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Alumni Association News

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HOW STRONG IS THE CHAIN?

Let's suppose you are running a construction job and need a chain to carry a heavy and very valuable load. You order your blacksmith to forge a chain; you want it made of the best steel—each link must be perfect. Such a strong chain will carry the valuable cargo safely. But if just one link parts—DISASTER!

Life is like that. It is like a chain composed of ambition, perseverance, character—and TRAINING. Until your link of Training has been forged there is nothing to tie the Success chain together. And you need a strong link to hold it together.

You are using good, strong, time-tested material now. But don't skimp on material. Don't think you know a subject—**KNOW THAT YOU KNOW IT!** Don't try to cover a subject or a lesson in a day when common sense tells you it should require a week. Don't ruin your steel by allowing flaws to creep in which may eventually weaken your chain.

Put all of your N. R. I. Training into your success chain—make it as big and as powerful as possible. The time will come when you need a strong chain to support you—to help you over difficulties—to carry you through competition—to carry you onward, forward, and upward to the success goal which you have set for yourself.

J. E. SMITH, *President.*

High-Fidelity Alignment with a Cathode Ray Oscilloscope

By J. A. DOWIE
N. R. I. Chief Instructor



J. A. Dowie

The editorial policy of N. R. News is to present articles which will interest both our new and advanced Students. An article such as this one is definitely intended for the more advanced Students and Graduates who have Receiver Alignment problems to solve. Therefore, beginning students who find this material "over-their-head" should keep in mind that as they progress with the Course they too will understand and appreciate articles such as this.

—EDITOR.

THE c.r.o. finds one of its most important service applications in the alignment of high-fidelity receivers. The problem of alignment of such receivers is entirely different from that of the ordinary receiver, which requires only a standard signal generator and an output meter.

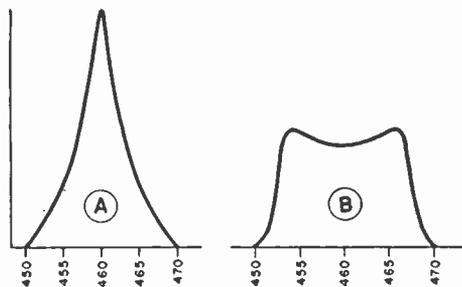


Fig. 1. Resonance curves. A shows a high-selectivity, high-sensitivity response, while B shows a broad pass-band for higher fidelity.

If the i.f. amplifier of a high-fidelity receiver is adjusted for maximum response at a single frequency, the bandpass characteristic will be destroyed and the receiver will lose the "fidelity" which it was designed to have.

The necessity for a band-pass i.f. in a high-fidelity receiver is plain if we remember that

a modulated carrier consists of a *group* of frequencies, which extend *above and below* the carrier as far as the highest frequency to be transmitted. Thus, a 5000-cycle modulation range requires a band of frequencies 10-ke. wide, and this is the usual broadcast practice, entirely adequate for voice or dance music. Many stations now modulate to 7500 cycles, however, and some special ones go even higher. Such higher frequencies are necessary for true fidelity with fine music.

Receivers designed for distant reception cannot pass a band 15 ke. or 20 ke. wide which is necessary for high fidelity. Fig. 1A shows how such receivers are designed for a much sharper response, in order to eliminate interference between stations only 10 ke. apart in the broadcast band. Naturally, when frequencies only 5 ke. from the carrier are so sharply "cut" as shown in Fig. 1A, the high-frequency modulation will be practically eliminated and the receiver will heavily emphasize the bass frequencies. This may suit some "ears," but it is not true fidelity.

In order to get the higher frequencies through the i.f. amplifier, high-fidelity receivers have a "flattop" band-pass characteristic. This can be made wide enough to pass 5000 cycles without attenuation, as shown in Fig. 1B, or may be made even wider to obtain high fidelity. Naturally, such receivers can be used on strong local signals only, since their wide response would permit serious interference from distant stations, if the sensitivity were also high.

To align a band-pass circuit properly, you must adjust the response so that it is even over the whole width of the pass band, and not "peaked" at one frequency, as in an ordinary i.f. circuit. This could be done by feeding different frequencies throughout the pass band into the amplifier, and plotting the various output levels as a response curve. This is a tedious process, however, and would have to be repeated each time the circuits were adjusted.

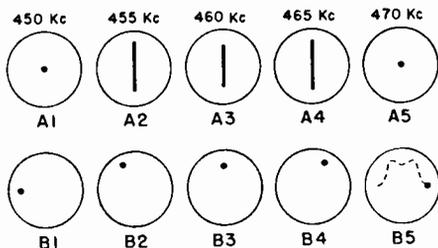


Fig. 2. The application of voltage to the vertical plates only will produce lines of varying length as in A₁ to A₅. By sweeping the spot as in B₁ to B₅, a trace of the wave as shown by the dotted line in B₅ is obtained.

With the c.r.o., the response over the whole pass band can be made instantly visible on the screen, and the effect of adjustments will be apparent as they are made.

This is done by changing the frequency of the generator signal back and forth over the pass band at a regular rate, and at the same time applying a horizontal sweep on the c.r.o. which carries the spot across the screen and back at the same rate. If the input level is held constant, the vertical height of the spot above the center line will be proportional to the signal output, and since the spot is also moving horizontally in step with the changing carrier frequency, it will plot a graph of the amplifier response over the band covered. Fig. 2B shows the spot at different positions in the sweep and in B₅ indicates the curve that is formed.

To use this system, the generator frequency must be varied over a wide band at a steady, rapid rate, and the c.r.o. horizontal sweep synchronized with these variations to make the curve stand still. This is obviously impossible to do by hand, but there are two means of doing it, one mechanical and one electrical. Both systems, which use special signal generators known as "wobblers," use a variation rate of 40 to 60 times a second, and sweep the signal frequency over a band 20 or 30 kc. wide. As this is frequency modulation, such generators are also called f.m. signal generators. Both systems will be described.

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Mechanical Wobulation

Mechanical wobulation is obtained by placing a small variable condenser in parallel with the regular tuning condenser of the oscillator tank circuit, and driving this small condenser by means of a motor. The condenser is made so it rotates through a complete circle, its capacity going from maximum to minimum and back, once for each rotation. This carries the signal frequency up and back again in step with the rotation.

For example, suppose the oscillator is set at 1400 kilocycles and the trimmer, such as the one shown in Fig. 3, is being rotated. The circuit is set for normal frequency when this condenser is half in mesh, as shown at C. Then the motor is started, which rotates the condenser through its range 30 or 40 times per second. As it changes from maximum to minimum capacity, the signal frequency goes through a range of about 20 kilocycles, 10 kilocycles on each side of the normal or resting frequency.

As this condenser has a certain fixed capacity change, it will give a different band width as the main tuning condenser is adjusted for a different resting frequency, because this changes the ratio of the capacity *change* to the total capacity. As a fixed band width is desired, standard practice is to make use of a fixed oscillator. A frequency of 700 or 800 kilocycles may be used by some manufacturers, while others may use

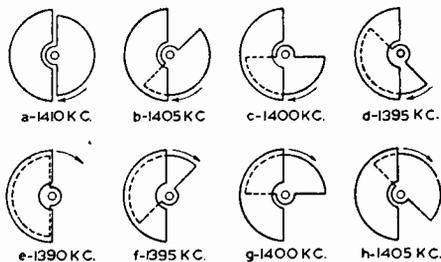


Fig. 3. Rotating the trimmer produces a frequency change with the change in capacity.

2000 kilocycles. In any event, the motor-driven condenser varies the frequency of the fixed-frequency oscillator, so the band width is fixed. Then, the output of this fixed-frequency oscillator is mixed with the output of a variable-frequency oscillator in a mixer-detector circuit. The resulting beat frequency is the output, so the resting frequency can be varied at will, but it is swept over a fixed band width. The dial on the signal generator is calibrated in terms of the frequency which actually comes out of it as a result of this mixing process.

OBTAINING SYNCHRONIZATION. Various means of synchronizing the c.r.o. horizontal sweep with the rotations of the condenser can be used. A magnet on the condenser motor shaft, turning near a fixed pickup coil, will give a regular pulse for each rotation. The magnet can be shifted on the condenser shaft to give the pulses at just the right time. Or, an R-C sweep circuit can be built right in the wobbulator and its out-

ductance is the fact that the voltage across it leads the current through it by 90° . Any device, therefore, which will exhibit this characteristic is acting like a coil. Thus the control tube of Fig. 4 acts like a coil too.

As the current i_c flows through condenser C_4 , the *voltage* drop across this condenser will be 90° behind the current i_c . This is the normal action of a condenser. Therefore, the voltage e_g lags current i_c by 90° .

The plate current flowing through tube VT_2 follows the grid voltage e_g . When e_g becomes positive, the plate current increases, and vice versa. Therefore, the plate current i_p is in phase with the grid voltage e_g . Since e_g is 90° out of phase with e_p , this means the plate current is likewise 90° out of phase with the plate voltage. Furthermore, it lags behind the plate voltage, which is the correct relationship for an inductance.

The value of resistor R_2 is chosen so that the tube draws some particular amount of current, and acts as an inductance of a certain value. This inductance is in parallel with coil L_1 . This lowers the effective amount of inductance, but condenser C_1 is adjusted to where the proper frequency is obtained.

CONTROL PULSES. Now, when control pulses are applied to the input of the oscillator control tube, the plate current drawn by the tube will vary according to these control pulses. When the grid becomes more positive, the tube draws more current, thus acting as a smaller inductance. This reduces the effective inductance of the tank circuit so that the circuit is tuned to a higher fre-

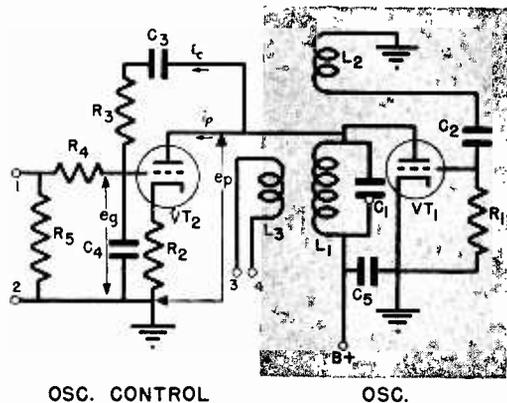


Fig. 4. The oscillator control circuit for electronic sweeping is just like the control circuit used in a.f.c. systems.

put fed through the horizontal amplifier instead of using the c.r.o. built-in sweep. This R-C circuit can be connected to a shorting switch on the condenser shaft, which allows the condenser voltage to build up and then discharges it every rotation.

Electronic Wobulation

The oscillator control circuit, which is the heart of the automatic frequency control system, provides a means of getting electronic wobulation. You will recall that by connecting a tube to the oscillator circuit properly, we can make the tube act as an inductance coil. Then, by feeding a control signal to the tube, we can obtain an inductance which varies at a regular rate, thus varying the main oscillator frequency at the same rate.

THE OSCILLATOR CONTROL. As a review, refer to Fig. 4. Here we have a tuned-plate oscillator connected so the plate current of the control tube must flow through tank coil L_1 . This plate current is made 90° out of phase with the plate voltage by using the network C_3 , R_3 and C_4 which is connected across the tank circuit. As the resistance of R_3 is large compared to the reactances of C_3 and C_4 , the current i_c is in phase with e_p , as shown in Fig. 5.

One of the important characteristics of an in-

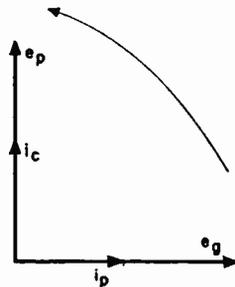


Fig. 5. The current and voltage relationships in the oscillator control circuit.

ductance. On the other hand, when the control pulses add to the bias, this reduces the current, making tube VT_2 act as a larger inductance, and this tunes the circuit to a lower frequency. By adjusting the value of the control pulse amplitude, a fixed amount of swing about the normal or resting frequency is obtained.

For the purposes of drawing a characteristic curve, the frequency must be swept over this band of frequencies at an even and steady rate, first up, then back down over the same frequencies. This means the control pulse must swing gradually positive, then gradually negative. This form of change is produced by a voltage having a triangular or pyramid shape.

