New York after a survey of European broadcasting methods and systems.

In England especially is the President's voice popular. Not only are all his speeches rebroadcast there but they are recorded as well for redistribution to the Colonial possessions, the announcer declared. Europeans, traditionally interested in politico-economic trends, show more interest in Mr. Roosevelt and his addresses than in any President of the United States since Wilson, Young said.

But the President's voice, apparently, isn't the only thing American that people overseas like to hear on their radios. They like our music, too, the announcer asserted.

During his research studies at Cambridge University Mr. Young, using a fifteen tube radio set that had been placed at his disposal, tuned in his first European program. It originated in Brussels, and the music that resounded through his sedate dormitory room came from recordings by Paul Whiteman, the Pickens Sisters and Bing Crosby.

Young went to England at the invitation of the Warden of the King's English to deliver a series of lectures on American speech at Oxford University.

Sidney H. Gatty Rewarded By Simplex with Big Job

Having been associated with the Philadelphia office of Simplex Radio Co., Sandusky, O., Sidney H. Gatty has been rewarded for his successful sales in the metropolitan New York district. A New York office has been opened for him by Simplex at 1133 Broadway and he has been made metropolitan sales manager. Formerly New York sales were made by him, working out of the Philadelphia office.

Mr. Gatty, who is well liked for his obliging courtesy and friendly spirit, has a full line of Simplex radio sets on display at his new handsome quarters.

NEW POLYMET CATALOGUE

Polymet Manufacturing Corporation, 829 East 134th St., New York, N. Y., announces its new condenser and resistor catalog. Technical information regarding Polymet products will also be found in this booklet. Copies are available upon request.

"Short Wave Radio" Stops Publication

The following announcement was made by "Short Wave Radio," a monthly magazine:

"It is with deep regret that we are forced to announce the suspension of 'Short Wave Radio,' brought about by the failure of the former distributor of the magazine, Mutual Magazine Distributors, Inc. The failure of this latter firm has seriously embarrassed us, a burden that we, as young publishers, were not able to stand. Sadly enough, the October 1934 issue, which is our last, marks the completion of a full year of existence of the magazine.

"That 'Short Wave Radio' has been an editorial as well as an advertising success is attested by the gratifying reception the magazine has been accorded everywhere during the past twelve months. We have consistently maintained a policy of independence and honesty, a policy that was just starting to benefit us materially in the way of increased reader response and advertising lineage.

"We leave the magazine with the satisfying knowledge that we have done a good job in all respects, and with the additional knowledge that its demise is greatly regretted by the prominent radio executives and advertising agents to whom we have already broken the news."

Later an assignment was announced for benefit of creditors. Siegfried Schoenbach, of 305 Broadway, N. Y. C., is assignee.

Reciprocal Treaties Aiding Export Volume

Efforts to increase foreign markets are being made by Radio Manufacturers Association in behalf of the radio industry in connection with present negotiation of new reciprocal treaties with many foreign countries. Under the new "tariff bargaining" law the first reciprocal treaty with Cuba provided for increased concessions on radio products. The margin of preference to U. S. exporters on radio sets, tubes, parts and accessories was increased from thirty to thirty-five per cent. On sets the new ad valorem rate is 26 per cent as compared with 28 per cent, while the new Cuban rate on tubes, parts and accessories is 19½ per cent as against 20 per cent under the old treaty.

The RMA is advised that the State Department has arranged for negotiations of new reciprocal treaties with Brazil, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua, and information in connection with such treaties must be presented before October 15th. The RMA is acting to present the interests of the radio industry in the new reciprocal treaties.

Trade Combines Against Man-Made Static

A comprehensive plan to reduce radio interference was launched by the Radio Manufacturers Association's board of directors. In the public interest as well as that of the radio industry, a broad centralized movement to reduce electrical interference with radio reception was recommended by the RMA Engineering Division, of which Dr. W. R. G. Baker of Camden, N. J., is chairman, and was approved by the RMA managing board.

An "Interference Conference" of leading radio engineers will be held by next November in Rochester coincident with the fall meeting of the Institute of Radio Engineers and detailed plans made for institution of many efforts to reduce radio interference.

Dr. Baker said:

"The problems of electrical interference with radio broadcast reception have never been considered as a matter for a concentrated program headed up and directed by one organization. Instead there have been fragmentary bits of this important work done by various groups in a completely unorganized manner. While these bits were in many cases well done, the attack on the whole problem has never been really effective due to lack of a carefully planned and adequately directed program.

"The sources of interference are very numerous, and the causes are scattered through many other industries. For that reason a well-organized and directed program is the only hope of securing results. The use of the short waves for broadcasting has tremendously broadened the scope of interference elimination work, and any public use of ultra-short waves will still further do so. As a specific instance, motor car interference is not a factor in the standard broadcast range, but it is in many locations on short waves."

