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1933

STABILIZED OSCILLATOR

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RADIO
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WORLD
The First and Only National Radio Weekly
Twelfth Year *574th Consecutive Issue*

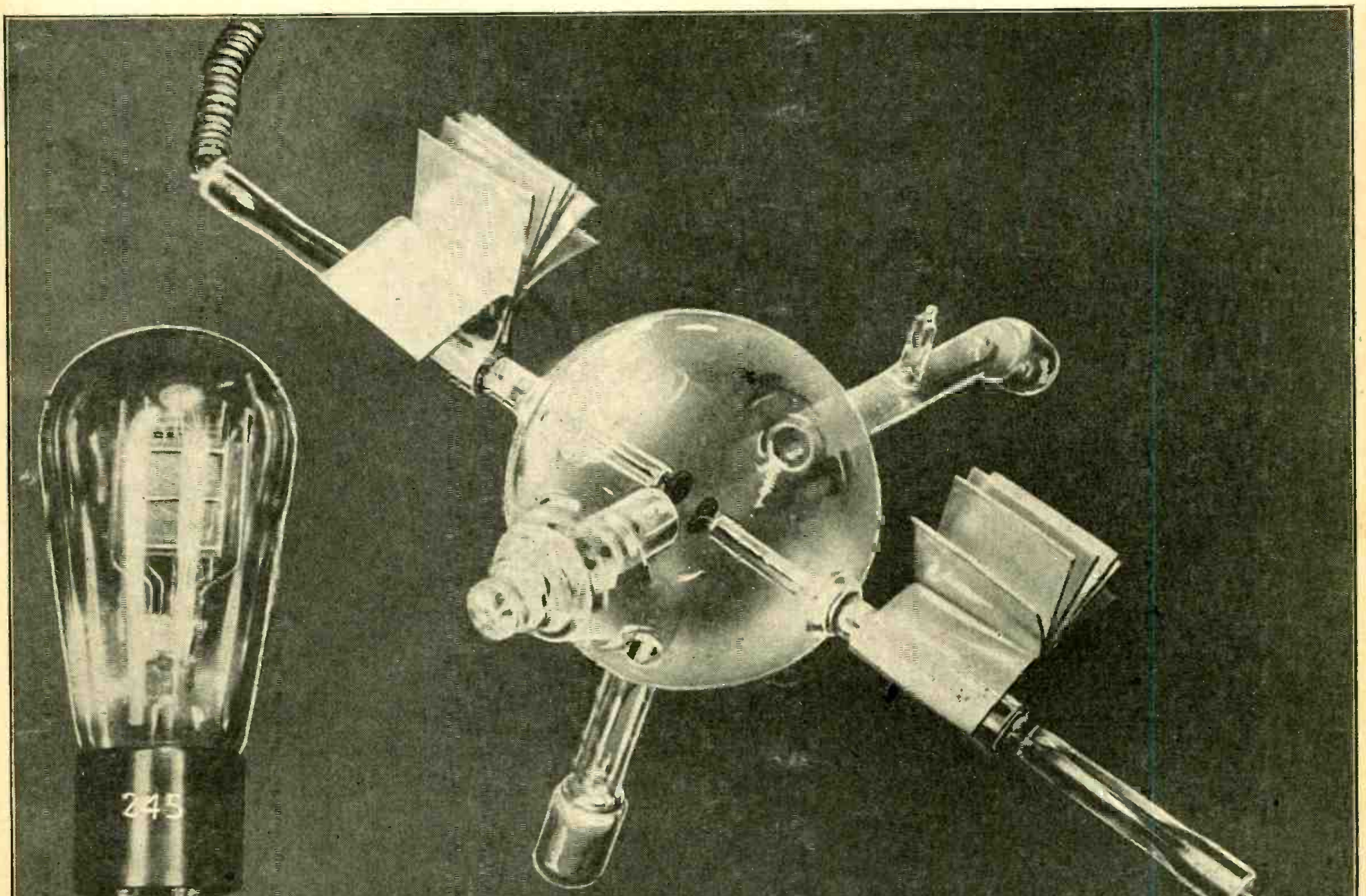
New Tubes Reviewed

The 77 as Detector

Matching Impedances

Purpose of a Baffle

NEW "WHITE LIGHT" TELEVISION TUBE



A new light source for television is the mercury arc tube, compared in size to a 245. This is a high voltage device, the voltage applied across the coiled terminals, upper left, lower right. The light is conducted through a quartz rod (left). The "book leaves" are fins to radiate heat. See article on page 8.

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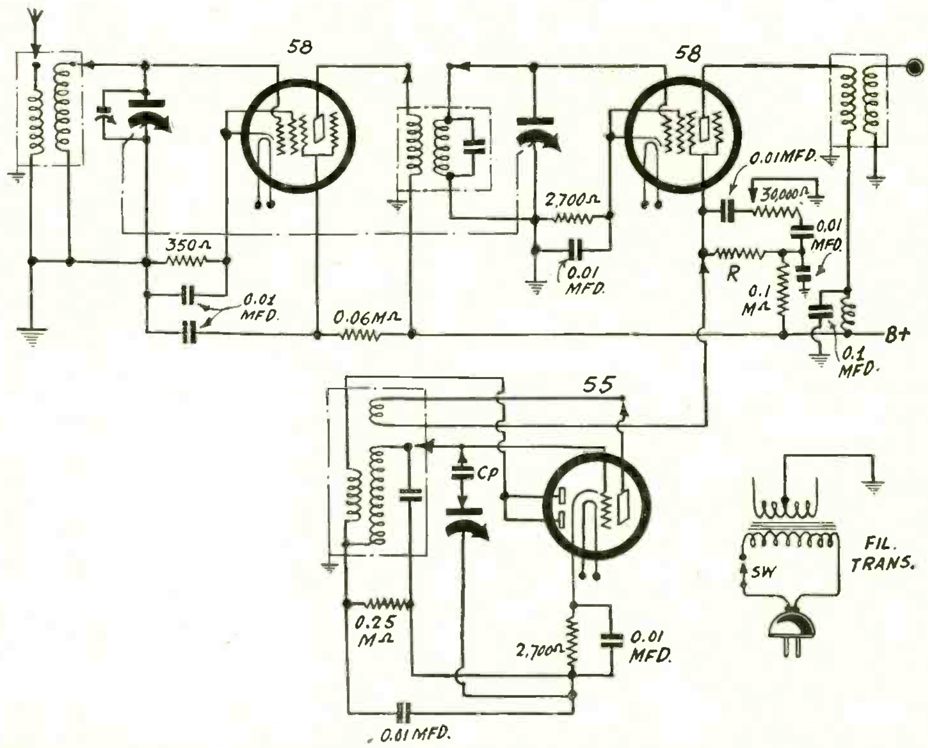
Frequency-Stabilized Oscillators and Electron-Coupling in Design of
STEP-TUNED CIRCUIT

By Herman Bernard



The converter for use with a receiver, whereby the oscillator (lower) is tuned in steps. The short-wave tuning (above) is conventional at the signal level, but instead of tuning the oscillator continuously, the intermediate level is tuned. The oscillator is frequency-stabilized by the constant plate impedance method via bias control.

THE subject of a step-tuned circuit for short waves, and affording broadcast coverage by usual means, was first broached in these columns in the January 21st issue. The general plan is to have a broadcast receiver and use this for broadcast reception by switching the antenna to the receiver's input; then have a mixer consisting of a short-wave signal-tuning device, and a separately tuned short-wave oscillator which is adjusted in band-steps, and not continuously tuned, while the broadcast receiver is tuned as usual, but this time being used as a variably tuned intermediate channel. Thus, if the broadcast band is taken as 1,000 kc, because that frequency coverage can be obtained readily, while the "front end" of the combination for short-wave use would be subject to formal tuning, the short-wave oscillator would be moved from step to step in 1,000 kc grades, and the band-spread for the rest of the short-wave tuning, as derived from the broadcast receiver, would be in 1,000 kc spreads. Hence for much of the tuning effect there would be 1,000 kc band-spread, and as this would apply independent of signal frequency, one would have the benefit of this great spreadout even on the highest frequency bands, where of course it is needed most.

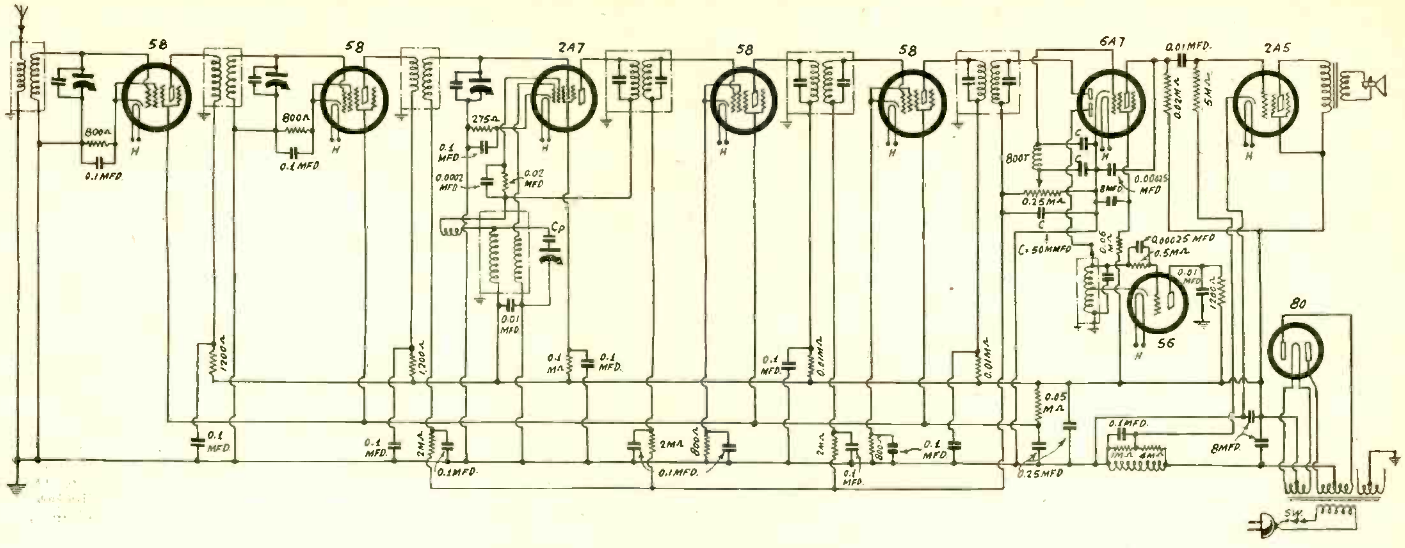
To state the situation a little differently, there would be a broadcast receiver for broadcast use, and a short-wave converter for short-wave use, the broadcast set being used on short waves as a variably tuned intermediate amplifier. A feature of the converter would be that the oscillator is tuned only in steps, because the broadcast receiver tuning for short waves would be used instead of oscillator frequency continuous variation.

Switching to Be Tried

The method, therefore, may be applied to almost any receiver, whether tuned radio frequency or superheterodyne, and the same principle holds. If the broadcast receiver is itself a superheterodyne we have two intermediate frequencies, first that of the broadcast set for amplifying short-wave signals at a lower level, then that of the channel that in superheterodynes is conventionally called the intermediate amplifier for amplification at a still lower level. Suppose the receiver tuned from 530 to 1,530 kc. Then that would be the first intermediate amplifier. Suppose the low-frequency amplification in the r-f realm were 465 kc. Then that would be the second intermediate amplifier.

It is proposed to accomplish the converter purposes by using a switching device, in conjunction with tuned circuits and tubes, deriving the B power from the receiver

(*Continued on next page*)



The broadcast-frequency unit, consisting of a superheterodyne covering a little more than the broadcast band, i.e., 1,000 kc., from 530 to 1530 kc. This is used for tuning in broadcast signals, also for variably tuned first intermediate amplifier. The 2A7 oscillator-modulator is used, with loading coil type of frequency stabilization. The 56 is the beat oscillator for i.c.w. The diode-pentode is the 2B7.

(*Continued from preceding page*)
proper, but using an independent filament transformer.

The circuits have been formulated in general as shown herewith, but little work done on them, and no report of operating results will be given until all the experimental and developmental work is completed. It can be seen, however, that there is a liberal sprinkling of new tubes.

The attempt will include a stage of t-r-f in the short-wave signal-tuning unit, because since the receiver is a superheterodyne pressed to utmost amplification at the broadcast level as well as at the 465 kc level, the only place where greater radio sensitivity can be developed is at the short-wave signal level, and a stage of t-r-f will do that, and besides will reduce interference. No interference trouble should arise in so selective a system except at the very high frequencies, and despite what selection follows the short-wave mixer, the effect of images would be carried through, hence the t-r-f stage.

Constant Output Oscillator

At the high frequencies to be tuned in at the or near the extreme it is particularly important that the local oscillator in the short-wave mixer be stabilized. So the method has been adopted of having an auxiliary negative bias on the oscillator controlled by the amplitude of the oscillation. This can be accomplished with a 55 tube, by using the triode as the oscillator and one of the diode units, or both diode units in parallel, for rectifier. A winding inductively related to the grid coil feeds the diode, and the load resistor is apportioned so that not all of the possible bias will be added.

So there is a starting bias equal to the drop in the cathode leg resistor, and as the oscillation rises the voltage across the load resistor increases, this elevates the bias to that extent, and the increased bias lowers the amplitude, linearly. Hence a correction factor is introduced to cure both slow and rapid fluctuations in frequency. The correction takes place within the time of a single cycle, in theory, if one disregards the time constant of the resistor-capacity circuit associated with the load, but at all hazards the plate impedance is maintained constant within an undetermined time short enough to be beyond any ordinary method of measurement. The constancy of the plate impedance, around 7,500 ohms, results in the frequency stability.

Grid-Leak Oscillator

There has been all kinds of trouble in connection with short-wave oscillators, particularly in regard to the ultra or near-ultra frequencies, due to drifting of the oscillator. This is by far the most serious frequency-instability trouble, because of the great effect on the tuning caused by the oscillator. When the frequencies are high the change in frequency would be great, so frequency drift in the oscillator would result, as it were, in the set tuning itself out, or tuning from one station to another automatically. Moreover, if the frequency change is small, and consistent with some definite period, the same effect is produced as if there were fading, and this would be present though the frequencies involved are in the fading-free realm. It is well-known that the ultra-frequencies are virtually immune from fading and static.

Very little has ever been offered to the constructional public to enable the building of a short-wave or ultra-wave receiver that has a frequency-stabilized oscillator. About as far as this opportunity has been developed has been the use of the grid-leak type. This is quite stable if the ratio of the capacity to the inductance is large, and the leak high, but where a wide span is to be covered the ratio will be small for the greater percentage of frequencies, if only because the frequency change is more rapid at the smaller capacity settings. What is not often said is that the grid-leak oscillator is unstable at the higher frequencies through which the circuit is tuned, although this point was brought out by Argimbau in the "Proceedings" of the Institute of Radio Engineers a few months ago, and was reported at about that time, and previously, in these columns.

A Ready Relative Measurement

In the absence of any precision measuring equipment it is advisable to use broadcasting stations in the higher frequency brackets, say, 1,300 to 1,500 kc, for since the stations are limited to a variation of plus or minus 50 cycles from assigned carrier frequency, and besides having their frequency crystal-controlled and crystal-monitored, the percentage of accuracy required is higher for the higher frequency stations, because 50 cycles is a smaller percentage of the carrier frequency. Thus, at 1,500 kc 50 kc is 1 part in 30,000 whereas at 550 kc 50 kc is 1 part in 11,000, or the percentage of accuracy requirement is about three times as great in one instance than in the other. However, some stations on lower frequencies have a reputation for most scrupulous adherence to assigned frequency, such as large stations of considerable power and important engineering facilities, and might vary much less in absolute frequency than a 1,500 kc station which has imposed on it a requirement of greater percentage of accuracy.

Attempt at Zero Beat

Therefore, selecting either a high frequency broadcasting station, or any broadcasting station of high repute as to frequency stability, it is quite easy to build a grid-leak type oscillator, filter it well, have a sharp and unmodulated emission, and beat its carrier with that of the selected station. The attempt should be made to establish zero beat, that is, no difference in frequency, test oscillator compared to the oscillating wave from the station.

While zero beat is a common recommendation, in actual practice it is almost impossible for the general experimenter to establish the condition, because the adjustment has to be so fine that a precision or laboratory dial must be used. Even then the O adjustment is delicate and not at all infallible. About the best that can be expected is a low growl that passes for zero beat, but of course at zero beat there would be no sound due to the mixing. We shall assume some sound, the lowest pitch you can establish. Now you may listen to the beat. It will not change in pitch if the oscillator is frequency-stable. This condition would exist for about three-quarters of the mechanical spread of the dial, but as to the rest there will be a rising and falling of pitch, and this denotes frequency instability. On a frequency basis, there is stability for about half the range and instability for the other half.

Electron Coupling

Nevertheless the frequency stability is better by the grid leak method than by the uncorrected negative bias method. The grid leak type is of the negative-bias variety, also therefore may be called the grid current type, as distinguished from "infinite impedance grid" type. The correction factor proposed is the one outlined as to principle by Argimbau, although he showed no circuit diagram, but it is the same proposition outlined by the author in connection with discussion of and statement of desirability of a "constant output amplifier tube." The stabilized oscillator is a constant-output amplifier tube. Argimbau applied the constant-output idea to an oscillator.

Along with frequency stabilization of oscillators one naturally would expect something about electron coupling, and the local oscillator in the short-wave mixer is coupled to the modulator by the electron method. This coupling may be defined as that arising from intercommingly in the space streams of tubes. Space stream contributions by the elements concerned are thus made mutual. Here we have the oscillator plate attracting electrons from the cathode of the oscillator, hence there is conduction from plate to B minus, and at the same time part of the oscillator plate stream is diverted to the screen circuit of the modulator, whereas part of the modulator screen electrons return through the oscillator tube, and this mutuality constitutes electron coupling. To establish such mutuality there must be a common impedance, but this should not be regarded as the coupling medium, for it exists for the purpose of introducing a positive modulated voltage.

Percentage Modulation Control

The common impedance is the small resistor R, which may have a value of a few hundred ohms, while across it, isolated by condensers so the rotor may be grounded, may be any non-inductive potentiometer, used as a percentage modulation control, to prevent modulator overload and also to serve as volume control, if it is desired to control volume on short-wave reception from this point, rather than anywhere else.

A small manual trimmer is across the antenna coil's secondary, the trimmers for the modulator and the oscillator are across the coils and not across the condensers, as they must be set differently for the respective bands, and besides different values of padding condensers are introduced into the oscillator so that the steps will be more nearly evenly distributed. Otherwise there would be about ten times as many 1,000 kc steps for the highest frequency span as for the lowest.

As for the switching, antenna has to be switched from one primary to another for four coils, and to a fifth position for the broadcast set (broadcast frequencies); the high ends of the primary and secondary be switched to four positions; so must the the interstage coil, while the oscillator is entirely independent, and may be switched to five or more different positions for greater segregation of steps, with padding capacities accordingly.

A 12-Tube Combination

There are three tubes in the converter and nine tubes in the broadcast receiver unit.

The mixer tube, third from left in the broadcast receiver, is the new 2A7, and the oscillator unit thereof is frequency-stabilized by the loading coil method. The stabilization arises from the change in phase introduced by the loading coil so that the voltage is in phase with that of the tuned circuit. The method is a very simple one and was designed by J. E. Anderson, who is also responsible for the step-tuned oscillator idea and continuously tuned intermediate channel.

