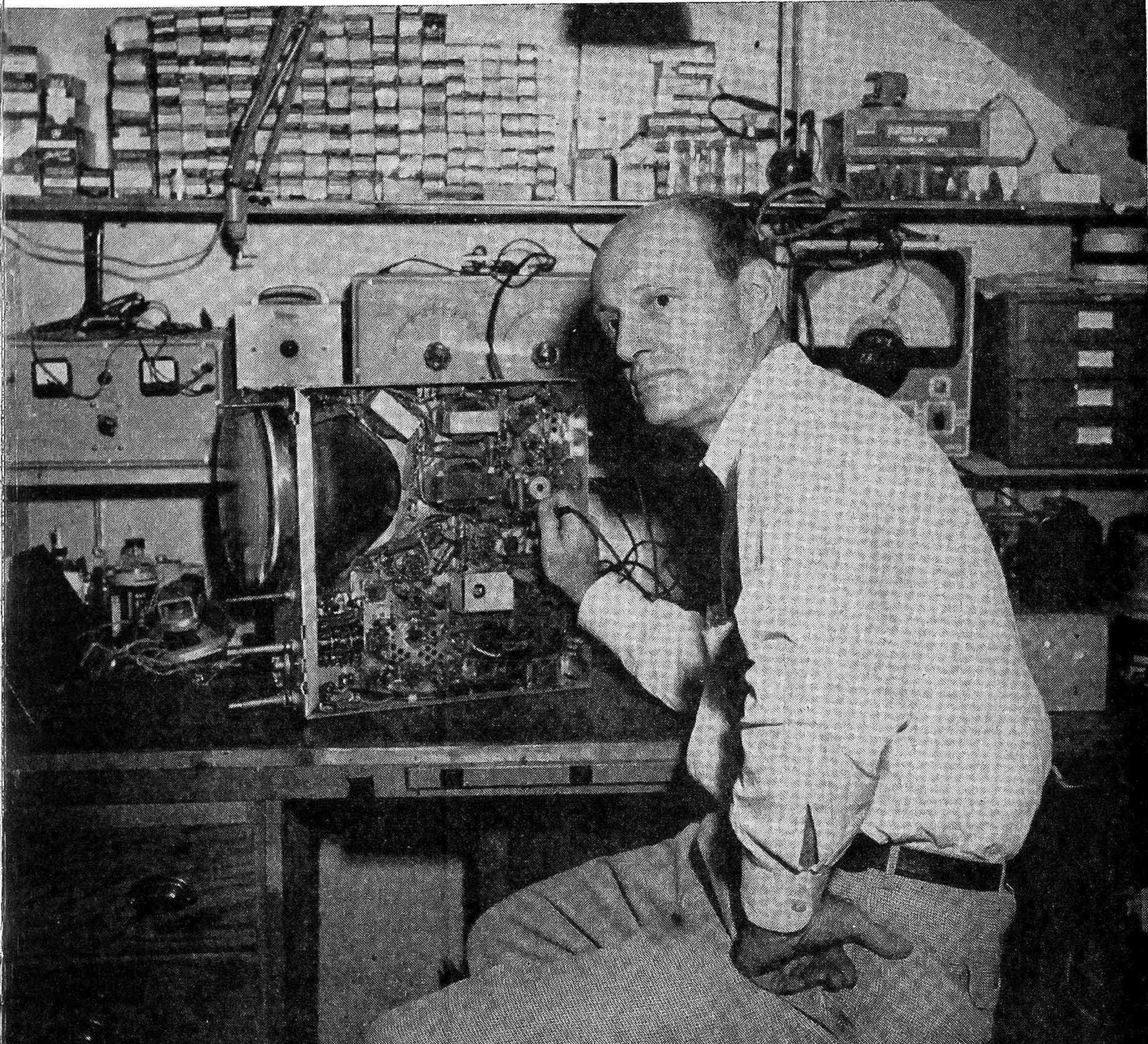
National RADIO-TV NEWS



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A Look At Transistor Receivers

Crossover Networks for Hi-Fi

NRI Alumni Association News

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When Things Go Wrong

When things go wrong,
as they sometimes will,
When the road you're trudging
seems all up hill,
When the funds are low and
the debts are high,
And you want to smile,
but you have to sigh,
When care is pressing you
down a bit,
Rest, if you must,
but don't you quit.

Life is queer with its
twists and turns,
As every one of us
sometimes learns,
And many a failure turns about
When he might have won
had he stuck it out;
So don't give up,
though the pace seems slow—
For you may succeed
with another blow.

Often the goal is nearer than
It seems to a faint
and faltering man,
Often the struggler
has given up,
When he might have captured
the victor's cup.
And he learned too late,
when the night slipped down
How close he was to the
golden crown.

Success is failure,
turned inside out—
The silver tint of the
clouds of doubt—
And you never can tell
how close you are,
It may be near
when it seems afar;
So stick to the fight
when you're hardest hit—
It's when things seem worst
that you mustn't quit!

(*Author Unknown*)

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A LOOK AT TRANSISTOR RECEIVERS

B. van Sutphin

By B. VAN SUTPHIN
NRI Consultant

en transistors were first announced, some -styled prophets predicted that in five years e, the vacuum tube would disappear enly and be replaced by the transistor. Five rs have passed and the vacuum tube remains se. Transistors have, however, become more ular in many applications.

s doubtful that the transistor will ever comely replace the vacuum tube any more than vacuum tube completely replaced the crystal ector. In some applications, the transistor outperform the vacuum tube; in other apations the vacuum tube will outperform the sistor. Consider a few examples.

first electronic computers required thousands acuum tubes, each generating considerable t. Redesigning the equipment to use transistors has decreased computer cost, decreased the number of breakdowns, and decreased the overall operating expense.

In equipment which is subject to considerable mechanical vibration, transistors are ideal since they are not particularly sensitive to shock. Recently, some transistor equipment was placed inside a mortar shell and the shell was fired. The equipment continued to operate normally. This would be impossible with normal vacuum tubes.

In applications such as high power transmitters, however, vacuum tubes still represent the most efficient way of obtaining an rf signal of sufficient strength.

In small portable radios, transistors are ideal since they require very little power—giving long battery life—and the receiver weight can be kept low. The first "transistorized" commercial receivers that appeared on the market used tubes in the rf and i-f stages, and transistors in the audio circuits. At that time, there were no transistors capable of rf operation.

Long strides have been made since then. Today, high frequency transistors that can be used in the rf and i-f stages of receivers are available. One manufacturer even has a short-wave converter tuning to 30 megacycles which uses transistors in every circuit. Transistors capable of UHF operation are the next step, and they are already under consideration.

Now that receivers using transistors are widely available, it is important that the serviceman be familiar with such equipment so that he can service it effectively. This article is not intended as a discussion of how and why the transistor has the ability to amplify. As the serviceman, you will, of course, want to know the "how and why," but it is unimportant in this particular discussion. That information is given in the regular NRI lessons. This article will deal primarily with the circuits commonly used and the practical points of servicing transistor receivers with very little emphasis on the theoretical knowledge necessary to understanding transistor action.

There are five important points that must be remembered about transistors. Keep these points in mind as you read this article and study transistor receiver circuits.

1. There are two different types of transistors—*npn* and *pnp*. With an *npn* transistor, the collector must be positive with respect to both the emitter and the base; with a *pnp* transistor the collector must be negative with respect to both the emitter and the base. Generally, *npn* transistors are used in the rf and i-f stages; *pnp* units, in the audio stages. There are exceptions, however.

2. A transistor is a current amplifier, while a vacuum tube is a voltage amplifier. Voltage amplification can be obtained in a transistor circuit by taking advantage of the current gain and the difference between the input impedance and the output impedance.

3. A direct connection exists between the input circuit and the output circuit of a transistor; this is not true of the vacuum tube.

4. By tube standards, the input and output impedances of a transistor are quite low.

5. With transistors, some odd circuit configurations are possible. There are some transistor circuits unlike any vacuum tube circuits you may have seen.

Servicing Techniques

Basically, servicing a transistor receiver is just like servicing a vacuum tube receiver. At first, you confirm the complaint; then, look for surface defects; then, locate the defective section; then, locate the defective stage; then, locate the defective circuit; and finally, locate the defective parts.

The actual tests used to isolate the defect in a transistor circuit are somewhat different, however. For example, in an operating vacuum tube receiver, touching the center terminal of the volume control produces a loud buzz in the speaker. Touching the center terminal of the volume control in an operating transistor receiver, however, produces no sound whatsoever. The input circuit of a vacuum tube is a high impedance circuit and consequently picks up hum voltage from your hand; the input circuit of a transistor is a low impedance circuit and there is very little hum pickup. This is just one example.

Voltmeter tests and ohmmeter tests are just as useful in transistor receivers as they are in vacuum tube receivers. There are, however, certain precautions that must be kept in mind when making these tests. Both signal injection testing and signal tracing are very useful in transistor receivers. Again, there are certain precautions that must be observed.

Let's consider the individual testing methods and the precautions that must be observed. This is perhaps the easiest way to gain the knowledge necessary in servicing these receivers.

Volmeter Tests. Correct operating voltages are just as important in a transistor receiver as in a vacuum tube receiver. Some technicians, however, seem to feel that the lower voltage values commonly found in transistor receivers are relatively unimportant. That is, they often overlook slight—in turns of number of volts—changes in the operating voltages. This is not a good policy. The technician must always be careful to read the meter carefully to be sure that the correct voltages exist.

For general purpose testing in transistor receivers, a vacuum tube voltmeter is recommended since the input resistance of such a meter is high and it is not likely to cause excessive loading of the circuit. Also, the input resistance of the meter is constant, and changing ranges is not likely to upset the voltage readings.

Most transistor receivers operate from batteries, and batteries of course, wear out with time. When you receive a transistor receiver for servicing, the first step should be to check the voltage across the battery with the set turned on. Compare that voltage with the rating stamped on the battery, or given in the service informan for the receiver. Weak batteries are perhaps most frequent reason for failure of a transis- receiver.

the battery voltage is normal when the set urned *off* but drops to a very low value when set is turned *on,* this indicates that the bat- y itself has developed high internal resistance, that a defective component in the receiver is ısing the excessive current drain from the ttery. Try a new battery. If the voltage of a v battery drops to a very low value when the is turned on, look for a short somewhere in receiver.