Station Sparks *By Alice Remsen*

PETER DIXON'S NEW SERIES

IT GIVES ME GREAT PLEASURE to announce that Peter Dixon, my very good friend, has a new four-time-weekly series on WABC and the Columbia network. It started October 2nd and is heard each Tuesday, Thursday, Friday and Saturday, at 5:45 p.m. "Robinson Crusoe, Jr." is the title; sponsored by the Bureau of Milk Publicity of the State of New York, on behalf of the state's campaign to increase the consumption of milk. Peter, of course, writes and directs the shows, and he has assembled a great cast of kids, with Lester Jay, 13 years old, filling the role of Robinson Brown, Jr. . . . Edsel B. Ford, president of the Ford Motor Company, announces a new series of Sunday evening broadcasts by the Ford Symphony Orchestra, conducted by Victor Koler, over the WABC-Columbia network, from 8:00 to 9:00 p.m. starting October 7th. The orchestra will be supported by a mixed chorus of twenty-four voices, and a notable array of guest stars. The programs will be broadcast from Orchestra Hall, Detroit. . . . Contract for the "Bill and Ginger" Mueller program, broadcast through WABC from WCAU, Philadelphia, Mondays, Wednesdays and Fridays, at 10:15 a.m., has been renewed. Arthur Q. Bryan, formerly of WOR, New York, writes and directs this series. . . . Lazy Dan, the Minstrel Man, has returned to the air; each Sunday at 2:00 p.m. Irving Kaufman, as usual, plays the roles of Dan and his Boss. . . .

ALEX BACK AGAIN

And a big HOORAY! Alexander Woollcott returns to the air via WABC on October 7th and each Sunday thereafter at 9:00 p.m.; sponsored by the Cream of Wheat Corporation. This is very good news! Robert Armbruster's Orchestra will supply the musical background. . . . And speaking of Bob reminds me I heard a rumor that Jimmy Kemper may be back on the air soon. I hope so, for Jimmy is a great artist. . . . With the passing of the Schlitz Revue, Raymond Paige's musical revue, "California Melodies," was expanded to forty-five minutes, but only for two broadcasts; on October 5th comes a return to their former half-hour schedule, 10:30 to 11:00 p.m., each Friday. . . . Cobina Wright, former operatic singer and director of many notable New York society events, has been engaged by the Artists Bureau of the Columbia Broadcasting System to provide talent and ideas for private engagements. . . . "Gulf Headliners" takes the air over the CBS networks on October 7th, starring Will Rogers. Will is to be heard for the first seven weeks, and then Stoopnagle and Budd will be starred for the seven weeks after. . . . If you are interested in "Doctors, Dollars and Disease," as applied to the health of you and your family, you might find food for thought in a series of programs now being heard over CBS each Monday at 10:45 p.m. . . . October 5th brings Stokowski and the Philadelphia Orchestra back to music lovers, each Friday at 3:00 p.m., for a series of nine concerts. . . . And won't the kids be glad to hear that "Skippy" is back again, five times a week from Monday through to Friday at 5:15 p.m. WABC. . . . In Columbia's "Quotes of the Week" Roxy says:

ROXY SAYS THAT:

"Radio has not only developed its own air personalities but has, with very few exceptions, introduced to the armchair audience the finest artists of the concert and opera stage. Facilities, transmission and reception have so improved that it is no longer considered a miracle to listen to musical festivals in Europe, songs of the native Hawaiians, or a broadcast from a ship at sea. There is really nothing left in radio to be done, except to do it better. I hope that our efforts at simplicity and realism will result in a better show and meet with the listener's approval." . . . I can still listen every morning to Muriel Pollock and Vee Lawnhurst—though how the girls can be so full of piano pep that early in the day I'm sure I don't know; and another thing that puzzles me is how so many single radio singers (by single I mean filling a spot alone) can drag out a fifteen minute program with slow songs—each one of the same tempo, timbre, and technique; guess they need a lesson in program building, which after all, is an art in itself. . . .Jack Benny is returning to NBC networks on October 14th at 7:00 p.m. With him will be Don Bestor, Frank Parker, and Announcer Dan Wilson. This will be Frank's third season with Jack and Don's one-and-a-half. . . . And back comes the Mystery Chef, which is good news for the housewife; October 3rd is the date at 9:30 a.m. and each Wednesday and Friday thereafter at the same time; NBC-WEAF. . . . Joe Penner and his famous duck will start to quack on October 7th, at 7:30 p.m. and every Sunday from then on throughout the winter. Ozzie Nelson and Harriet Hilliard will be heard with him. Sponsored by Fleischman's Yeast in behalf of the bakers of America. . . . Do you remember Mrs. Pennyfeather? Well, she, too, is back; this perennial pesterer of perturbed people will be heard regularly each Tuesday morning on NBC's Morning Parade program over WEAF at 10:35 a.m. She is one of the now numerous realistic characters contributed by radio and strangely enough is recognized as such largely by men. . . .