The second detector in the superheterodyne broadcast-frequency receiver is a 2B7, which is like the 55, except that the amplifier unit is a pentode, instead of a triode, and has an enormous amplification factor. This, like the 2A5, is a new tube. The 2A5 is like the 247, except that it is of the heater type, and that the amplification factor, or mu factor, is higher, i.e., 220, an increase of 70.

High Sensitivity as Goal

The power output is 3 watts, and this is sufficient for home use, as comfortable volume arises at between 1 and 2 watts output, depending on individuals. The sensitivity is the thing, particularly in conjunction with short waves. The idea is to raise to room volume all reception that otherwise would be of the whisper level, and the high sensitivity tubes accomplish this with minimum hum and with good tone.

The broadcast band level of tuning is of a standard type, but the local oscillator is special, as stated. Note that the local oscillator has plate circuit tuned. In this connection there is necessarily a step-down ratio between plate and grid windings, and 4-to-1 is suggested.

The padding of the oscillator circuit must be in accordance with the "second" intermediate frequency. Assuming 465 kc, the proper oscillator inductance would require a padding capacity of about 330 mmfd., so a padding condenser of 250 to 350 mmfd. would be suitable. If the tuning condensers are 450 mmfd., as they were in an experimental setup, then the r-f secondaries should have 200 microhenries inductance, obtainable by winding 100 turns of No. 28 enamel wire on 1.25 inch diameter. The primaries may have 20 turns, wound next to the secondary, or fewer turns if wound over the secondaries. The oscillator's tuned inductance should be close to 130 microhenries, obtainable by winding 70 turns of No. 28 enamel wire on 1.25 inch diameter. The tickler winding would be adjacent, consisting of 22 turns, while the loading coil would have exactly the same inductance as the directly tuned winding, but would not be inductively related to the other windings.

Air Dielectric Condensers

The intermediate transformers tried were those newly made by Hammarlund, whereby the primaries are tuned from the bottom and the secondaries from the top, air-dielectric condensers being used for tuning. Mica dielectric, not hermetically sealed, has been found to suffer from moisture and temperature effects too much for a highly accurate receiver. The selectivity is higher, as well as signal-to-noise level, using the air-dielectric condenser-tuned transformers.

Of course, the effect of unprotected mica at one place is repeated in any other place where it is used as condenser dielectric, and therefore examination must be made of the criticalness of a circuit as to frequency. We find the local oscillator uses a padding condenser, and this may be rated in the critical class, therefore an air-dielectric condenser should be used, if possible, especially as the padding condenser is small in comparison to the tuning condenser.

The two "second" intermediate stages are subjected to automatic volume control. If there is i-f oscillation, and there may be a little, the screen voltage may be reduced, by increasing the value of the resistor in series with the screen feed and B plus, or a resistor may be placed across the primary in the plate circuit of the oscillating tube, which likely would be the first intermediate. This resistor should not be of any lower value than that necessary to stop oscillation, and while 20,000 ohms will do the trick, higher values should be tried, consistent with killing off oscillation.

Power Tube Bias

The bias for the power tube may be taken from the drop in the field coil. By placing this coil in the negative leg the bias is obtainable from two resistors across the coil, grid return to joint. This permits the use of speakers with various values of d-c resistance in the field, and with an output transformer of 7,000 preferably of from 7,000 to 9,000 ohms impedance. Approximately the same power output at the same harmonic distortion (total 7 per cent.) is obtainable under either circumstance.

The resistor method of obtaining bias has the advantage of permitting the inclusion of a high value of grid leak. Then, though a heavy loud signal or passage would ordinarily cause grid current, and loss of bias in the power tube, the grid current would flow through the smaller resistance section of the voltage-dividing resistor network across the field coil, to B minus through the field coil, and, with signal removed by a condenser, the situation is akin to holding the bias fairly constant despite signal, because the same signal that tends to reduce bias on the power tube tends to increase it in the other part of the circuit.

The apportionment of biasing resistors may be on the basis of the voltage drop across the field coil and the required bias. Thus if 100 volts are dropped, and 20 volts of bias are desired, then the resistors require a 1-to-4 ratio, with the resistor between joint and ground made as high as is practical or convenient, so that any grid current will have a greater bias-elevating effect at this position. Since resistors of the value order of megohms might be selected, they may be 1 and 4 megs. respectively, the lower value between grid return and ground. An easy way of arriving at correct values would be to test for the plate current flow in the power tube, using resistance values accordingly for bias. The B current should be kept at around 40 ma. if measured in the cathode leg (for here screen and plate currents combine) or if in the plate circuit only, 32 ma.

Forum

I READ the short article in your publication, the issue dated February 18th, 1933, concerning your explanation of echo reception.

Echo reception in this vicinity seems to be a rather common thing, to such an extent that it has aroused an interest of investigation on my part.

Your explanation of the echo phenomenon seems plausible enough and perhaps the echo is produced in some cases in this manner. However, I have found echo reception on certain frequencies in as many as 100 receivers, with no existing defect in the receiver and the receiver does not necessarily have to be a super.

Do you not think this phenomenon is the result of two stations operating on very close channels, and transmitting the same signal from a chain hookup, with a large difference in the mileage in the connecting wires of the two transmitters and the central studio? When the receiver is tuned so that it picks up the side bands of each wave, the signal from one of the transmitters is not quite in synchronism with that of the other due to variation of the impedance of the various parts of the land sound carriers. Thus, an echo effect is produced in the receiver.

JOHN WALTER MOORE,
203 East Main Street,
El Dorado, Ark.

* * *

HAVING NOTED a query in your columns in the February 18th issue regarding "echo reception," beg to advise that we have made some extensive experiments in regard to this phenomenon, and in our opinion it is due entirely to time lag or delay in land lines of the chains.

This may be readily verified by observing that echo reception is only to be had with the receiver tuned exactly in between two station carriers modulated by the same land line program. As echo reception is found on tuned radio frequency receivers as well as superheterodynes, it is improbable that adjustment of the super will remedy this condition in any way. At least, we have checked it with supers that were carefully balanced throughout, and found no difference. The fact that the t-r-f set is more susceptible to echo due to broader tuning seems to bear out the theory, as it would take in a wider section of the adjacent channels when tuned between them.

RALPH W. CUTTS,
Bloomington, Ind.

A THOUGHT FOR THE WEEK

MUSIC PUBLISHERS, SINGERS AND STATION CONDUCTORS, BEWARE! Thousands of mothers in this country are growing indignant over some of the song numbers that have been offered recently on the air. They believe that they are unfit in words and suggestion for the ears of the youngsters—and the oldsters, too.

And ye sponsors, listen! If you really want to alienate the greatest buying force in the country, keep right on permitting those singers to associate your names and products with their mushy and offensive songs.

BAND SPREADING
With Variable Intermediate Frequency

By J. E. Anderson

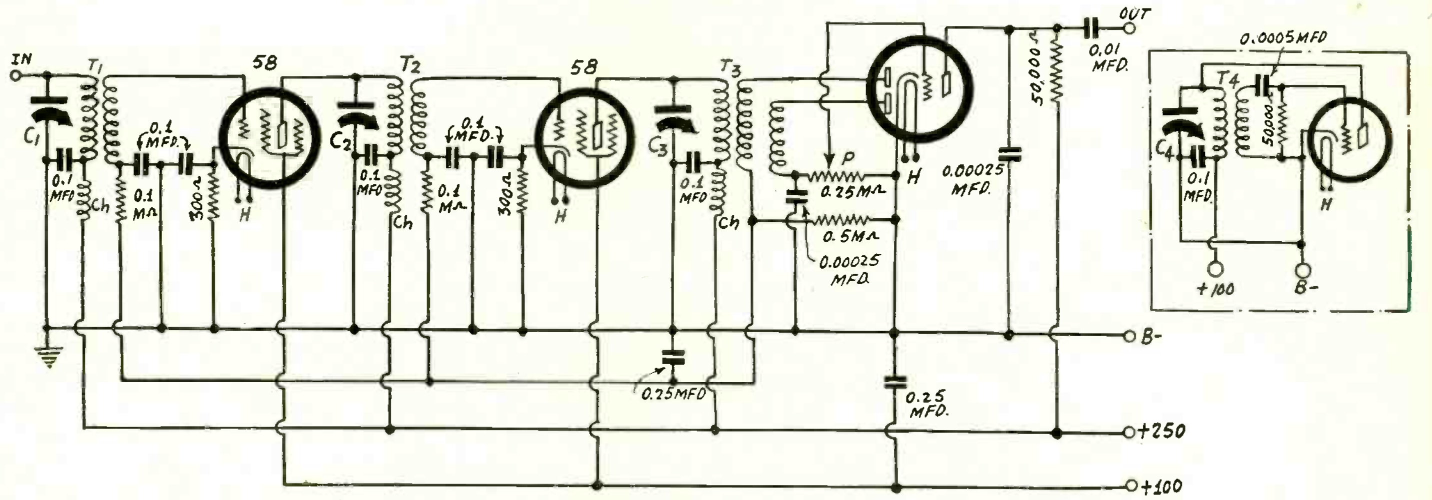


FIG. 1
A band-spanning intermediate amplifier in which a four-gang condenser is used for tuning. Three of the sections tune the plate windings of three transformers and one tunes the heterodyne oscillator.

WHEN the variable intermediate frequency of band-spanning is employed the intermediate tuner should be constructed on same principle as the radio frequency tuner. Indeed, it may be the radio frequency tuner for broadcast signals or for the long wave band used in Europe.

A high gain is one of the requirements, and another is fairly high selectivity. A high gain can be obtained if the tuning condensers are put across the primary of the coupling transformer and if the coupling is made fairly close.

For practical reasons the tuning condensers should be ganged. And if they are to track satisfactorily they all should be in closely similar settings. That is, if one is tuned in the primary they should all be. The tuning condensers may be put across the primaries and still be ground on one side by using a filter condenser with each tuning condenser to complete the circuit, the coil being connected to the B supply and the condenser rotor to ground. These filter condensers should have the same value. Just what the value is does not make a great deal of difference but they should be equal in capacity. A value of about 0.1 mfd. is all right.

Stators Hot

When the condensers are put across the primaries in this manner the stators will be "hot." This fact should be kept in mind when wiring the circuit and also while testing it afterward.

If the intermediate frequency is to cover the broadcast band the three variable condensers in the i-f selector should have the same value as the condensers in a regular t-r-f set, and the primary inductances should have the same values. If no special coils are available, ordinary coils intended for broadcast reception with tuned secondaries can be used by simply inverting the coils. That is to say, the windings ordinarily connected in the plate circuit of the tube head would be connected in the grid circuit of the next tube and the largest winding would go in the plate circuit. Of course, it is not desirable to have a step-down transformer even if the primary is tuned. Therefore an r-f transformer with a small primary winding would not be selected for this circuit, but rather a transformer in which the two windings are equal or one in which the untuned grid winding is larger than the tuned. Certain transformers intended for coupling between the antenna and the first tube in which the two windings are practically equal would be all right.

The Frequency Span

If the intermediate frequency tuner covers the broadcast band the span will be about 1,000 kc, from 540 to 1,500 kc or a little higher. This coverage will be obtained with the ordinary tuning condensers nominally rated at 350 mmfd. However, the coverage depends on the value of the minimum capacity. As a rule, this is higher in the plate circuit than in the grid circuit. If the 1,000 kc band from 540 to 1,540 kc is to be covered the ratio of the maximum to the minimum capacity should be 8.11. If the range of the tuning condenser is 350 mmfd. the minimum must not be greater than 49.2 mmfd. in order to give the desired span. This minimum is easily reached even when the condenser is placed in the plate circuit.

If the intermediate tuner will cover a band of 1,000 kc when it is used for receiving broadcast it will have the same coverage when it is used as intermediate tuner in a short-wave superheterodyne.

Beat Frequency Oscillator

At the right of the intermediate frequency amplifier circuit is shown an oscillator circuit. It is customary in short-wave receivers to have an oscillator operating at or near the intermediate frequency for use as an aid in tuning for stations for rendering continuous wave code signals audible. Such an oscillator is a very valuable adjunct in a short-wave superheterodyne.

The fact that the intermediate frequency is variable does not preclude the possibility of using the beat frequency oscillator. It is only necessary to make the oscillator condenser the same size as the tuning condensers and to put it on the same control in order to effect tracking of the oscillator with the i-f. The inductance of the oscillator should also be equal to the inductance in the i-f circuits. Actually there should be a slight difference between the natural frequencies of the i-f and the oscillator circuits. It is hardly necessary to make any effort to introduce the difference but rather an effort to prevent it from being too great. The best beat frequency is around 1,000 cycles per second. If the mean i-f is 1,000 kc the tracking required is about one in one thousand. That is a very severe requirement but not one that need cause any worry. The proper beat may be produced by slight detuning, so slight that there will be no appreciable diminution in the sensitivity, assuming that the tracking of the i-f oscillator with the i-f tuner has been effected reasonably well.

Tuning by Heterodyne

When the oscillator is working there will be typical heterodyne every time the oscillator sweeps through a carrier. If the circuit is adjusted to zero beat and the oscillator then stopped, the signal co-responsible for the heterodyne should be heard plainly. It may possibly be increased in intensity slightly by readjusting the intermediate tuner. Without the aid of the heterodyne it is possible that this particular signal could not have been brought in at all.

Sometimes it will happen that the heterodyne can be brought to a distinct zero beat with some carrier, yet the signal cannot be heard when the oscillator is turned off. This is mainly due to the weakness of the signal and the relative strength of the beat note. In such cases one has to forego the pleasure of listening to that station at that time, unless the sensitivity can be increased greatly by means of the volume control.

I. C. W. Reception

When receiving interrupted continuous code signals the beat frequency oscillator is essential. Without it the signals may be entirely inaudible or they may merely be heard as dull thuds and key clicks. With the heterodyne oscillator the signals will be clear musical dots and dashes.

MATCHING IMPEDANCES

Object to Transfer Maximum Power Usefully

By Einar Andrews

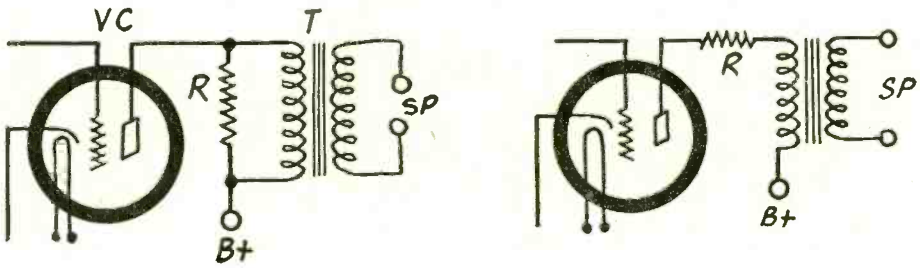


FIG. 1

Proper matching of impedances cannot be effected by putting a resistance R across the primary, as at left, or in series with the primary, as at right. The resistance only wastes power.

THE subject of matching impedances is frequently misunderstood by many radio fans. They forget the object of matching entirely or they have not yet come to realize it. One place where the misunderstanding shows up is illustrated in Fig. 1. Here we have a power tube VC and an output transformer T. Let us suppose that the transformer has not been designed to match the impedance of the tube and that of the speaker and also that the impedance of the transformer is too high for that of the tube. Then the question is, "Why cannot a resistance R be connected across the primary of the transformer and adjust its value until the impedance of the primary and the resistance, in parallel, is equal to the output impedance of the tube?"

It is true that impedance connected to the tube can be adjusted in this way so that the tube delivers the maximum power, or the greatest undistorted power, to the load on the tube. But that is not the object of the circuit, that is, to get the tube to deliver the greatest output to *some* load. The object is to deliver it to the loudspeaker or to some other device where it is useful.

Wasting Power

If the transformer does not match impedance properly, part of the energy that should go to the useful load is either wasted in the internal resistance of the tube or it is left in the d-c source of power. If the impedance of the primary is too low the power is wasted in the internal resistance of the tube and if it is too high it is never converted from d-c to a-c. In either case the power delivered to the useful load is less than what it would be if the match were right.

Now, we can reduce the load on the tube by connecting a resistance R across the primary. The power converted from d-c to a-c by the tube would increase, but this increase would not go to the speaker or other useful load. It would be wasted in the resistance R. If the impedance of the primary of the power transformer is too high it is better to leave it as it is than to attempt to match impedances by connecting a power absorbing resistance across the primary. The quality will be better and less power will be wasted.

Case of Low Impedance

The case when the impedance of the primary is too low is similar. In this case a resistance could be connected in series with the primary in order to make the total impedance of the load such that greatest power, or greatest undistorted power, would be delivered to the total load. But, as before, there would be no gain as far as power in the useful load is concerned, for the power that is wasted in the resistance would not add anything to the power in the speaker or other load.

In this case, however, there might be a slight improvement in the quality by putting the resistance in series. There might even be an actual saving in power, but there would be no increase power to the useful part of the load, and the improvement in quality, if any, would probably not be appreciable.

Impedance of Primary

We have mentioned the "impedance of the primary" a number of times. This expression is rather indefinite, for the impedance of the primary depends on what is connected across the secondary. If the secondary is short-circuited the primary is practically short-circuited, too, in effect. Neglecting the resistance of the secondary winding, as well as the resistance of the primary, the reactance of the primary when the secondary is short-circuited is $Lw\ (1-k^2)$, in which L is the inductance of the primary, w is 6.28 times the frequency, and k is the coupling coefficient between the two windings. In a well-designed power transformer the coefficient k is very nearly unity and therefore the short-circuit impedance is nearly zero.

When the secondary is open the impedance of the primary is simply Lw, assuming that the resistance is so low that it may be neglected in comparison with the reactance of the coil. Thus the primary impedance, as presented to the tube, may vary between nearly zero and Lw, which is usually a very high value.

Neither of these extremes gives the best match, for in practice the load is neither zero nor infinite. The best match occurs when load on the secondary is such that the primary impedance is equal to the output resistance of the tube, if greatest power is desired, or equal to the optimum load impedance, if greatest undistorted output is desired. This match occurs when the inductances of the two windings bear the same ratio as the two resistances. Since for an iron core transformer the inductances are proportional to the square of the number of turns, the proper match occurs when the ratio of turns is equal to the square root of the ratio of the resistances.

Matching Formula

Suppose the effective resistance of the voice coil of the speaker, while sounding, is R ohms and that the optimum load resistance of the tube used is r ohms. Let the primary and secondary turns be N1 and N2. Then the best match occurs when $(r/R)^{1/2} = N1/N2$. The assumption is that there is no leakage reactance or that the coupling between the primary and secondary windings is perfect. If that is the case the matching does not depend on frequency and the impedance of the secondary will look like a pure resistance to the tube if the voice coil impedance is a pure resistance.

Even if the voice coil impedance of the sounding speaker is a pure resistance, this resistance does not remain the same for all frequencies. Hence if the transformer matches at one frequency it does not necessarily match at any other. But if the matching is exact at one frequency in the audio band it will be close enough for most other frequencies for the matching condition is not extremely critical.

Typical Values

Let us give a few typical examples of matching. A 48 tube requires an optimum load resistance of 2,000 ohms. Suppose that the effective resistance of the voice coil of the speaker is 5 ohms. Then the ratio is 400 and the ratio of turns should be 20 to one.

The 247 tube has an optimum load resistance of 7,000 ohms. Suppose it is to be used with a speaker that has a voice coil resistance of 15 ohms. Here the ratio of the resistance is 466 and therefore the ratio of turns should be 21.8/1.

Perhaps the matching transformer is to be used between a tube and a speaker with a built-in transformer which has not been designed for this tube. Let us assume that the speaker with its transformer has been designed for use with a 247 tube and that it is required to use it with a 48, which requires a load of 2,000 ohms. If the built-in transformer is correct is has a primary impedance of 7,000 ohms. Hence we have to have a transformer that will match 2,000 to 7,000 ohms. In this case it will be a step-up transformer. The resistance ratio is 2/7, the square root of which is 0.535, which should be the ratio of the primary to the secondary turns of the extra matching transformer. This is a ratio of 1-to-1.9, or practically 1-to-2 step-up.