ıen servicing transistor receivers, a small in- ɔensive 0-50 ma meter is convenient. You can rchase an inexpensive meter and mount it on eparate panel for use in checking the current ıin of transistor receivers. The correct current ıln is usually listed in the receiver service in- mation.

the problem is not one of a defective battery, n voltage tests at the individual transistor minals may be useful. Check the voltages and npare your readings with those listed in the vice information. This is often a quick way locate the trouble.

mmeter Tests. Ohmmeter tests are just as ful in a transistor receiver as in a tube re- ver. Before making those tests, however, you st know the polarity of the ohmmeter. That you must know which ohmmeter lead has the itive side of the internal battery connected it. Otherwise, you might damage the low- tage electrolytic capacitors in a receiver by ɔlying incorrect polarity with the ohmmeter.

re is the information regarding all the volt- ters that have been sold in recent years by tional Radio Institute. In the Model 44 Pro- sional Volt-Ohm-Milliammeter, the positive e of the ohmmeter battery is connected to the nmon lead of the instrument. The same thing true of the Model 45 and the Model 46. This ans that the probe that is positive for volt- ter measurements is negative for ohmmeter asurements. In the Simpson Model 260, how- r, the negative voltmeter lead is also the nega- e ohmmeter lead.

the NRI Electronic Multitester, the positive tmeter lead is the negative ohmmeter lead. the new Model W vtvm, the common volt- ter lead is the negative ohmmeter lead. In Model 11 vtvm, the common voltmeter lead the negative ohmmeter lead.

th other types of instruments, you can de- mine the ohmmeter polarity by setting the in- ument for a medium ohmmeter range and n measuring the voltage between the two nmeter leads with a separate instrument. By ing which ohmmeter lead the negative terminal of the external voltmeter must connect to, you can determine the ohmmeter polarity.

When making ohmmeter tests in a transistor circuit, it is generally best to remove all the transistors from the equipment. This will prevent your accidentally damaging one of them while making tests. Later on, we will discuss a simple method of checking the transistors themselves.

Another precaution when making ohmmeter tests is that the ohmmeter never be set to a range which uses an ohmmeter battery greater than 4.5 volts. This is generally no problem with vacuum tube voltmeters such as the NRI Model W and the NRI Model 11, since these units use the same battery on all ranges. With non-electronic vacuum tube voltmeters, however, caution must be practiced.

For example, with the NRI Model 44 only the R x 1, the R x 10, and the R x 1K range could be used. On the higher ohmmeter ranges, greater ohmmeter battery voltage is used, and this might damage the low-voltage capacitors in the receiver. With the NRI Model 46, only the R x 1 and the R x 100 range could be used. With the Simpson Model 260, only the R x 1 and the R x 100 could be used. With other instruments, carefully examine the schematic of the instrument to determine what battery voltage is used on the individual ohmmeter ranges.

Transistors rarely fail. When servicing a transistor receiver, the transistor itself should be the last part suspected. In any case, an approximate

Courtesy General Electric

FIG. 1. A commercial transistor tester.

check of a transistor can be made with an ohmmeter. This test is not absolute, but it will give you some idea of the transistor's worth. For this type of testing, you must choose an ohmmeter range giving sufficient series resistance in the ohmmeter itself to protect the transistor from excessive current. Generally, the R x 10, or R x 100, ranges satisfy this. In addition, commercial transistor testers like the one shown in Fig. 1 are available.

Checking a transistor with an ohmmeter simply involves checking it as two separate diodes. There is a polarity difference between a *pnp* transistor and an *npn* transistor and for that reason the testing method and the expected results will be different.

Let's consider *pnp* transistors first. With the ohmmeter set to the R x 100 range, connect the positive ohmmeter lead to the transistor base. When the other ohmmeter lead is touched to the collector or the emitter, the resistance reading should be 50,000 ohms or higher. A lower reading indicates that the transistor is defective. (If a lower reading is obtained in each case, it may be that the transistor is actually of the *npn* type.) Check the service information and the manufacturer's list for that particular transistor.

With the negative ohmmeter lead connected to the base of a *pnp* transistor, the resistance reading to either the emitter or the collector should be 500 ohms or less.

With an *npn* transistor, the same tests apply except that the high resistance readings will be obtained with the negative ohmmeter lead connected to the transistor base, and the low resistance readings with the positive ohmmeter leads connected to the transistor base.

Fig. 2 shows the normal results to be expected

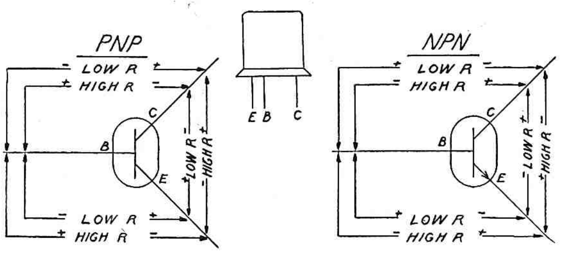


FIG. 2. Normal results when checking transistors with an ohmmeter.

when testing each type of transistor. Also, it shows how to identify the transistor leads. (The *pnp* transistor, at the left in Fig. 2, should have an arrowhead in the emitter symbol pointing toward the base.)

This same testing method can, of course, be used for simple diodes. In testing those units, a reading of 500 ohms or less should be obtained when the negative ohmmeter lead is connected to the "cathode" terminal (the one marked with the bar) of the diode. A much higher reading should be obtained when the ohmmeter leads are reversed.

In testing transistors or crystal diodes in this manner, you must remember that these tests are not absolute. That is, you cannot always depend on these tests. Transistors fail very rarely, however, and you can always check a crystal diode by temporarily substituting one that is similar.

Signal Injection Tests. The most important precaution to be observed in connection with signal injection testing is to keep the signal generator output as low as possible while obtaining satisfactory results. Overloading a transistor receiver input circuit may damage the transistors in the set. At first, always keep the signal level as low as possible with consistent results. With experience in servicing transistor receivers, you will come to know approximately what signal level is required in checking each of the individual stages.

Another important point is to always use a series capacitor. If the signal generator does not have such a capacitor built in, you must add one at the "hot" output terminal. Use a .1-mfd condenser in this application.

When using the signal injection technique in the i-f and rf stages of a transistor receiver, it is generally unnecessary to touch the signal generator output lead to the circuit point where the signal is to be fed. Simply bringing the signal generator lead close to the point will generally give sufficient coupling.

In servicing a receiver having the i-f stages placed close together, however, it may be difficult to tell just where the signal is being injected unless you touch the circuit point. In a case like that, of course, you must touch the signal generator lead to the circuit point where you wish to feed the signal. Keep the signal generator attenuators at reasonably low settings as explained previously to prevent overloading in any of the stages.

A safety precaution: When making signal injection tests, *always* short the signal generator output leads after touching a point in the receiver. This will discharge the series capacitor and prevent damage in the next test. Always do this—it will soon become a habit.

In general, it is not possible to directly couple the signal generator output to the mixer circuit of a transistor receiver. Most of the receivers use an autodyne combination oscillator-mixer, and adding the signal generator loads the circuits and prevents oscillation. For that reason,

›u must connect a two or three-turn loop to ‹e signal generator output terminals and place ‹is loop near the receiver antenna to obtain ‹upling to the mixer. This method can be used ‹ feed in an i-f signal, or an rf signal.

‹gnal Tracing. Signal tracing is an excellent ‹chnique to use in servicing transistor receiv‹s since there is no chance of overloading any ‹ages in the set, and signal tracing provides a ‹uick method of determining which stage is de‹ctive. When you know what stage is defective, ‹u can then check the individual parts. For ‹is purpose, a tuned signal tracer (such as the ‹RI Model 34) is best since that type will allow ›u to check the oscillator operation and fre‹uency, and also be sure that the i-f signal is ‹ing produced.

‹hecking the operation of the local oscillator in ‹ transistor receiver is considerably more diffi‹ult than checking the local oscillator in a ‹cuum-tube receiver. In a vacuum-tube re‹iver, the presence of negative voltage at the ‹cillator grid indicates oscillator operation. ‹here is no such simple test with a transistor ‹ceiver. That is, there is no voltage which ‹finitely indicates normal oscillator operation.

‹hen a tuned signal tracer is not available, the ‹cillator operation can be checked by tuning ‹e transistor receiver to approximately 1000 kc, ‹d then using a separate receiver to attempt ‹ pick up the signal from the oscillator. The fre‹ency, of course, will be at 1000 kc plus the i-f ‹equency. In the particular case described, it ‹ll be at 1455 kc, assuming a 455-kc i-f circuit ‹ the transistor receiver.

‹here is an error in Fig. 3. The lower end of the ‹tenna coil and tuning capacitor should be ‹ounded. Also, the lower end of the oscillator ‹ning condenser.

‹nsider the converter circuit shown in Fig. 3. ‹ partial open in condenser C2—amounting to ‹sharp decrease in the value of the condenser ‹would shift the oscillator frequency. With con‹derable experience in using an untuned signal ‹acer, a technician can tell when the oscillator ‹ not working, but if it is working, and he ob‹ins the normal soft "hiss" when the signal ‹acer probe is brought near the oscillator coil, ‹ knows that the oscillator is working, and he ‹ll assume that it is operating at the proper ‹equency.

‹ith a tuned signal tracer, however, the first ‹st not only indicates whether the oscillator ‹ working, but also indicates at what frequency ‹ is working and shows whether the oscillator ‹ll tune properly.

‹nother important advantage of a tuned signal ‹acer is the ability to check the approximate ‹in of the various stages in the transistor re-

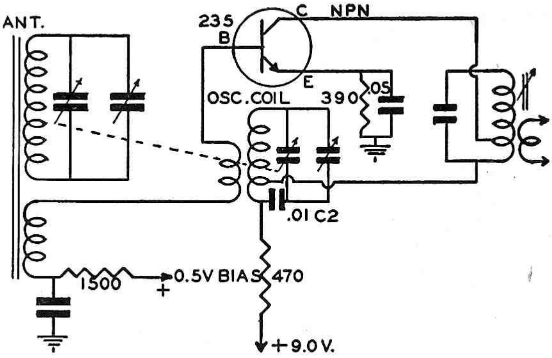


FIG. 3. A common emitter converter stage.

ceiver simply by moving the probe from one point to another and retuning the tracer input as necessary.

In general, the audio stages of all signal tracers are basically similar. That is, there is no tuning of the audio tracing stages, and about the only difference in individual instruments is the type of output provided—whether speaker or headphone—and the types of tubes used.