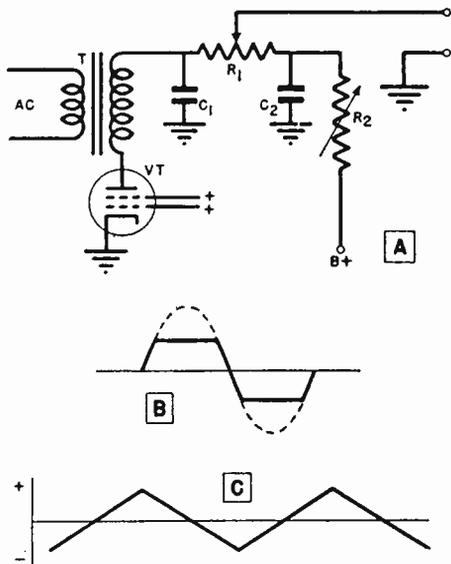


Fig. 6. A circuit for producing a triangular or pyramid wave shape.

A circuit for producing this special wave is shown in Fig 6A. Essentially, this is an amplifying tube, adjusted to operate on a characteristic having a short straight portion. Then a high value of a.c. is applied, so that the tops and bottoms of the swings are cut off by the characteristic curvature, producing a square-wave shape as shown in Fig. 6B. These square-wave current pulses must pass through the filter C_1 - R_1 - C_2 . As a result of the time constant of the filter, a wave shape which is like that shown in Fig. 6C will be obtained. This is the desired wave shape. The voltage can be varied by adjusting the slider on R_1 , which makes it possible to vary the range over which the oscillator frequency is changed. Thus, the sweep can be adjusted to be any desired width from perhaps 5 kc. to 40 kc.; this is not possible with a mechanical system.

COMPLETE WOBBLATOR. The triangular voltage generator is connected to the oscillator frequency control, which in turn varies the frequency of the fixed oscillator over the desired band. The output of the fixed oscillation is fed

to a mixer-detector circuit, along with the output from a standard variable frequency oscillator, as shown in Fig. 7. The "mixing" action is exactly similar to that in the mechanical wobbulator already described, producing a signal that varies over the pass band at a regular rate.

Wobbulator Alignment

Let's take a wobbulator and actually use it to line up a high-fidelity receiver. Connect it through a blocking condenser to the first detector grid just as usual for i.f. alignment. Then, assuming a diode second detector, the c.r.o. vertical input is connected across the load resistor. Now, a connection must be made from the wobbulator to the sweep control circuit on the c.r.o. The receiver, oscillator and c.r.o. are turned on and allowed to warm up.

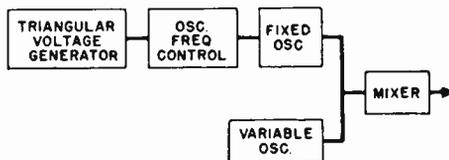


Fig. 7. This block diagram shows how the sections of an electronically wobbulated oscillator are interconnected.

Now, suppose the oscillator is set to the i.f., and the sweep frequency is adjusted for a stationary pattern, at the same rate as the wobbulation. The result will be a double-hump pattern as shown in Fig. 8A. You can see the reason for this if you will remember that the wobbulator goes through the resting frequency *twice* for each cycle of revolution of the revolving condenser, or twice for each cycle of the triangular sweep wave. In this particular instance, the wobbulator is sweeping over a band 20 kilocycles wide, 10 kilocycles on each side of the 460-kc. i.f. value (450 kc. to 470 kc.).

Each one of the humps on the screen will have a shape similar to the response characteristic of the amplifier. However, it is difficult to tell with his kind of curve just when the middle or resting frequency of the oscillator is at the mid-frequency of the i.f. passband. For example, as shown in Fig. 8B, the oscillator has been moved to 462 kilocycles. Comparing A with B shows that there is very little difference in the appearance of these waves.

The solution to this difficulty is to adjust the sweep frequency of the c.r.o. to *twice* the wobbulator rate. Now, there is time for only one of the variations for each cycle of the sweep. The result is that the two "humps" are placed one on top of the other, as shown in Fig. 9. This over-

lapped pattern is the one normally used for high-fidelity alignment, so most mechanical and all electrical systems provide a controlling voltage twice the wobulator rate.

Starting from point *a* and moving to point *b*, etc., you will find that the tracing is made through the resting frequency, then snapped back to the beginning and another trace is formed, appar-

pass, high-fidelity i.f. can now be made by causing the peaks to spread out to the proper flat-top shape, with the two humps exactly coinciding with each other. Therefore, we first must peak-align the i.f. amplifier, then increase the capacity of one trimmer and decrease that of the other on *each* transformer, so the primaries and secondaries are tuned above and below the proper frequency, to get the band pass curve.

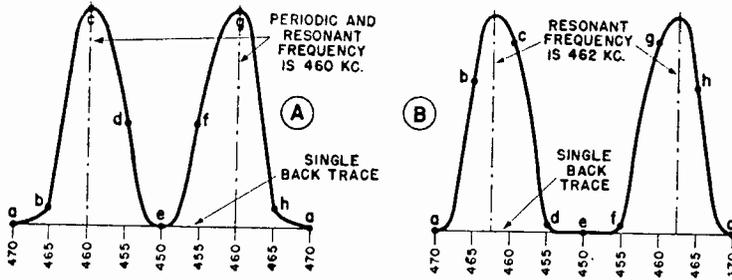


Fig. 8. The double hump resonance curve pattern is obtained when the c.r.o. sweep is set to the same rate as the wobulation. This pattern does not indicate clearly when the circuits are resonant to the resting frequency of the oscillator.

ently behind the first one. Notice the frequency goes up for one trace and down for the overlapped trace. This means the upper and lower halves of the band pass curve are overlapped, so we can see directly when both halves are alike.

If you turn the adjustments too far, you will detune the circuit so the shape of the wave will change or the peaks may even separate. Typical distorted waves are shown in Figs. 10A and 10B.

If we are not exactly in resonance, the tracings will separate to a position similar to that of Fig. 9A. As we tune to resonance, however, one

When a bank-pass circuit is perfectly adjusted, you will get a figure something like Fig. 10C. Incidentally, you can determine the amount of

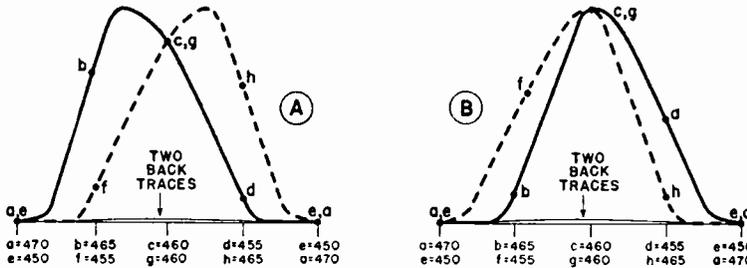


Fig. 9. This overlapped pattern is the one usually used for band-pass alignment. It is obtained by making the sweep frequency twice the wobulator rate.

tracing moves behind the other one. When we are exactly in resonance, the two *peaks* will exactly coincide, as shown in Fig. 9B.

Therefore, the receiver can be tuned to the proper resting frequency by making these peaks coincide. Now, the sides of the traces do not coincide until the proper alignment has been obtained. Therefore, the alignment of our band-

band-passing (an important adjustment), because the length of the back-trace line between points 1 and 3 of Fig. 10C corresponds to the sweep band width of the oscillator. The resting frequency is at point 2. If the sweep is adjusted for 30 kilocycles, the distance from point 1 to point 3 will be 30 kilocycles. Therefore, you will have to be sure that you have obtained the proper amount of band-passing by comparing the

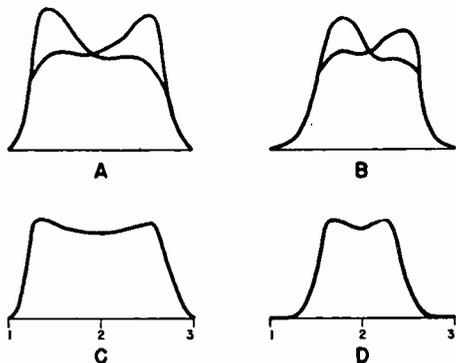


Fig. 10. Typical distorted patterns are shown in A and B. The band width can be determined by comparing the spacing of the sides of the pattern with the length of the back-trace line. Thus, C shows a circuit band-passed to the full limit of the wobulator while D shows a band-pass of only about half as much.

spacing of the sides of the image with the back-trace length. For example, in 10D the circuit is band-passed, but only for a 10- or 15-kilocycle band width. This may be all the set is designed for. However, if the set should have a wider band width, the adjustments should be continued so the flat top is retained, but the sides are moved further apart.

CONNECTING THE C.R.O. Practically all high-fidelity receivers will have a diode second detector, using a resistive load, as in Fig. 11. The c.r.o. should be connected across resistor R_2 when band-passing the receiver. When the receiver uses A.F.C., the connection is made across the audio load.

Should the receiver happen to use transformer coupling, or should the connection be made to an audio stage instead of the detector, phase distortion may occur. This causes part of the image to exist below the back-trace line as shown in Fig. 12. Phase shifts distort the wave to a useless form insofar as determining proper band-passing is concerned, so must be avoided. Where transformers are found, replace the primary temporarily with a 10,000- to 50,000-ohm resistor, or connect a 20,000- to 25,000-ohm resistor in parallel with the primary, with the c.r.o. connected across the resistor.

Practical Hints

Let us now review the basic procedure for high fidelity alignment, to be sure the proper procedure is followed.

First, the receiver must be peak-aligned by following Page Eight

lowing the standard procedure, particularly if any tampering has occurred. Then, the wobulator is connected to the grid of the first detector and the c.r.o. is connected across the second detector load. The pre-selector is tuned away from from any interfering station frequency—usually to the low frequency end of the band.

The wobulator is tuned to the i.f. frequency, then the c.r.o. sweep is adjusted to give the double or overlapped trace, with a fixed image. Assuming the wobulator to be producing the correct i.f., the trimmers are varied to get coinciding peaks, then adjusted for a flat-topped, square-

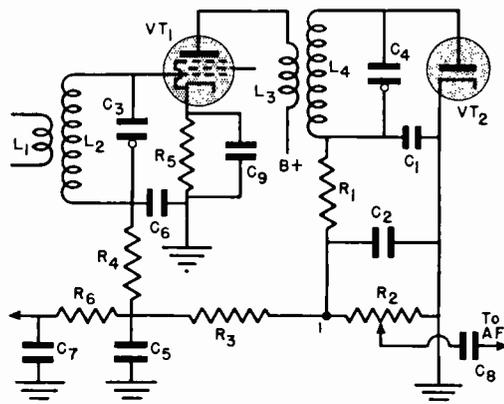


Fig. 11. Tube VT_2 is a typical diode detector of the type usually found in high-fidelity receivers. The c.r.o. should be connected across R_2 .

shaped band-pass characteristic, with the sides of both traces coinciding. The width of the pass band should be adjusted as is proper for the set, comparing with the length of the back-trace line, which corresponds to the band width for which the wobulator is set.

To complete the high fidelity alignment procedure, the wobulator should be moved to the input of the receiver and a check of the overall response made. The c.r.o. remains connected to the diode load of the second detector.

The wobulator is now of course tuned to some frequency within the broadcast band and the receiver is tuned to the same frequency. The output wave shape should be very similar to that attained through the i.f. amplifier alone. Normally, the preselector is not band passed, but is so broadly tuned that it does not appreciably affect the shape of the output wave. If any alignment adjustments are made on the preselector, it is important to see that the wave shape is not greatly changed.

In some cases you may find that the band pass

adjustments of the i.f. amplifier produce a wave having two rather pronounced peaks with a valley between. Check to be sure you are not trying to adjust for too wide a pass-band, as the receiver may be of limited fidelity. If the peaks are separated the proper distance for normal band passing, and the i.f. adjustments do not seem to make the top of the band pass wave more flat, then wait until the overall check has been made. You will usually find in such cases that the preselector selectivity is somewhat more sharp with the result that, when tuned exactly to resonance, it introduces a third peak between the two i.f. peaks. This peak "lifts" the valley, producing a more flat characteristic.