Voice Coil Impedance

It should be remembered that the voice coil resistance as measured with a d-c instrument is not the effective resistance that is put across the secondary of the transformer. If this were the only resistance there would be no appreciable change with frequency. The resistance that really counts is the motional resistance, that due to the radiation of sound from the diaphragm. This resistance is similar to the radiation resistance of an antenna. The radiation, or motional, resistance of the speaker varies with frequency, increasing as the frequency increases.

The radiation resistance also depends on the baffling on the speaker diaphragm and on the size of the diaphragm. The larger the diaphragm, provided it acts as a piston, the greater is the radiation resistance. Also, the larger the baffle the greater the resistance.

NEW VISION TUBE

Mercury Vapor Lamp Gives "Almost White" Light

By Samuel S. Torrisi

Chief Engineer, Television and Electric Corporation of America

For the past two years the laboratories of the Television and Electric Corporation of America, New York City, have spent most of their efforts on the development of a commercially practical television light source. In the course of this time all of the available television lamps on the market were tested.

These investigations showed that television lamps could stand a great deal more research if the brilliance of television pictures is to approach that of the home movies. The size and detail of television pictures must approximate that of the home movies, so it is reasonable to believe that the brilliance should also be on a par.

Mercury Arc Selected

When we stop and analyze the power requirements of the lamps for a home movie projector and find out that the smallest of these machines consumes a minimum of 100 watts and a maximum of about 375 watts to produce sufficient light for a well-lighted scene, we see that the feeble glow of the present television lamps have a long way to go to compete with the highly developed home movie lamps.

At this writing, and to the best knowledge of the writer, light sources for electrical scanning systems do not match the brilliance of light sources already on the market for mechanical scanning systems. This means that the light source should have as high an intrinsic brilliance as possible.

A glance at a set of tables giving the intrinsic brilliance per square inch of the known commercial light sources shows the mercury arc as being from twenty to twenty-five times that of any other gaseous type of discharge device. Because of this fact and because that here is a wealth of information on this type of lamp pioneered by Peter Cooper Hewitt, it was decided that research along this line would bear the best fruit.

A-C Impedance

One of the greatest difficulties with this type of lamp is in the matching of its a-c impedance as is also the case in inert gas arcs. The one great advantage of mercury vapor over inert gas is in its great stability of operation. In the course of the investigations it was found that impedances of mercury arcs worked well when placed in series in the tank circuits or high frequency drivers, producing resistances comparable to the reflected load of a properly coupled antenna.

Driver Modulated

As this solved the impedance matching problem, and the stability of the mercury vapor allowed powers approaching those used in home movie lamps, this gave a lamp that could compete with the better average home movie lamps.

The problem of modulation was solved by modulating the high frequency driver. It is possible to obtain as much as 100 per cent. modulation with only 5 per cent. distortion. By properly designing the audio system and reflecting the proper resistance in the tank circuit of the high frequency driver it is possible to obtain frequency response to within plus or minus two DB out to 50 kc with the same response as at 20 cycles.

Almost White Light

The extremely short arc for this type of lamp is of great importance because it is this fact that does more to fill out the spectrum in the arc than would be at first expected. At the powers that the lamp has been designed for it produces an almost white light. The electrodes are designed to withstand many times the running current so that there is no failure to be expected at this point.

The lamp in its present stage of development can be compared for size with the 245 photographed with it. All the glass work on this particular lamp is of quartz to withstand the extremely high pressures during the tests. A very brilliant white light forms between the two electrodes and is carried out of the lamp by the quartz rod to a place where it can be put through a television scanning system. A mask at the end of the quartz rod allows the use of any size hole that the scanning system may be designed for.

Stronger Spectrum

The purpose of the quartz rod is mainly to carry the light from the arc to the outside of the lamp, for if the light had to pass through the mercury vapor a great many of the spectral lines would be reversed, due to the absorption of light passing through vapors. This absorption effect is quite high when the pressure of the vapor is high, so that a great deal of the light would be lost by a reversal effect. Consequently this new lamp has a much stronger and a better filled spectrum. A small chamber in the bottom of the lamp holds the mercury, which can be heated to any desired temperature so that either a very low or a very high mercury vapor pressure can be obtained. An external heating system for this chamber can be regnlated to within a very fine degree. A condensing chamber is in the rear to relieve the main chamber when the mercury vapor pressure gets too high. This rear chamber, it will be noticed, is at the end of a considerable length of quartz rod and is not effected by the temperature of the main chamber because of the poor transmission of heat in quartz.

Air-Cooled Chamber

A blast of air, as in the home movie projectors, cools the main chamber. Despite its odd shape the lamp lends itself to easy mounting. The quartz rod is flush with the front of the lamp house so that the mask for the television scanning system serves to keep out all the light that does not go through the scanning system. As the light from the lamp is considerable, a well-built lamp house, as in a home movies projector, is necessary to keep the residual light down as low as possible in the room.

The lamp is not fragile and will withstand much rough handling. There is nothing in its construction that should break due to vibration.

Fills a Need

The new lamp fills a great need in the television field and with a properly-designed scanning system built along the same lines as the lamp, as to efficiency, will produce television pictures that the public should accept. As the development work goes on and the reasons for limitation of brilliance and frequency response are solved it is almost certain that this lamp will be able to keep at least one or two steps ahead of the other major developments in this fast-moving industry.

[Illustration on Front Cover]

Indians' Flares and Television Today Held Not to Be So Far Apart

"A million variations per second in the intensity of a beam of light are accurately translated into variations in the amplitude of an electric current by means of the photoelectric cell," said Dr. A. R. Olpin in his first lecture on "The Transmission of Images and Television" before a large group of students at the Polytechnic Institute, of Brooklyn, N. Y. "These variations are amplified some millions of millions of times before it is possible to transmit them over wires or throughout space to produce what is termed television." He continued his remarks as follows:

"It is a long step from the building of signal fires by savages to modern day television, and yet in principle these two processes are closely allied. Aborigines signalled their scattered tribes by successive flares of smoke, or flame, thus making use of a succession of impulses which excite the sense of sight. In television practice today, intelligence is also conveyed by the transmission of a succession of impulses which can also be made to stimulate the visual sense organs. In the later case, however, these impulses are transmitted millions of times faster."

These remarks opened the first series of a course of twenty lectures. This series considers the physical principles underlying the advances of picture transmission, while the second series will deal with engineering and design problems in modern television transmission and reception and will be given by Ivan Bloch.

THE 77 DETECTOR

100-Volt Source for A-C and D-C Use

The following is the first of a series of "Application Notes" from RCA Radiotron Co., Inc., and E. T. Cunningham, Inc.:

To the set engineer faced with the problem of most efficiently resistance coupling the detector to the output tube in small universal sets, the following circuit, with its table of constants, is of interest.

Inasmuch as 100 volts is about the maximum plate supply voltage available in universal AC-DC receivers, tests for optimum operating conditions for a 77 as a self-biased detector were conducted at this voltage. Even when receiving signals of low percentage modulation, it has been found possible to secure an output voltage from the 77 when operated at this low plate voltage comfortably sufficient to insure full audio output from a type 43 resistance coupled to the 77.

Meaning of Headings

In the tabulation of conditions obtaining for optimum operation, the column headings have the following meanings:

R_p is the plate load resistance of the 77.

R_g is the grid resistor for the 43.

R is the self-biasing resistor for the 77.

Mod. per cent. refers to the per cent. modulation of the r-f signal supplied to the 77.

E_{c2} is the screen grid supply voltage for the 77.

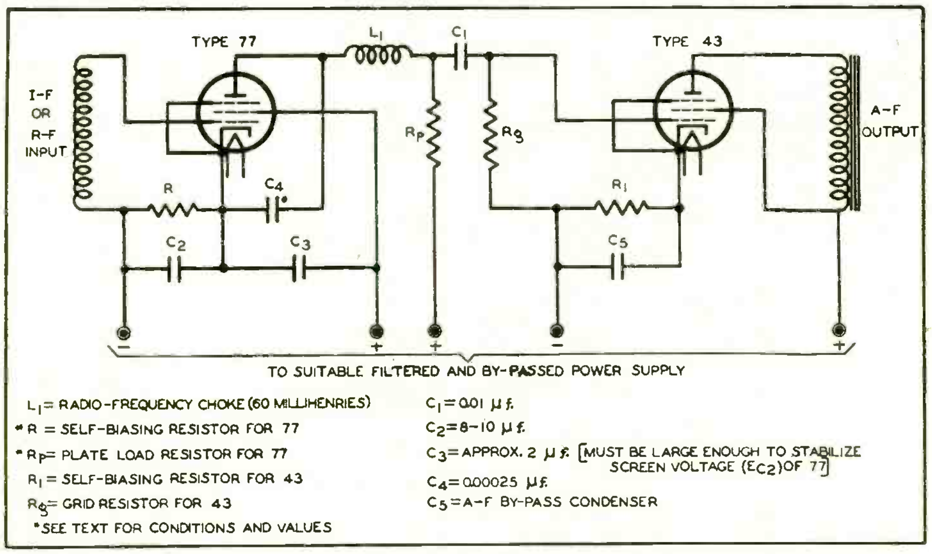
RMS r-f mod. volts is the root-mean-square, radio-frequency modulated voltage which must be supplied to the 77 in order to obtain full audio output from the 43.

Cathode I is the cathode current of the 77. The first column shows the current with no signal, and the second with a signal.

Oscillograms Taken

Bias Voltage is the bias on the grid of the 77. The first column shows the bias voltage with no signal, and the second with the specified signal voltage.

If a higher bias resistance, or a higher screen supply voltage is used instead of the values shown in the table, the sensitivity of the detector will be reduced. The tabulated conditions for optimum operation were determined by varying first one and then another of all possible variables and noting the results. Oscillograms of the resulting wave forms were also taken to guide the selection of optimum conditions. In this way, conditions for maximum power output with minimum distortion for a required r-f signal input and various combinations of plate and grid resistors were determined, with the output voltage of the 77 held constant at 14 peak volts input to the 43.



A detector circuit for universal a-c and d-c receivers, with constants selected for 100-volt supply. The detector is a 77, which is the automotive equivalent of the 57, and is a new tube.

CONDITIONS FOR OPTIMUM OPERATION AS A SELF-BIASED DETECTOR
(Plate supply of 100 volts)

R_p Megohms	R_g Megohms	R Ohms	E_{c2} Volts	RMS R-F Mod. Volts	Cathode I No. Sig. Microamps.	Cathode I Sig. Microamps.	Bias Voltage No. Sig. Volts	Bias Voltage Sig. Volts
0.25	0.25	12,500	36	1.88	155	255	1.94	3.18
0.50	0.25	17,500	30	1.86	100	178	1.75	3.15
0.50	0.50*	15,000	20	1.10	90	135	1.35	2.02

Notes:
*A resistance of 0.5 megohm in the grid circuit is allowable only when the receiver is so designed that the heater voltage for the 43 does not exceed 25 volts under the maximum line-voltage conditions encountered in service.
All of the above readings were taken at 1,000 kc.

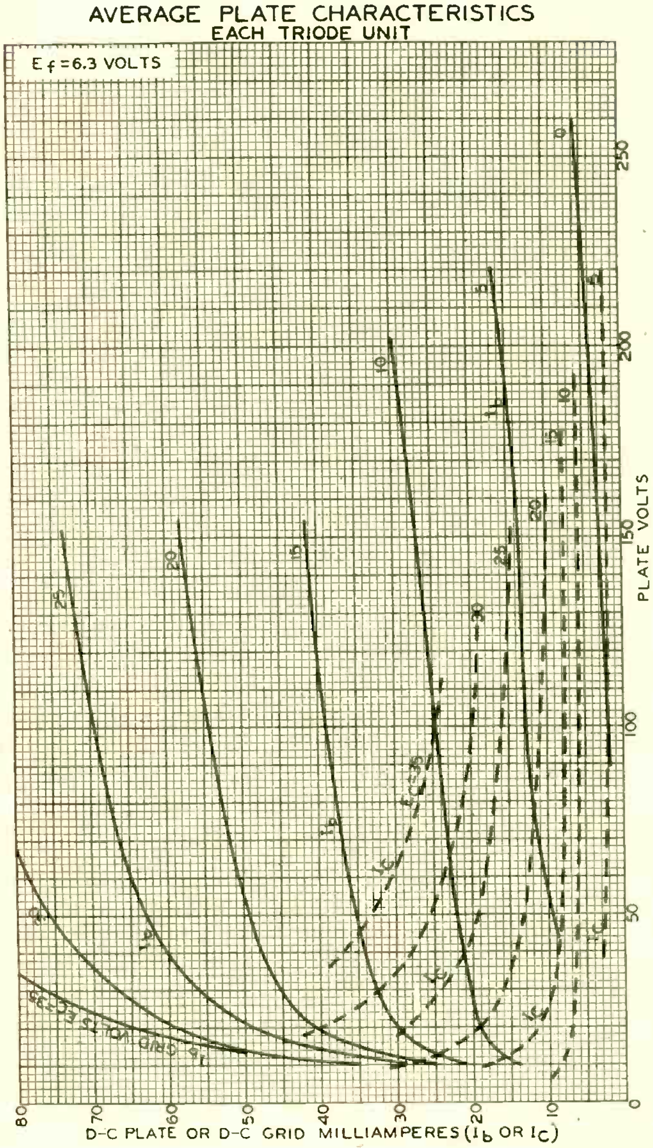
Cuban Broadcasting Stations

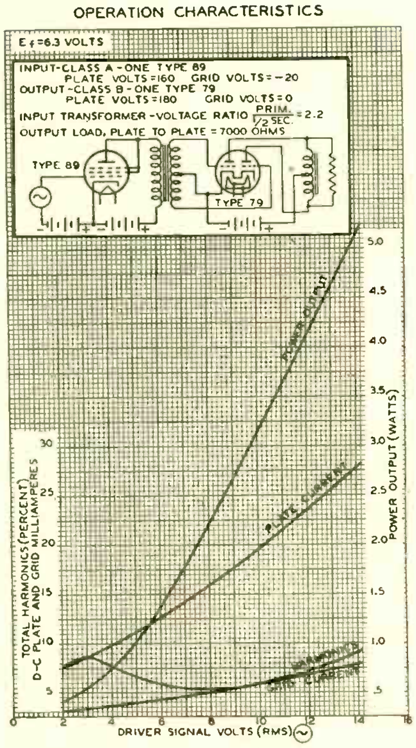
All Stations of 50 Watts or More Are Listed, With Frequency in Kilocycles, Equivalent Wavelength in Meters, Call Letters, Location and Owner, With Address

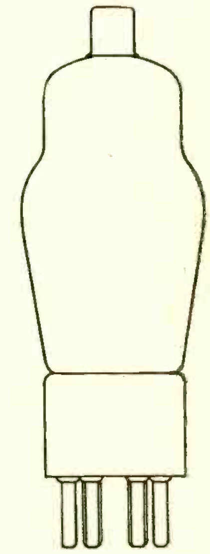
kc.	*m.*	*Power*	*Call*	*Location*	*Owner*
1,405	213.4	100	CMBY	Havana	Lino E. Cosculluela, Animas número 134
1,327	226	250	CMKH	Santiago de Cuba	Alberto Ravelo, J. A. Saco s/n
1,249	240	250	CMKE	Santiago de Cuba	Edmundo Recamier, E. Palma, baja 72
1,225	244.7	150	CMCA	Havana	Manuel Cruz, Amistad y San José
....	...	250	CMCN	Marianao	Antonio Ginard, Reina y Av. B. Retiro
1,154	260	200	CMHA	Cienfuegos	Fox Bross Co., Gacell núm. 48, altos
1,150	260.7	250	CMQ	Havana	José Fernández, 25 número 445, Vedado
....	...	600	CMCQ	Havana	Andrés Martinez, Vista Alegre 80, Vibora
1,070	280.2	150	CMBT	Havana	Emilio Perera, Finlay número 84
....	...	150	CMBG	Havana	Francisco Garrigó, Dragones número 16
...	...	150	CMCB	Havana	M. D. Autrán, Neptuno número 141
1,034	290	150	CMKC	Santiago de Cuba	M. P. Martínez, Lacret y San Pedro
1,010	296.8	150	CMBZ	Havana	Manuel y G. Salas, San Rafael número 14
....	...	150	CMBW	Marianao	Modesto Alvarez, A entre 6 y 8, La Sierra
...	...	250	CMCX	Marianao	"El Mundo," Aguila número 60
955	313.8	150	CMBD	Havana	Luis Pérez García, Enmorados y Flores
...	...	150	CMBC	Havana	Domingo Fernández, Máximo Gómez número 139
920	235	250	CMHD	Caibarién	Manuel A. Alvarez, M. Escobar número 17
900	333.1	500	CMX	Havana	Francisco Lavín, San Lázaro número 99
...	...	250	CMCF	Havana	Raoul Karman, Rayo número 67
845	354.8	500	CMC	Havana	Cuban Telephone Co., Aguila número
834	360	100	CMGA	Colon	Leopoldo V. Figueroa, Martí número 19
790	379.5	150	CMBS	Havana	Enrique Artalejo, Calzada y H. Vedado
...	...	500	CMHC	Tuinucú	Frank H. Jones, Central Tuinucú
730	410.8	3,000	CMK	Havana	Cia. Cubana de Radiodifusión Hotel Plaza
660	454.3	225	CMCO	Marianao	John L. Stowers, Almendares número 58
588	510.0	700	CMW	Havana	Columbus Com. and Radio Co., Paseo de Martí número 103
550	545.1	250	CMCJ	Havana	Rafael Rodríguez, Estévez número 4

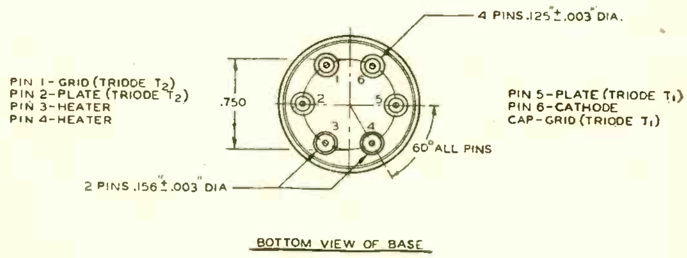
THE NEW TUBES

A Review of Those on the Market or Out Soon









Diagrams from RCA Radiotron Co., Inc., and E. T. Cunningham, Inc.

Curves on the 79 twin amplifier, with socket connections and a sketch of the appearance of the new tube. The purpose is to have two Class B push-pull tubes in one envelope. The heater takes 6.3 volts, and therefore the tube is for so-called d-c use, including battery operation, car use and d-c line receivers.

MANY new tubes are about to appear on the radio market. Some have entirely new features while others are similar to existing tubes but provided with heaters or filaments adapting them to other services.

One of the new tubes is the 75. It is a duplex diode triode with a high amplification factor in the triode part, and it is provided with a 6.3-volt heater so that it can be used on storage batteries and in d-c receivers where the heaters are connected in parallel. It is essentially the same as the 85 tube with the exception that the amplification factor of the triode is much higher. Since it is a high-mu tube it will be particularly suitable for resistance-coupled amplifiers. Its list price will be $1.60.

Another new tube is the 77, a triple-grid tube with a 6.3-volt heater. The tube corresponds with the 57 in the 2.5-volt series and the characteristics of these tubes are alike except for the difference in the heater voltages and currents. The tube will be suitable for detection in grid bias circuits, for mixing in superheterodynes, and for noise suppression controls. It will require a six-contact socket. The list price of this tube will be $1.80.