An audio signal tracer will have a relatively large series coupling capacitor. When testing in a transistor receiver, always short the input leads together after testing at each point. This will discharge the series capacitor and prevent your damaging the transistors.

The simple audio signal tracers consisting of a pair of headphones with a capacitor in series with one lead are completely unsatisfactory in servicing transistor receivers. The circuit impedances are quite low, and the voltages developed are also quite low. This makes a relatively insensitive audio signal tracer unsatisfactory for use in testing these receivers.

Transistor Circuits

Let's look at some of the common circuits. In this way, you can learn to recognize the differences in circuits, and identify the various types.

Converter Stages. The converter stage in a transistor receiver corresponds to the oscillator-mixer of a vacuum-tube receiver. The term is not used in this case since both functions take place at the same time in a single three-element device. In a vacuum-tube oscillator-mixer circuit, part of the tube acts as an oscillator, and an electrically separate part of the tube acts as a mixer. In a transistor converter stage, there is no such separation.

In the common-emitter converter circuit shown in Fig. 3, the oscillator coil is coupled to both the base and the collector of the transistor. The coupling to the base is obtained by a separate tickler on the oscillator coil, and the coupling to the collector is obtained through a tapped section of the oscillator coil itself. This tapped section is connected in series with the supply voltage lead to the collector.

Notice that an *npn* transistor is used in this circuit and that the collector is therefore positive with respect to both the base and the emitter. For efficient mixer action, the base is made slightly positive with respect to the emitter.

Notice that an adjustable slug is provided in the oscillator coil for use as a padder. The padder allows the receiver to be adjusted for best response at both ends of the broadcast band. In older broadcast band receivers, the padder was quite common but it has virtually disappeared from modern sets. Of course, the normal trimmer for adjusting the high end of the band is also provided.

The collector is tapped down on the primary of the i-f transformer to obtain better matching. By doing this, the transistor collector circuit works into the proper impedance to give maximum power, and excessive loading of the i-f transformer by the collector circuit, with consequent decrease in selectivity, is prevented. This is a very common practice in transistor receivers.

Fig. 4 shows a common-base type of mixer stage. (Incidentally, notice that a *pnp* transistor is used in this circuit; therefore the supply voltage applied to the collector must be negative.)

In this circuit, a pick-up winding is connected

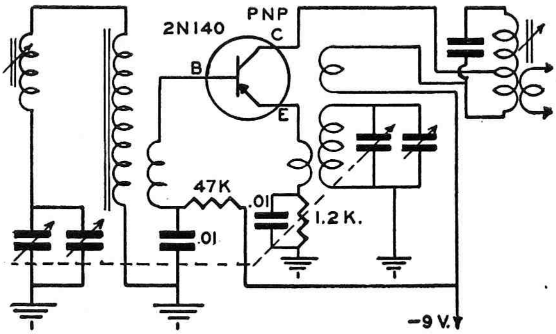


FIG. 4. A common base converter stage.

in series between the emitter and the emitter bias network. This winding is coupled to the oscillator coil. At the same time, a feedback winding is connected in series with the supply voltage lead to the collector. Therefore, feedback is obtained between the collector and the emitter. The feedback is of the proper polarity to support oscillation.

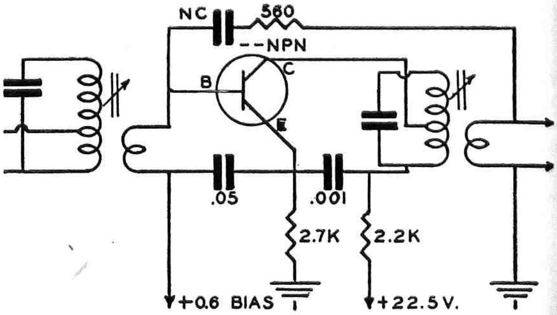


FIG. 5. Second i-f stage of the Regency TR-1.

In this circuit, notice that a slug for use as a padder is not provided in the oscillator coil. Instead, a variable inductance coil in series with the ferrite stick antenna is provided for adjusting at the low end of the tuning range. In the first system described, the designer assumed that the antenna circuit would tune the proper range when it was adjusted for maximum response at a frequency near the high end of the tuning range. A padder was then provided in the oscillator coil for adjusting the oscillator to stay "in step" with the antenna tuning. In this case, the designer assumed that the oscillator would tune the proper range, and provided a padder in the antenna circuit for adjusting the antenna circuit to stay "in step" with the tuning of the oscillator. In each case, the effect is the same. The two tuning curves match so that best response is obtained over the entire range.

As in the previous circuit discussed, notice that the collector is tapped down on the i-f transformer primary to give proper impedance matching and to preserve the Q of the transformer.

A common-collector type of converter circuit is not possible since it has a gain of less than 1. Therefore, a common-collector circuit cannot be made to oscillate.

I-F Stages. Now let's look at some common i-f stages found in commercial transistor receivers.

Because a transistor is roughly the equivalent of a triode vacuum tube, there is considerable danger of oscillation if provisions are not made to prevent it. The methods used to neutralize the stages are new to servicemen accustomed to pentode i-f circuits which require no neutralization.

Fig. 5 shows the second i-f stage of the first all-transistor receiver, the Regency Model TR-1. The transistor used in this circuit is a special unit, and no type number has been given for it. The neutralizing condenser, marked "NC," is also a special unit. It is chosen to match the particular transistor. If the transistor in this stage should become defective, it would have to be ordered om the factory, and a new neutralizing con-nser would be furnished at the same time. rticularly notice that a resistor in series with e emitter is not bypassed. The importance of is will be pointed out a little later.

ow look at Fig. 6. Notice that the circuit is al-ost identical to the one shown in Fig. 5 except r minor changes in parts values and the dif-rent battery voltage.

the circuit shown in Fig. 6, the combination of more efficient transistor especially designed for h frequency use which has very low capacity tween the individual "elements" plus the un-passed resistor in series with the emitter gives fficient stability for normal operation. No utralizing circuit is needed.

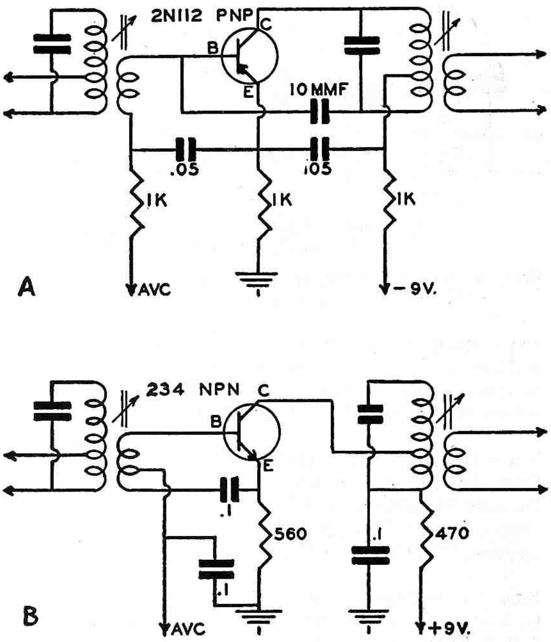
vo more or less unusual i-f amplifier circuits e shown in Fig. 7. Both these circuits have ecial components in them that are designed to lp with the neutralization.

nsider the circuit shown in Fig. 7A. A type 112 *pnp* transistor is used. The resistor in ries with the emitter is not bypassed. Now tice the output i-f transformer. The transistor llector connects to the top of the primary nding. The supply voltage connects to the nter tap on the transformer winding. The sup-y voltage line is bypassed to the emitter with .05-mfd condenser. The transistor base con-cts to the battery of the winding through a mfd capacitor.

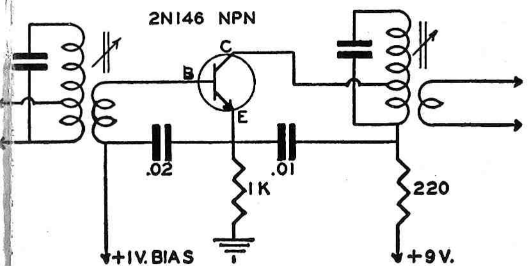
better understand the operation of the i-f am-fier circuit shown in Fig. 7A, consider the nplified version shown in Fig. 8. The *pnp* nsistor in Fig. 8 should have an arrowhead the emitter symbol pointing toward the base. this simplified version, condenser Cn repre-nts the 10-mmf condenser in the original cir-it and Cbc represents the capacity existing tween the base and the collector of the tran-tor. Through the action of the .05-mfd con-nser connected from the center tap of the i-f nsformer primary in the original circuit, the nter tap is grounded, as far as the rf signal concerned.

sume that the rf signal existing at the collec-tor of the transistor has a certain phase. A por-tion of this signal existing at the collector will be fed back to the base of the transistor through the base-collector capacitance.

Because the center tap of the i-f transformer primary is grounded as far as the signal is con-cerned, the voltage at the lower end of the trans-former will be 180 degrees out of phase with the voltage at the other end. If this voltage is fed back to the collector base through a suitable capacitance, it will tend to balance out the volt-age fed back through the collector-base capaci-tance. Because the two signals are alike in am-plitude and frequency, but opposite in phase, they balance each other leaving no feedback signal at all. By choosing a neutralizing capaci-tor (Cn) with a value to match the collector-base capacitance of the transistor, perfect bal-ance can be obtained. The particular transistor used in this circuit is manufactured under care-fully controlled conditions, and the internal



FIGS. 7A and 7B. Two unusual i-f amplifier stages.



. 6. I-F stage requiring no separate neutralization.

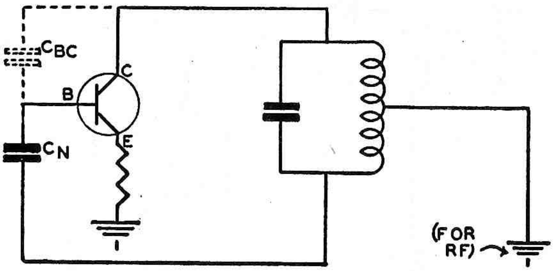


FIG. 8. Plate neutralization of triode i-f amplifier.