Fig. 12. Connecting the c.r.o. across a transformer or to an audio stage instead of the second detector produces a phase shift, pulling part of the pattern below the back-trace line and so distorting the pattern that it cannot be used.

N. R. I. GRADUATE WINS AIR SERVICE AWARD

Inventors Given Prizes at Rites of Air Service

Time-saving, cost-cutting, life-protecting ideas contributed by six civilian employes of the Long Beach Fifty-eighth Subdepot of the Air Service Command brought hundreds of dollars reward yesterday to prize-winners in this district, four of them Long Beach men.

The first award, \$150, went to Robert A. Oliver, colored, Los Angeles, whose ingenious radio diagram simplifies repair of the intricate radio system on airplanes. Oliver, a senior radio mechanic, is a graduate of the National Radio Institute, Washington, D. C. He studied engineering at Caltech, Pasadena.

The second prize, \$100, was

Graduate Robert A. Oliver of Los Angeles, Calif., a senior Radio Mechanic with the United States Army Air Forces, Ferrying Group, won top honors in a contest for time-saving and life-protecting ideas as is attested by the accompanying reproductions of a newspaper clipping and Army Headquarters letter.

HEADQUARTERS
6TH FERRYING GROUP
FERRYING DIVISION - AIR TRANSPORT COMMAND
LONG BEACH ARMY AIR FIELD
LONG BEACH, CALIFORNIA

XXXXXXXXXXXX

Mr. Robert A. Oliver,
158 1/2 E. 46th St.,
Los Angeles, California

Dear Mr. Oliver:

It is a pleasure to inform you that your suggestion concerning a radio diagram has been adopted and a cash award of \$150.00 will be paid to you.

It is requested that you be present at a ceremony to be held Wednesday, 8 December 1943, at 9:30 A.M. on the east side of L-20, Hqs. building, so that I may thank you for your very worth while idea and present your award to you.

Sincerely yours,

Dwight W. Chamberlain
DWIGHT W. CHAMBERLAIN,
Captain, Air Corps,
Chairman Local Committee
for Suggestions.

The Value of Graphs and How to Use Them

By L. T. BRISEBOIS
N. R. I. Consultant

THERE are many ways to present a collection of data. One can wade through complex and exhaustive reports. Or the material in the reports can be condensed into tables. Perhaps the simplest way to study a collection of data is through graphs.

Although a bewildering spectacle to the uninitiated, a graph is a source of valuable information to the trained Radiotrician. You will find graphs very valuable tools once you clearly understand how to construct and use them.

A graph can be considered a pictorial recording of a group of facts. For example, suppose we

are interested in the growth of a weed from a seedling to maturity. Every two weeks, for eleven weeks, we could measure the height of the stalk, recording our results in a table.

First week	1 foot
Third week	1½ feet
Fifth week	3 feet
Seventh week	4½ feet
Ninth week	5½ feet
Eleventh week	6 feet

This table gives us the facts. It does not give us a very clear picture. Figure 1 gives a better idea than the table above.

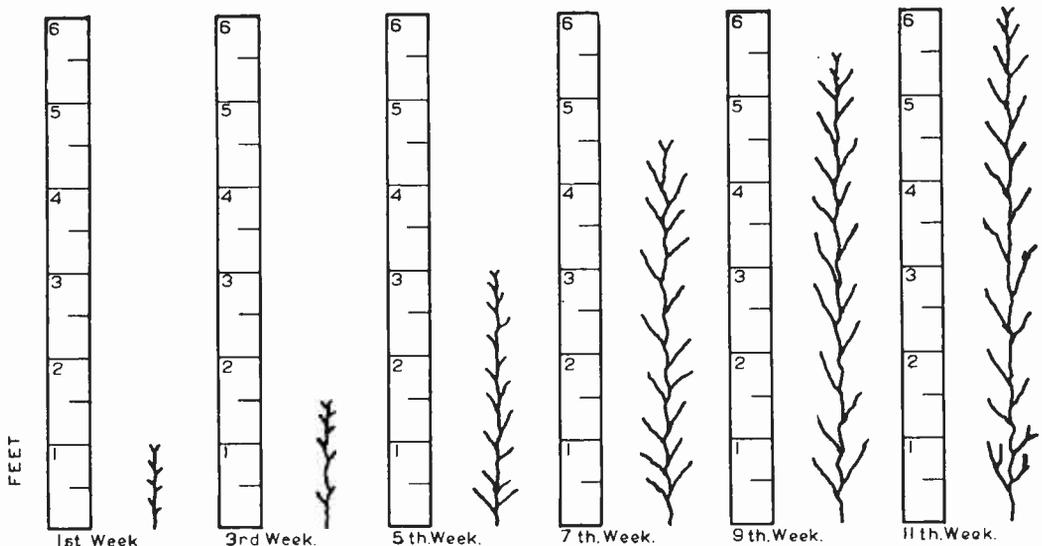


Fig. 1

Notice that by comparing the height of the weed with the ruler, we can find just how tall the weed was at the end of each two week period. It is just as easy to do away with five of the rulers and show the growth of the weed as in Figure 2. We can quickly compare the height of the weed at the end of the seventh week with the ruler at the left. We see that the weed was 4.5 feet high.

We can also eliminate the pictures of the weed. Just put a dot where the top of the stalk should come, as shown in Figure 3 and we still have the height clearly indicated. By going one step further and connecting the dots together with a line, we have, in Figure 4, a graph.

This line shows us at a glance the growth of the weed. Its growth was slow at first, speeded up between the third and ninth weeks, and finally slowed down again.

Furthermore, this line enables us to find where the top of the stalk was at any time between the two week intervals. For example, let's find the height of the stalk at eight weeks. You see seven and nine weeks marked at the bottom of the graph, so eight weeks will fall on the line halfway between seven and nine. Notice that there is a line in the graph right here.

From this point, go straight up to the curve, and from there straight over to the left-hand side showing the height in feet. We find that the stalk was five feet high at the end of eight weeks.

Thus, with the complete graph, we are able to find values which were not even present in our original tabulation of facts. This demonstrates one of the most important uses for graphs.

Let's use our graph again. (See Figure 4). Suppose we wish to find when the stalk was four feet high. Just locate four feet at the left, then go straight over to the curve. From the curve, go straight down to the bottom of the graph. We will hit the bottom line at the point marked "a".

This is not on a marked value, so we must estimate the time. We know that the line halfway between five and seven represents the sixth week, and point "a" lies about one-third of the way between six and seven, so we call point "a" six and one-third weeks, the time at which the stalk was four feet high.

The scale at the left of the graph, which has numbers one above the other in a *vertical* column, is called the *vertical* scale. These are the numbers for the lines going across the page, which show the vertical distance from the bottom scale. The scale along the bottom of the graph is called the *horizontal* scale. These numbers are for the lines going up and down the page and show the horizontal distance from the scale at the left of the graph.

It is also convenient to know that the vertical scale is sometimes referred to as the Y axis and the horizontal scale is sometimes referred to as

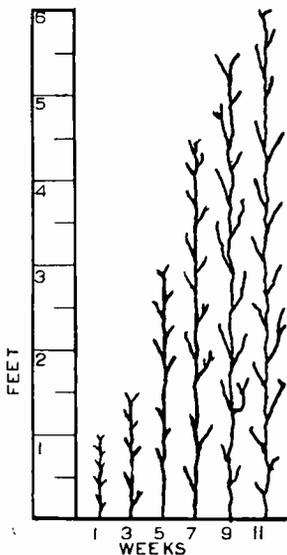


Fig. 2

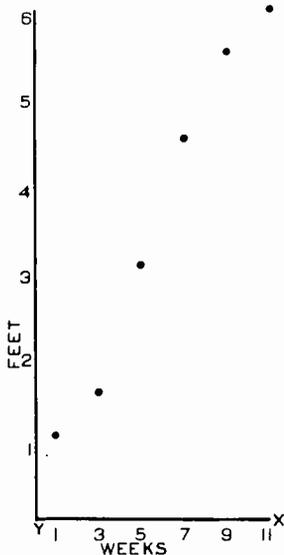


Fig. 3

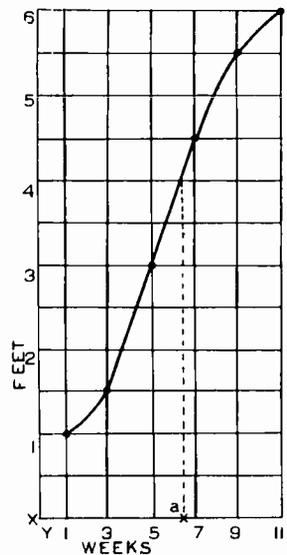


Fig. 4

the X axis as indicated in Figure 4. This is simply a matter of convenience.

You can see immediately how much valuable information is included in a graph. Before we

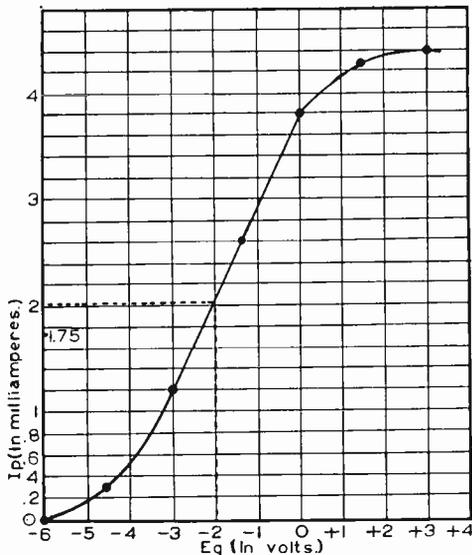


Fig. 5

go on to the consideration of graphs for radio problems, here are some additional facts which will help you to get the most out of any graph.

GRID VOLTAGE	PLATE CURRENT
-6	0
-4.5	.3
-3	1.2
-1.5	2.6
0	3.8
+1.5	4.3
+3	4.4

Fig. 6

Notice that the line drawn by joining the points together is not straight. Very few graphs will be straight lines. It is common practice, therefore, to refer to all graphs as *curves*.

Notice, also, that you can almost "see" the plant grow. As the weeks pass, the plant gets taller and taller. This is clearly evident just by glancing at the curve. Many, many times you will look at a curve for this type of information alone.

You will have to know what "overall" change can take place under certain conditions.

Finally, notice the portion of the curve between the third and seventh weeks. Between the third and fifth weeks, the plant grew 1.5 feet. Between the fifth and seventh weeks, the plant grew 1.5 feet. This *portion* of the curve is a straight line. If you don't trust your eyes, place a ruler along this section. You will see this to be true.

Under these conditions, the change (growth in this case) is said to be *linear*. This is a piece of information for which you will have frequent need. You will want to know when the response of a circuit or a part is linear. You will be able to tell very quickly by referring to a graph.

In your radio studies, graphs are going to prove very valuable in learning how tubes, for example, perform their many duties. It is important that you know just exactly how a tube will work in order to make maximum use of it, or to know what could cause it to operate improperly.

One type of graph which you will study is known as an E_g-I_p curve. E_g stands for "grid-voltage" and I_p stands for "plate current." This graph tells us how the plate current will change when the grid voltage changes. A graph of this type is shown in Figure 5.

This graph is made up in exactly the same manner as the one we just described in Figure 4. The necessary facts are taken from a table such as Figure 6. The facts presented in this table were secured by applying several different grid voltage values to a tube circuit and measuring the resultant plate current for each of the grid voltage values. The plate voltage was kept at a constant value.

Since some of the grid voltage values are negative while others are positive, we must lengthen the horizontal scale (the Y axis) at the bottom of the graph. Instead of zero (0) grid voltage being at the left end of the horizontal scale, it has been moved over. Positive numbers go from 0 toward the right, while negative numbers start at 0 and go to the left.

The vertical scale (the X axis) is like the scale used in Figure 4, except that the numbers are separated more, so that intermediate fractional values can be more easily read. Each vertical section of the scale is divided into five units. Therefore, each line is one-fifth or two-tenths of a milliampere. We usually use decimals because it makes our calculations simpler. In this case, the intermediate values of $2/10$, $4/10$, $6/10$, and $8/10$ would be written .2, .4, .6, and .8.

Here's how you'd go about locating one of these intermediate points. Suppose you wanted to find the point representing 1.75 ma. plate current.