The 78 and the 79

Still another tube in this series is the 78, which is like the 58 in all respects except that it has a 6.3-volt heater. It can be used as r-f and i-f amplifier and as first detector in a superheterodyne. The list price of this tube will be the same as that of the 77, $1.80.

The next tube is the 79, which is a twin amplifier with a 6.3-volt heater. It has been designed especially for Class B power amplification in automobile receivers, but it may also be used in universal receivers, since it has an independent cathode. Only one of these tubes is needed for a Class B stage, as it is really two push-pull tubes in one bulb, but a driver stage is needed in front of it. The list price of this tube will be $2.60.

Several other new tubes are about to be announced officially. These are the 2A7, 2B7, 6A7, and 6B7. All of these are of the heater type, the first two having 2.5-volt heaters and the second two having 6.3-volt heaters.

The 2A7 and 6A7 tubes are pentagrid converters and have been designed especially for oscillators and mixers in superheterodynes. A single tube will perform the two separate functions without the necessity of resorting to the autodyne arrangement, for these tubes have separate elements for the different functions. The inside elements are the oscillator and the outside, together with the cathode, which is innermost, are the mixer elements. These tubes are expected to be on the market early next month, and they will list for $2.20. *(See next page)*

(*Continued from preceding page*)

The Duplex Diode Pentodes

The 2B7 and 6B7 tubes are duplex diode pentodes and they are for 2.5 and 6.3 volts, respectively. These tubes are similar to the 55 and 85 except that the amplifier portion is a pentode instead of a triode. They may be used for all purposes where the 55 and 85 could be used and they will give considerably greater output voltage because of the higher gain in the pentode. The 6B7 is particularly suitable for automobile receivers in which diode detection, automatic volume control, and high gain are essential. The 2B7 is equally suitable for a-c operated receivers.

The two duplex diode pentodes will be available about the same time as the 2A7 and the 6A7, and they will list for $2.00.

The advantages of the new tubes are obvious. Let us take the automobile tubes, for example. First, we have the 78 as a radio frequency amplifier of high gain. Then we have the 6A7 pentagrid which will serve both as oscillator and mixer. Thus we not only save a tube but we gain in conversion efficiency.

In the i-f amplifier we might use one or two 78s, according to the sensitivity required. Then would come a 6B7 duplex diode pentode to act as automatic volume control, diode detector, and pentode audio frequency amplifier. The efficiency of this detector and audio amplifier would be high enough to justify the omission of the intermediate audio stage, and following up the detector with an 89 power pentode. An automobile receiver of six new tubes having a greater sensitivity than one of eight using the older tubes could be assembled. Even if only one i-f stage were used the receiver would be satisfactorily sensitive for most conditions.

It is possible that the 77 tube will also be known as the 6C6 and that the 78 will be known as the 6D6.

The 2A3 is another of the new tubes which is destined to be popular among those who want excellent quality and a great deal of it. The tube is a filamentary triode requiring a filament current of 2.5 amperes and a filament voltage of 2.5 volts; that is, a filament wattage of 6.25 watts. Two of these tubes in a class A amplifier are capable of 15 watts of undistorted output. That is more than the output of a pair of 250 tubes in push-pull and about five times as much as the maximum undistorted output of a pair of 245s in push-pull. The 2A3 will have a list price of $4.00.

Operating Voltages

The operating voltages of the 2A7 and 6A7 are as follows: Plate voltage, 250 volts; screen voltage, 100 volts; anode grid voltage, 250 volts; control grid bias, minus 3 volts. The total cathode current, that is, the sum of the plate and screen currents, is 14 milliamperes. The filament current for the 2A7 is 0.8 ampere and that for the 6A7 is 0.3 ampere.

The operating voltages of the 2B7 and 6B7 are: Plate voltage, 250 volts; screen voltage, 125 volts; grid bias, minus 3 volts. The amplification factor is 730, the plate resistance 0.65 megohm, the mutual conductance 1,125 micromhos, and the plate current, 9 milliamperes. The heater currents of these tubes are the same as the currents of the 2A7 and 6A7.

While the plate and screen voltages are the same for the 2.5 and 6.3 volt tubes, the voltages on the automobile tubes may be less. For example, the tubes may be operated on a 135 or a 180 volt battery.

PENTAGRID POSSIBILITIES

The new pentagrid tubes, being two tubes in one envelope, may be used for purposes now served by two different tubes. Thus, one could be an audio modulator for a test oscillator surrounding the other, or the two entities used for an audio frequency beat oscillator

TUBE CHARACTERISTICS

233

Type of tube	Filamentary pentode
Socket	Five-contact
Purpose	Power amplifier
Overall height	4 11-16 inches
Overall diameter	1 13-16 inches
Filament voltage	2 volts, d-c
Filament current	0.26 ampere
Ballast for 3-volt supply	3.85 ohms
Ballast for 6-volt supply	15.4 ohms
Plate resistance	50,000 ohms
Optimum load resistance	7,000 ohms

Amplifier

Plate voltage	100 volts
Screen voltage	100 volts
Grid bias	8 volts
Plate current	10.5 milliamperes
Screen current	2.5 milliamperes
Amplification factor	60
Mutual conductance	1,200 micromhos
Max. undistorted output	300 milliwatts

Amplifier

Plate voltage	135 volts
Screen voltage	135 volts
Grid bias	13.5 volts
Plate current	14.5 milliamperes
Screen current	3 milliamperes
Amplification factor	70
Mutual conductance	1,450 micromhos
Max. undistorted output	700 milliwatts

(*Socket No. 6, January 21st issue*)

49

Type of tube	Filamentary two-grid
Socket	Five-contact
Purpose	Class A and Class B power amplifier
Overall height	4-11/16 inches
Overall diameter	1-13/16 inches
Filament voltage	2 volts, d-c
Filament current	0.12 ampere

Class A Amplifier

Plate voltage	135 volts
Grid bias	20 volts
Plate current	6 milliamperes
Amplification factor	4.5
Plate resistance	4,000 ohms
Mutual conductance	1,125 micromhos
Max. undistorted output	170 milliwatts
Optimum load resistance	8,000 ohms

Class B Amplifier

(*Average two tubes*)

Plate voltage	180 volts
Grid bias	zero.
Plate current	4 to 28 milliamperes
Mutual conductance	3,000 micromhos
Optimum load resistance	9,000 ohms (min.)

A driver stage with a special coupling transformer is required to feed the Class B amplifier tubes. The driver may be a 49 operated as a Class A amplifier.

(*Socket No. 7, January 21st issue*)

234

Type of tube	Filamentary pentode
Socket	Four-contact
Purpose	Super-control r-f amplifier and detector
Overall height	5 1-4 inches
Overall diameter	1 13-16 inches
Filament voltage	2 volts, d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Grid-plate capacity	0.02 mmfd. (max.)
Grid-filament capacity	6.4 mmfd.
Plate-filament capacity	12.8 mmfd.
Screen voltage*	67.5 volts

Bias Detector

(*For detector in superheterodyne*)

Plate voltage	90 to 180 volts
Grid bias	8 volts for 180 volts on plate
Plate current	Adjust to 0.3 milliamperes or less by means of bias

Amplifier

Plate voltage	135 volts
Grid bias	3 volts
Plate current	2.8 milliamperes
Screen current	About 1-3 of plate current
Amplification factor	360
Plate resistance	600,000 ohms
Mutual conductance	600 micromhos

Amplifier

Plate voltage	180 volts
Grid bias	3 volts
Plate current	2 milliamperes
Screen current	1 milliampere
Mutual conductance	620 micromhos
Amplification factor	620
Plate resistance	One megohm

*If the tube is used in a resistance coupled circuit for amplification with a high resistance in the plate circuit the screen voltage should be much lower.

The cap is the control grid.

(*Socket No. 4A, January 21st issue*)

231

Type of tube	Filamentary triode
Socket	Four-contact
Purpose	Power amplifier
Overall height	4 1-4 inches
Overall diameter	1 9-16 inches
Filament voltage	2 volts, d-c
Filament current	130 milliamperes
Ballast for 3-volt supply	7.7 ohms
Ballast for 6-volt supply	30.8 ohms
Amplification factor	3.8

Amplifier

Plate voltage	135 volts
Grid bias	22.5 volts
Plate current	8 milliamperes
Plate resistance	4,100 ohms
Mutual conductance	925 micromhos
Max. undistorted output	185 milliwatts
Optimum load resistance	7,000 ohms

Amplifier

Plate voltage	180 volts
Grid bias	30 volts
Plate current	8 milliamperes
Plate resistance	3,600 ohms
Mutual conductance	1,050 micromhos
Max. undistorted output	375 milliwatts

(*Socket No. 1, January 21st issue*)

232

Type of tube	Filamentary tetrode
Socket	Four-contact
Purpose	Detector and amplifier
Overall height	5 1-4 inches
Overall diameter	1 13-16 inches
Grid-plate capacity	0.06 mmfd. (max.)
Grid-filament capacity	6.0 mmfd.
Plate-filament capacity	11.7 mmfd.
Filament voltage	2 volts, d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Screen voltage*	67.5 volts

Bias Detector

(0.25 megohm load.)

Plate voltage	180 volts
Grid bias	6 volts
Plate current	0.3 milliamperes or less
Screen current	About 1-3 plate current

Amplifier

Plate voltage	135 volts
Grid bias	3 volts
Plate current	1.7 milliamperes
Screen current	About 1-3 plate current
Amplification factor	610
Plate resistance	950,000 ohms
Mutual conductance	640 micromhos

Amplifier

Plate voltage	180 volts
Grid bias	3 volts
Plate current	1.7 milliampere
Screen current	About 1-3 plate current
Amplification factor	780
Plate resistance	1,200,000 ohms
Mutual conductance	650 micromhos

(*Socket No. 4, January 21st issue*)

*When a high load resistance is used in an amplifier circuit the screen voltage should be much less from 7.5 to 22.5 volts.

The cap of the tube is the control grid terminal and the G-prong on the base is the screen grid terminal.

230

Type of tube	Filamentary triode
Socket	Four contact
Purpose	Detector and amplifier
Grid-plate capacity	6.0 mmfd.
Grid-filament capacity	3.7 mmfd.
Plate-filament capacity	1.25 mmfd.
Overall height	4 1-4 inches
Overall diameter	1 9-16 inches
Filament voltage	2 volts, d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Amplification factor	9.3
Plate resistance	10,300 ohms
Mutual conductance	90 micromhos
Optimum load resistance	20,000 ohms

Bias Detector

Plate voltage, maximum	180 volts
Grid bias	18 volts

Amplifier

Plate voltage	135 volts
Grid bias	9 volts
Plate current	3 milliamperes
Max. undistorted output	70 milliwatts

Amplifier

Plate voltage	180 volts
Grid bias	13.5 volts
Plate current	3.1 milliamperes
Max. undistorted output	130 milliwatts

(*Socket No. 1, January 21st issue*)

STOPPING GR

to Effectuate a Frequer

IN the construction of a test oscillator wherein an attempt is made to attain frequency stability and linear modulating characteristic, using a-c on the plate, and a rectifier adjunct, the circuit formation naturally requires a high value of resistance common to the grid and rectifier circuits. Any high resistance in series with the grid will render operation on the basis of grid-leak oscillators, if there is any grid current, and the danger of grid current is considerable.

In the circuit tested, using a 55 tube, the biasing resistor was 3,500 ohms, the voltage drop across it 14 volts, hence the plate current 4 milliamperes. The separate winding for the plate was 270 volts a-c.

Only direct current through the biasing resistor accounts for the steady bias, as alternating current would not change it any, and besides it would be of the oscillation frequency, hence bypassed by the condenser across the resistor. The rectified current through this resistor is due to the oscillation voltage being rectified in the triode. There is also some direct current component in the plate circuit proper (plate to cathode), reading 20 volts on a sensitive d-c instrument.

Optional Grid Returns

In erecting the circuit, the grid may be returned through the common resistor, marked 0.25 meg., either to center of the 2.5-volt winding, or to cathode, but if made to cathode there would be no bias on the grid except that due to the diode-anode current through the 0.25 meg. or to grid current, if any. By returning to the center point the 3,500-ohm resistor is effective as bias, because then the 14 volts are established in the right direction as between cathode and grid, and any bias obtained from the diode is additional. However, before there can be any additional bias the voltage across the load resistor must exceed the fixed bias voltage. That is, not until the diode's anodes get 14 volts do they begin to add, for no rectification takes place until then.

The rectified voltage was found to vary between 20 volts and zero, with zero at the low frequency settings and 20 volts at and near the high frequency settings. This is exactly the same behavior as experienced with grid leak type oscillators, which are stable at the low frequencies, when the capacity is large is relation to the inductance, but unstable at the higher frequencies. The oscillation intensity is least at the higher frequencies in the grid leak type, for the plate current is greatest, hence the bias as derived from the grid current through the leak is least, and the grid current itself is of course least.

Grid Current

Some grid current was experienced at first at all settings, and then the oscillator was simply of the grid leak type, because though the 0.25 meg. resistor was intended as the rectifier load, it necessarily was a grid leak. despite its position at the low end of the circuit, as compared to the more usual place. The presence of grid current denoted that the oscillation amplitude exceeded the bias voltage. This was not unexpected. The bias was raised to 75 volts, by using 100,000 ohms for biasing resistor, and still there was some grid current, for the rectifier diode became ineffective, since it would not rectify until the voltage across the 0.25 meg. exceeded 75 volts, which it never did, despite aid from the voltage drop due to grid current.

Such values of oscillation voltage as 75 to 100 volts or so need not be considered large in experiments with this type of circuit, as it is easy enough to let the oscillation amplitude run unchecked so that there is arcing between the plates of the variable condenser. This arcing would take place only at around 300 volts, so it can be imagined that the oscillation voltages have to be treated carefully.

Aside from defeating the diode rectifier, the high value of starting or fixed bias requires a high value of resistor, and the modulation becomes a broad growl at resonance with the tested circuit (say, a broadcast receiver), and zero beat becomes impossible to identify. With the circuit as shown there is zero beat quite definitely at the lower frequencies, with something of the resonance growl left, without discernible zero heat, at the higher frequency settings, and as this is due evidently to overload, a grid suppressor may be introduced, which is more effective as a damper on the higher than on the lower frequencies. When this suppressor was 30,000 ohms the flow of grid current stopped, but values up to 50,000 ohms or so may be used, although at 0.25 meg. the circuit stopped oscillating.

Grid Current Measured

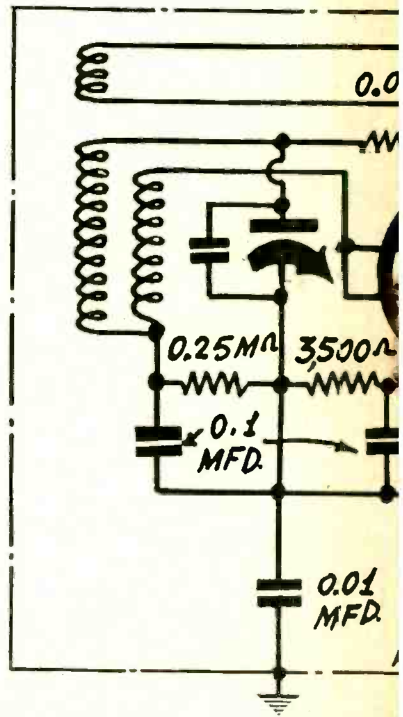
If the diode rectifier load resistor is returned to cathode instead of to ground there would be no bias on the tube except that resulting from the voltage drop due to such rectification, and this again opens up the possibility of considerable grid current. From all angles, therefore, it is clear that the coupling between the rectifier coil and the tuned winding should be close, and should be particularly as stated, rather than a close coupling between plate winding and rectifier, for there is not much power in the plate circuit compared to the grid circuit.

If there is grid current, one method of correction is to introduce still tighter coupling between rectifier winding and grid winding, but the suppressor method has the advantage of not requiring so extremely tight coupling between these two that there is a serious equivalent resistance effect introduced in the grid coil by virtue of the power extracted by the rectifier winding.

Without the grid resistor the grid current ran from 15 microamperes to 0, being highest at the high frequency end, whereas with the grid suppressor there was no measurable grid current, though the instrument would measure as little as 2 microamperes. Then the rectified voltage, assumitively due only to the anodes of the diode, ran from 20 volts to 0, being greatest at the high frequency extreme. This was consistent with absence of grid current, since the amplitude was greatest at the high frequencies, as is usual with high fixed bias amplifiers and tubes generally, save those operated on the grid-current basis with leak. There was some rectified voltage for three-quarters of the dial, or more than 85 per cent. of the frequency span, hence for so much of the coverage the rectification took place because the voltage on the diode anode was positive.

Line Blocking Attempted

The reason for using a separate high voltage winding, instead of the line directly, was to take precautions against shorting the line, and also in attempt to determine whether radiation through the line could be



A test oscillator, with a considerabl modulation uniformity, despite a-c either eliminated grid current or r

Oscillator-Tester Se

By J. E.
President, Nation

Due to new tubes and circuits the serviceman finds that his plug-in set-analyzer or tube tester bought only a short while ago will not fill the complete bill. The result is a rush for adapters.

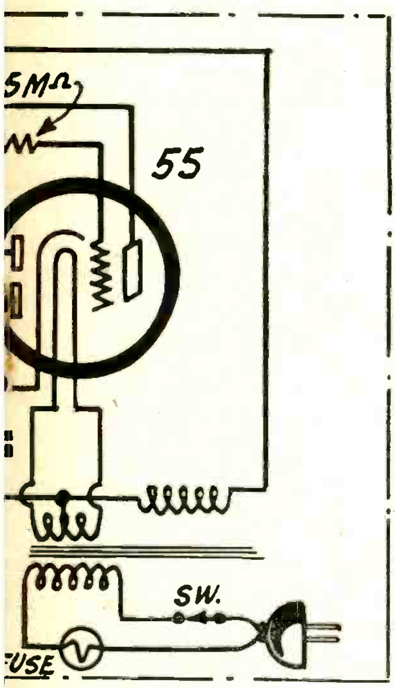
We have had our convictions confirmed by inquiry and observation and by the engineering cooperation of the Philco Radio and Television Corporation in designing a basic testing device that one of the first specifications of the all-purpose tester is that it should be moderately priced. In addition it should be compact and easily portable.

This instrument has a modulated oscillator. By means of two sets of coils controlled by a switch, and by use of harmonics it covers a range of 105 to 2,000 kc. The oscillator tube is electron-coupled to the load. A shielded twin lead permits connection to any r-f. detector, or i-f stage. An attenuator permits wide variation in output signal.

On the meter side of the instrument is to be found a high-grade jewel pivoted microammeter. First, by means of insulated pin jacks, two d-c ammeter ranges are available, 0-1 and 0-100 ma. The 0-1 ma is valuable in that it is a basic instrument for all important radio measuring circuits. There are five d-c voltmeter ranges, 0 to 10, 20,

ID CURRENT

icy-Stabilized Oscillator



e degree of frequency stability and on the plate. The method outlined educed it to inconsequential value.

prevented. So far this prevention has not been accomplished. It is plain that condensers across the primary and secondaries of the power transformer would not help any, since the line a-c would simply pass through the condensers, and matters even became worse, due to the reduction of the choking effect of primary and high-voltage secondary by the condenser put across it. Radio frequency chokes in both primary legs helped a little, probably due to their d-c resistance reducing the voltage, but further than that, nothing. R-f chokes in the legs of the high voltage winding are effective only to the extent that they reduce oscillation, and naturally they become 100 per cent. effective, if large enough.