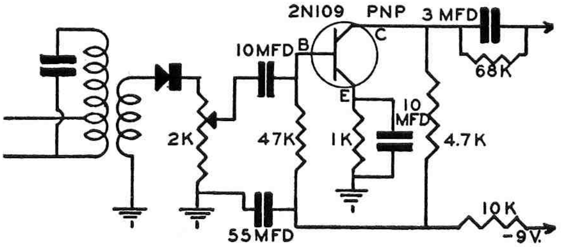


FIG. 9. Second-detector and first-audio stages of a commercial receiver.

capacities of the transistor are carefully kept within very close limits. Therefore, it is not necessary to change the neutralizing capacitor when the transistor is replaced.

Now consider the circuit shown in Fig. 7B. In this circuit, the primary of the input i-f transformer is tapped and the tap is used as an avc connection. Through the action of the .1-mfd avc bypass, the tap is effectively grounded for rf.

Now, out-of-phase signals will exist across the two sections of the transistor. That is, the signal fed to the transistor base will be 180 degrees out of phase with the signal fed to the emitter. The .1-mfd condenser connected between the lower terminal of the input i-f transformer secondary and emitter serves to couple the signal between the two points.

This circuit does not work on a simple basis of phase relationship. Instead, it is a means of balancing the two forms of transistor operation. The common-emitter transistor circuit has high output and will readily oscillate. The common-base circuit, however, is more stable. By connecting the circuit in this manner so that the input signal is fed to both the base and the emitter, but out of phase, the two modes of operation are balanced against one another, and the overall effect is stabilization.

Audio Amplifier Circuits. Because transistors are comparatively new, there are many variations in the circuits found in commercial receivers. In some cases, the circuits are entirely new, and in others they are simply reworked versions of older standard circuits. Let's look at a few of the common circuits.

Fig. 9 shows a very common audio amplifier circuit. (In the *pnp* transistor of Fig. 9 there should be an arrowhead in the emitter symbol pointing toward the base.) The only unusual thing about this circuit is the coupling capacitor values. Since transistors are low impedance devices, the coupling capacities must be quite great in comparison with those found in vacuum-tube receivers. Also, notice that the value of the volume control is only 2000 ohms—quite a change from the 1-megohm value common in vacuum-tube receivers.

Fig. 10 shows a transistor audio section that has two unusual features—the volume control connection and the fact that dc coupling is used between the two stages.

Study the connections to the volume control for a moment. Notice that moving the slider closer to the top of the control decreases that portion of the load resistor across which the input voltage for the stage is developed. This decreases the volume. As the contact moves closer and closer to the top of the volume control, thereby decreasing the volume, the resistance in series with the 10-mfd condenser is increased. Therefore, the effectiveness of this bypass decreases.

In this circuit, the volume is controlled in two different ways at the same time. The input signal to the amplifier is varied, and the effective amplification of the stage is varied.

Notice that a dc path exists between the collector of the first audio amplifier transistor and the base of the second. Therefore, there is dc coupling between the stages. This accounts for the slightly different method of connecting the base and the collector of the first transistor in the circuit. (Incidentally, the circuit shown in

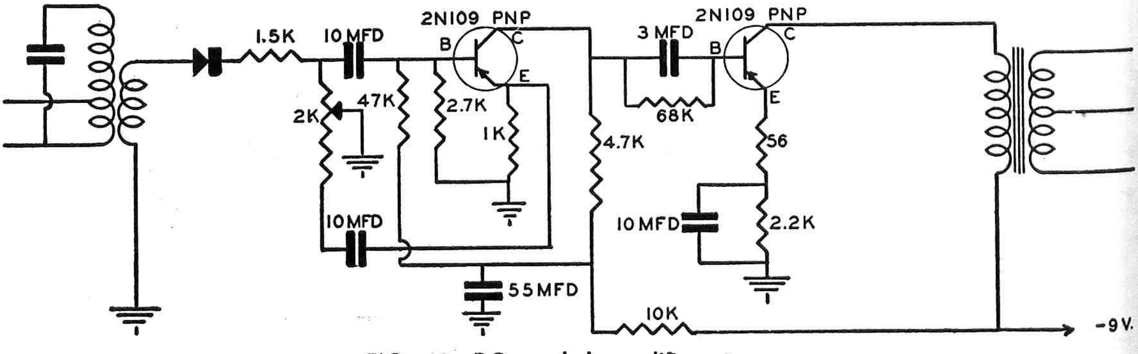
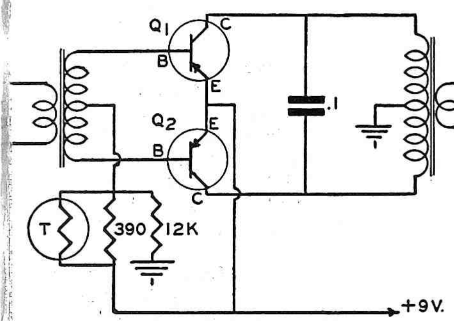


FIG. 10. DC-coupled amplifier stages.

ig. 9 is also designed for use in a system such s this.)

udio Output Stages. In some of the first all-ransistor receivers, a class A audio output stage sing a single transistor was employed. In mod-rn sets, however, push-pull class B audio output vith transformer coupling to the preceding am-lifier is standard.

ig. 11 shows a push-pull class B audio output ircuit arranged for negative ground supply. otice that the center tap of the output trans-ormer is grounded. This means that the center ap is connected to the negative lead of the bat-



G. 11. Push-pull class B audio output circuit arranged r negative ground supply. Both Q1 and Q2 are 2N109 *pnp* transistors.

ery. The collector is negative with respect to e emitter. This is correct for *pnp* transistors uch as are commonly used in such circuits. ias for the bases of the transistors is obtained rough a voltage divider network consisting a 12K-ohm resistor and two other resistors in arallel. One of these is simply a 390-ohm car-on resistor. The other one is a "Thermistor." he value of a Thermistor varies according to eat. As the unit is heated, the resistance drops wer and lower thereby decreasing the voltage etween the base and the emitter. Therefore, the crease in the current through the transistor ue to outside heat is offset by the change in ias.

ig. 12 shows a similar circuit but arranged for ositive ground supply. The transistor types are e same as before. In this circuit, notice that e 12K that was connected from the center tap the input transformer secondary to ground now connected in series between the battery erminals and the battery. Also, notice that the attery polarity has been reversed. The effect these two changes and the change in the con-ection of the emitters, is to make the voltage xisting between the emitters and the bases of e transistors shown in Fig. 12 about the same s the voltage existing between those elements Fig. 11.

There is one slight difference worthy of comment. In the circuit shown in Fig. 12, a 10-ohm resistor is connected in series between the emitters and ground, which is one side of the battery. This small resistor tends to limit the current through the transistors. Having this resistor in the circuit helps prevent damage to the transistors from excessive current.

Receiver Servicing

From the lessons of the NRI course, you are already familiar with the general methods of locating the defective stage in a receiver. There are some changes, however.

In transistor receivers, the circuit disturbance technique is not satisfactory. You cannot pull the transistors from their sockets and then plug them back in to check for a click. This is likely to damage the transistors.

By applying the precautions given previously, however, you can use the signal injection technique. Just be sure to short the output leads of the signal generator after you make each test. Practice this until it becomes a habit.

Signal tracing is also a useful technique. Again, remember to short the probe and the ground clip together after you check at each point. This will prevent any charge stored in the series capacitor of the signal generator from damaging the transistors in the circuit. Again, this should be practiced until it becomes a habit when servicing this type of set.

Generally, transistors rarely fail. Consequently they should be the last part you suspect when checking this type of receiver. If your test conclusively proves that a particular transistor is defective, carefully check the manufacturer's service information. It may be that you will have to replace two transistors at the same time. Typical examples of this are the transistors used in the i-f amplifier stages where replacing one of them also requires replacement of the other. This same thing is true of the transistors used in class B audio output stages.

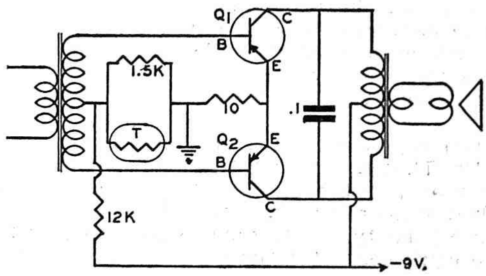


FIG. 12. Push-pull class B audio output circuit using positive ground supply. Both Q1 and Q2 are 2N109 *pnp* transistors.

You must always replace both of them at the same time since the transistors must be balanced to give satisfactory operation.

Incidentally, it is a good idea to keep the extra transistor that you had to remove for test purposes. Be sure to store it in a reasonably cool place so that it will not be damaged.

Many modern transistor receivers use printed wiring. There are a number of precautions that must be observed in servicing that type of equipment. Perhaps the most important one is taking care to avoid excessive heat. Never attempt to use a full size soldering iron on printed wiring. You may loosen the printed wiring on the board, and cause trouble. A low wattage iron is important. Most manufacturers recommend using a 30 or 40-watt soldering pencil when working with printed wiring boards. Some servicemen use high wattage soldering guns in servicing such equipment, but that is not a good idea.

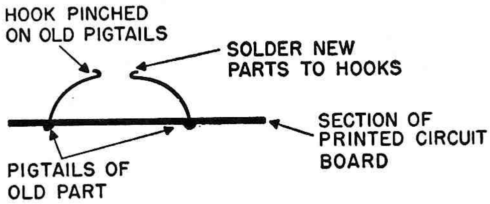


FIG. 13. Replacement of parts on a printed wiring board.

To replace a part on a printed wiring board, clip the leads of the defective part as close to the body of the part as possible. Then put the new part in place on the board and attach the leads of the original part to the leads of the new part. The proper procedure is shown in Fig. 13.

By following this procedure for replacing parts on a printed wiring board, there is little chance of applying excessive heat to the wiring itself. Excessive heat will often melt the banding on the board and cause the wiring to spring loose. Pulling on the wiring too much can have the same effect. Be careful. If the printed wiring is broken at any point, solder a short length of reasonably heavy wire across the break to complete the circuit.

When replacing parts, observe all the normal rules. That is, try to get a replacement part as near as possible to the value of the original; when connecting electrolytics, be sure to observe polarity. Never remove but one part from the equipment at a time.

With the information given here, you are ready to start servicing transistor receivers. Good luck.

Mystery Student!

Who is He?