From the previous explanation you know that the third line above 1 on the Y axis indicates 1.6 and the fourth indicates 1.8. Therefore, 1.7 would fall half-way between these two lines. And the point we want, 1.75, would be half-way between this mid-point and 1.8. Notice that the approximate location of this point has been marked on Figure 5. Consider the graph lines, either horizontal or vertical, as building blocks. Then, when it is necessary to estimate some intermediate value, mentally divide the section into smaller convenient sections. Almost never will it be necessary to divide it into more than five sections. Usually two or four will be sufficient.

Now, having learned how to read the scales, we can plot the graph from the data given in Figure 6. At the first grid voltage (C bias) value of -6 volts, we have zero (0) plate current. Locate the C bias voltage value and place a dot at the intersection of this line and the zero plate current line.

For a C bias of -4.5 volts, we must locate the line half-way between -4 and -5 volts on the X axis. We travel up this line until we encounter the horizontal line for the corresponding plate current, .3 milliampere. Note that .3 ma. is half-way between the .2 ma. and the .4 ma. lines. Put a dot here.

In the same manner, locate the -3 volt line and read up until you cross the horizontal line having a value of 1.2 ma. The -1.5 volt value is found half-way between -1 and -2 volts, and the corresponding plate current of 2.6 ma. is on a horizontal line. The zero grid voltage, 3.8 ma. plate current point is plotted in the same way.

Now we come to positive grid voltage values. You can see that the $-$ and $+$ signs used along the X axis are very important. The $+1.5$ volt value is entirely different from the -1.5 volt value so we must be careful to use the proper signs and to locate the proper lines.

After the dots have all been placed on the graph, they are connected together by a smooth (not straight) line, thus completing the graph. We now have a curve which shows us the over-all response of the tube and from which we can calculate quickly many intermediate values not included in our original table.

Suppose we wish to determine when a plate current of 2.0 ma. will flow. Locate this value on the vertical scale and read across the graph until you strike the curve. Then travelling downward, you will find that you cross the horizontal line at a bias value of -2 volts.

Now that we know how to construct a characteristic curve and how to find values from it, we can put this curve to work for us.

Suppose we are operating this tube with a fixed grid bias of -2 volts and with a fixed plate voltage. From our curve, we can find the plate current for this static condition. On Figure 7, this point is marked OP, called the Operating Point.

You know from your previous study that if you vary the grid voltage on a tube, the plate voltage supply remaining constant, the plate current will vary in a manner similar to the grid voltage variation. Suppose we applied a sine-wave signal voltage to the grid of this tube. If this voltage applied to the grid has an amplitude of 2 volts, the voltage on the grid will vary as shown in Figure 7, being first -1 volts and then -3 volts.

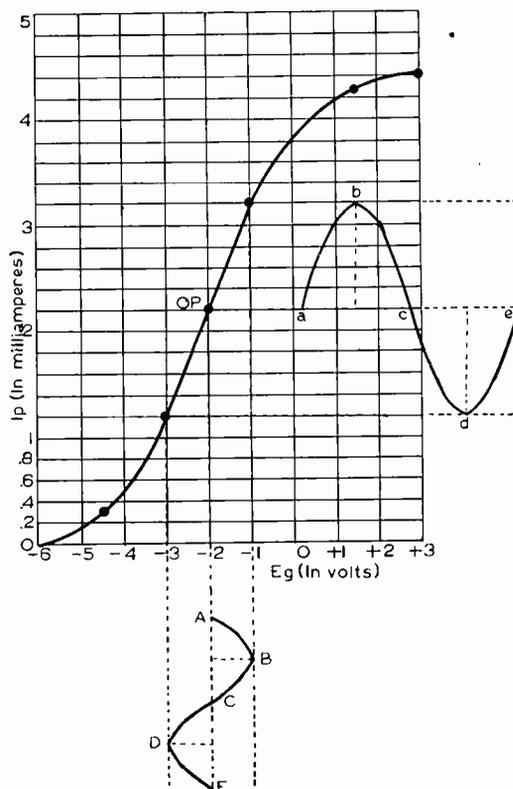


Fig. 7

When the signal voltage is $+1$, this will subtract from the fixed grid bias and the resultant grid voltage will be -1 volt. When the signal voltage is -1 , this will add to the grid bias and the resultant grid voltage will be -3 volts.

Now the plate current will vary as the grid bias varies. Let's consider one complete cycle. When

the voltage on the grid is as shown at point A, the plate current will be the value shown at point a. A quarter of a cycle later, the grid potential will be as shown at point B. The plate current will, therefore, be as shown at point b.

At the end of a half cycle, the grid voltage will again be at the resting value. This is indicated by point C. The plate current will, of course, have dropped to the static position at point c.

After three-quarters of a cycle, the grid voltage will have changed to the value shown at point D. Since the grid voltage is now more negative, the plate current will have dropped to the value shown at point d. Finally, at the end of a complete cycle, the grid potential will again be back to the resting value. This is shown at point E. The plate current will be at its resting value also, as shown at point e.

The signal voltage applied to the grid was a pure sine-wave. The resultant plate current change is approximately a pure sine-wave. It is so close to a pure sine-wave that we can say that it has very little distortion.

The plate current change when the tube is operated at point OP in Figure 7 with an applied signal as shown, is practically an exact reproduction of the signal applied to the grid. Therefore, it is reasonable to assume that if an audio signal, such as voice or music were applied to the grid under these conditions, it would be reproduced in the plate circuit by the plate current with the same fidelity. Now let's consider Figure 8. This time we are applying a fixed grid bias of -4 volts to the tube with fixed plate voltage. The operating point, the static plate current, is much lower as you can see from the curve.

Again let's apply a signal with an amplitude of 2 volts to the grid. We can plot the resultant plate current just as we did for the previous example.

You can see at a glance that there is definitely something wrong here. The upper part of the curve is about twice the size of the lower part. Do you think this plate current curve is very similar to the grid voltage curve? Indeed, it is easy to see that it is not.

Consequently, if we applied voice or music signals to the grid, the reproduction in the plate circuit would be greatly distorted. The reproduction of the signal would be very poor.

The actual practical value of graphs is immediately apparent. If you found that the output of a receiver was distorted, you wouldn't draw a graph but remembering what you have learned from them you would certainly immediately check the bias on the audio amplifier stages. Thus you have learned where to look by your study of graphs. You will learn what can cause improper

bias and how it may be corrected in your advanced lessons.

As you will learn from your lessons, it is not necessary in many instances that the values be marked down on a graph, once the correct shape of the graph has been determined. In other words, you are going to encounter tube curves similar to Figure 5, in which just the curve is shown with no corresponding values. This is because you, a serviceman, are usually more inter-

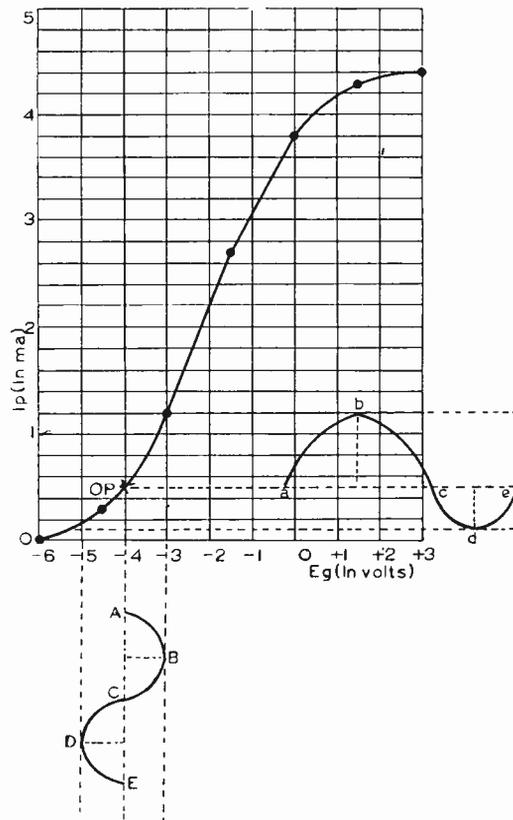


Fig. 8

ested in the shape of the curve than in the exact amount of current at some particular grid voltage. As you will learn, a tube operates best as an amplifier when the curve is made more nearly straight, or when operation is limited to the linear portion. It acts as a detector over a curved portion of the characteristic curve. This is fully explained in the regular N.R.I. Course.

You won't have to use graphs very often in your servicing work. But if you understand them,

you will be far more efficient than the average repairman.

The difference between you, a trained Radio-technician, and the average repairman is that you understand the basic underlying theory. You know how the various parts operate in various types of circuits and you know why they operate in that manner. Thus, when some part fails, you can quickly reason through to a cause.

As previously pointed out, graphs are basically an "aid." They enable you to visualize just exactly what is happening. If what does happen differs from the picture you learned through study, you know just exactly where to start looking for the circuit breakdown. The fact that you are able to apply a knowledge of graphs to your analysis makes your efforts easier and more effective.

The experienced serviceman and the student need graphs constantly. From published graphs, the expert can find out just exactly what he can expect from a certain circuit. A student uses graphs to help him more thoroughly understand the theory he is learning. His future success in radio depends on the foundation he acquires during his student days.

Put a little "extra" effort into the job of learning to use graphs. It will pay you "extra" dividends.

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OUR COVER PHOTO

The photograph on our cover this issue shows the delivery trucks and store front of the Radio and Electrical business owned by Mr. and Mrs. John D. Meadwell, 110—3rd Ave., S. Saskatoon, Sask., Canada. In the picture, left to right, are Mrs. Meadwell, Mr. Meadwell, a helper, and N. R. I. graduate Fritz Fischer, an employee. Both Mr. and Mrs. Meadwell are N. R. I. graduates. They write, as follows:

"Both husband and wife being graduates, we express our gratitude to N.R.I. for the fine training and loyal cooperation received. We owe our success to N.R.I. Your textbooks are thorough from cover to cover, making the most complicated parts so simple that anyone can understand. As the years roll by, we look back and wonder what we might have done had we not seen your ad. We started with nothing and truthfully can say that every bit of our Radio knowledge came from your fine Course. We have done wonderfully well and at present we believe we have the largest Radio repair shop in Saskatoon and have won the reputation of being very efficient in our work. No thoughtful person should fail to appreciate the advantages of home study courses. Your Course was the beginning of our success."

Men of Science



"Colonel" L. A. Hawkins

Godfather to most of the developments in General Electric's Research Laboratory is Laurence A. Hawkins. He has coined such names as *thyatron* and *phanotron* for so many electron tubes that he has created a new language! The electrical industry calls it "Greco-Schenectady."

Though he entered Williams College intending to study law, his interest was slanted toward electricity during summer work at the Stanley Electric Co. in his home town of Pittsfield, Mass. So in 1897 he took his new B.A. from Williams to the Massachusetts Institute of Technology, where two years later he was graduated as an electrical engineer. Back to the Stanley he went then, and when it merged with General Electric he went to Schenectady as a G-E patent lawyer. In a few years he was made engineering assistant to the director of the Research Laboratory. Later he became executive engineer, a position which he has kept for thirty years.

During these thirty years, Larry Hawkins has translated laboratory science into engineering terms and vice versa. As the "Larry" of the "House of Magic" shows, which the late Floyd Gibbons broadcast, he became the voice of the laboratory. And he gained such a wide reputation as a story teller that he was made a Kentucky colonel, along with such men as Will Rogers and Irvin S. Cobb!

Larry Hawkins is a firm believer in the "scientific attitude"—the basing of opinion on facts that can be proved. And he's an idealist, too, for he believes that applying this attitude to social and economic problems might, in time, solve them.

Sample Questions and Answers for Radio Operator License Examinations

By WM. FRANKLIN COOK

N. R. I. Technical Consultant



THIS is another installment of the questions taken from the "Study Guide and Reference Material for Commercial Radio Operator Examinations," together with typical answers. The questions give a general idea of the scope of the commercial radio operator examinations.

The basic theory for these questions has been covered in your Course, but is being repeated here as answers to these questions. Remember, the following answers are far more detailed than would be required for an operator's license examination. The questions are theoretical, so the answers go more thoroughly into the basic theory, in order to permit similar questions to be answered.