In many locations the a-c line is grounded, and therefore if the oscillator's power supply is taken directly from the line, the cabinet should be of insulated material, or the circuit insulated from the cabinet. Hence if a simple filament transformer were used with a metal cabinet, and the transformer had its center automatically connected to case, and case were connected to the cabinet, there would be danger of an a-c line short, if ground were connected to the cabinet.

Although a special transformer is shown, with extra plate winding, it is practical to use a shielded metal container or cabinet, with only a filament transformer, and still afford a good measure of protection against shorting of the line, particularly through the body, if a resistor is placed between the grid return of the tuned circuit and the connection to the line side. The higher the value of this resistor the better, although it must not be so high as to stop or seriously reduce oscillation. And of course the resistor should be bypassed by a condenser of 0.0005 mfd. or higher capacity. A value of 10,000 ohms may be tried. This always would be in series with the body and the line, and the voltage would scarcely exceed 50 or 60 volts across the body.

It can be seen that the metal box introduces difficulties, and yet the object of such a box is not radio frequency shielding, because the radiation gets out through the line anyway, hence there will be coupling to a broadcast receiver in the same house, through a-c line conduction. It might seem at first glance that there should be an easy way of preventing it, but there is not.

Shielded Cabinet

In the circuit shown a metal shield cabinet was used, and provision made for grounding. The shield box of course does not prevent the line from carrying the oscillation. The circuit itself is not conductively related to the cabinet, but its r-f ground potential is derived from the capacity to ground in the power transformer and the series ground condenser, 0.01 mfd. Thus, if the line is grounded or not, there is no danger, although a fuse might be included nevertheless, especially one of the automobile type, and around 0.5 ampere, if you can get one of that small capacity, otherwise 1 ampere.

The fundamental frequencies of oscillation of the circuit diagrammed were about 50 to 150 kc, so that the range is useful for determining and fixing intermediate frequencies, either fundamentally or harmonically, and besides the tenth harmonic represents the broadcast band.

It was found that using the ground connection altered the frequencies, and therefore any calibration should be made on the basis of the ground wire attached. Frequency will change due to capacity of the bypass condensers and degree or coupling between windings, but these have nothing to do with frequency stability, only with load constants for resonance, and once selected become an inherent part of the circuit and included in the calibration.

Unheard "Zero Beat"

The frequency stability consists of the freedom from change of frequency due to the behavior of the tube. The stabilizing effect is that of rendering the tube substantially a pure resistance. If the oscillation amplitude controls the bias, and thus tends to establish itself at a steady level at any and all positions of the dial, the condition of constant output is achieved, which is another way of expressing frequency stability.

Besides stability of frequency it is desirable to have linearity of modulation characteristic. This is hard to check up on a self-modulated device like this, where the line frequency constitutes 100 per cent. (or more) modulation, but it will be found that if the oscillation intensity is well inside the overload characteristic of the tube (well removed from grid current conditions), the line hum is very low, and when this is true the zero beat is easy and pronounced. The reason, then, for "absence" of zero beat really is that it is absent from the ear only, but present in the oscillator. The terrific modulation accompanying overload simply drowns it out.

While blocking the line has been discussed and attempted, there is no serious necessity for it, because that method of line coupling may be used at broadcast frequencies when lining up or padding a receiver, although for intermediate frequencies there would be no communication, and a wire from output of the test oscillator would have to be coupled to the intermediate channel. The only thing common with the line would be the heater winding and there would be no coupling through this.

Coil Data

The coil used for the tuned winding was a honeycomb wound on a ½-inch diameter, and having a full diameter of about 1 inch when the winding was completed. The number of turns was 1,300. The tickler winding consisted of 800 turns, the same kind of coil, but need not be so large. However, tight coupling between tickler and secondary aids frequency stability. The rectifier winding was a 400-turn honeycomb coil tightly coupled to the secondary.

It became evident from the frequency span that the distributed capacity of the honeycomb coils of large number of turns is small. This is to be expected, as the capacity of one turn may be regarded as in series with the capacity of the next turn, so the greater the number of turns, the smaller the distributed capacity. It was estimated that the distributed capacity was less than 2 mmfd., and indeed it was less than the amount of capacity necessary to enable the circuit to oscillate. That is, tuning condenser capacity had to be included before oscillation was present. The tuning condenser had rated minimum capacity of 18 mmfd.

—HERMAN BERNARD.

Combines

rvicing Methods

SMITH

l Radio Institute

100, 200 and 1,000 volts, all ranges having a sensitivity of 1,000 ohms per volt.

There are to be found five a-c voltmeter ranges, namely, 0 to 10, 20, 100, 200 and 1,000 volts, having a 1,000 ohm per volt sensitivity. Similarly, there are five output measuring ranges. A switch is provided to change from d-c to a-c.

The meter may be switched from a shunt to a series type ohmmeter by means of a rotary switch. The ohmmeter ranges are 0 to 1,500, 150,000 and 1,500,000 ohms and the readings appear on a well-spaced, easily-read scale. A zero adjustment is provided. The meter is provided with the necessary d-c and a-c scales and a razor edge type needle indicator.

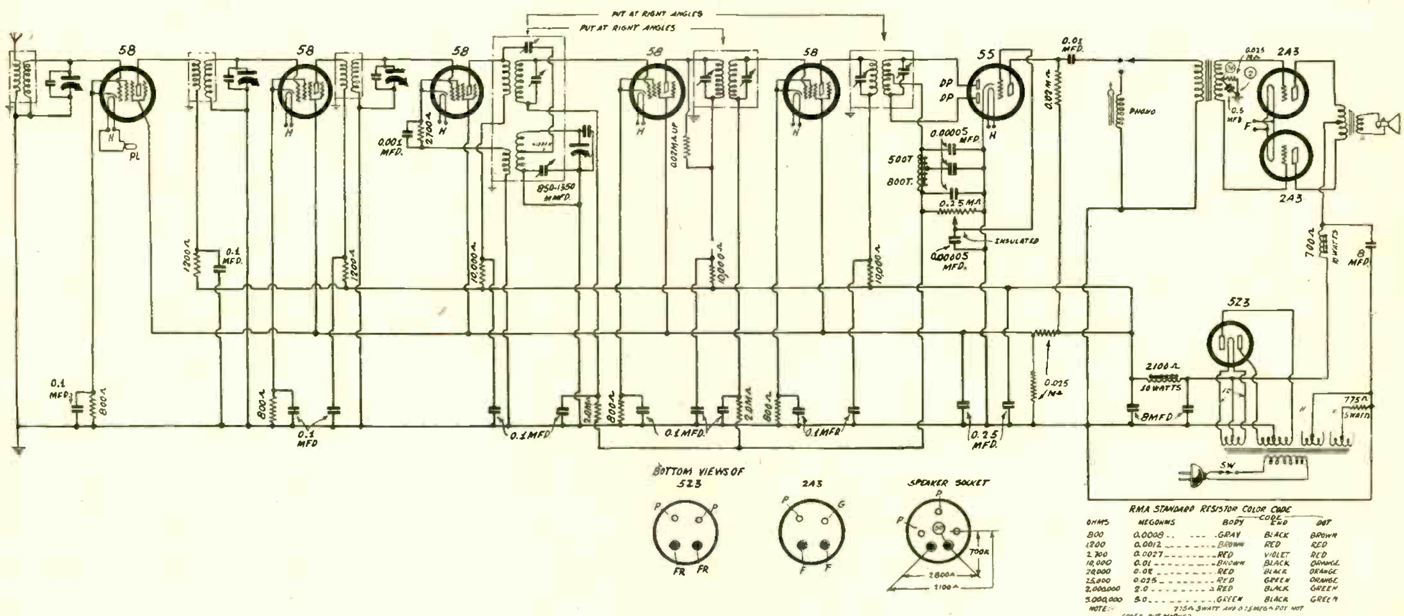
The instrument is provided with test prods and output adapter and is furnished with batteries and tube ready for use. As it comes, it is possible to test tubes, circuits, align r-f and i-f systems and trace power supply and signal circuits. The ambitious serviceman may build special socket analysis and tube testing adapter if his particular requirements make it advantageous.

The instrument is basic in its all-purpose testing ability and its future adaptability is not dependent on the type of circuits or tubes in use.

TWO T-R-F IN SUPER

Push-Pull Diamond Accomodated to 4-Gang Condenser

By Perry Ash



A modification of the Push-Pull Diamond, to assist those who desire to use a four-gang condenser they have. An extra stage of t-r-f is provided, but the total number of tubes remains nine, because the 56 driver of the push-pull stage is omitted. The circuit otherwise follows the standard Push-Pull Diamond detailed in last week's issue (March 18th).

THE circuit herewith is patterned after the Push-Pull Diamond, or rather it would be better to say that it is the Push-Pull Diamond, with two changes introduced. There are two stages of tuned radio frequency amplification, instead of one stage, and the total number of tubes remains nine because the 56 driver of the push-pull output is omitted. This may be done because the total amount of amplication is about the same, or may be even a little greater.

The reason for the circuit is that some builders have four-gang condensers they would like to use. The circuit shows the values of the parts and also the connections. If the standard chassis is used, then the four-gang condenser will project into the space intended for two electrolytic condenser cans, hence these cans would have to be placed underneath, which may be done handily if the condensers are of the dry type.

The total amount of plate current drawn will be just a little higher, as the 56 would draw about 5 ma and the supplanting 58 would draw around 7 ma or a little more, under conditions as diagramed.

Circuit Components

The circuit therefore consists of the following: two stages of t-r-f (58's), autodyne (58), two stages of intermediate amplification at 175 kc (58's), full-wave second detector and direct-coupled first audio stage (55), and push-pull output (2A3's), with 5Z3 as rectifier. The total is nine tubes.

The performance will not be much different with this model than with the standard one, but one may use a still longer aerial. The limitation as to length of aerial depends in a sense on the amount of selection ahead of the first detector, and as we have increased this quantity by the extra stage of t-r-f, we may therefore use a longer aerial.

With the extra t-r-f stage there is a little danger of oscillation at this level, as there is some such danger in the intermediate channel. However, as stated in previous discussions, the intermediate oscillation may be cured by putting a resistor across the primary used in the undesirably oscillating tube, 20,000 ohms or more, the higher the better, consistent with no oscillation.

Parallel Feed

At the radio frequency level the oscillation may be checked in the same way, but the value of resistance should be higher than in the previous example. The danger of r-f oscillation is small, however, as the resistor-capacity filters are more effective at the frequencies concerned than they are at the intermediate level.

While the triode of the 55 feeds the power tube stage, the primary of the push-pull input transformer is not put directly in the plate circuit, but rather a resistor in that circuit carries the direct current, and parallel feed permits grounding the primary. With the direct current kept out of the primary the inductance of the primary is kept at a higher level, and therefore the tone is aided, that is, on low notes. However, with currents of a few milliamperes the subject is not one of any vital concern, and it would not be necessary to introduce parallel feed into the model detailed last week.

The new tubes included in the circuit are the 2A3's and the 5Z3. The push-pull pair are really worth while, for they have a high emission, and are much better output tubes than the 245's which, in a general sense, they supplant. The 2A3's are biased more than the 245's would be normally, and the plate voltage is not quite proportionately higher, and they will stand more than the 245's. The tone quality is even better.

The receiver was built with 245 tubes in the output position as a preliminary, and then when the 2A3's were received they were put in those sockets instead, and the result was a distinct and delightful improvement on the loudest passages. That is, the new tubes stood more gaff, and of course the circuit is so gaited that they are likely to get plenty.

Great Performance

Circuits like this one—that is, the regular Push-Pull Diamond, or modified as outlined now—are proving very gratifying to constructors, especially as they compare them to sets of last season and the year before. The selectivity and sensitivity reach those heights that all have been seeking, and therefore interference due to crossmodulation or cross-talk is eliminated, and the number of squeals is reduced to a very small amount.

It is to be expected there will be four or five squeal points, and so far no one has a sure remedy for their elimination from supers, nor is the theory concerning the squeals fully understood, or, were it so understood, the remedy would follow as a ready consequence.

But four or five squeals are as nothing, when one has a receiver that is such a splendid performer that it causes distant stations to "pour in," and make them audible at almost incredible volume, and with virtually no fading, due to automatic volume control governing the two intermediate tubes.

$282,425.27 MONTH'S TAX YIELD

The United States Internal Revenue Bureau reports collections of $282,425.27 during January, 1933, of excise taxes on radio and phonograph records, under the new five per cent. excise law. Radio Manufacturers Association, Inc., is advised that the monthly reports of the Treasury are of actual "collections" and not of accruals or uncollected assessments. The official monthly collection figures include assessments made in part in previous months, but are of actual current collections.

WHAT BAFFLE DOES

Relationship of Tone to the Radiating Area

By Felix Woodruff

THE purpose of a baffle board in a loudspeaker is not very clear at times. Just what effect does it have? Well, practically we know that a large baffle will bring out the bass notes more strongly. But why?

Let us draw on analogies. Suppose we have a bright source of light. Let us set this up out in the open on a dark night. It does not produce a great deal of illumination. It almost seems lost in the darkness. Now place the same light in the center of a large, flat, white surface, such as a white-painted wall. The illumination seems to be much greater than before, yet the light given out is the same. In the second case, however, it is concentrated. The wall prevents any light from passing backward; all must be on the illuminated side of the wall. Most of the light that would have gone in the direction of the shadow side of the wall now is reflected forward, and the illumination not only seems to be greater, but it actually is.

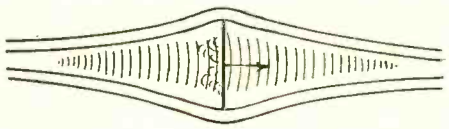


FIG. 1
An unbaffled diaphragm of a loudspeaker moves through the air without setting up much sound disturbance. Turbulence back of the diaphragm causes loss.

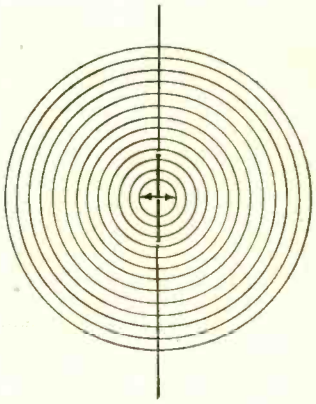


FIG. 2
The radiation pattern of a baffle speaker diaphragm. Strong sound waves are set up because the air cannot escape around the edges.

Another Analogy

Suppose we put the same light inside a room with white walls. Now the light seems very bright and the illumination very great. Of course, the light is no more bright now than it was before but the illumination that it causes is very much greater because now the white walls keep tossing the light waves back and forth many times.

A vertical radio antenna is like an isolated light in the darkness. It shines, though we cannot see the light it gives out. If a reflecting wall were erected on one side of the antenna no signals would move in the direction of the shady side because the wall would send the waves forward. The intensity of the signals would be much greater on one side because of the wall, and that because they would be less on the other side.

Wall to Waves

Such a wall to radio waves would be a series of vertical antennas erected in a row and tuned to the frequency of the transmitting antenna. The tuning would make the wall "white," or it might even "polish" the wall like a mirror. A reflector of this type is equivalent to a baffle board in a loudspeaker.

It is easy to see what happens when a light is set in a white wall but it is not so easy to see that the same thing happens when a large baffle is put on a speaker or when a plane row of antennas is put up on one side of a transmitting antennas. The three cases are closely analogous. In each case a type of wave motion is involved. In each case there is reflection causing the wave motion to be intensified on one side because it is eliminated from the other side.

Of course, there are striking differences among the three cases but they are due to difference in wavelength and to the nature and dimensions of the reflecting surfaces.

Loading the Diaphragm

The speaker case differs particularly from the other two cases in that reflection is not of the same nature. The vibration diaphragm is set in the middle of the baffle in such a manner that it can radiate sound in both directions. The diaphragm either does or should act as a piston moving air back and forth. For the low frequencies where a baffle is particularly effective the diaphragm does act as a piston.

Suppose there were no baffle board attached to the speaker but diaphragm had the same dimensions. It would move a certain distance forward. In doing so the air would flow around the edges. Very little air would be set in motion forward. There would be streamlines past the diaphragm but very little wave motion in either direction.

Diaphragm Reset

Now let the same diaphragm be set in the center of a large rigid baffle board and so arranged that it can move freely yet so that extremely little air could get through the opening between the piston and the baffle. We might imagine a kind of piston ring to prevent leakage. As the piston now moves forward, or backward, no streamlines can appear around the piston edges. But the air must move when the piston moves. The motion takes the form of a wave disturbance. As the piston moves rapidly back and forth the disturbance takes the form of a regular sound wave. If the air is to flow around the edges it must go around those of the baffle board. While some of the air will escape motion in this way a large part of the air in front of the piston and the baffle will be set in sound motion.

Load on Diaphragm

The air constitutes a load on the diaphragm, and it is that load which shows up in the voice coil winding as a radiation resistance. A baffle will increase the radiation resistance on all frequencies, but particularly on the low frequencies.

The diaphragm can also be loaded by means of an exponential horn. In this case the diaphragm, or piston, may be much smaller than when a plane baffle is used. But the area of the opening should still be large and comparable with the wavelength of the lowest pitch sound that is to be reproduced.

The advantage of the exponential horn is that no air can escape around the edges of the piston and extremely little can get back around the edges of the horn itself. To be satisfactory the horn should really be exponential from the piston to the opening. The horn is really a special form of baffle.

Illustration of Air Motion

In Fig. 1 is illustrated the motion of the air in the case of a non-baffled diaphragm. The motion is caught in that phase when the actual motion of the piston is toward the right. Small sound waves are radiated, that is, weak ones, and these are represented by the arcs of circles in front and back of the diaphragm. Note that all these arcs of circles have their centers on the same side. They are drawn in this manner to indicate phase. If there is a condensation at the right there is a rarefaction on the left. This is obvious from the motion of the diaphragm that causes the waves.

Air Streamlines

The long curved lines around the edges represent the streamlines of the air. The air does not actually move along these lines for the motion is only relative in respect to the piston. The air does move a little at right angles to the streamlines. The small curls back of the diaphragm represent air turbulance, which arises because the moving piston is not streamlined. The turbulance causes a loss which reduces the efficiency.

Fig. 2 represents the case of a baffled speaker diaphragm. No air escapes around the edges of the diaphragm and a large amount of air is set into sound vibration. The large circles represent the sound waves. They are concentric circles about the center of the piston. It is understood that the two sets are 180 degrees out of phase.

WORTH THINKING OVER

THE grand total of $3,500,000 *spent last year by cigarette firms for programs on the air may be lost or be very materially reduced during* 1933. *Three leading firms in the tobacco industry have been spending more money during a given period than any ten firms in other branches of business. Then came the price-cutting war and now—well, ask the sorrowful representatives of some big advertising agencies and you will hear some tales of woe. But it was great while it lasted!*

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Transposition Blocks

WHAT ARE transposition blocks and on what theory do they work? I know that they are used in connection with short wave receivers.—B. W. R., Portland, Me.

A transposition block is a special insulator used for lead-ins from antennas. The theory is that two leads are brought down and that these run parallel all the way. However, at each transposition block they cross over and change relative positions. The blocks are means for making this cross-over easy and definite. These blocks are placed from 15 to 30 inches apart from the radio set to the antenna. The object of transposition is to "confuse" stray noises that would be picked up by the lead-in. When the wires are transposed the pick-ups in the two wires balance each other out without affecting the signal that comes in from the antenna proper. In effect the transposition blocks perform the same function as a shielded line connecting the antenna and the set.

* * *

Power in Modulated Wave

IF A GIVEN POWER is radiated by a transmitting station when the carrier alone is on, is that power increased when the waves is modulated? If so, what is the increase?—W. B. L., Jamaica, L. I., N. Y.

If the carrier is modulated 100 per cent the power is increased by the factor 1.5, or 50 per cent. If the degree of modulation is less, which it always is, the increase is much less.