REAL MUSIC HERE

Interest among radio listeners in the world's best music will receive considerable support and impetus in two new series of programs to be heard four times a week over NBC networks. These two series will be known as the Great Composers Program and the Master Music Hour. The first named will be heard on Mondays and Thursdays at 1:45 p.m. over WJZ and the Blue network. The Master Music Hour will be heard on Tuesdays at 1:30 p.m. and Fridays at 4:00 p.m. over WEAF and the red network. The programs will be under the joint direction of Frank Black, NBC music director, Walter Koons, music supervisor, and Dr. Damrosch and his assistant, Ernest La Prade. . . . A new series of programs is coming in from the NBC Chicago studios, re-creating for the listener Jules Verne's immortal "Mysterious Island," with all its original charm and flavor. These cleverly dramatized programs are heard each Monday, Wednesday and Friday at 6:15 p.m. over WEAF. . . . Jessica Dragonette has been honored by the American Dahlia Society. This year's prize dahlia has been named after the Cities Service soprano. . . . And now Mary Lou has gone to Hollywood. Muriel Wilson, who sings the role of Mary Lou in the Maxwell House Showboat, is having a good time and a bit of a vacation—something she deserves, as she has been kept very busy during the last year. . . . Am very glad to find that Al Bernard and Paul Dumont, those two minstrel veterans, are putting on a show for Molle over NBC-WEAF. Tune in and listen to these two minstrel cut-ups; each Monday, Thursday and Friday at 7:30 p.m. . . .

IRENE BEASLY, RADIO QUEEN

Of course, you know it was Irene Beasly who gained the title of Radio Queen this year. Irene is a clever girl, talented and intelligent. Good luck to you, my dear. . . . Eddie Cantor is welcome on Sunday nights at 8:00 p.m. WEAF. The popeyed comedian is back with his old sponsor, Chase & Sanborn. Rubinoff is there also. . . .

ELECTED BY THE NBC

New officers have been elected by the Board of Directors of the National Broadcasting Company. Mr. M. H. Aylesworth is still the President; R. C. Paterson, Jr., is Executive Vice-President; Mark Woods, Assistant Executive Vice-President, and A. L. Ashby, Vice-President and General Attorney. Among the nine other Vice-Presidents are George Engels and John F. Royal. H. K. Norton is Treasurer; Lewis MacConnach, secretary; and R. J. Teichner, Assistant Treasurer. . . . The American Broadcasting System announces a new program to be heard over WMCA-ABS on Thursdays at 6:15 p.m. The broadcast will emanate from the studios of WDEL, Wilmington, Del., and will be conducted by Dr. Edmund E. Miller, of the Modern Languages and Literature Department of the University of Delaware. Dr. Miller will review current books. . . . Tom Noonan is still keeping up the good work of helping the under dog; his broadcasts, as the Bishop of Chinatown from "The Cathedral of the Underworld," may be heard each Sunday over the WMCA-ABS facilities at 3:00 p.m. . . .

BITS AND PIECES

Ralph Kirbery, the Dream Singer of NBC, is an expert pistol shot; he recently donated a gold medal to be awarded to the high scorer in a police pistol match at Teaneck, N. J. . . . June Meredith, NBC actress, got her start in the dramatic profession with the New York Theatre Guild. Richard Bennett was head of the cast in which she had her first part. . . . Courtney Riley Cooper, the author, who is writing the script for "The Gibson Family," was once a circus clown. . . . Mr. and Mrs. Fred Waring are the proud parents of a baby daughter, born Friday, September 14th. They named the child Dixie, because Papa Waring was on his way to Virginia during the time the baby was born. . . . Roxy is breaking his butler into the radio business; the butler played a cockney part on Roxy's first program over WABC. . . . H. V. Kaltenborn will lecture on current events at Columbia University this winter. . . . The ABS-WMCA folks put themselves on the radio map with their sensational broadcasting of the Morro Castle trials. . . . Phil Duey has two children, a boy six years old and a girl, four. . . . Donald Novis is married to Juliett Burnet, a Pasadena, California, girl he met while both were singing in a church choir. . . .

ANSWERS TO CORRESPONDENTS

E. V. MASON, N. Y.—Ray Heatherton is unmarried. Lives in Floral Park, Long Island, with his family. Has blue eyes, brown hair. Will send his photograph if you write him in care of the National Broadcasting Company.

FRANCES ERNST, Forest Hills, Long Island.—A letter will reach Andrea Marsh, in care of the Columbia Broadcasting System, 485 Madison Avenue, N. Y. C. I don't believe Miss Marsh is broadcasting at present.

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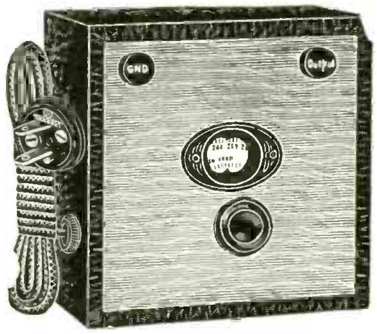

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