Some time ago we received the following letter:

"Dear Mr. Straughn: Received your most welcome letters and was more than glad to hear from you. I am more than sorry that I didn't answer you sooner but have been quite busy. I am going to have to ask you to be a little bit patient with me for a little while more. I thought that I would be able to do some of the work while I am working but was unable to. I sure hope you don't think that I have forgotten about my course. I haven't. I will start them when I get through with my work. I'm not one to give up on something that I start and I do like to give most of my time to it. I am going to try very hard to pass this course as I know how much it will help me later on. Please believe me when I say that I have learned a whole lot from what I have studied. I sure hope to hear from you soon. As ever your student."

Nice letter? Surely. And Mr. Straughn, our cooperative Chief of Consultation Service, would have liked very much to send a speedy answer. But where, and to whom? The envelope had no return address, there was no address or student number on the letter itself, and it wasn't *even signed.* Our only clue was the postmark "Herkimer, New York" which just wasn't enough to enable us to identify this fellow.

Our "student" probably waited patiently for his reply and when he didn't get it, must have thought that Mr. Straughn was falling down on his job.

So a friendly word of advice to all you NRI men: when you write, be sure to include your full name, complete address, and student number on both the envelope and your letter. If you are a graduate, write "Grad." after your name. That way you'll get quick answers to the letters you send NRI.

——*n r i*——

Donovan worked in a factory where they encouraged the employees to put forward ideas for the betterment of business.

One morning he was shown into the office of the chairman and announced that he had thought of a way of insuring that none of the employees would be late in the future.

"That sounds good," said the chairman. "How do you propose to do it?"

"Sure—that's easy sir," said Donovan. "The last man in blows the whistle."

J. G. Dodgson

How To Build Crossover Networks For High-Fidelity Speaker Systems

By J. G. DODGSON
NRI Consultant

udspeaker crossover networks are L-C fre-ency dividers connected between the amplifier itput and the speakers. They are used in eaker systems when two or more speakers th different frequency ranges are used since is desirable to feed to each speaker only the nge of frequencies for which it was designed.

e most common use of crossover networks is a high fidelity speaker system employing a oofer for low frequency sound and a Tweeter high frequencies. The crossover network is nnected between the amplifier and each speak- and then only the low frequencies are fed to e Woofer while only the high frequencies are d to the Tweeter. The low frequencies are thus evented from being applied to the Tweeter d conversely the high frequencies are pre-nted from being applied to the Woofer.

is always necessary to prevent low frequen-s from being applied to the Tweeter in any eaker system since its smaller and lighter ice coil will very easily become damaged with v frequency, high amplitude energy. Very en a so-called crossover network in commer-l speaker systems and coaxial speakers con-ts only of a condenser in series with the eeter. This is, in effect, a high pass filter th a cut-off rate of about 3 db per octave. though this may prevent damage of the Tweet- it does not prevent high frequency sound m being applied to the Woofer and being dis-ated in the Woofer voice coil in the form of at. In addition to this loss of the upper high quencies in the Woofer voice coil as heat the ddle high frequencies are being reproduced both the Woofer and the Tweeter. This uble-source sound usually causes frequency ncellations in various spots in the listening m due to out-of-phase conditions.

The crossover network will, of course, eliminate most of these difficulties and in addition will prevent any possible frequency modulation of the high frequencies by the low frequencies which generally occurs in most medium and low priced full range loudspeakers. This effect is referred to as intermodulation. A distinct feeling of presence is always obtained with a two-way loudspeaker system as compared to a single full range loudspeaker. Perhaps one reason for this is the cone "break-up" of the full range speaker at medium-high frequencies. This "cone break-up" is due to parts of the cone moving in different directions at the same time. The uniform movement of the cone is called piston action and all loudspeakers act like pistons in the lower part of their frequency range.

When the voice coil of a speaker moves outward, due to an applied signal, it presses against the part of the cone cemented to it. This portion of the cone, in turn, presses on the portion next to it and pushes it out. In this way, as each small section of the cone moves outward, it pushes the next section outward. Some time after the coil moves, the outermost section of the cone moves. The voice coil and cone rim do not move at exactly the same time.

This cone movement advances along the cone surface like a ripple or wave and the voice coil continues to move as this ripple moves outward toward the rim. At a certain frequency, the coil will have advanced to the limit of its movement and returned to its original position by the time the wave has reached the cone rim. The cone will then vibrate like a tight string and unfortunately it wlil vibrate not only at some fundamental frequency but also at overtones of that frequency. A crossover network then can prevent cone break-up and its resulting distortion

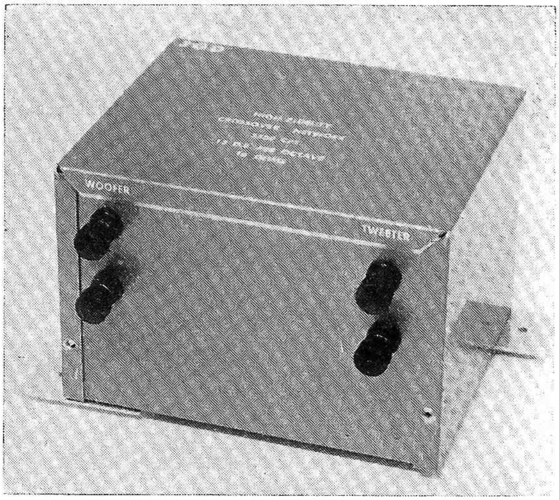
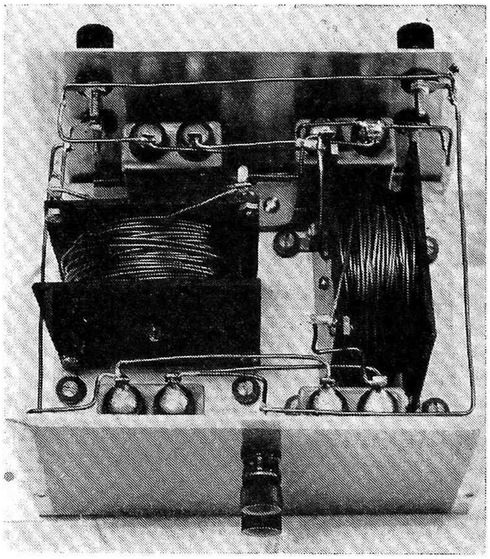


Fig. 1. A 3,500 CPS half section crossover network built from the data in this article.



by feeding to the speaker only the signal at which the speaker acts as a piston.

There are actually two types of crossover networks—series and parallel. This article concerns only parallel crossover networks since the series type is rather limited in use and is almost never used in home high fidelity systems. A simple parallel type crossover network is shown in Fig. 2.

You will notice that the crossover network shown in Fig. 2 consists of a single condenser in series with the Tweeter to block the low frequencies and a coil in series with the Woofer to block the high frequencies. This particular type of crossover network is known as a quarter-section and attenuates at approximately 6 db per octave. That is, the low frequencies fed to the Tweeter are attenuated 6 db per octave starting at the crossover frequency while the high frequencies fed to the Woofer are attenuated 6 db per octave starting at the crossover frequency. Choice of crossover frequency in this system depends mainly on the frequency response of the speakers.

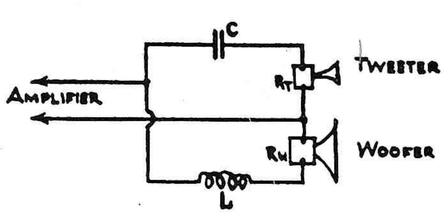
The crossover network shown in Fig. 5 is more complicated than that shown in Fig. 2. Notice that it consists of two coils and two condensers. This type of crossover is known as a parallel half-section crossover and has an attenuation rate of approximately 12 db per octave.

From the diagrams of the quarter-section and half-section crossovers you can see that it would be possible to add additional condensers and coils to obtain an even higher rate of attenuation. In the half-section network, for example, another condenser connected in series with the Tweeter between the coil junction and the Tweeter voice coil and another coil connected in series with the Woofer between the condenser junction and the Woofer voice coil would result in an attenuation factor of 18 db per octave. Although it may seem desirable to have a faster cut-off slope such as this, extended listening tests have indicated that the ear cannot determine the difference between this 18-db per octave cut-off and the 12-db per octave cut-off. In fact, there is the possibility of distortion with the steeper cut-off slope. Because of this, information is not given for building such a crossover in this article.

It is possible to build a three-way crossover network for use with three speakers. In this type of crossover network there are two crossover frequencies for the Tweeter and Woofer and the mid-range speaker is connected through a band-pass filter to the amplifier.

Although the author tried to obtain practical data—especially graphs—on such systems none seemed to be available at this time. Some indication of the necessary coil and condenser values could be obtained from the graphs in Figs. 2 and 5 but they would not be accurate since the parts interact on each other. However it would give a reasonable starting point and with the use of a VTVM and an audio signal generator more exact component values could probably be reached.

It is desirable to have the Woofer and Tweeter impedances equal to each other although it is not necessary. They should not, however, be too far apart or difficulty will be encountered in choosing the network component values. More about this later.



SINGLE FILTER ELEMENT NETWORK
CUTOFF ATTENUATION AT 6DB PER OCTAVE
CONSTANT RESISTANCE TYPE

BASED ON RELATIONSHIP:

$$R_W = 2\pi f L \times 10^{-3} \quad \text{OR} \quad L = \frac{159 \times R_W}{f}$$

$$R_T = \frac{10^6}{2\pi f C} \quad \text{OR} \quad C = \frac{159000}{f \times R_T}$$

WHERE

- L = INDUCTANCE IN MILLIHENRIES
- C = CAPACITY IN MICROFARADS
- f = CROSSOVER FREQUENCY
- R_W = IMPEDANCE OF WOOFER VOICE COIL
- R_T IMPEDANCE OF TWEETER VOICE COIL

TO FIND THE VALUE OF L OR C BY MEANS OF THE CHART, SELECT THE DIAGONAL LINE AT THE TOP OR RIGHT SIDE OF THE CHART CORRESPONDING TO THE DESIRED CROSSOVER FREQUENCY. NEXT SELECT FROM THE BOTTOM OR RIGHT SIDE OF THE CHART, THE OPPOSITELY SLOPING LINE CORRESPONDING TO THE IMPEDANCE OF THE VOICE COIL CONCERNED. AT THE INTERSECTION OF THESE TWO DIAGONAL LINES, MOVE HORIZONTALLY TO THE LEFT AND READ THE VALUE OF L. FROM THE SAME INTERSECTION, MOVE VERTICALLY TO THE TOP OF THE CHART AND READ THE VALUE OF C. APPLY THESE VALUES TO THE WIRING DIAGRAM ABOVE. SEE TEXT