* * *

Overloading Chokes

WHY IS IT that an overloaded choke coil ceases to be a choke? Is not the choking due to the inductance and is not this in turn due to the number of turns? The turns do not change with the current flowing through the coil.—H. W. C., Jacksonville, Fla.

The inductance depends not only on the number of turns and the geometry of the choke but also on the core material. In fact it primarily depends on the core, or on the permeability of the material. The permeability varies with the current flowing in the winding. If the current is excessive the permeability drops to a very low value, and then the value of the coil as a choke ceases.

* * *

Determining Transformer Windings

CAN YOU SUGGEST a simple way of determining which winding of a transformer is the primary and which the secondary? I have special reference to audio transformers but I have also power transformers in mind.—R. B. N., Toledo, Ohio.

The primary winding is the one that is connected to the source and the secondary the one that is connected to the power absorber or the load. Sometimes the secondary has a higher resistance than the primary and sometimes a lower. Something must be known about the transformer before any tests can be made. For example, is the transformer step-up or step-down? If it is step-down the secondary is likely to have a lower resistance than the primary, and if it is a step-up the secondary is likely to have a higher resistance. Which winding has the lower resistance can be determined by means of a resistance meter, or a voltmeter and a battery. If the transformer is intended for a power transformer there may be many windings, a primary and several secondary windings of different voltages. The winding with the highest resistance is likely to be the high voltage winding and those with the lowest the filament voltage secondaries. The winding with the medium resistance is likely to be the primary.

* * *

Greatest Gain

WHAT IS THE GREATEST possible gain in a stage of radio frequency amplification using tuned transformer, the tuning being done either in the primary or in the secondary? The question does not relate to the practical gain but rather to the goal toward which one should strive.—C. V. R., Camden, N. J.

If m is the amplification factor of the tube, M the mutual inductance between the primary and the secondary, L the inductance in the tuned circuit, C the capacity in this circuit, R the resistance in the circuit, and r is the plate resistance of the tube, then the amplification at resonance is $A=mM/(L+RCr)$. The greatest amplification is obtained when RCr is zero. We cannot make this zero for no matter how good the coil is, it will have some resistance, and no matter how small we make the tuning capacity there will be some stray capacity left, and if we reduce r we also reduce the amplification constant. R may be made small in effect by regeneration, and that is the only means by which the gain can be increased greatly. The formula shows that the greatest gain is mM/L. If the primary and the secondary windings are equal then the maximum possible gain is mk, in which k is coefficient of coupling between the two equal windings of the transformer.

* * *

Air Dielectric for Intermediates

WHAT ADVANTAGE is gained by using air condensers in the intermediate frequency tuned circuits of a superheterodyne? Would the gain be greater and would the noise be less?—W. T. C., Atlantic City, N. J.

Losses in air dielectric condensers are lower than in those of any other types of condensers. Since losses decrease the selectivity and the sensitivity there would be a gain in both of these qualities. Moreover, the increased selectivity would tend to reduce noise. The tuning would also be less affected by changes in atmospheric conditions.

* * *

Birdies in Supers

WHICH is better for the purpose of elimination of birdies in a superheterodyne, the use of an extra intermediate tuner or an extra r-f tuner? I am planning to reconstruct my super to overcome birdies and should like to know which is the better method.—R. T. M., Cincinnati, Ohio.

If the birdies are really due to the interference of other stations then an additional r-f tuner should help. It may be, though, that the only trouble now is that the oscillator and the r-f circuits are not lined up properly or it may be that the circuit is so designed that the r-f tuners now in the circuit are not fully effective because of stray coupling. The addition of another i-f stage would not help a great deal. This is true even if the birdies are due to heterodyning between harmonics of the intermediate frequency and the signal. If the trouble is of that kind the only thing to do is to change the intermediate frequency. Another i-f tuner will do no harm if the addition can be effected without upsetting stability.

* * *

Voltage "Power" Amplifier

IN A SPECIAL JOB we have need for an amplifier that will cause the voltage across a device swing between 500 and 1,500 volts. Are there any tubes suitable for such service and would they have to be operated as power amplifiers or as voltage amplifiers?—L. W. N., Fort Wayne, Ind.

There are transmitting tubes that will take plate voltages considerably higher than 1,500 volts. If the voltage is to swing between 500 and 1,500 volts the applied plate voltage would have to exceed 1,500 volts. Whether the tube is to be operated as a power amplifier or as a voltage amplifier depends on the device that is to be operated. If this is a potentially operated device the tube should be operated as a voltage amplifier but if it is a current operated device the tube should be operated as a power amplifier.

* * *

Behavior of D-C Receivers

IN A D-C RECEIVER 48 and 25Z5 tubes are connected in series with 237, 236, and 239 type tubes. When the power is first turned on the heaters of the 237s, 239s, and 236s glow brightly whereas the others do not appear to be on. After a while the power and rectifier tubes begin to glow normally and then the other tubes become less bright, but bright enough. Please explain the reason for this behavior.—F. R. B., Newark, N. J.

The reason for this behavior apparently lies in the difference in resistance while the tubes heat up. If the resistance of the heater of the 25Z5 and the 48 is low at first, the other tubes would get excessive voltage and that would account for their initial briliancy. As the power tubes heat up slowly the resistance goes up and all the tubes settle down to normal.

* * *

Colpitts Oscillator

WOULD IT BE POSSIBLE to use the Colpitts types oscillator for a superheterodyne with the padding condenser as the plate portion of the capacity and the variable condenser as the grid portion of the capacity. If this is practical will you kindly show a circuit diagram how it may be done? —G. W. R., Albany, N. Y.

If you will examine the Bosch oscillator on page 18, Feb, 25, 1933, you will see an oscillator exactly as you outline it. The grid stopping condenser seems to be superfluous in this case but it may be that it had to be used for stability. By examining the conditions for oscillation it will be found that this oscillator is more uniform than many of the familiar oscillators. That is to say, it generates about the same amplitude for all settings of the variable condenser. Exact equality is not to be expected, of course.

* * *

Overcoming Noise

MY RECEIVER is extremely sensitive but the high gain is of little use to me because as soon as I turn up the amplification the noise is terrific. I am sure that most of this noise originates outside but in the neighorbood of the receiver. Can you suggest any method whereby I could eliminate the noise without at the same time diminishing the signals. I do want to get some of the foreign stations clearly. I get them loud enough now.—F. G. A., Butte, Mont.

There are two methods available. One is the use of transposition blocks for the lead-in. The other is the use of a shielded transmission line from the antenna to the set. In either case the antenna should be erected high above the building and as far away from power lines as practicable.

Wobbulation

IF THE FREQUENCY of oscillation depends on the effective voltage on the plate, how is it possible to avoid wobbulation of the frequency when the oscillator is modulated? How do the broadcast stations avoid the difficulty?—J. M. B., Brooklyn, N. Y.

One way of avoiding wobbulation by the modulation is to use a master oscillator and modulate in another tube. That is essentially what is done now, for most stations use quartz crystals to control the frequency. Another way is to use a stabilized oscillator, one that has been so constructed that its frequency will not vary with changes in operating voltages.

* * *

Super Pick-up

IF THERE IS STRAY capacity coupling between the oscillator and the first detector of a superheterodyne does this add to the magnetic pick-up or does it detract? In other words, is the circuit more sensitive as a result of stray capacity coupling or is it less sensitive?—B. E. C., Brooklyn, N. Y.

It depends on the phase of the two. It may be either. The only way is to test this experimentally by reversing the leads of the pick-up coil. There is no way of reversing the capacity coupling so it has to be done on the inductive. Louder signals indicate that the capacitive and inductive couplings are in phase.

* * *

Inductive and Radiation Fields

WHAT IS THE DIFFERENCE between the induction and radiation fields about a transmitter? Are radio receivers affected by both?—C. W. T., Syracuse, N.Y.

The induction field is simply the magnetic field around the antenna due to the current flowing in it. It is similar to the magnetic field existing around any wire carrying an electric current. The energy in this field returns to the antenna twice every cycle. It gives rise to reactance in the antenna. The radiation field is the electromagnetic field that is whipped off the antenna. It represents energy which does not return to the antenna. It is the useful portion of the total field. A radio receiver is affected by both, but beyond a few wavelengths the induction field is so weak that it is not easily picked up.

* * *

Time Constant of Condenser

FREQUENTLY you speak of time constants of coils and condensers. Just what is the meaning of time constant? Please explain in simple terms.—T. H. Y., St. Louis, Mo.

There is no time constant of a condenser or an inductance alone. There is always resistance involved. The time constant of a condenser and a resistance is the product of the two in farads and ohms, the constant being given in seconds. The time constant is a measure of the rate at which the condenser will discharge through the resistance. Particularly the time constant is the time required for the condenser to discharge from a voltage V to a voltage V/2.718. This ratio is the base of natural logarithms. The time constant of a coil is L/R, where L is the inductance of the coil and R is the resistance. If there is resistance in the circuit other than that of the coil then L/R is the time constant of the circuit and R is the total resistance. L/R is a measure of the rate at which current builds up in the circuit after the voltage has been applied, or the rate at which it dies down after the voltage has ceased. L must be measured in henries and R in ohms if the time constant is to be given in seconds.

* * *

Power and Energy

ARE POWER AND ENERGY the same thing? At least they seem to be for we speak of buying electrical power and energy interchangeably.—W. B. L., Birmingham, Ala.

If we speak technically power and energy are entirely different. We buy electrical energy, not power. The rate at which we buy it is the power. Of course, the rate has nothing to do with the price. We buy so many joules per second, or more simply, watts. Of course, we do not take energy from the line at the same rate all the time. The wattage changes every time we throw a switch. The monthly bill states the total number of kilowatt-hours taken that month. One kilowatt-hour is equal to 3,600,000 joules. Of energy not of power. In popular parlance the term power is used for energy as well as for rate of energy. Energy is that property by virtue of which work can be done, and power is the rate at which the work is done.

* * *

Measuring Frequency

HAVING BUILT a test oscillator that covers low frequencies, I do not know the approximate range. Once I know this, the rest of the calibration will be easy. Please give me some help.—U. W., Camden, N. J.

Set the test oscillator going, couple it to the input of a broadcast receiver, tune the test oscillator to its lowest frequency, or as near lowest as possible, and beat with a broadcast station tuned in by the receiver. Then leave the test oscillator as it is and tune the broadcast set to higher frequencies. When the beat is heard a second time, or the modulation in the absence of beat, note the difference in frequency between the first and second settings of the broadcast set. That is the frequency the test oscillator is generating. As the frequency ratio of the test oscillator is known or may be estimated, you can get an idea of the high frequency extreme and check up by the method outlined. The frequency ratio, if the tuning condenser is 0.00035 mfd. or thereabouts, will be about 3 to 1, and if the capacity is 0.00015 mfd. or thereabouts, will be approximately 2.3 to 1.

* * *

Ultra Frequencies

IN ATTEMPTING to get some results on the ultra frequencies, do you think I should use a Hartley oscillator? Would it be practical to use a coil wound on a diameter of 1.5 inches, or would the thick copper wire without winding form be better?—J. R. E., Mt. Vernon, N. Y.

Good results have been obtained in this region, using the Hartley. The coil may be on a form as stated, or may be wound "on air", using the thick copper tubing. Try a single turn, 3 inches winding diameter, copper tubing, and tap approximately at the center for cathode connection.

So-ooh! Now It's Ed Wynn, Chain Executive

Ed Wynn, at a dinner given recently for the representatives of the daily papers and radio publications, made an announcement to the effect that he is to inaugurate a new radio chain under the name of the Amalgamated Broadcasting System. Eventually he hopes to extend the chain from coast to coast, but at the start the system will consist of six stations at points between New York and Washington.

The stations already arranged for are WCDH, New York, WPEN, Philadelphia, WOL, Washington, D. C., WCPM, Baltimore, and stations at Trenton, N. J., and Wilmington, Del. Mr. Wynn and his associates are not buying these stations but merely using them as units of the chain. Claiming that the programs as now offered the public today are too frequently interrupted by prolonged advertising talks, the new chain is going to cut down the advertising announcements on its programs to a minimum, giving long stretches of entertainment unbroken by advertising references.

Mr. Wynn claims also that his concern will endeavor to give back to newspapers much of the advertising they assert they have lost because of radio competition. After a program is finished, Amalgamated will have its announcers state that such-and-such a firm which has been sponsoring the program, is having a sale and that for further details listeners-in should see the daily papers the following day for further detailed information as to the products mentioned.

The Amalgamated has signed up 27 advertisers who agree to broadcast under these new restrictions as to percentage of advertising mention allowed. In addition, the new system is going to bring more noted stars of the stage to the microphone. For example, when a skit is given, players like Alfred Lunt and Lynn Fontanne will be engaged.

The offices of the Amalgamated, of which Mr. Wynn is president, are located in the Liggett Building, 42nd Street and Madison Avenue, New York City.—R. B. H., Jr.

TICKLER TURNS

When using short-wave coils for regenerative circuits, it is sometimes found that though the standard number of tickler turns will do for the lowest and second lowest bands, that for the next two bands, especially the highest frequencies, the tickler has to have as many turns as or more turns than the tuned windings.

CBS TELEVISION DISCONTINUED AFTER 1½ YEARS

Declaring that operation under present facilities offers little opportunity for further contribution to television, the Columbia Broadcasting System temporarily suspended broadcasting from W2XAB, its experimental television station in New York.

The suspension was made known by Edwin K. Cohan, technical director. The station had operated more than 2,500 hours in the past year and a half.

William A. Schudt, Jr., program director of television for Columbia, has been appointed manager of WBT, Charlotte, N. C., key to the CBS Dixie network.

"A year and a half ago," Cohan said, "Columbia established its television station W2XAB for the purpose of maintaining a daily experimental transmission schedule which would enable us to learn from practical experience the methods, procedures and limitations of television transmission on the basis of the development of the art existing at that time, to wit: sixty-line images, twenty per second, employing the flying spot method of scanning and indirect pickup.

"Since July, 1931, W2XAB has operated in excess of 2,500 hours, during which time much practical knowledge has been gained and a foundation of future television production laid.

"We now feel that further operation with the present facilities offers little possibility of contributions to the art of television, and we have, accordingly, decided to suspend temporarily our program schedule.

"Columbia is continuing to follow with keen interest the laboratory development work which is constantly going forward in this new art, and it is our intention to resume our experimental transmissions as soon as we are sufficiently satisfied that advanced equipment of broader scope can be installed. Until then our activities in the field of television will be confined to the laboratory and the maintenance of our close contacts with the other organizations specializing in this field."

During its year and a half of steady operation W2XAB presented many novelties to lookers-in and brought before its "flying spot" a great number of notables in the theatre, politics and newspaperdom. Ex-Mayor Walker of New York, Kate Smith and Morton Downey were among those who took part in its first program. A few months after its opening the station presented the first "million dollar broadcast." This consisted in the televising of a million dollars worth of rare jewelry from the vaults of Cartier's. Natalie Towers, the original Television Girl, wore the gems.

In the fall of 1931, W2XAB visualized the Northwestern University-Notre Dame football game through the use of a football player board on which each play was recorded. This was synchronized with the broadcast description of the game from Chicago. The first air fashion show was presented by the station in October, 1931, with a display of gowns by a New York dressmaker. In December of the same year television's first millinery show was staged from the W2XAB studio, with a display of hats by Madame Nicole de Paris, one of which was worth $3,500.

One of the most interesting features presented by the station was the televising of La Argentina, South American dancer, as she sat for a portrait by M. Aurel Rasko, Hungarian painter, who sketched her in charcoal before the flying spot.

Last year Columbia introduced dual modulation in television broadcasting as a result of its experiments with W2XAB. This consisted in transmission of sight and sound in the same channel.

Reception of signals from W2XAB was widespread in the United States, as indicated by letters received from lookers-in. Some of the cities heard from were Shreveport, La., Houlton, Me., Indianapolis, Ind., St. Louis, Mo., Flint, Mich., Boston, Mass., and Dover, N. J.

Receiver Principle Used in New, Sensitive Meter

A meter which keeps a continuous record of infinitesimal electrical currents and which, because of the electronic principle employed, is the most sensitive of its kind ever developed, was recently described by H. L. Bernarde and L. J. Lunas, engineers of the Westinghouse Electric and Manufacturing Company.

The new meter records with the greatest accuracy direct currents of as low an energy level as four or five micro-watts, equivalent approximately to 1/10,000,000 of the energy in an ordinary light bulb in the home. It also records alternating currents of lower value than any similar apparatus, according to its inventors.

Inspiration for solving the problem of recording low energy values came in the form of a radio receiver, Bernarde said. A radio receiver picks up microscopic amount of energy from the air and amplifies it to concert volume. The two engineers reasoned that similar electronic means would help solve their problem.

Miss Perkins "Hates" Radio

Just before she left New York City for Washington to become Secretary of Labor, Miss Frances Perkins submitted to a "mass interview" by newspaper reporters, in which she answered many questions. Some of these had to do with her hobbies and Miss Perkins was quick to report that she has no use for radio and does not possess a set.

Miss Perkins, in private life Mrs. Paul C. Wilson, and the mother of a girl in her 'teens, was the head of the New York State Industrial Bureau, and administrator of the Workmen's Compensation Law, under Governors Smith and Roosevelt. When Roosevelt became President he appointed her Secretary of Labor, the first woman to become a member of a Presidential cabinet.

So the reporters felt that their readers would like to know as much as possible about this woman who bids fair to become the best-known woman holding an administrative post anywhere on earth.

Concerning music, Miss Perkins said that she was "semi-illiterate," but added she is interested in modern art and painting.

"I hate telephones, automobiles, airplanes and anything that makes noise," said Miss Perkins, in answer to a question. "That includes the radio. No, I do not possess one."

With that reply the interview closed and the reporters slowly filed out of the room.

Ten days later, Secretary Perkins, if still without a set, and if not listening to some one else's set, was unable to hear her own chief address the country on the banking situation, in what is regarded as the most important talk ever broadcast.

DRAMA TO LAST ONE FULL HOUR, PALEY'S IDEA

By **WILLIAM S. PALEY**
President, Columbia Broadcasting System

Dramatic programs are mounting to a dominating position in broadcasting. But they will be of a superior type. They will be the work of writers who concentrate their efforts on radio. They will be original scripts, not plays adapted from the stage or the motion pictures. New writing technique undoubtedly will be developed to fit the needs of radio. Already the radio writer enjoys possibilities for scenic and character creation beyond the bounds of the theatre. A facile pen can build scenes in the listener's mind which surpass any constructed of wood and canvas. A writer with the knack of character building can bring forth imaginary air personalities that will take on reality for the listener in direct proportion to his writing ability.

And as the importance of the dramatic show increases, I believe the length of the play will increase, so that eventually its duration will be a full hour. This does not mean, though, that the serial story will wane in popularity. There will always be a place for the short nightly, weekly or semi-weekly episode production.

Two Hams, Same Name, Have Plethora in Common

With perhaps 35,000 licensed amateur radio stations in the United States, many thousands of them operating on the air at any given instant, curious coincidences are bound to develop. Not long ago W6DOO, of Bakersfield, Calif., contacted W2DOO, Brooklyn. Both had the same name—G. Siegel. Both used the same types of tubes in their transmitters (in itself a coincidence, for there are several dozen types). Both used the same kind of antennas. Both used almost exactly the same frequency. And neither had ever heard of the other before the conversation over the air!

Service Men Organize

The Radio and Television Technicians Association was organized by a group of enterprising radio service men in greater Cincinnati, with headquarters at 1 Park Place, Mt. Auburn, Cincinnati. An announcement set forth:

"Realizing the need for such an organization to protect the public from so-called cut-rate or unreliable service establishments, only the most competent radio technicians are accepted.