Some of the material is advanced technical data, of course, which can be properly understood only by the advanced student or graduate. However, you will find this information valuable, whether or not you intend to take the operator's license examination.

ELEMENT III

Radiotelephone

(3-1) In Fig. 3-1, (a) Knowing the impressed voltage E and the values of the resistors R_1 , R_2 and R_3 , explain how to calculate the current in each of the resistors. (b) Knowing the value of current in R_1 and the values of the resistors R_1 , R_2 and R_3 , how would you calculate the currents in R_2 and R_3 ? How would you calculate the voltage drop across each of the resistors?

Ans. (a) First determine the resistance

of R_1 and R_2 in parallel. This may be found by using a formula $R_A = \frac{R_1 \times R_2}{R_1 + R_2}$. The result added to the value of R_3 is the total circuit resistance ($R_T = R_A + R_3$). The current flow may be determined by using the formula $I = E \div R_T$. This is the cur-

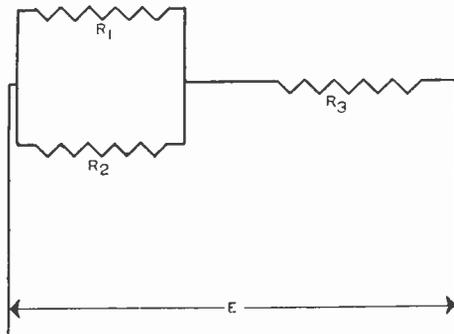


Fig. 3-1

rent flow through R_3 , so the voltage drop across R_3 is determined by the formula $E_3 = I \times R_3$. The voltage drop across R_3 is now subtracted from the impressed voltage, leaving the value of the voltage across R_1 and R_2 . The current flow through each of these resistors is found by using the formula $I = E \div R$.

Knowing the current in R_1 and the resistance of R_1 , first determine the voltage across R_1 by $E_1 = I_1 \times R_1$. This is also the voltage across R_2 , so $I_2 = E_1 \div R_2$. The total

current is $I_1 + I_2$, which is the current flowing through R_3 .

You have already found E_1 , which is the same for both R_1 and R_2 . The voltage across R_3 is $E_3 = I_T \times R_3$

(3-2) In Fig. 3-2:

- (a) The d.c. plate voltage will bevolts.
 (b) The d.c. grid bias will bevolts.
 (c) The supply voltage will bevolts.

Ans. (a) We do not know the applied voltage nor the plate resistance. However,

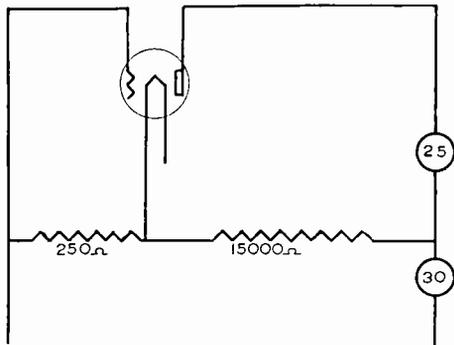


Fig. 3-2

the connections of the plate and cathode puts the plate resistance across the 15,000-ohm bleeder, so the bleeder voltage drop will be the same as the plate voltage. We see the supplied current is 30 ma. and the plate takes 25 ma., so 5 ma. must flow through the resistor (Kirchhoff's Current Law). Hence, $E = I \times R$, so $.005 \times 15,000 = 75$ volts, which is also the plate voltage.

(b) The grid bias is the voltage drop across the 250-ohm resistor, found by $E = I \times R$. The current flow will be the sum of the 25-ma. plate current and the 5-ma. bleeder current, so is 30 ma. Hence, $E = .03 \times 250 = 7.5$ volts.

(c) The supply voltage is the sum of the plate and grid voltages, so is $75 + 7.5 = 82.5$ volts.

(3-3) Define a negatively charged body. A positively charged body.

Ans. A body is negatively charged when it has more than the normal number of electrons. The number of excess electrons is a measure of the amount of charge. A positive charge is the charge on an object having less electrons than normal.

(3-4) What are the desirable electrical characteristics of a radio frequency choke coil?

Ans. A radio frequency choke should have low resistance and possess maximum impedance at the operating frequency. This means that the distributed capacity must be low as it would otherwise nullify the inductance.

(3-5) Explain the purposes and methods of neutralization in radio frequency amplifiers.

Ans. The purpose of neutralization is to prevent an amplifier from acting as an oscillator. Should any feedback in the proper phase occur in a high power r.f. amplifier, it will oscillate instead of amplifying. Neutralization is the process of feeding back an out of phase voltage so as to counteract undesired feedback.

There are two methods of cancelling feedback, known as plate neutralization and grid neutralization. The names are obtained from the methods of feedback. In plate neutralization, some of the energy from the plate tank coil is fed back to the grid circuit through a neutralizing condenser, the connections being arranged so this feedback is out of phase with the feedback through the grid-plate capacity of the tube. In grid neutralization, the opposite occurs—energy is taken from the grid tank circuit and fed to the plate circuit.

To make the neutralizing adjustment, first remove the plate voltage from the stage to be neutralized. Then, excitation is applied and the grid circuit is tuned to resonance, as indicated by a maximum reading on the grid current meter. When the plate tank circuit is now tuned through resonance, the grid meter will dip as the plate tank absorbs energy through the grid-plate capacity of the tube. The neutralizing condenser is adjusted as the plate tank is tuned back and forth through resonance, until minimum effect on the grid meter reading is noted.

Of course, neutralization is necessary in triode amplifiers but is not commonly required in screen grid and pentode stages, where there may not be a great amount of feedback.

(3-6) In a circuit consisting of an inductance having a reactance value of 100 ohms and a resistance of 100 ohms, what will be the phase angle of the current with reference to the voltage?

Ans. It is possible to find the answer to this problem by use of vector diagrams or

trigonometry. However, since the examination uses the "multiple choice" type question you will be given five answers for each question, only one of which is correct. Since you probably will not carry a protractor (a device for measuring angles) nor trigonometric tables with you the solution follows: \tan

$$\theta = \frac{X}{R} = \frac{100}{100} = 1 \text{ which is the tangent}$$

for an angle of 45°. Since the reactance is inductive, the current will lag behind the voltage.

(3-7) In a circuit consisting of a capacitance having a reactance value of 100 ohms, what will be the phase angle of the current with reference to the voltage?

Ans. The phase angle will be 90°, as there is nothing but a condenser in the circuit. Since the reactance is capacitive, the current will lead the voltage. By trigonometry:

$$\tan \theta = \frac{X}{R} = \frac{100}{0} = \infty \text{ and infinity is}$$

the tangent of an angle of 90°.

(3-8) What is the effective value of a sine wave in relation to its peak value?

Ans. The effective value of a sine wave is the r.m.s. value, and is equal to .707 times the peak value. This is sometimes given as the peak value divided by 1.41.

(3-9) What is the meaning of "phase difference"?

Ans. Phase difference is the elapsed time between the instant when one wave reaches a point on its cycle and when a second wave reaches a corresponding point on its cycle. The difference may be expressed in time units, in terms of cycles of a wave or in electrical degrees. The latter is the preferred method.

(3-10) What factors must be known in order to determine the power factor of an alternating current circuit?

Ans. The power factor in a circuit is the ratio of the real power to the apparent power. In any circuit containing a reactive device, power is alternately absorbed and then returned to the circuit by the reactive device. The only power that is actually dissipated in heat is the loss in resistance in the circuit. Due to phase relationships, multiplying the voltage by the current, as obtained by ordinary voltmeters and current meters, does not give the true power in an a.c. circuit. This is called the apparent power.

Then, the power factor = $P \div (I \times E)$. The true power P is in watts and is read by a watt-meter. As this power is never greater than the apparent power, the power factor is a number between zero and one. It will be "zero" in a purely reactive circuit, and will be "one" in a purely resistive circuit.

To distinguish between the real power in watts and the apparent power, the apparent power is frequently called the power in volt-amperes.

As the real power dissipation is dependent on the resistance in the circuit or part, while the apparent power is dependent on the impedance of the circuit or part, we can find the power factor by dividing the resistance by the impedance ($R \div Z$). The power factor is sometimes expressed as a percentage, by multiplying the power factor by 100.

(3-11) What is the product of the readings of a voltmeter and ammeter in an alternating current circuit?

Ans. The product of the readings of a voltmeter and an ammeter in an a.c. circuit is called the "apparent power." This product must be multiplied by the power factor of the circuit in order to determine the "actual" power in watts.

(3-12) In what units is the power output of an alternator (a.c. generator) usually expressed?

Ans. A.C. generators or alternators are generally rated in kilovolt-amperes (1000 volt-amperes, abbreviated k.v.a.), although sometimes they are rated in kilowatts.

(3-13) What are the properties of a series condenser, acting alone in an a.c. circuit?

Ans. A condenser connected in series with an a.c. circuit introduces capacity reactance. The current through a perfect condenser leads the voltage by 90°. Further, as the reactance goes down as the frequency is increased, there is less opposition to higher frequencies.

(3-14) If the value of inductance in a purely inductive circuit is doubled, what is the effect upon the phase angle?

Ans. When an inductance is acting alone in an a.c. circuit the current lags the voltage by 90°. This phase angle is not changed, regardless of the inductance value as long as it is the only part in the circuit.

(3-15) What is the reactance value of a

condenser of .005 microfarads at a frequency of 1000 kilocycles?

Ans. The answer to this problem may be found by using the formula $X_c = \frac{1}{6.28fC}$, where f is the frequency in cycles and C is the capacity in farads. Substituting values given in the problem we have:

$$X_c = \frac{1}{6.28 \times 1000 \times 1000 \times .005 \times .000001} = \frac{1}{.0314} = 31.8 \text{ ohms.}$$

Because f is in cycles

it is necessary to multiply the frequency in kc. by 1000 in order to reduce the value to cycles. The capacity is in mfd.s. so this value must be multiplied by .000001 to express it in farads. Another variation of this formula

$$\text{is } X_c = \frac{159.2}{fC}, \text{ where } f \text{ is in kc. and } C \text{ is in } \mu\text{C}$$

mfd.s. Using this formula, $\frac{159.2}{1000 \times .005} = \frac{159.2}{5} = 31.8 \text{ ohms.}$

(3-16) State the mathematical formula for the energy stored in the magnetic field surrounding an inductance carrying an electric current.

Ans. The energy stored in joules is found by using the formula $W = 0.5LI^2$ where $W = \text{joules}$, L is in henrys and I is in amperes.

(3-17) What is the current and voltage relationship when inductive reactance predominates in an a.c. circuit?

Ans. Whenever an inductive reactance predominates in an a.c. circuit, the current will lag the voltage.

(3-18) Given a series circuit consisting of a resistance of 4 ohms, an inductive reactance of 4 ohms and a capacitive reactance of 1 ohm; the applied circuit alternating e.m.f. is 50 volts. What is the voltage drop across the inductance?

Ans. This problem is solved by the use of the formula $Z = \sqrt{R^2 + (X_L - X_C)^2}$. Substituting the values given in the problem in the formula we have $Z = \sqrt{4^2 + (4-1)^2} = \sqrt{16 + 9} = \sqrt{25} = 5 \text{ ohms.}$ Now, $I = \frac{E}{Z}$

$$\frac{50}{5} = 10 \text{ amperes, so } E = I \times X_L = 10 \times 4 = 40 \text{ volts.}$$

(3-19) What would be the effect if d.c. were applied to the primary of an a.c. transformer?

Ans. The only factor limiting d.c. current flow is resistance. Therefore, if a d.c. voltage is applied by mistake to the primary of a transformer, the current flow will be determined by the resistance of this primary winding. If this resistance is not high enough to limit the current flow to the safe maximum current rating for that size wire, the transformer primary will burn out in a short time. If the d.c. voltage is approximately the same as in normal rated a.c. voltage from the transformer a burn-out is certain to occur. Where there is danger of plugging into d.c. power lines, fuses should always be installed in series with the primary winding as a safety measure.

(3-20) If a power transformer having a voltage step-up ratio of 1 to 5 is placed under load, what will be the approximate ratio primary to secondary current?

Ans. The current ratio of a transformer varies inversely with the voltage ratio. Therefore since the voltage step-up is 1 to 5, the primary current ratio to the secondary current will be 5 to 1. Thus, for a voltage increase we get a current decrease so the secondary volt-amperes will approximately equal the primary volt-amperes.