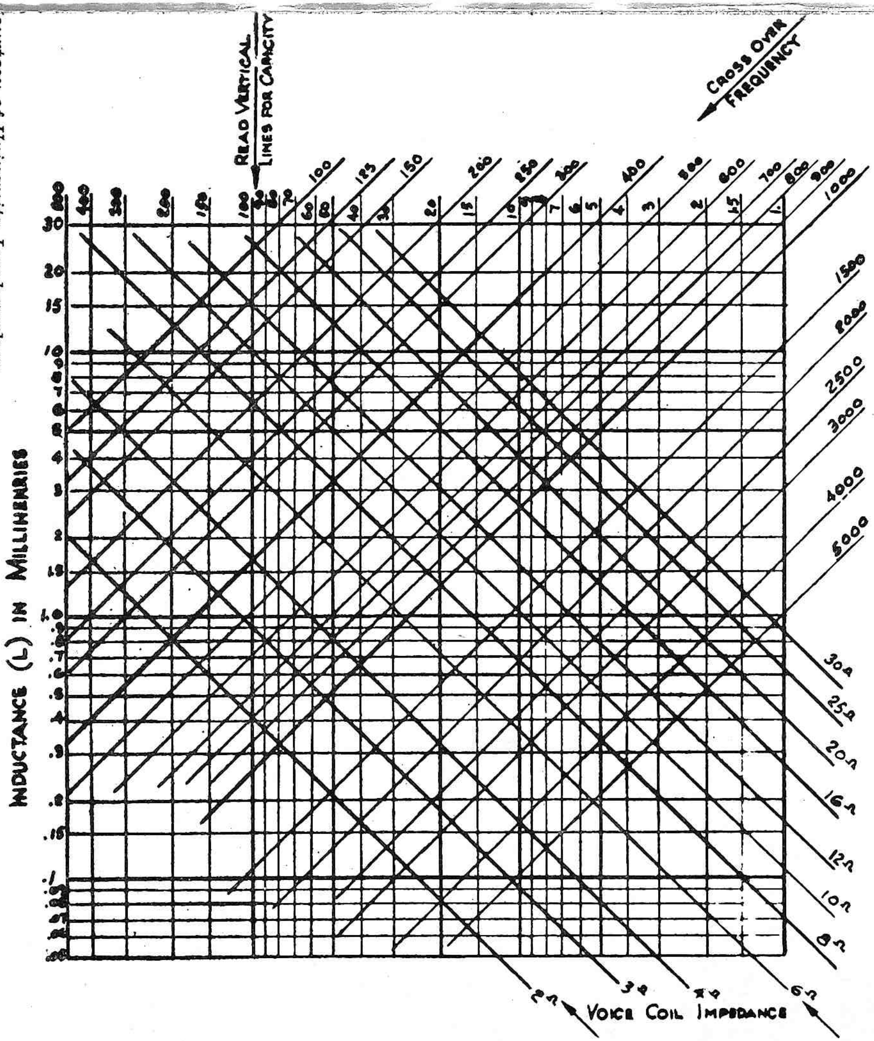


Fig. 2. Single filter element crossover network.

ourtesy of University Loudspeakers

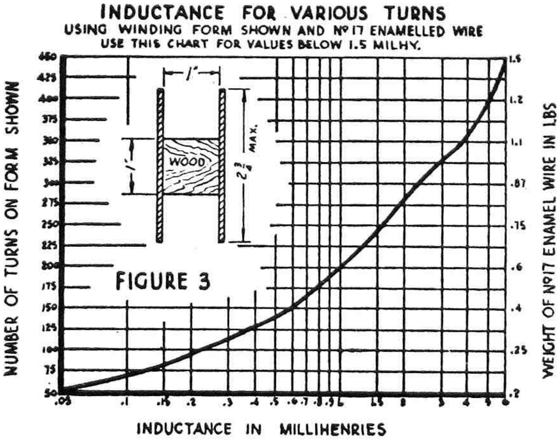


Fig. 3.

The selection of the crossover frequency depends, as mentioned previously, on the Woofer and Tweeter characteristics. Generally, the crossover frequency is chosen to be slightly above the low frequency cut-off of the Tweeter. Although this is a good rough rule it is not necessarily the best.

There are several other facts that should be carefully considered when choosing the crossover frequency. (1) The crossover frequency should be above the cut-off frequency of the Tweeter. This cut-off frequency can be determined from the manufacturer's specifications. (2) The crossover frequency should be just below the lowest frequency at which Woofer distortion is first evident. That is, at some point the high frequencies applied to the Woofer will cause cone break-up and result in considerable distortion. Careful listening tests may show this, especially if the system is operated at a very high level (very loud). (3) If complete specifications are available on the Woofer they will show the polar distribution of the Woofer output at various frequencies. The crossover frequency should then be selected below that frequency where the polar distribution becomes narrow. (4) In a Klipsch type horn, or any other in which the signal off the back of the speaker is not used, a very low crossover frequency from 300 to 600 cps is necessary.

All of the above facts should be kept in mind when choosing the crossover frequency. This is especially true with low and medium priced Woofers. Expensive Woofers are generally free from distortion at reasonable volume levels and break-up does not usually occur below 5000 cycles. Therefore, the basis for the selection of the crossover frequency would, in most cases, be determined by the low frequency cut-off of the Tweeter.

If several Tweeters are available or if none have already been purchased for the system, it may be well to write to the Woofer manufacturer for advice of the most desirable crossover frequency. Most manufacturers are very cooperative. One other helpful way of determining the best crossover frequency is to check the Woofer manufacturer's other speaker products. Very often you will find that a speaker manufacturer produces Woofers, Tweeters, and crossover networks which are designed to work with each other. For example, the Jim Lansing Model 075 High Frequency Tweeter is designed specifically for use with the Lansing Model N2500 crossover network and various Lansing Woofers. Therefore, an owner of one of the Lansing Woofers (or full range speakers) can be fairly certain that the best crossover frequency for his system would be 2500 cycles if he also has a Model 075 or comparable Tweeter. However, should he have a Tweeter with a higher cut-off frequency, of say, 3000 cycles, then it would be advisable for him to build a 3000-cps crossover network rather than a 2500-cycle crossover network.

Figs. 2 and 5 also show graphs for determining the capacitor and coil values according to the speaker impedances and crossover frequencies. A simple explanation of using the graph is given in the illustration.

As an example, let us assume that we have two speakers, each with a voice coil impedance of 12 ohms, and we wish to build a parallel half-section network with a crossover frequency of 1500 cycles. Our first step is to locate the voice coil impedance of 12 ohms at the bottom of the graph in Fig. 5 and then to move up the diagonal line until we reach the 1500-cycle crossover frequency diagonal line. This line will be found

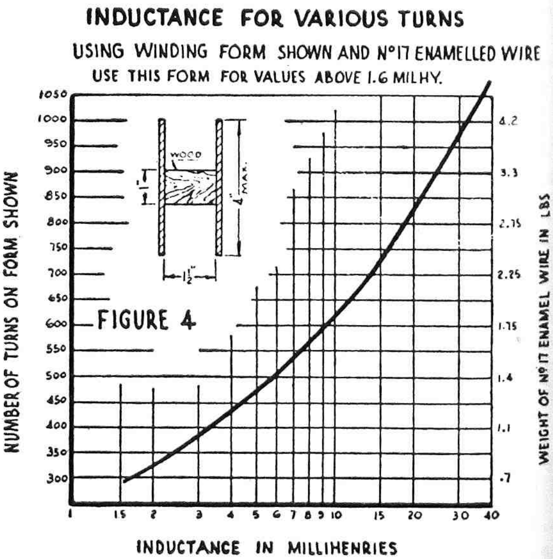
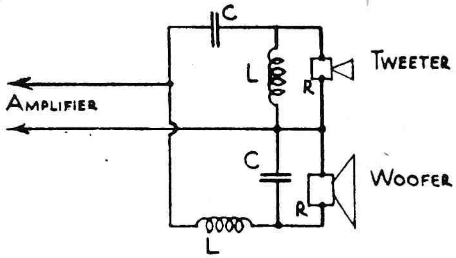


Fig. 4.



Parallel - Constant Resistance Network
Cutoff Attenuation at 12DB Per Octave

Based on relationship:

$$L = \frac{\sqrt{2}\,R \times 10^3}{2\pi f} \quad \text{or} \quad L = \frac{R \times 225}{f}$$

$$C = \frac{10^6}{2\pi f R} \times \frac{1}{\sqrt{2}} \quad \text{or} \quad C = \frac{113000}{R \times f}$$

Where

L = inductance in millihenries
C = capacity in microfarads
R = voice coil impedance
f = crossover frequency

To find the value of L or C by means of the chart, select the diagonal line at the top or right side of the chart corresponding to the desired crossover frequency. Next select from the bottom or right side of the chart, the oppositely sloping line corresponding to the impedance of the voice coil concerned. At the intersection of these two diagonal lines, move horizontally to the left and read the value of L. From the same intersection, move vertically to the top of the chart and read the value of C. Apply these values to the wiring diagram above. See text.