"The purpose of the Association is to standardize radio service, and educate radio service men, thus giving the public the best in radio maintenance.

"The organization receives the latest developments in radio and television and passes it on as instructive matter to its members.

"Regular meetings are held at headquarters every Monday at 8:30 p. m."

SHORT-WAVE CLUB
Charles R. Reil. R. F. D. 1, Cooperstown, Pa.

37 FAVORED AS RECTIFIER IN UNIVERSAL SET

By WILLIAM RANKINE
Triad Manufacturing Company

In view of the rapidly increasing popularity of the so-called "universal" receiver, tube manufacturers have been giving consideration to the development of special types of tubes for use as rectifiers in receivers of this nature. While it is possible that satisfactory operation can be obtained from these new tubes, it is also desirable from the viewpoint of economy to keep the number of different types of tubes on the market as low as possible. This is desirable for two specific reasons. First, the dealer and the serviceman is not compelled to carry too large an investment in stock and secondly, the consumer may always be assured of satisfactory service in the event of his receiver becoming faulty.

From the viewpoint of the serviceman, the dealer or the radio owner, there are four essential points to be considered in the selection of a tube for any particular function in the receiver. The first is that the type is of a standard nature and one on which renewals may easily be obtained, as a result of complete distribution. It should be not more expensive than the type which it replaces. It should, as far as possible, either reduce the number of component parts required for the circuit or at least it should not require additional parts. The fourth and possibly most important point is to determine whether or not the tube will give a satisfactory account of itself throughout its life.

97.5 to 108 Volts

Following tests made in the laboratory of the RCA, on type 37 tube for use in rectifier circuits of this nature, we have come to the following conclusion and have, therefore, determined not to introduce another type of rectifier to accomplish this purpose. The circuit characteristics of these small receivers are now quite well known and, since it is not necessary for the rectifier tube to supply more than approximately 20 milliamperes, it is not necessary for us to use one of the mercury vapor type rectifiers or a rectifier capable of delivering the amount of power which we can take from a type 80.

For the purpose of our test, however, we decided to put the tube on a life test which would be much more severe than it would ever encounter in practice. The tests were conducted with a drain of 40 milliamperes at 135 volts d. c. between the heater and the cathode. Under these conditions, the filament voltage applied to the type 37 tube was 6.3 and the filament consumption 0.3 ampere. The maximum plate voltage applied was 125 volts and the drain approximately 40 milliamperes.

No R-F Chatter

Several types of universal receivers were operated with the type 37 tube as a rectifier with the following results. Where the load was 20 milliamperes, the average d.c. output of the tube was 103 volts. The maximum voltage delivered by any of those tubes tested was 108 and the minimum was 97.5. This variation was noted in about 10% of the tubes and even with this variation it was found that there was no appreciable difference in either sensitivity or power output.

Furthermore, it was found that the use of the 37 eliminated the generation of radio frequencies noise, which sometimes occurs when other types of rectifiers are used in these receivers, and it was therefore unnecessary to use the radio frequency choke, required when the other types of tubes were used. Of course, when the 37 is used as a rectifier, the plate and grid elements are fastened together. This may be done by tying the two terminals of the tube socket together with a bus.

Therefore, we are of the opinion that when design engineers recognize the fact that this tube will perform all of the necessary functions for the universal type of receiver, it will rapidly come to replace those special tubes which have been developed to take care of this job.

Electro-Magnetic Lens Invented for Television

A new "electro-magnetic lens" for use in television receivers has been developed by Vladimir K. Zworykin, television expert of the RCA-Victor company, according to an announcement he made at a meeting of the American Physical Society at Columbia University.

This "lens" consists of a fine helical coil carrying a small current, through which the cathode ray passes. Without this lens the pencil of cathode rays, which is very feeble at best, spreads out and causes comparatively little light on the fluorescent screen. When the ray passes through the coil it converges to a very fine point on the screen and appears as a concentrated spot of light. As the concentrated beam is made to move over the screen to draw the picture, an image of intense brilliancy results. The concentration may be made to nearly as fine a point as would be possible with optical lenses, yet it is done without loss of light. In a complicated optical system as much as a third of the original light may be lost by absorption.

"Hams" Depression-Proof

The remarkable "depression boom" of amateur radio, which saw the number of amateur stations increased nearly 100% during three years of depression, is becoming an important economic factor in the radio trade. As evidence of the purchasing power of the recruits to the amateur art, the American Radio Relay League cites sales figures on its recently announced tenth edition Radio Amateur's Handbook, total distribution of which now reaches the unparalleled figure of 185,000. 18,000 copies of the new edition have been sold in the eight weeks elapsed since its announcement, and total sales over the three month period ending February 28th were 13% greater than the corresponding period a year ago.

A. R. R. L. NEW ENGLAND MEET

The 1933 New England Division convention of the American Radio Relay League is to be held in Hartford, Conn., on April 28th and 29th. The national headquarters of the League are located in West Hartford, and it was while in the Radio Club of Hartford that Hiram Percy Maxim, long a prominent Hartford resident, first developed the idea that resulted in the foundation of the League by him in 1914.

CORPORATION REPORTS

The Sangamo Electric Company reports a net loss after deduction of taxes and charges, of $263,-931, compared with a net profit in 1931, of $393,-549, which, after preferred dividends, equals $2.65 a share on 125,000 common shares.

The Scovill Manufacturing Company, Waterbury, Conn., reports a net loss for 1932, after deduction of taxes, depreciation and other charges, of $1,322,932, compared with a net profit for 1931 of $132,912.

SUN CYCLE PUTS DX AT ITS PEAK, ENGINEERS SAY

Hartford, Conn.

Philip S. Rand, W1DBM, North Falmouth, Mass., recently communicated two-way across the Atlantic ocean on 1,750 kc.

Not since early 1924 has there been two-way transatlantic communication in this lowest of amateur frequency bands, just beyond the broadcast band, said F. E. Handy, communications manager of the American Radio Relay League, here today.

Frequency Significant

The significance of the feat lies not in the distance covered, but in the frequency or wavelength used, according to Mr. Handy. World-wide communication has long been associated with amateur radio, but in the short-wave, or high-frequency, region.

The 1,750 kc band has chaarcteristics greatly resembling those of the broadcast band, which it neighbors. In fact, many broadcast listeners equipped to pick up police calls on 1,712 kc are also able to hear amateur stations as well, for the amateur band runs from 1,715 to 2,000 kc.

Still Interested

The ten-year lapse of transoceanic activity on this low frequency band does not imply that the band has been deserted by amateurs, although the exodus to the short waves which began in early 1924 did remove most of the impetus to DX work on the lower frequencies.

Radio conditions themselves, now believed to vary over an 11.1 year cycle corresponding with the solar cycle, are thought to be responsible. That radio conditions are just now returning to the peak of effectiveness encountered in the earliest days of the art, is the contention of engineers.

B Eliminator Useful On Farm and in Home

If one is now operating a 32-volt A source or battery on the farm or elsewhere it will be good news to learn that the Postal "B" Battery Eliminator may be used in conjunction with this source, or a 6-volt battery likewise may be used. This should be of great interest to the man with a radio receiver operating at any point, whether in a boat, plane, auto, farm or home.

It practically means that he need not be bothered with the replacement of B batteries in connection with his radio receiver, for now in the majority of cases he can be equipped with this B battery eliminator which will give him the required voltages.

For those who may want to construct their own, the various parts may be purchased either in a complete kit form with instruction, schematic and pictorial diagrams, or individual parts. This is said to be the only high-grade eliminator that can be purchased this way. There is a big demand for a unit of this kind, not only for one's personal use, but for the various classifications as mentioned. Wherever a compact and complete B source is required for a radio receiver at any point, no matter how remote, as long as there is an A source this B eliminator should fill the need.

CIGAR, JEWELRY STORES SELLING "PEEWEE" SETS

By R. M. KLEIN
Fada Radio and Electric Corporation

A few years ago well-posted men in the radio industry would have laughed had you suggested that the cigar counter of a hotel would soon become an important radio outlet even as the musical instrument store was dismissed by some in the early days of radio's fight for distribution. But today, owing to the new child of the industry, the pee-wee sets, not only the cigar counter in the hotel is looming as a natural and important outlet for radio sales but many other hitherto undreamed-of outlets are being groomed by radio.

Particularly is this true in regard to the smaller-than-midget receivers that, because of special eye appeal and encasement, lend themselves readily to being merchandised over new counters.

Enter Non-radio Outlets

Not only are entirely new outlets opening up for these baby receivers but in old-established channels sales are being made in a variety of departments not heretofore concerned with radio. For example, in the big department stores in metropolitan centres—and elsewhere, too—the tiniest of radio sets are being sold in several parts of the store. It is obvious that all of this is proving helpful to radio trade.

Where sets are put out by well-known manufacturers already enjoying the confidence of the public there is everything to be gained by this widening of distribution. Novelty stores and counters are displaying these newest of sets; luggage shops and even the novelty counters in men's wear and women's wear shops have them for sale.

Even Jewelry Stores

Another outlet that has appeared on the horizon is the jewelry store. In the past many efforts were made to interest jewelers in radio and in sporadic cases one found sets on display but now the special leatherette case in which a real honest-to-goodness radio set is built makes a strong appeal to the jewelry shop interested in novelties of all kinds. My bet is that these new small sets will do much to build up a new phase of radio selling which conveniently may be called the "cash-and-carry" business.

Culver New Head of "Ham" Pacific Group

Hartford, Conn.

Announcement of the election of S. G. Culver as director of the Pacific division of the American Radio Relay League, national organization of transmitting radio amateurs, was made at League headquarters in this city.

Culver's choice by the membership of the Pacific division, which includes California, Arizona and Nevada and the territories of Hawaii and the Philippines, was the result of a special election following the resignation of Clair Foster, Carmel, Cal., the former director.

Culver is the owner and operator of W6AN, 2303 Seventh Avenue, Oakland, Calif. Formerly he was assistant director of the division.

Work is Started On Studios for World's Fair

Chicago.

Construction has started on the radio studios at the World's Fair. There is already built and in operation in the Administration Building a small studio (35x18 feet), which is being used for speeches, soloists, etc.

On the south end of the island, in the region to be known as Hollywood, will be two studios, equipped with organ, with a seating capacity of between 600 and 700, one studio with a capacity of 2,000 to 2,500. These studios will be available to advertisers and stations. Some of the leading features of the air have intimated their intention to broadcast from these studios during the Exposition.

Efforts are being made to have a large radio representation among the exhibitors at the Fair, as well as large attendance by radio groups geographically apportioned.

INTERFERENCE BY HETERODYNE IS HELD WORST

London.

It is expected a Plan de Lucerne will revise European broadcast channels, to supplement the Prague Plan (now in operation, amended but needing much revision due to the advent of high power stations).

The International Broadcasting Union experts will meet in Switzerland next spring and re-assign the air, probably before the anticipated big shift in American stations partly made necessary by the demands of Canada and Mexico as emphasized at the Madrid Conference.

Giants of the ether will go on an eleven kilocycle separation; most stations will be re-assigned on nine kilocycle division. The re-distribution of wavelengths, it is hoped, will free Europe from the heterodynes now annoying listeners—and, of course, there is much more DX-tuning in Europe than in the United States. The Madrid gathering allowed extra wavelengths to Europe on the range between 1,000 and 2,000 meters.

Alan Hunter, British expert, says:

"A recent report by the Radio Research Board, which is a brainy government organization that delves into highfalutin radio problems, indicates that present day interference can be divided into two types. The first type involves the wanted station's carrier wave, as with high pitched heterodyne whistles and some of the sideband splash we hear. The second type is independent of the wanted station's carrier wave and is due to interaction between the side waves of the wanted station and the carrier or side waves of the unwanted station. It appears that wanted station carrier heterodyning cannot be cured by stenode-type high selectivity circuits followed by tone correction, whereas the second type of interference can be so cured. This leaves us with the unfortunate conclusion that the worst form of interference. that is, heterodyne whistles and side band conflict, cannot be cured at the receiving end by selective tuning and tone correction. It seems that certain interference can be cut out only by a great sacrifice of quality at the receiving end or by a concerted action on the broadcasters' part to keep the modulation down or the carrier waves well apart."

BRITAIN SENDS TYPICAL VOICE, NO BLAH-BLAH

By ERIC PALMER

Two men talk to an empire, every day. Their voices reach the ends of the earth. J. N. Lampson and W. M. Shewen are their names, and their service is given on behalf of the British Broadcasting Corporation on the Empire programs going out over Daventry's short waves.

The need for two announcers for this service alone is easily understandable. The transmissions cover five time zones. Those heard in Canada and naturally also in the United States, for example, are radiated at 1 to 3 a. m. GMT, or about dinner time for listeners on the eastern seaboard and the middle western portion of the North American Continent. These particular programs are sent on 31.30 and 49.59 meters, with 20 kilowatts power.

It is essential that the Empire announcers' voices should be "typically English." This is one comment from London:

"Unfortunately many colonial and possibly many American listeners, too imagine that the typical English cultured accent is a rather effeminate sort of mincing tone, where 'quite nice' becomes 'quaite naice' and 'India' becomes 'Indiah.' What we call the 'blah-blah' accent over here is strictly limited to ultra-cultured graduates of the University of Oxford. The real English voice, though soft compared with the Yank's, is certainly not mincing and is in fact robust without being strident. So, from as many as fifty applicants, the B. B. C. had to choose the Empire announcers. Their news bulletins are given fairly quickly, as it was found easier to read a fading signal of speech that is rapid better than a fading word by word announcement with a quickly fading signal you miss parts of words but not whole words, as you might easily do with very slow speech, they found."

Broadcasting House, the new de luxe headquarters of the B. B. C., has twenty-two studios in its central tower, sound insulated from the administrative offices. There is a suite (parlor, bedroom and bath) for the Empire announcers, who must be on hand in the middle of the night and on duty again at 9:30 a. m. to send out the Australian programs. Empire announcing is an around-the-clock responsibility.

WCAU and WGY are now the American stations on the broadcast wave span most frequently heard in the British Isles. Several listeners report reception after midnight for four months. On the short waves, in daylight, W3XAL is picked up; W8XK at night on the 46 meter band, and in afternoons on 19.8 meters. W2XAF is regularly received at night. The "Cotton Queen" program on WLW has been picked up on normal wavelengths.

Short Radio Course

A short radio course will be given under the auspices of the Radio Department of the University of Wisconsin Extension Division in Milwaukee, April 10th, 11th and 12th, with sessions all day, every day. There will be inspection trips and exhibits by manufacturers.

The topics for lecture and discussion will cover the new sets, new circuits, new tubes, testing equipment, interference, automobile radio, and amateur transmission and reception on ultra-short waves. The speakers will be specialists from the leading manufacturing concerns.

STATION SPARKS
By Alice Remsen

The Veteran Comedian
FOR EDDIE CANTOR

(WEAF, Sundays, 8:00 p. m.)

Hello! You funny little man!
Where do you get your pep?
How do you pop your goggle-eyes?
And how do you keep in step
With all the youngsters of today
Who coin new comedy?
They cannot reach your starry heights
So far as I can see

Of course, you dig up ancient gags
And dress them down in style;
But you can put them over great,
And make them sound worth while.
Your current continuity
Is really up-to-date;
And how you bowl them over, boy,
Across that old home plate.

All hail to you, old-timer, for
To you all credit's due.
I've seen them come, I've seen them go
Since you first hove in view.
Don't stick around in ancient ruts
Like other comic mimes,
But always keep within your heart
The spirit of the times.

—A. R.

* * *

IT REALLY IS MARVELOUS the way Eddie Cantor has adapted himself and his style to radio. He has made a genuine hit and comes over excellently. I give Eddie credit for his cleverness in realizing the limitations of radio and working accordingly.

* * *

The Radio Rialto

Things look pretty blue along the old rialto at this writing. Radio stations in the Cincinnati territory are hard hit and have cut salaries and staffs down to the bone. The bank holidays declared by the President seem to have precipitated the disaster. There was absolutely no money to be had, and it would have been funny if it hadn't been so pathetic to watch hitherto well-to-do people actually anxiously counting their pennies. A great many folk received a practical lesson in economy, and surprised themselves by realizing that life may be enjoyed just as well with less money. . . .

Meanwhile, in New York, the radio programs are still carrying on. B. A. Rolfe is back on the Saturday night air with an hour of dance music. The Saturday Night Dancing Party, sponsored by the Hudson Motor Car Company, has brought the veteran broadcaster back with a new forty-piece orchestra on a Coast-to-Coast NBC network each week at his old hour of ten p. m., EST. . . . Rolfe and his musicians—most of whom were with him during his previous long broadcasting engagements—plan to limit themselves strictly to popular music; with the exception of brief vocal interludes by the Men-About-Town, well-known harmony trio, the new program will be an uninterrupted dancing party with real B. A. Rolfe music; scorning the conventional baton. Rolfe, as usual, leads his new orchestra into action with swinging arms and pointing fingers; the portly music maker always has been surprised that most dance directors are content with a baton; to him it is just a piece of wood; therefore, lifeless, without animation or fire; Rolfe's favorite gesture is to double his right fist, and wave it in a half circle; that, he says, means more to the musician it is aimed at than all the air beating of a dozen batons; the musician immediately knows that Rolfe wants more vigor, more strength and life; he uses a baton just to get the orchestra started; that is his bow to convention, but once he has the orchestra started, he lays the baton down and uses ten fingers and two hands; he doesn't beat the air, nor wave his arms like a madman; he lifts his finger at the violins, waves his hand at the clarinets, closes his fist and makes a sweep at the drums; it all means something; B. A. knows his business. . . .

A welcome piece of news is that little Welcome Lewis is back on the air; she has been away playing vaudeville for some time, but may now be heard each Sunday, Monday and Friday, over an NBC-WJZ network at 11:15 p. m., E. S. T. . . . Octavus Roy Cohen, noted writer of detective and negro stories, who is now writing for the air, has made a hit with his Murder Mysteries, heard over an NBC-WJZ network each Tuesday, Thursday and Saturday at 7:45 p. m.; Mr. Cohen went against convention when he wrote his first air mystery, for, instead of using gangsters, he used the average American home in a typical American town for the locale, and average human folks were the people involved.

James Melton, the NBC tenor, has a deep dark secret in his life—he once played the saxophone; that was back in his college days, and that instrument, together with his voice, paid Jimmy's tuition; but, he admits that he hasn't tooted a sax since he received his sheepskin.

If you ask them, the Neil Sisters, NBC's "Blondes in Blues," will tell you that they are not at all superstitious; however, if you press them, they admit that they will not walk under ladders, dislike to light three cigarettes on one match, hate all black cats, won't put hats on a bed, and refuse to open umbrellas indoors; of course, I could think of a few more, but, what's the use? . . . Norman Cordon, the six foot, five inch basso, heard with NBC'S Ambassadors Quartet, has a funny hobby—he collects comic sections of Sunday newspapers; there may be a method in Norman's madness; perhaps he plans to be a comic columnist when he quits radio. . . . Did you know that Ben Bernie, the lovable old maestro, broke his back playing football when he was nineteen years old? He did, but got over it; now he almost breaks it every night swinging a baton. . . . Lennie Hayton, the conductor of Columbia's Chesterfield program, is a true night owl; he regularly attends a movie at the conclusion of his nightly broadcasts; after that he spends from two or five hours arranging music before he retires; he says he's in a better mood for making arrangements in the wee sma' hours of the morning than at any other time of the day.