(3-21) What factor(s) determines the voltage ratio of a power transformer?

Ans. The turns ratio determines the voltage ratio of an iron-core transformer.

(3-22) Define "eddy currents."

Ans. Eddy currents are induced in conducting materials by varying magnetic fields. When set up in the core of an iron-core transformer, they are undesirable because they represent loss of energy and cause heating. Eddy currents are kept at a minimum by employing laminated construction for the iron-core transformer, a.f. choke coils and other magnetic devices. Eddy currents set up in shielding also represent a power loss, but are necessary to the proper performance of the shield.

(3-23) What is the meaning of "skin effect" in conductors of radio frequency energy?

Ans. Skin effect is the tendency of a high

frequency current to flow near the surface of a conductor. Electrons try to move to the position where they are surrounded by the least amount of magnetic lines of force. At high frequencies, there are even lines of force within the conductor itself, thus causing electrons to avoid the middle of the wire more and more as frequency goes up. This effect becomes so pronounced that the middle of the wire might just as well not be there, which explains why hollow tubing is a very effective high frequency conductor. As this effectively reduces the useful cross-sectional area of the wire, this means the a.c. resistance is much higher than the d.c. resistance. Also, for reasonably low values of resistance, it is necessary that wire with a relatively large surface area be used.

(3-24) Neglecting distributed capacitance, what is the reactance of a 5-millihenry choke coil at a frequency of 1000 kilocycles?

Ans. This problem may be solved by using the formula $X_L = 6.28fL$ where f equals the frequency in cycles and L equals the inductance in henrys. Changing 1000 kc. to 1,000,000 cycles and 5 millihenrys to .005 henry, then substituting these values in the formula, we have $6.28 \times 1,000,000 \times .005 = 31,400$ ohms.

(3-25) What is meant by the term "radiation resistance?"

Ans. Radiation resistance is a rating for a transmitting antenna. It is equal to the value of resistance which will consume the same amount of power as is actually radiated. Thus, multiplying the square of the current (at the point of maximum current) by the radiation resistance gives the power actually radiated by the antenna.

(3-26) What is the value of total reactance in a series resonant circuit at the resonant frequency?

Ans. In a series resonant circuit $X_L = X_C$, therefore they cancel each other, leaving no reactance at resonance.

(3-27) Should the number of turns of an inductance be increased or decreased in order to raise the resonant frequency?

Ans. When we apply a higher frequency, the capacitive reactance decreases. To obtain resonance, the inductive reactance must equal the capacitive reactance, so the inductive reactance must likewise decrease. This means we need a smaller coil, having less inductance, in order to resonate to a higher frequency with the same tuning condenser capacity. Since the inductance of a

coil varies directly with the square of the number of turns, in order to decrease the inductance, the number of turns must be decreased.

(3-28) What is the value of reactance across the terminals of the capacitor of a parallel resonant circuit, at the resonant frequency, and assuming zero resistance in both legs of the circuit?

Ans. A parallel resonant circuit is resonant when the coil and condenser reactances in the respective legs are equal. Under this condition the reactance between the terminals of the circuit becomes zero but the impedance becomes quite high. In fact, under the conditions of zero resistance in both legs of the circuit the impedance between the terminals of the parallel resonant circuit (across the terminals of the condenser) will be infinitely high, but the reactance will be zero.

(3-29) Given a series resonant circuit consisting of a resistance of 6.5 ohms, and equal inductive and capacitive reactances of 175 ohms, what is the voltage drop across the resistance, assuming the applied potential is 260 volts?

Ans. The problem gives a series resonant circuit with equal inductive and capacitive reactances. Hence, these reactances cancel out, leaving only the resistance in the circuit. From this, the voltage drop across the resistance will be equal to the applied voltage. This can be shown from Ohm's Law, as the circuit current is $E \div R$, and the drop across the resistance in turn is equal to this current multiplied by the resistance, which gives us the source voltage.

(3-30) Given a series resonant circuit consisting of a resistance of 6.5 ohms, and equal inductive and capacitive reactances of 175 ohms, what is the voltage drop across the inductance when the applied circuit potential is 260 volts?

Ans. The same reasoning applies here as in the answer to question 3-29. The inductive and capacitive reactances are equal, so only the resistance determines the current flow. Dividing the source voltage of 260 volts by the resistance value of 6.5 ohms gives a current of 40 amperes. This current flows through the coil, so the voltage drop across the coil will be equal to $E = I \times X_L = 40 \times 175 = 7000$ volts. Here is an example of resonant voltage step-up.

(3-31) Under what conditions will the voltage drop across a parallel tuned circuit be a maximum?

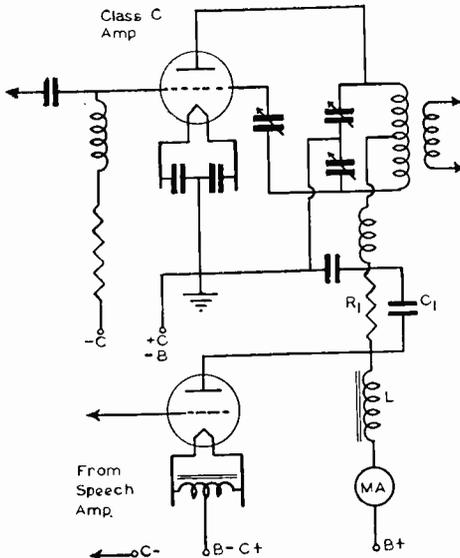


Fig. 3-33

Ans. In a parallel tuned circuit, when the inductive reactance is equal to the capacitive reactance, the circuit is resonant. The circulating current is then dependent only on the resistance in the circuit and will be at a maximum. This means the voltage drop across the coil or condenser will be maximum, and since this is the voltage across the parallel circuit, it too will be maximum.

Also, the lower the circuit resistance, the greater the current and the greater the voltage drop. Hence, the maximum drop will occur for a particular circuit when the circuit is tuned to resonance. This drop can be increased by using parts of minimum resistance within the resonant circuit.

In this case, we are presuming that the source has high resistance or that there is a high resistance between the source and the tuned circuit. Should the resonant circuit be connected directly across the source of negligible resistance, then the voltage of the resonant circuit will be that of the source, regardless of conditions in the circuit.

(3-32) How may a resonant frequency of an antenna circuit be increased?

Ans. With any of the Marconi or grounded antennas, the lead-in wire is a part of the antenna system. By inserting a condenser in series with the lead-in, it is possible to tune this type aerial to a higher frequency.

With the Hertz or doublet type antenna,

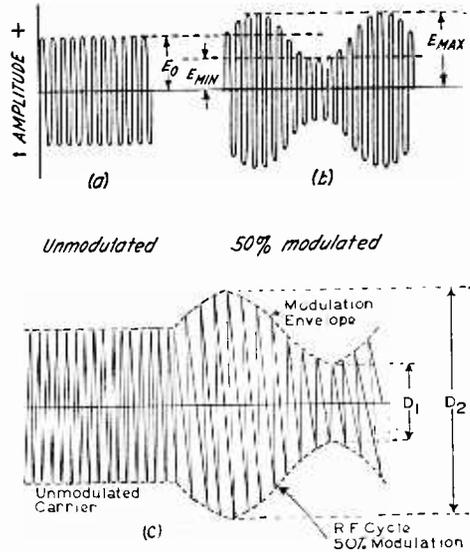


Fig. 3-34

the length is supposed to be one-half wavelength long. If the change is to be permanent, it is possible to cut the antenna, to a shorter length, which tunes it to a higher frequency.

(3-33) Draw a simple schematic diagram showing a method of coupling a modulator tube to a radio frequency power amplifier tube to produce plate modulation of the amplified radio frequency energy.

Ans. The circuit shown in Fig. 3-33 is called the "Heising System" of plate modulation. When proper circuit components are used it is capable of good quality, high percentage modulation.

(3-34) Draw a diagram of a carrier wave envelope when modulated 50% by a sinu-

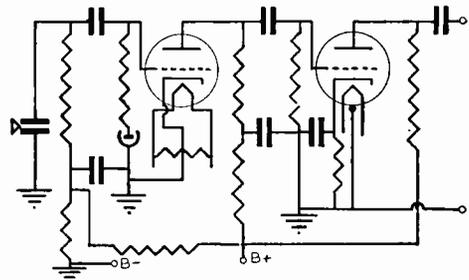


Fig. 3-35

soidal wave. Indicate on the diagram the dimensions from which the percentage of modulation is determined.

Ans. Fig. 3-34 shows an unmodulated wave at (a) and the wave modulated at 50% at both (b) and (c).

There are a number of ways of determining the percentage of modulation from the dimensions in these diagrams. Using Fig. (b), the most useful formula is
$$\frac{E_{\max} - E_o}{E_o}$$

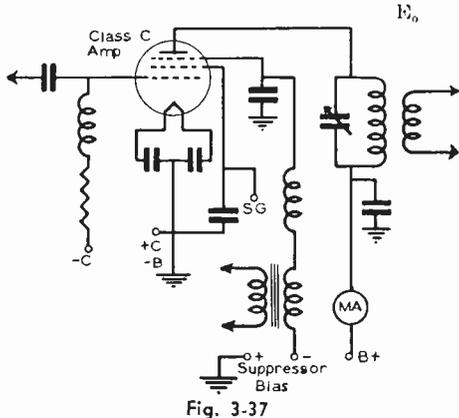


Fig. 3-37

$\times 100$. In this formula E_o is the peak value of the unmodulated carrier while E_{\max} is the peak value of the modulated wave. Both these factors can be determined by using a peak voltmeter. It is also possible to determine the modulation from the formula
$$\frac{E_o - E_{\min}}{E_o} \times 100$$
. The E_{\min} value of the wave must be determined by a special trough-indicating vacuum tube voltmeter.

When a c.r.o. is available, and where it is possible to get symmetrical wave about the X axis of the screen, you can use the formula:

$$\frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}} \times 100$$

You can use this same general formula and the total swing as shown in Fig. (c) if desired, where the formula is:

$$\frac{D_1 - D_2}{D_1 + D_2} \times 100$$

These formulas will work only when modulation is not greater than 100%. When using the c.r.o. picture for getting the dimensions, you must remember that it is possible for the c.r.o. itself to distort the image if the tube elements are not centered

properly or if the dimensions of the image are permitted to become too great.

(3-35) Draw a diagram of a microphone circuit complete with two stages of audio amplification.

Ans. Fig. 3-35 shows a condenser microphone coupled to a two-stage vacuum tube class "A" amplifier. Other microphones could be used by making the appropriate changes in the input circuit.

(3-36) Draw a simple schematic diagram showing a Heising Modulation System capable of producing 100% modulation. Indicate power supply polarity where necessary.

Ans. Fig. 3-33 shows the Heising Modulation System. To get 100% modulation, the modulator must operate at a higher plate voltage than the modulated stage. The re-

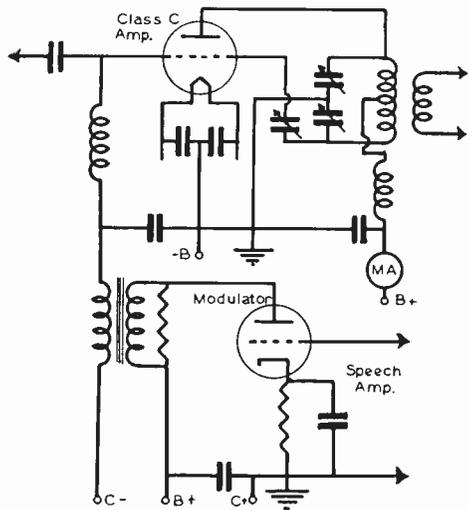


Fig. 3-38

sistor R_1 drops the modulated stage voltage to this lower value. The condenser C_1 is necessary to prevent the resistor from causing a loss of signal power.

(3-37) Draw a simple schematic diagram showing the method of suppressor grid modulation of a pentode type vacuum tube.

Ans. An r.f. amplifier can be modulated by applying the signal voltage to the suppressor grid as shown in Fig. 3-37. With fixed r.f. grid excitation and fixed plate voltage supply, the amplitude of the plate current pulses can be varied from maximum to minimum values by increasing and decreasing

the negative bias on the suppressor grid.