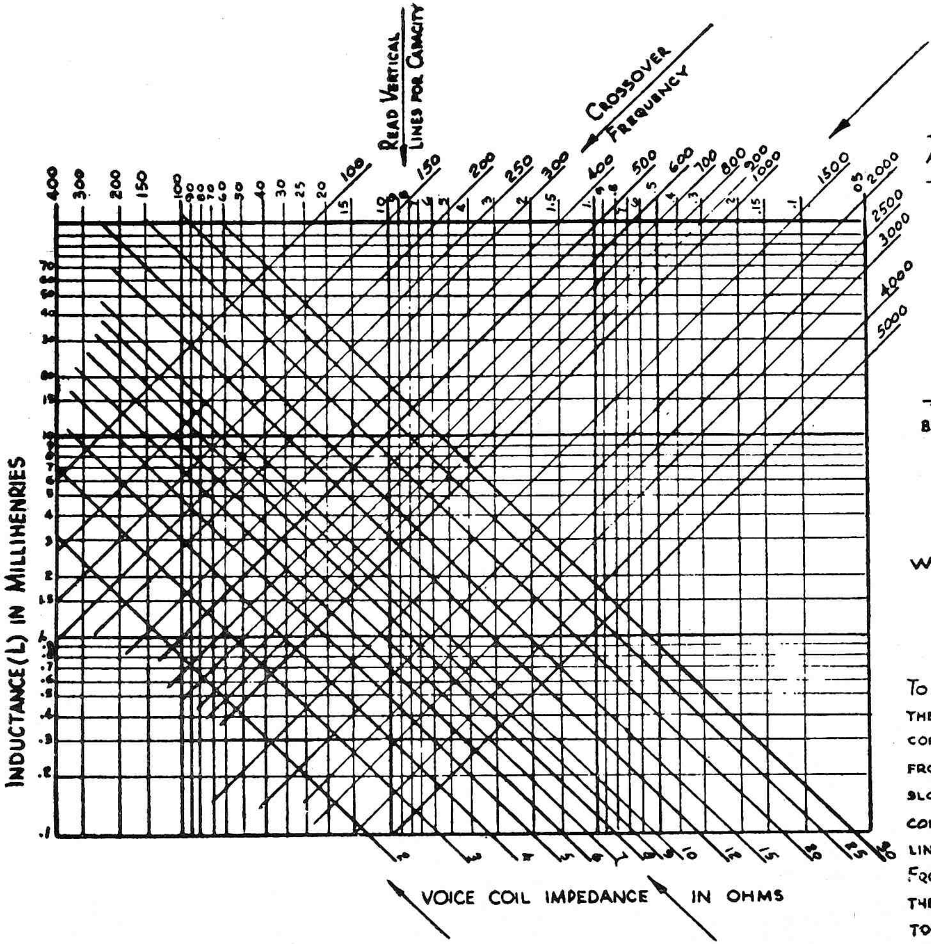


Fig. 5. Parallel type half-section.

Courtesy of University Loudspeakers

to start at the upper right-hand corner of the graph. Notice that these two lines intersect at a point about mid-way from the right and left-hand sides and almost mid-way from the top and bottom. At this point of intersection there are two other lines. The horizontal line will be seen to extend to the left to indicate 2 millihenrys inductance while the vertical line will be seen to move up to the top to indicate 6 microfarads capacity. Thus, for this half-section crossover network each capacitor will have a value of 6 microfarads and each coil will have an inductance of 2 millihenrys. The coil should then be wound according to the graph in Fig. 4.

Notice that, of the two graphs in Figs. 4 and 5, one is for values below 1.5 millihenrys and the other for values above 1.5 millihenrys. Since our coil inductance is 2 millihenrys we will need to use the graph in Fig. 4. By locating the value of 2 millihenrys at the bottom line of the graph we will move up this line to the intersection of the curved line. On the left-hand side you will notice that the number of turns of wire will be somewhere between 300 and 350. Since we are about mid-way between these points we can assume 325 turns.

Another helpful feature of this graph is the approximate weight of No. 17 enameled wire which is shown on the right-hand side. If we move over to the right-hand side from our intersection point we will find that we need approximately .8 pound. Since wire is sold in one-half or one-pound spools it will be necessary to purchase a one-pound spool of wire for each coil.

Where No. 17 gauge of wire is not available it is desirable to use a larger diameter wire (smaller number) for inductances over 1 millihenry and a smaller diameter wire (larger number) for inductances below 1 millihenry. Since our inductance is 2 millihenrys we will need to use either No. 17 wire or larger. No. 16 gauge wire would be perfectly satisfactory. Any wire larger than No. 14, in addition to being expensive, would be very difficult to wind on the coil form because of its stiffness. If the wire size is not available from your local Radio wholesaler, try hardware stores or mail-order houses. It is necessary to use such large wire in crossover networks in order to keep the coil Q high. Otherwise, the resistance of the coil would become appreciable and seriously affect the transient response of the speaker system as well as reducing the efficiency.

The previous discussion and the charts concern only crossover networks in which the Woofer and Tweeter impedances are equal. This is the most desirable condition. However, if the Woofer and Tweeter impedances are not identical it is necessary to determine from the chart separate values for the capacitors and coils for the Woofer and Tweeter. The network input impedance is then considered to be a value half-way between the two voice coil impedances.

For example, should we have a Woofer of 8 ohms and a Tweeter of 12 ohms and intend to use a half-section filter such as that shown in Fig. 5 we would first determine the values of the coil and capacitor for the 8-ohm Woofer voice coil and we would next find the coil and capacitor values for the 12-ohm Tweeter. Thus, the coils and capacitors would not be equal to each other as they are when the Tweeter and Woofer voice impedances are equal. The input to the network with our unequal voice coils would then be connected to an amplifier output impedance as close as possible to 10 ohms. Naturally, such a network does not represent a perfect constant impedance to the amplifier and there is also a shift of the crossover point, although it is negligible.

If there is a large difference in impedances between the voice coils, the mid-impedance for the network will result in a mismatch. The only great trouble in this is a loss of efficiency. However, such wide differences are to be avoided if at all possible since overall performance of the system will suffer accordingly.

Some engineers feel that it is desirable to deliberately mismatch the Tweeter when it is not as efficient as the Woofer in order to balance the system. This is especially true with cone type Tweeters since they are usually less efficient than the horn type Tweeters. That is, a 16-ohm Woofer and an 8-ohm Tweeter could be used together with the crossover network designed only for 16 ohms. The Tweeter would then be mismatched but this would result in higher output at high frequencies. Whether or not this is desirable depends on the efficiency of the Tweeter and the individual owner's taste.

The capacitors used in crossover networks should be of the non-polarized type. That is, they should be of the usual commercial paper dielectric type or the oil-filled type. Paper dielectric condensers are generally available up to 4 microfarads from Radio wholesalers or mail-order houses and the oil-filled type condensers are often available as surplus. If neither are available it is permissible to use good quality electrolytic condensers providing they are connected in a non-polarized manner. That is, it is necessary to use two condensers each with twice the specified capacity and connect them in **series**, back-to-back (both positive or both negative leads connected together). If can type condensers are used it is preferable to connect the uninsulated metal cans together so that if they should accidentally touch the circuit is unaffected.

The "motor-starting" condensers available from most wholesalers and hardware stores are quite excellent whenever large capacity values are called for. These motor-starting condensers are actually two electrolytic condensers wired back-to-back internally within their container.

It was previously considered undesirable to use electrolytic condensers in crossover networks. However, recent testing of such networks has indicated that they are completely satisfactory. It is desirable though to carefully test the electrolytic condensers before using them since it is not uncommon to find that the actual value of an electrolytic condenser may vary by as much as 100%—especially with small value condensers. It is almost a necessity to have the capacity of the condensers carefully checked before they are used. In addition it is important that the condensers not be subjected to heat which will change their capacity. If convenient, the condenser capacity should be checked every few months.

The voltage rating of the condensers should be 30 volts or more. Since the condensers generally come in ratings of 6, 12, and 50 volts it is preferable to use the 50-volt units.

The coil forms are shown in Figs. 3 and 4. Notice that for small inductance the main coil form is one inch in diameter and one inch long while the larger inductance requires forms one inch in diameter and one and one-half inches long. The 4-inch siding on the larger coil form and the 2¾-inch siding on the smaller coil form merely prevents the wire from slipping off the center core. That is, the turns of wire required on the coil form will pile up on top of each other and would otherwise slip off. Both the coil form and the siding must be of non-metallic material. Although wood is specified, Bakelite or plastic could be just as easily used if it is available. It is not desirable to use cardboard unless it is waxed for otherwise it would absorb moisture.

When fastening the sides to the coil form do not use large nails since they might change the inductance. It is preferable to glue the siding to the main coil form and then, if necessary, use small nails or brass screws for additional strength. The winding of the coil on the form is not all critical and does not have to be done with carefully wound layers of wire. Scramble winding is satisfactory.

With high efficiency horn type Tweeters it is very often found that the high frequency output is excessive. If this is the case, a wire-wound potentiometer can be installed in series or in shunt with the Tweeter. Since the audio energy in the high frequency range is small, a control with a rating of 3 to 5 watts is generally adequate. Probably the easiest and best method is to use a commercial T-pad available from most Radio wholesalers. These T-pads are rated according to the voice coil impedance and generally come in 8 and 15-ohm sizes.

The crossover network shown in Fig. 1 was built by the author for his High Fidelity system. It is a half-section type for 16-ohm speakers with a crossover frequency of 3500 cps. The speakers consist of a J. B. Lansing D123 12-inch unit for low frequencies and an Electro-Voice Super-Sonax T35B horn type Tweeter for high frequencies installed in a Karlson 15 enclosure.

No problem was presented in choosing a crossover frequency since the Tweeter manufacturer not only recommends 3500 cps but also offers various 2-way systems employing this network frequency. In addition the full-range Lansing speaker being rated 30-15,000 cps works quite well up to 3500 cps with good polar distribution and no signs of cone break-up.

The components used in the network were obtained from two mail-order houses—the wire from Allied Radio Corporation and the condensers from "Tab." The wire is Belden, type HNC, No. 16, while the condensers are 1.0-mfd, 500-volt, oil-filled units which were readily available. Since 2.0-mfd values were needed, two condensers are connected in parallel for each leg of the network.

The coils are scramble-wound (by hand) on forms made of a plastic tubing core and Bakelite square sides. The coil forms are attached to a 4″ x 5″ piece of plywood by small aluminum brackets. The condensers come with mounting brackets and were easily attached with wood screws.

The base board itself is attached to a 4″ x 5″ x 6″ ICA "Flexi-Mount" aluminum case. The addition of mounting brackets, rubber feet, and decals give a professional look. Of course these last items are not at all necessary. The actual cost of the crossover network will depend on the necessary condenser values and whether surplus or "on sale" units can be obtained.

Careful listening tests of the author's system with the crossover network switched in and out have indicated a noticeable improvement with the use of the network.

It was further checked with an audio generator and VTVM and found to be even better than first anticipated. The crossover occurs exactly at 3500 cps and the cut-off is smooth and precise.

In conclusion, the crossover network was considered a very worthwhile project. However, it should be mentioned that little money was actually saved by this "do it yourself" method and if time is taken into account there was a definite loss in the project. Fortunately, the personal satisfaction is not rated in dollars and cents!

Building and checking your own crossover network is one method of being sure of the exact crossover frequency.

For those who are interested: (Approximate prices)

Two lbs of wire	$2.56	(to eliminate splicing although only about 1.2 lbs are used.)
Two 2.0-mfd capacitors	2.12	
Aluminum case	1.75	
Audio decals	1.35	
Postage & hardware	1.00	
Total	$8.78	

Therefore the crossover network cost about 50¢ more than a factory-built unit disregarding the time spent building it although the author does have a bit of wire and a mess of audio decals left over!