Fred Allen, of Columbia's Bath Club Revue, has received so many requests from people wanting to know who writes his scripts that, without anybody's permission, he has issued the following statement: "It is not generally known, thank heaven, that Harry Tugand, my colleague, and I hide in a dark closet with two empty fountain pens and write our scripts separately. As soon as we come out we give these scripts to our relatives, who promptly throw them away. Then we throw away the fountain pens. Half an hour before the broadcast we wander down to the lower level of Grand Central Station, but instead of leaving town we buy our gags from a couple of red caps and then we race back to the studio just in time to go on the air." . . . Very good explanation; eh, what!

Dale Wimbrow, featured announcer on the Mills Brothers program, has written a new song in collaboration with Irving Bibo and Charlie Abbott; it's a rousing new march tune with a stirring plea for prosperity's early return, and is titled "It's the Start of the Big Parade." . . . Popular response to the vocal selections offered by the versatile musicians in Waring's Pennsylvanian's on their CBS programs has led Conductor Fred Waring to announce that a greater amount of the orchestra's vocal work will be incorporated into future broadcasts. . . . "Beer is Beer" these days with Billy Hillpot, of the CBS Smith Brothers, and Maestro Nat Shilkret; the pair are now at work on a two-reel movie bearing that title; they are featured in the picture with Joe Weber and Lew Fields, and Vera Marsh. . . . Emil Seidel, Singin' Sam's stellar accompanist, has been in the musical profession since he was eight years old, when he played piano regularly in the first movie theatre in his native town of Eureka Springs, Ark. . . . Jane Froman, who is now singing on the Chesterfield programs, was a discovery of Grace Clauve Raine, vocal director of WLW, Cincinnati; Grace also discovered the Mills Brothers and the new colored sensations, The Southern Singers: Mary Steele was also a protege of hers.

Don't be surprised if you hear of my being back in New York soon, as the panic has hit around here.

* * *

Biographical Brevities
ABOUT EDDIE CANTOR

Eddie Cantor was born on New York's lower East Side. His father was a violinist. Both of his parents died before he reached his second birthday. There was a no-good future prophesied for this parentless boy, but his street singing, mimicking and other youthful caperings finally took him to the stage of Miner's Bowery Theatre for an amateur night. From there he graduated to a Coney Island saloon as a singing waiter, where Gus Edwards, always on the lookout for youthful talent, spotted him and hired him. (By the way, Cantor's accompanist on the battered old saloon piano, was none other than Jimmy "Schnozzle" Durante.) It was in 1912 that Gus Edwards gave Eddie his chance. Cantor's debut was made with Georgie Jessel, in the "Kid Kabaret." It was their first meeting and they have been fast friends ever since.

After some years of success with Edwards, Flo Ziegfeld took him in hand, gave him a one-night trial on the New Amsterdam Roof; Cantor stopped the show, and Ziggy signed him up. Then came those marvelous successes, "Midnight Frolics" and "Kid Boots"; then came the movies with pictures of "Whoopee," "Kid Boots," "Palmy Days," and "The Kid from Spain.' . . . It was only natural that Eddie should graduate to the ether. His Chase & Sanborn program is a popular classic of radio.

He is forty-one years old and a veteran comedian, for his first appearance in public was at Miner's in 1909; almost a quarter of a century's service in the theatre. He's just as full of pep as ever and just as popular. Eddie is married and has five lovely daughters. He loves to help others and has been the chief support of more than one Jewish charity in New York. Each summer, with the aid of actor friends, he sponsors mountain and seashore excursions for the unfortunate young. In 1929 he lost two million dollars in the Wall Street debacle. That didn't mean a thing for he still carried on. In fact, that loss has been the subject of some of his most pointed jokes uttered during broadcasts.

Ban on Short-Wave Sets in Cars Grows; RMA Is Attentive

Police authorities in several States have recently inspired legislation to prohibit civilian use of short-wave receiving sets in automobiles. Such legislation has been enacted by the Indiana Legislature and has progressed in New York, Texas and a few other States.

The legislation has received attention by the RMA through Paul B. Klugh, of Chicago, chairman of the Association's Legislative Committee, and will be considered further by the RMA Board of Directors.

The Indiana law and other similar proposals do not affect equipment of automobiles with regular broadcast receivers but prohibit short-wave sets capable of receiving police broadcasts. Licensing by local authorities of short-wave sets in automobiles used by civilians is required.

Radically New Housings Planned for Receivers

Development of an entirely new style of receiving set housing, radically different from the general console and midget models, is being given serious consideration by many radio industry leaders. Success of many other industries in developing radical new designs or types for their products, such as the new streamline departure in automobile bodies and radiators, has developed wide discussion of the sales possibilities of a new design of radio.

The subject was discussed at a luncheon conference of radio and industrial merchandising experts of other industries in New York City.

"Styling radio sets for sales appeal" was the subject of the conference. Addresses will be made by Kenneth Collins, widely known merchandising manager of Gimbel Bros. and formerly with R. H. Macy & Co.; Grover Whalen, general manager of the John Wanamaker store, and several industrial designers. They discussed possible changes in external design of radio receivers to secure greater popular appeal and wider sales.

The National Alliance of Art and Industry is an organization of industrial executives and designers which has exerted much influence in developing new designs of automobiles, packages, instruments, furniture, textiles, machines, etc., and results in increased sales accomplished in other fields of merchandising and production and their possible application to radio were discussed.

Standard Resistor Code

For First or Second Significant Figure		*Number of Ciphers After the Significant Figures*
Black	0	None
Brown	1	0
Red	2	00
Orange	3	000
Yellow	4	0000
Green	5	00000
Blue	6	000000
Violet	7	——
Gray	8	——
White	9	——

The color for the first or second significant figure follows this code: body color denotes first significant figure; end color denotes second significant figure; dot denotes number of ciphers after the first two significant figures.

ASSIGNMENT
New York

Pacent Electric Co., Inc., 91 7th Ave., New York, handling phonograph, radio and electrical supplies, has assigned to Stanley K. Oldden, of 444 Madison Ave., New York.

TRADIOGRAMS

By J. Murray Barron

Short-wave reception in the heart of New York City from the old timer's viewpoint is not the best. Today European reception during the afternoon is getting quite commonplace. A good short-wave receiver will bring in Germany frequently. To the many who get tired of some of the broadcast programs and want a new thrill there is plenty of opportunity nowadays if equipped with a good short-wave receiver or a well-designed short-wave converter. Those living out of the city, who can avoid some of the interferences and likewise erect a good aerial, will experience many new thrills.

* * *

Tobe C. Deutschman, president of the Tobe Deutschmann Corporation, addressed a meeting of more than 125 radio dealers and servicemen of central and southern Connecticut at the office of Hatry and Young, parts jobbers, Hartford. His subject was how to make money with the filterizers. Perry S. Graffan, of the Tobe engineering staff, took up the technical side of the noise elimination. This group of men was the largest of this type ever gathered in Hartford.

* * *

With the almost daily appearance of new tubes on the market it is becoming almost a problem to keep abreast of the releases, not only for the man in the street, but for the tube salesman behind the counter. Many stores, of course, do not keep right up to the minute and are often several "numbers" behind, and yet for the readers of the radio publications, especially the experimenters and custom set builders, a source of supply on the latest tubes is quite essential.

* * *

There has made its appearance on the market a new radio control. It is the latest gadget in the small radio essentials and has been designed, according to the manufacturers, to eliminate man-made static and thereby clear up radio reception in general. Its purpose is also to filter and it may be used without an outside aerial or ground. A descriptive circular, showing diagrams and method of installing in connection with a radio receiver, is issued for free distribution. Those interested should send requests to Trade Editor.

* * *

G. Leonard Werner announces the opening of his new organization, Allied Radio Laboratories, 25-27 Warren Street, New York, to specialize in transmitters, amplifiers and sound systems.

* * *

Al Feinberg, well known in the industry in downtown New York, is now in charge of the parts department at Nussbaum's, 61 Cortlandt Street. He is building up a special short-wave department and is interested in having fans and others consult him on such matters. Out-of-town radio experimenters may address him by mail.

* * *

Recently there have been numerous inquiries regarding transmitters that might indicate that a considerable interest has developed for further details. If there is sufficient interest some papers or articles may be run on a beginner's transmitter and the subject carried along. The many who have not studied this branch of radio probably do not realize the great fellowship that exists among the amateurs.

* * *

Servicemen and experimenters should bear in mind the great demand among stores for amplifiers. Daily we see demonstrators in store windows, addresses being made to the audience on the street through a microphone connected to an external loudspeaker. This form of advertising can be sold to stores in communities as well as the cities.

Andrea Reminisces; Goes Back 12 Years to $77.50 Beginning

By FRANK A. D. ANDREA
President Fada Radio and Electric Corporation

So RADIO WORLD is eleven years old! That's a lifetime in this fast-moving industry. Perhaps no other industry in the world's history has accomplished so much and become so much a part of the life of the people in a decade as has radio.

Because RADIO WORLD was started just a year after the firm of F. A. D. Andrea, Inc., was born, I am going to reminisce just a bit.

In July, 1921, we started. The first products were rheostats, crystal detectors and sockets, designed to meet the market and conditions of that day of radio, before the time of the factory-built receiver. The first month's business amounted to exactly $77.50. (Within five years we paid out in a single year several hundred thousand dollars in royalties to manufacture under the neutrodyne patents!) By 1922, the year RADIO WORLD started, our sales were $50,000 per month. In 1923 Fada radio turned out the first commercial neutrodyne receiver, the famous Model One Sixty, known wherever radio was known. A new era in radio reception was opened by this circuit of Professor Hazeltine. Before the end of 1923—ten years ago—we reached a sales volume of $500,000 a month.

In 1925, a writer said of FADA: "The company is one of the few in the industry to build practically every part for its own receivers. The history and operation of each of the parts are in themselves romances of industry . . . instead of a single little item to permit a radio bug to build his own set the Fada factory turns out a complete line of broadcast receivers, models of all kinds, from the simple 'box' type to the finest console models."

And so radio marched on—battery sets, battery eliminator sets, then the electric set, known as the all-electric; improvements, improvements, until we come to the finished product of today. I am proud of the fact that we have ever been in the vanguard, ever in the front in engineering design and practice.

But above all I am proud of the fact that radio sets—that is to say the finest radio sets—are American to the core. Every development worthy of the name is a product of our country and this nation is fully five years ahead of any other country in radio. The hard road traversed by the pioneers seems softened by that great accomplishment.

Literature Wanted

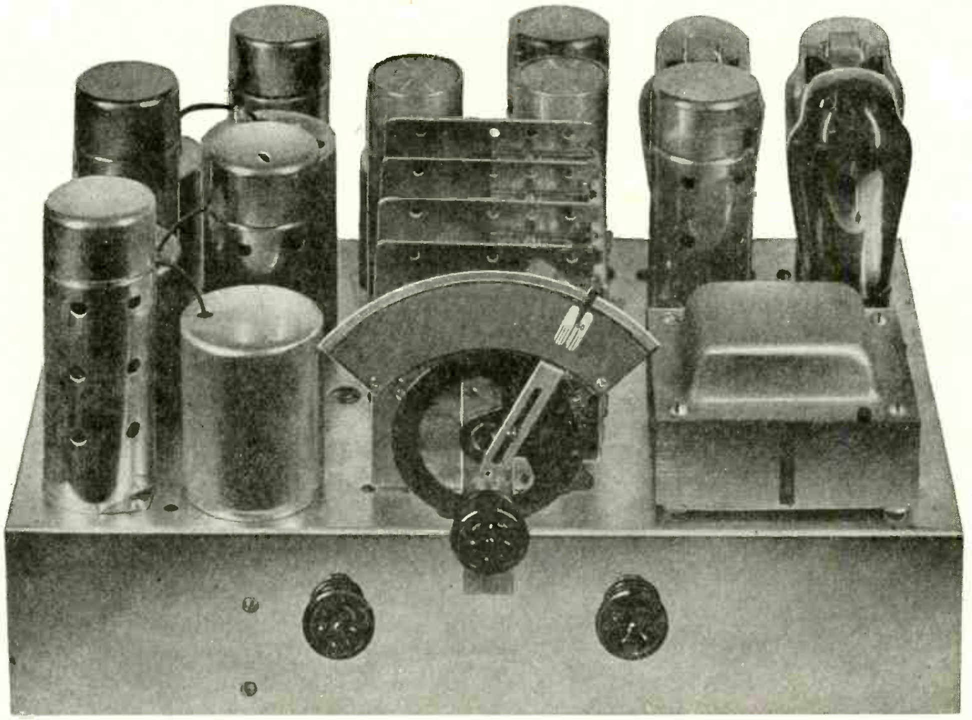
Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor,* RADIO WORLD, *145 West 45th Street, New York, N. Y.

Vernon Bernard, Route A, Box 282, Orosi, Calif.
Olan C. Drake, Passadumkeag, Maine.
Harry L. Kagamaster, D. B. A. Keg's Radio Service, 107 W. Market St., Akron, Ohio.
Harry H. Abery, Abery Radio, 51 William St., East Hartford, Conn.
C. M. Shaffer, Tyndall, S. D.
Wm. F. Brannon, 124 Elizabeth St., N. E., Atlanta, Ga.
Herman Phillips, Radio, P. A. and Sound Service, Roscoe, Texas.
Cliff Crandall, 1423 Herkimer St., Houston, Texas.
James Kelly, 306 Cecile St., Knoxville, Tenn.
John D. Page, 201 W. Frederick St., Athens, Pa.
J. E. Wieman, 418 No. 8th St., Fort Smith, Ark.
Matthew Fitzgerald, 97 No. 4th St., Old Town, Maine.
K. V. Woodworth, 129 E. 3d St., Ashland, Ohio.
Ivan Finan, 1115 Victoria Ave., Ft. William, Ont., Can.
H. M. Hyre, 557 S. Main St., Brookfield, Mo.
George Schatzle, 124 Church St., Newark, N. J.
Martin C. Smith, Newkirk, Minier & Newkirk, 1830 Standard Bank Bldg., Cleveland, Ohio.

The Greatest DIAMOND of them All!

Designed by Herman Bernard and Indorsed by Us as the Greatest Circuit We've Ever Offered

1. Push-Pull 15-watts undistorted output, the great power serving as a reserve that avoids distortion on strong low notes of orchestras.
2. New tubes. The heavy-duty 5Z3 rectifier and the 2A3 output tubes are used. The power stage is a cross between Class A and Class B, but of the no-grid-current type.
3. Full wave duplex diode linear second detector. Stands up to 60 volts signal on second detector.
4. Noise suppression control without an extra tube. This means no inter-channel hiss or "hash" without elimination of which a.v.c. is a nuisance.
5. Two stages of intermediate frequency amplification, both subject to full automatic volume control.
6. Selectivity affording non-interfered reception from a distant station through a local 10 kc away delivers 100 times as much antenna voltage.
7. Sensitivity of better than 0.5 microvolt per meter.
8. Volume control can completely eliminate signal, and has sound volume range from bare audibility to 400,000 times bare audibility.
9. Dual range. Broadcast and police bands by throwing a front-panel switch. Some amateurs, short-wave music and television can be received.



The knob at left is for throwing a switch, so 1,500-530 kc or 4,300 to 1,500 kc can be tuned in. At right is the combination a-c switch and volume control.

The Push-Pull Super Diamond

ON a chassis only 13.5 x 3 x 8.75 inches is built one of the finest a-c dual-range receivers any one could desire—the Push-Pull Super Diamond, using nine tubes, with eleven-tube performance. The reason for the extra performance is the use of a single tube as oscillator and modulator, and two tubes in one envelope as second detector and first audio amplifier (55).

The push-pull output stage uses two of the new 2A3 tubes, affording 15 watts output (5 per cent. total harmonic distortion), and the output stage is driven by a 56, which will load up the 2A3's. The gain is built up tremendously at the intermediate frequency level, where it may be done without distortion. Then follows a distortionless full-wave detector, the full-wave feature being protection of quality. The audio stages are worked well within their power-handling capacity, to a total gain at audio frequencies of less than 1,000.

The performance of the receiver is such that you never need worry about interference due to a strong local spoiling reception of a distant station on an adjacent channel, or interference due to cross-modulation, for there is no cross-modulation.

The controls are limited to the tuning dial, which is frequency-calibrated, the combination a-c switch and volume control, and the wave-band switch. Total, three controls. Result, utter simplicity. Any one in the family can tune the set without any trouble. No tuning indicator, be it meter or neon lamp, is necessary, due to noise suppression control.

You may use as long an aerial as you desire on this receiver, yet you will get an abundance of results from even remotely-distant stations on only ten feet of wire. The only precaution necessary is that the aerial be long enough to cause some voltage to exist in the second detector at all times, as on this voltage alone depends the bias on the first audio amplifier, (triode of 55). Without any bias there would be grid current, and consequent hiss at all settings, but 10 feet of wire as aerial, wherever placed, is usually sufficient to overcome this, and besides every one uses an aerial longer than that. Any type of outdoor aerial will meet the requirement of 55 triode grid current elimination.

The circuit was designed by Herman Bernard, has been carefully tested out by us in all particulars, and is unhesitatingly recommended as an outstanding circuit that will satisfy those who want "something better." The Push-Pull Super Diamond is distinctly "better."

Wired Model of Push-Pull Super Diamond, including speaker, tubes and everything else, except cabinet. Lined up and padded by experts. Licensed. Cat. WM-PPSD - - - - - - $36.27

Complete parts, speaker, tubes, everything except cabinet. Cat. K-PPSD. $32.77

Direct Radio Co.

143 West 45th Street
New York, N. Y.

FOUNDATION UNIT

The Foundation Unit for the Push-Pull Super Diamond consists of a shielded antenna coil, a shielded interstage r-f coil, a comibnation oscillator and 175 kc assembly in one high shield, a shielded regular 175 kc transformer, and a shielded 175 kc transformer with center-tapped secondary; also a 0.00041 mfd. tuning condenser, three-gang, with compensators; an 850 to 1,350 mmfd. padding condenser, a frequency-calibrated dial and a drilled chassis. Cat. FU-PPSD @ **$6.55**

[The coils for r-f and oscillator are wound exactly according to specifications of Herman Bernard and are of a higher order of accuracy than in commercial practice, and moreover provide for matching the tuning to the scale of the frequency-calibrated dial that bears Mr. Bernard's name.]

ADDITIONAL PARTS

The nine 0.1 mfd. and two 0.25 mfd. bypass condensers for the Push-Pull Super Diamond are specially made up in one shield, with three mounting lugs for which the chassis is drilled. Cat. CU-PPSD @........................ **$1.20**

Three-gang 0.00041 mfd. tuning condenser, compensators. Cat. TC-PPSD @ **$1.80**

Cadmium-plated drilled steel chassis for the Push-Pull Super Diamond. Cat. CH-SD7 @ .... **.98**

The tube kit consists of four 58, one 55, one 56, two 2A3 and one 5Z3, total 9 tubes. The radiotron tube kit is Cat. TK-PPD @.... **$10.62**

850 to 1,350 mfd. padding condenser...... **.50**

Knobs for ¼ inch shafts............. **7¢ each**

Bernard's frequency-calibrated dial........ **.90**

Four electrolytic 8 mfd condensers, two in one case, two in the other, to occupy top panel positions, ... **$2.36**

Bypass condenser, 0.5 mfd................. **.29**

70-meter switch **$1.56**

Heavy-duty power transformer, 150 ma rating, correct voltages and windings............. **$2.95**

Heavy-duty push-pull 2A3 speaker, 2800-ohm field, tapped @ 700 ohms and reverse-wound. Rola or Magnavox at our selection........ **$7.05**

Complete kit of the 17 one-watt resistors.. **$1.87**

250,000 - ohm tapered potentiometer with switch .... **.62**

Complete set of ten sockets (one for speaker) .... **.92**

0.00005 mfd. mica condensers, 50 mmfd..**36c each**

Push-pull input transformer, unshielded.. **$1.87**

775-ohm, 5-watt resistor...................... **42c**