(3-38) Draw a simple schematic diagram showing a method of coupling a modulator tube to a radio frequency power amplifier tube to produce grid modulation of the amplified radio frequency energy.

Ans. A typical circuit is shown in Fig. 3-38; the tube here operates as a fully excited class B radio frequency amplifier, the C bias and excitation being so chosen that at 100% modulation the plate current pulses are perfect half sine waves. The plate tank circuit converts each plate current pulse to a full sine wave r.f. current.

(3-39) What is meant by "frequency shift" or "dynamic instability" with reference to a modulated radio frequency emission?

Ans. During modulation, rather large changes in plate current occur in the output tubes of the transmitter. Unless the power supply has good regulation, these changes will produce changes in operating voltage which can produce changes in the characteristics of the oscillator stage, resulting in a slight shift in the carrier frequency. In other words the carrier frequency shifts somewhat during modulation unless the power supply has good regulation. This shift is, of course, an undesirable condition.

(3-40) In radiotelephony, what is meant by "the process by which the amplitude of the carrier wave is varied in accordance with the speech or other signal to be transmitted"?

Ans. This is known as amplitude modulation.

(3-41) What is meant by "high level" modulation?

Ans. High level modulation is modulation at a point in a transmitter where the power level is approximately the same as at the output of the transmitter, such as the final radio frequency stage.

(3-42) What is meant by "grid modulation"?

Ans. Grid modulation is modulation produced by introduction of a modulating wave into the grid circuit of any tube through which the carrier is passed.

(3-43) Define "plate modulation."

Ans. Plate modulation is modulation that is produced by introduction of the modulat-

ing wave into the plate circuit of any tube through which the carrier is passed.

(3-44) Describe the construction and characteristics of a "dynamic" type microphone.

Ans. A dynamic microphone operates on the same moving coil principle as a dynamic loudspeaker. Sound waves move the diaphragm, causing the attached voice coil to move in and out of the fixed magnetic field, which may be produced either by means of a permanent magnet or an electromagnet. As the voice coil moves through the magnetic field, an audio frequency output voltage is induced in the moving coil. This voltage is amplified by speech amplifier tubes and passed on to the modulator.

(3-45) Describe the construction and characteristics of a "ribbon" type microphone.

Ans. The ribbon microphone has a moving element which is a thin, light-weight corrugated ribbon. This moving element is suspended between the poles of powerful permanent magnets. The sound waves move this ribbon back and forth in the magnetic field. An audio frequency voltage is induced in the ribbon by this movement in the magnetic field.

(3-46) Describe the construction and characteristics of a "condenser" type microphone.

Ans. A condenser type microphone consists essentially of a flexible metal diaphragm and a rigid metal plate arranged to form a two-plate condenser. Sound waves set the diaphragm in motion, causing the capacity to vary according to the frequency of the sound waves. This variation in capacity causes a variation in the current flow from a charging voltage source and these variations are passed on to the amplifier.

(3-47) What is meant by "low level" modulation?

Ans. Low level modulation is modulation at a point in a transmitter where the power level is low compared to that of the output of the transmitter.

(3-48) Which type of commonly used microphone has the greatest sensitivity?

Ans. The single button carbon microphone has the greatest sensitivity.

————— n r i —————

How many of our readers want these Questions and Answers for Radio Operator License Examinations continued? How many would prefer Radio Servicing articles in this space?

Philco Develops Electronic "Master Mind"

Manpower and money-saving war emergency device contains promise
of important post-war applications

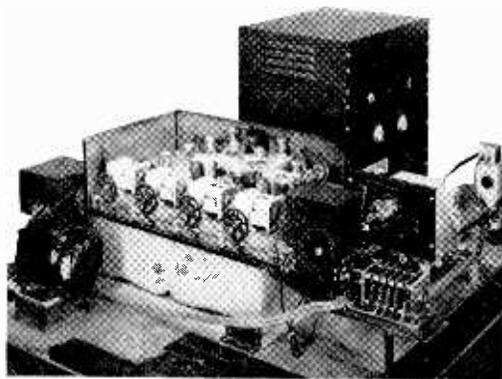
AMONG the many contributions of the Philco organization to the war effort has been the design and creation of an electronic "master mind" which saved 144,000 manhours of labor last year and, with other economies, made it possible to reduce the cost of one type of radio equipment to the Government by \$1,170,000 in 1943.

This electronic "master mind" was created to meet a very definite need. In the manufacture of highly precise measuring instruments, such as the Frequency Meter which Philco is making for the United States Army Signal Corps, it has heretofore always been necessary to do the work of calibrating by hand—a painstaking, laborious process subject to human error. In the particular case of the Frequency Meter, Signal Corps specifications called for a margin of error of less than one hundredth of one per cent.

After considerable experience with hand calibration, the Philco Research Department, working in conjunction with the Production Engineering staff, decided that many advantages would be gained and very substantial savings effected if the task could be done electronically.

Months of intensive research and development work followed, and finally resulted in the perfection of a special electronic instrument employing 126 tubes which can "think," calibrate, calculate, and record dial readings many times faster than any human being—all without danger of error.

Essentially the Philco calibrator consists of three parts. The first supplies a source of standard frequencies against which the Signal Corps frequency meter is calibrated. The second provides a means of mechanically continuously driving the dial of the frequency meter and electrically generating a sharp pulse every time the frequency meter is turned through "zero beat" with the standard signal. This standard signal, incidentally, is derived from WWV, the United States Government standard frequency station in Washington, which in turn is calibrated



Employing 126 vacuum tubes, this electronic "master mind" calibrates Signal Corps frequency meters and records dial readings many times faster than any human being.

against the stars. The third unit of the calibrator automatically records and tabulates the dial reading.

For the purposes of this electronic "master mind," it was necessary to develop a special type of frequency modulation (FM) detector, because the problem of exact calibration is far more complex than ordinary broadcast detection. In this instance, a form of frequency modulation, highly involved as compared with ordinary broadcasting, has been put to work to perform a precision job.

Not only is this electronic "master mind" now saving manpower and money for the Government during the war emergency, but it contains the promise of important peacetime applications in industry after the war. It represents one of the many ways in which research, engineering, purchasing, and production are all working in conjunction at Philco to further the war effort and to prepare to help create a higher standard of living when victory is won.



N.R.I. ALUMNI NEWS

Louis J. Kunert	President
Peter J. Dunn	Vice-Pres.
Earl R. Bennett	Vice-Pres.
F. Earl Oliver	Vice-Pres.
Dr. Geo. B. Thompson	Vice-Pres.
Earl Merryman	Secretary
Louis L. Menne	Executive-Secretary

Phila-Camden Chapter

This chapter is back in full stride. Looks like the days before the war. John McCaffrey is proving to be a fine leader and everything at meetings runs along smoothly. Chairman McCaffrey, assisted by our other officers, is giving us some excellent programs.

Charles J. Fehn proposed a special meeting for the second Thursday in April instead of the third to allow National President Louis J. Kunert of New York to visit us. Both New York and Philadelphia Chapters meet on the same nights, the first and third Thursday of the month. Neither Kunert nor Fehn ever miss a meeting. Therefore the special date to avoid conflict.

Alumni President Kunert was joined by Executive Secretary L. L. Menne and N. R. I. Consultant, J. B. Straughn, who came from Washington for the occasion. Mr. Kunert and Mr. Menne said some very nice things about our chapter, the spirit of our officers and the loyalty of our members. Mr. Fehn responded on behalf of our chapter and said some very nice things about Mr. Kunert and Mr. Menne which made everything even and just right for Mr. Straughn to take over and deliver his technical talk. Mr. Straughn's subject was "Alignment of Superheterodynes." A fine talk and a big hand for the speaker.

While Mr. Straughn was speaking we were

brought to attention by the air raid siren. A practice black-out was on and lasted for about 45 minutes. It was necessary to extinguish all lights except one which was carefully shaded. During this interim Bert Champ and Norman Kraft assisted by numerous others in the group, attempted to take some pictures. The best of some six or seven shots are reproduced in this issue. We were anxious to get a picture of the entire group but not any developed, proving that a shoemaker should stick to his last, or as photographers. Bert Champ and Norman Kraft are darn good Radio men. And that goes for Chairman McCaffrey too who was busier than a one-eyed pup in a

butcher shop getting all present properly posed. Some day we are going to get a group picture of Phila-Camden chapter in session, so help me, but we may have to bring in a professional photographer to do it.



J. B. Straughn, Charles J. Fehn, Louis J. Kunert and L. L. Menne. Mr. Kunert, N. R. I. Alumni Ass'n President was guest of honor at Phila-Camden Chapter meeting.

Harvey Morris, we understand, is going to bring several boxes of cigars to our next meeting. Harvey is daddy to brand new Barbara Viola and from all reports she will probably be Miss Philadelphia in 1962. Congratulations Mr. and Mrs. Harvey Morris.

Starting in May we went back to our former schedule of two meetings a month, on the first and third Thursday of the month. All Students and Graduates in the area covered by the Phila-Camden Chapter, are cordially invited to attend our meetings. Come to see us at our new meeting place, Wissinoming P. O. Bldg., 4706 Comly St., Philadelphia.

JAMES SUNDAY, *Recording Secretary.*

Detroit Chapter

Our attendance has just about doubled since a year ago. And no wonder! We have been having some mighty interesting and productive sessions. Mr. Henry Rissi spoke to us at one of our meetings on "The Use of Meters in Service Work." He used our RCA Dynamic Demonstrator together with a multimeter. At another meeting our own Mr. Robert Briggs spoke on "Signal Tracing" and our secretary, Mr. Harry R. Stephens spoke on "Servicing by Resistance Measurements."

At still another meeting Mr. F. M. Hartz, Electronics Engineer of the Detroit Edison Co., spoke to us on "Frequency Modulation." A very interesting and instructive talk.



F. M. Hartz, Electronics Engineer, Detroit-Edison Co., speaker at Detroit Chapter, is seated in center. At right is Chairman Harold E. Chase, at left, Secretary Harry Stephens. John Stanish, Earl Oliver, James A. Quinn, Charles Mills, are some of the always dependable regulars who can be discerned in background. Don't seem to find Hiller or Briggs!

Mr. R. R. Barnes of the technical staff, Radio department of the Michigan Bell Telephone Co., also Radio Instructor at Lawrence Institute of Technology, is to be the speaker at our next meeting. From these comments it is easy to understand why our attendance is increasing.

A number of new members joined the chapter since the last report. They are August Hatula, William Hosmer, Arthur F. Anderson, J. W. Hasen, John Bandos, and Howard A. Sawyer who works for one of our Alumni members, Raymond B. Fouke of Trenton, Mich.

Page Twenty-eight

Our Chairman and Secretary have prepared a new notice of meetings which may have something to do with our better attendance. The new notice not only mentions the date and place of meeting but it gives the name of the speaker and subject. Incidentally refreshments are served at many of our meetings.

A number of our members, including Chairman Harold Chase, have taken pictures of our group at various times but with poor results. Then we discovered that one of our members, Mr. Floyd Buehler knew something about photography. Just when we found someone who could take a picture without getting the film backwards in the camera we learned that Mr. Buehler expects to be called into the Armed Forces very soon. At his request we elected Bernard Hiller to be Librarian to fill the vacancy Floyd will leave.

Mr. John Stanish, having held just about all of the offices in our Chapter as well as National Vice President, this year is heading our Entertainment Committee. He is preparing a reception for Executive Secretary L. L. Menne who will visit National Vice President Earl Oliver and Detroit Chapter during the month of May—date yet undetermined. Chairman Chase and other officers are working with John to arrange an interesting business program which will be combined with some pleasure.

Detroit Chapter meets every third Friday of the month. Our meetings are not always held at 2500 Jos. Campau and it is therefore suggested that N. R. I. students and graduates in this area, who wish to attend meetings, communicate with the undersigned at 4910 Grayton Road so that notices may be sent regularly.

HARRY R. STEPHENS, *Secretary.*

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New York Chapter

Vice Chairman Archie Burt continues his practical demonstrations with the N. R. I. experimental kits. This is usually followed by our service forum.

Mr. Paul Ireland gave a good talk on Analyzing Power Supplies with an oscilloscope. The oscilloscope was supplied by Chairman Bert Wappler. At another meeting Mr. Ireland spoke on Servicing R. F. Stages. At this same meeting Chairman Wappler gave a demonstration of a Cornell-Dubilier Capacitor Analyzer.

One of our members, Mr. William Peterson, took the speakers platform at the following meeting and gave a swell talk on R. F. Stages. Then the ever ready Mr. Ireland took over and spoke on Tube Amplification and Radio Wave Transmission.

Mr. William Peterson, by the way, has been elected Librarian.

Once or twice each month, in addition to our regular meetings, the New York Chapter Officers, Instructors and Librarian are called together by Chairman Wappler at an evening dinner where we discuss our program and plan things for the benefit of our members.

Our Chairman is a member of the American Institute of Electrical Engineers and the Institute of Radio Engineers. Mr. Wappler finds time somehow to attend all of these meetings and passes on to us anything he feels will be of value to us.

Our own Lou Kunert, visited Phila-Camden Chapter in his official capacity as President of the N. R. I. Alumni Association. He reports that he was cordially received and was very much impressed with the reception extended to him.

Out of town students and graduates who may be in New York on meeting nights are most welcome. Local N. R. I. men, whether students or graduates, are invited to join our chapter. We meet every first and third Thursday of the month at St. Marks Manor Community Center, 12 St. Mark's Place (between 2nd and 3rd Ave.) New York City. Make it a point to visit us next meeting.

FRANK ZIMMER, *Ass't Secretary.*

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Baltimore Chapter

We understand some of the other chapters are returning to two meetings a month instead of one. We are glad to know this because we have adhered to our two meetings a month schedule without interruption and we feel our judgment has been vindicated. In fact, two meetings a month is hardly enough for us to do all the things our Chairman and Officers plan for us.

Our attendance is very good. To be completely successful a chapter must have the whole-hearted support of all of its members. That is the spirit of Baltimore Chapter. It is remarkable how many of our members attend meeting after meeting without fail.

Mr. Rathbun leads us in our practical work. Each meeting several Radio receivers are brought in by members and we proceed to fix them or at least find out what must be done to fix them.

Mr. Menne, of headquarters, paid us a visit. We are always glad to have guests from Washington and as soon as travelling conditions improve we hope to have Mr. Smith, Mr. Haas, Mr. Dowie, Mr. Kaufman, Mr. Straughn and others visit us for a good old-fashioned get-together such as we formerly enjoyed.

Meetings every second and fourth Tuesday of the month at Redmen's Hall, 745 W. Baltimore St., Baltimore. If you are not on the mailing list to receive notices please write to Chairman E. W. Gosnell, 5222 St. Charles Ave., Baltimore 15,

Md. or to our popular Publicity Director, L. J. Arthur, 4419 Old York Road, Baltimore 12, Md.

P. E. MARSH, *Secretary.*

n r i

Lieutenant Robert Mains



Robert Mains, son of Mr. and Mrs. Orval L. Mains of Calhoun Ave., Detroit, was awarded the gold bars of a second lieutenant at graduation exercises of the Army Air Forces Training Command School at Yale University. Rated as a Technical Officer in Communications, he has been retained at Yale as an instructor. Lieutenant Mains is a member of Detroit

Chapter, N. R. I. Alumni Association.

n r i

Mr. J. A. Dowie, Chief Instructor
National Radio Institute
16th and U Streets, N. W.
Washington, D. C.

Dear Mr. Dowie:—

Right after signing up for the N. R. I. Course I attended a meeting of the New York Chapter of the N. R. I. Alumni Association. From the very first night I attended I became quite convinced that the Chapter was a wonderful adjunct to the Course. The Officers are fine fellows and gentlemen, and most anxious to show us all they possibly can to help us along with our studies of Radio.

At the last meeting Mr. Bert Wappler, our chairman, brought along an Oscilloscope and both he and our very able instructor Mr. Paul Ireland demonstrated the actual workings of the different currents in a radio set. It was most interesting and instructive.

I had been attending a radio class three evenings a week at a public school for the past three months. I had intended to keep up both the school and your Course, but after attending the Chapter I gave up the evening classes as I find I can attain more by applying myself to study of the books which you are sending me plus the Chapter. It also gives me more time at home, which is something to be considered as I put in a good many hours at the shop every day.

This letter is perhaps a little off the record but I felt I wanted to say something for the fine work and generous spirit of the fellows who are running the Chapter.

I feel sure I am expressing the sentiments of my fellow students.

Very truly yours,

ALBERT HARDING
882 Lexington Avenue
New York 21, N. Y.

HERE AND THERE AMONG ALUMNI MEMBERS



Our good friend Edw. M. Schminke, who has a fine Radio business in Newark, N. J., informs us that Fred Yauck, also of Newark, formerly employed by Mr. Schminke has been made Chief Radio-

man aboard a U. S. Battleship, on duty in the war zone.

Carl Gaddis of Clinton, Ill. is doing very nicely in his full time job as a Radio Serviceman. Just got a raise.

Robert A. Oliver of Los Angeles was awarded first prize consisting of \$150.00 for a Radio idea which he submitted to the United States Army Air Forces. He received considerable newspaper publicity and a fine letter of congratulations from Headquarters, 6th Ferrying Group, Ferrying Division—Air Transport Command, Long Beach Army Air Field. Mr. Oliver started as a mechanic's helper and worked up to the Radio Compass and Facilities Unit, at \$2300.00 per annum.

Alfred T. Brothers is back with Douglass Aircraft Co. in California as Personnel Manager for the Douglass Research Laboratories. The Laboratories involve 550 skilled technicians or engineers. Some of the best engineers and technicians in this group have had previous training with the National Radio Institute, says Mr. Brothers.

Harry A. Baker has an interesting job. He works in the Laboratory as Technician at the Montana School of Mines, Butte, Montana. He also attends to two Seismographs, checking the time marks on the grams with a standard time signal received by Radio.

We regret to learn that Stanley Smith of Philadelphia Chapter passed away. Quite a shock to his friends in the chapter who were very fond of him.

Earl L. Helwig of Towson, Md. is employed by the Dept. of State Forests and Parks as a Patrolman and Fire Fighter. He has a 3rd class operators license and expects to advance to 2nd class soon to work on the many transmitters and receivers in the Forest and Parks Service.

Russell Witt is a Technician in the Engineering Lab. at WLW, Cincinnati. Is ambitious to try for a first class Radiotelephone license.

A short time ago we mentioned that Phillip T. Sheridan of N. Quincy, Mass. was a First Lieutenant in the Air Corps. Well, it's Captain Sheridan now, and embarking for overseas duty. Good luck, skipper.

Graduate George B. Shaffer, chief electrician's mate, of York, Pa. has been awarded the coveted Navy and Marine Corps medal for risking his life to rescue an Army sergeant from a burning plane in Iceland. Presentation of the award was made at Camp Peary, Va. Shaffer is a veteran of the Mexican War, World War I, and now is again serving in World War II.

Got a nice letter from a customer of William Roach, Bill's Radio Service, Inverness, N. S. Canada, praising Mr. Roach for his fine job on a Radio. Another customer moved some 300 miles away but sent his Radio to Mr. Roach after another man "messed it up." That's making your reputation travel.

Henry Tysse of Holland, Mich. is now employed in the Electronics Laboratory at the Fairfield Air Service Command. Mr. Tysse, by the way, is a charter member of the N. R. I. Alumni Association having attended our convention in Washington in 1929.

Dieter Hess of Hudson, N. Y. is another young man who enrolled with N. R. I. while still in high school. He was 15 when he started his course. He started servicing after 12 lessons, made good profits while still studying and, upon graduation, had a fine Radio business established.

Ernest Horton lives in a rural section near Thomas, Okla. Whenever anything went wrong electrically the farmer neighbors would send for Horton because it was too slow and too expensive to call an electrical repair man from town, some 30 miles away. Soon the word went out "When in trouble call Ern Horton." Then Horton took up Radio with N. R. I. Now he is swamped with Radio work which he does in his spare time not neglecting his farm work when food is so necessary to win the war. But some day Ern Horton is going to have a full time Radio service shop.

Clyde J. Burdette is Radio Service Manager for Hammond-Brown-Jennings, Spartanburg, S. C., a mighty fine concern.

L. D. Styles, Jr. of Houston, Texas is employed by an Oil Well Servicing Company, using electronic equipment similar to the V.T.V.M. to locate oil in a drilled hole. This is called Electrical Well Logging.

Novel Radio Items

—BY W. R. MOODY—

According to Gilbert Seldes, head of the Television Program Department of Columbia, television will include color. This development may take place immediately after the war or might follow the end of the war by a year or two. He stated, recently, that it would reach many more cities than at present, would be cheaper than estimates previously indicated. For example, a certain type of tube used in television used to cost \$85. After the war it will cost \$5. The price of a good radio set will be the price of a medium quality television receiver.

— n r i —

Experiments with the electronic methods of dehydrating foods indicate that less than 100 watts of energy per pound of compressed food is required for successful removal of practically all water. Modern equipment operates on a frequency of 29 megacycles which is equivalent to 29,000 kilocycles.

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High speed soldering with radio frequency power is now possible. Small metal containers with bottoms and rings of solder in place are carried along a moving belt and through an applicator coil at the rate of 2500 per hour. Localized heating induced in the metal causes the solder to flow and seals the bottoms without endangering the capacitor.

— n r i —

The production of electronic tubes by Westinghouse was eleven times greater in 1943 than in the two previous years. The total sales exceeded \$22,000,000 as compared with \$1,800,000 in 1941.

— n r i —

In Australia, distant lighthouses communicate with each other by radio telephone. Power for the operation of the transmitter-receiver is obtained from a pedal-operated generator. Similar equipment is used by the Australian Inland Mission for contacting the flying doctor.

— n r i —

The Radio Marine Corporation of America, in the New York plant, is using girls in the factory for the production of coils which are a part of sea-going transmitters. The girls mount lugs for leads after the coils are wound.

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From 18,000,000 to 22,000,000 f.m. receivers may be expected to be in service by 1950, assuming conclusion of hostilities by the end of 1945, ac-

ording to J. E. Brown, Assistant Vice-President of the Zenith Radio Corporation.

— n r i —

Schools, colleges and civic organizations can obtain a 24 minute 16 millimeter sound film "Radio at War" upon payment only of transportation charges. The picture is sponsored by RCA in cooperation with the Communications branches of the Army and Navy. Requests for the film may be addressed either to the Educational Department of RCA Victor Division, Radio Corporation of America, Camden, New Jersey, or the producers of the film, William J. Ganz Company, 40 East 49th Street, New York.

— n r i —

A recent issue of Air Force (official service journal of the AAF) tells how Technical Sergeant Sachnoff, a radio operator-gunner used his wits and his radio training. In the course of a bombing mission he picked up a very strong signal in the proper code of the day, giving instructions to change course and attack a different objective. Although the message seemed proper, he became suspicious for, at that particular spot over Africa, he had never before been able to receive strong signals from the base. By using his radio compass, he determined the message was coming from a position in front of the ship and he radioed a warning back to the base. On the return trip, the Sergeant's flight encountered 150 Allied fighters at 30,000 feet, heading for the false target. When the fighters reached the area, they found 45 Messerschmidts circling at 20,000 feet and promptly dove on them, destroying 30 planes. Technical Sergeant Sachnoff was presented with the DSC for being the kind of a fellow who doesn't believe everything he hears.

— n r i —

Melted tooth paste tubes were used in place of solder by Signal Corps technicians in Iceland when the supply of solder ran low. The men salvaged the tubes from their buddies in order not to delay construction of vital communication facilities.

— n r i —

The Signal Corps on June 30 numbered 280,000 enlisted men and 28,000 officers, which represents twice the enrollment of the whole regular Army in peacetime. These men have been trained at 50 military and 269 civilian schools.



In uniform is 1st Lt. Alfred Wysoczanski, just back from Italy. He is flanked by Chas. J. Fehn, Norman Kraft and Bert Champ, all past chairmen. Lt. Wysoczanski has long been a member of Phila-Camden Chapter.



Chas. J. Fehn, Treasurer, James Sunday, Recording Secretary and William Little, Financial Secretary of Phila-Camden Chapter.

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