By the way, NRI cannot supply any of the parts needed for such networks. They can be obtained from local parts jobbers or mail-order houses.

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STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT AND CIRCULATION OF

National Radio-TV News, published bimonthly at Washington, D. C., for October 1, 1956.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, National Radio Institute, 16th & You Sts., N.W., Washington 9, D. C.
Editor, Theodore E. Rose, 16th & You Sts., N.W., Washington 9, D. C.
Managing editor. None.
Business manager. None.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)
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3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly and triweekly newspapers only.)

NATIONAL RADIO INSTITUTE
E. L. Degener, General Manager

Sworn to and subscribed before me this 1st day of October, 1956.

Charles Alexander
Notary Public

(My commission expires January 14, 1959.)

Tube Testers By Walter J. Swontek

*Courtesy Radio-Electronics**

The tube tester is one of the most valuable pieces of equipment a service technician can own. Since many are likely to disagree with this statement it might be advisable to change it to: A tube tester can be one of the most valuable pieces of equipment a service technician can own.

Practically all service shops own a tube tester of some sort. In many of these shops it is used only when a customer brings in tubes to be tested.

This article points out the many valuable uses to which tube testers can be put, and attempts to explain and overcome the prejudice in many technicians' minds against them.

Since a discussion of the merits of a tube tester is valueless when working against a heavy prejudice, let us see how this bias is produced and how entirely unfounded it is.

At the first contact with any sort of testing device, it is only human to expect a yes-or-no answer. In other words, the device is automatically expected to say: "Yes, the item is good" or "No, the item is bad." Actually, in real life, very few things are definitely good or clearly and undeniably bad.

Manufacturers cater to human weakness and provide a good-bad scale, clearly marked in red and green.

When such a device is offered, it is expected to be 100% accurate. In other words, the tester itself is judged on a "good-or-bad" basis. If 100% accurate, the tester is "good"; if not 100% accurate, the tester is "bad." Since nothing is absolutely perfect it is only human to judge tube testers "bad."

What usually happens is that the novice technician becomes acquainted with a tube tester and learns how to manipulate the knobs. He puts the tube tester on a pedestal as a tin god or supreme judge of all tubes. His tube worries are over! All goes well for a while, and the novice is a rabid tester of tubes. His faith is implict. He supports the tester ardently in discussions with more experienced technicians.

Then, one fatal day, the tube tester misses a bad tube. The bad tube is reinserted in the set and troubleshooting begins. All bad parts are replaced; everything is tested. The stubborn symptoms refuse to disappear. The technician becomes a nervous wreck. Finally, the help of a more experienced friend is sought. The friend swaps tubes and presto! the trouble is cleared.

"But I checked that tube . . . ," howls the novice. His friend just laughs with that horrible, superior air. The novice's faith in testers is completely shattered.

Now that we can see that this prejudice against tube testers is founded in unreasoning emotion (all prejudices are, really) we can inspect them for their real values.

The Tester as Tube Salesman

Let us consider this red-green scale in a realistic light. Its purpose is to sell tubes! The control settings given on the charts are calibrated so that the average new tube will read well in the green. If a tube measures an arbitrary percentage (usually 15% or 20%) "below normal," it will read in the red. This merely means that the tube is weak in emission (or. transconductance on some testers) and not necessarily "bad" in the sense that it will not operate. However, the customer can accept the tester as a supreme judge with the net result that we sell him a tube when his tests in the red, even though we know his old tube may work.

The function of a tube tester as a tube-selling aid is one of its most valuable uses and will, in fact, pay for its cost many times over. There need not be any sense of guilt connected with this selling. Most customers will usually buy a new tube even though they are told: "This tube will probably work, but it tests weak on the tester." The customer's logic is good. The tube tests weak, therefore it is likely to fail in the near future.

If the customer does not purchase a replacement for the weak tube, the technician has still gained several advantages: the customer is impressed with the technician's honesty; in case the set fails within the guarantee period, the customer is not as hostile when he brings it back. His thought is: "Maybe that weak tube went."

When the question of testing tubes for troubleshooting arises, the usual answer is: "Why bother? Swap them! That'll tell." This is true enough on the surface, and swapping tubes is a helpful maneuver. There are several disadvantages, however. If new stock is used for swapping, it soon degenerates badly. The cartons

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become shopworn and unusable. Unless extreme care is taken, used and defective tubes will work their way into the stock.

Many shops avoid the deterioration of their new stock by keeping a "bench stock" of tubes on the test bench for swapping. This is fine, but it represents an investment of a surprising number of dollars. In addition, the bench stock deteriorates rapidly. To prove this to yourself, take an afternoon when you are not busy and test the bench stock.

Advantages of Tube Testers

Tube swapping is not 100% accurate any more than a tube tester is! Swapping is accurate only when the substitute is known good. There can never be absolute certainty that it is.

One TV set was brought in for bench service. The outside man had (supposedly) swapped tubes. However, the bench man tested the tubes with a view of sales and found five defective (not just weak) tubes. This cleared all symptoms and the set required no further service. The only tube-swapping system that would have cleared the set would have been the insertion of a complete known-good set of tubes followed by reinsertion of the old tubes, one at a time.

This is time-consuming and not generally done by tube swappers. Had it not been for the tube testing, the bench man would have had a rip-snorting troubleshooting job.

A situation that arises repeatedly is the case of a circuit that contains both a defective component and a defective tube. The tube is swapped first, and, since no improvement is seen, it is reinserted. After the replacement of the defective component further trouble-shooting is needed to find the bad tube. Here, the tester would most likely have caught it on the first try.

As another example, take the case of a tube with a heater-cathode short. If this tube is inserted in a set where one side of the heater and the cathode are grounded and if the short is from the cathode to the grounded side of the heater, the tube will work perfectly and be considered a known good. This may seem a long chain of circumstances, but anyone who tests many tubes will testify that it happens surprisingly often. Now, when this "known-good" (but actually defective) tube is used as a substitute, it can cause a diagnosis that leads to much fruitless trouble-shooting.

Grid emission (not shown by the less expensive testers) also causes much confusion in tube swapping. If the tube is inserted in a circuit where the grid circuit resistance is very low, it may work perfectly and be considered a known good. This same tube inserted into another circuit with high resistance in the grid return will develop a positive voltage on the grid and cause many peculiar symptoms. The gas test on better tube testers catches these quickly.

The short test on tube testers is of more value to the bench technician than the emission or transconductance test. Any tube that shows an inter-element short can safely be considered defective (definitely "bad") and replaced. Circuits where the tube will work even though shorted are rare and the number of tubes unnecessarily replaced is negligible. If an intermittent short is suspected, the logical step is to tap the tube gently at each position of the short test.

The noise test present on some testers is seldom needed, but it is a life-saver when the occasion arises. Each tube can be checked for noise or microphonics separately with concrete, dependable indications.

Most of the preceding has been in favor of using the tube tester. However, this should not be taken as argument against tube swapping. The most profitable attitude a technician can take is to consider the tube tester as a valuable tool and tube swapping a valuable procedure, and use both.

The tube tester should be looked upon as a fact-indicating device, just as a voltmeter or ohmmeter, and not as a judge. The indications of the checker must be interpreted and judged, just as those of other test equipment.

A resistor measures 500,000 ohms. Is it bad? This reading of a resistor does not say whether it is good or bad. If it is marked 68,000 ohms, it is bad. Similarly, a 6K6-GT tests somewhat low on emission. It is bad? Well, let's see—if it is used in the sound output, the slight loss in volume may be unnoticeable. It will work, so we can consider it "good" or at least satisfactory. But wait—the focus coil is in the cathode of the sound output and the symptom is poor focus! Now, the interpretation is different. A new tube clears the trouble and the weak 6K6 is now considered bad.

When the disillusioned technician is ready to return to the use of a tube checker, he should also be ready to keep in mind the failings of most testers. The following is a list of common tube-tester shortcomings obtained from bench experience.

1. When a tube tester checks a tube "bad," the tester is much more likely to be accurate than when it says the tube is "good."

2. Rectifiers will often test in the green on emission test and still produce low B-plus voltage. This is because a tube may have sufficient emis-

sion to carry the dc required to test good and yet have insufficient emission to handle the peak currents demanded in actual operation.

3. Tubes used in high-frequency oscillators, such as the 6J6, will often test good and still refuse to operate.

4. Most power tubes, such as 6K6, 25BJ6, etc. operate at a much higher temperature in the receiver. If trouble shows up only after a long warmup, the suspected tube should be tested immediately upon removal from the set, while it is still hot.

5. High-voltage tubes, 1X2, 1B3, etc., are not tested under normal operation by most tube testers. A "good" test of one of these means little.

6. Certain tube type numbers, as those used in tuners, will show a strong tendency to test good and still refuse to operate.

Ten Commandments for Testers

A few general rules can be set up concerning the decision as to swap or check. These are merely guides to the use of the fastest and most convenient system.

1. In customers' homes it is generally much faster to swap tubes. A complete tube check is too time consuming. If the symptom is distinct and clearly indicates trouble in one specific circuit, the two or three tubes in that circuit can be changed quickly. In addition, carrying the tube tester is excess effort while the tube kit *must* be brought along for replacements.

2. When a set is placed on the bench and has many vague symptoms, it is wise to give it a complete tube test. Although new tubes will seldom cure the trouble completely, it will usually be found that defective tubes are causing some of the symptoms. Replacing these clarifies the remaining symptoms and makes troubelshooting easier.

3. If a receiver on the bench has one clear symptom, tube swapping is faster and more certain. For instance, lack of width indicates changing the horizontal output tube immediately without bothering to test it.

4. When a set has a long history of recalls and general customer dissatisfaction, a complete tube test is very helpful in most cases.

5. When a stubborn symptom, definitely in one specific circuit, is met, use both systems. Test the old tube. Test a new tube, then swap.

6. When a technician is completely stopped on a symptom that is apparently in one specific circuit, it is wise to give the set a complete tube test. The various circuits in any TV set are usually not completely isolated from each other. Often a defective tube in a completely different section of the receiver will be found to be causing the symptom.

7. When in doubt, test new tubes. Only too frequently will it be found that entire "runs" of a certain tube number will develop the same defect shortly after being placed in a radio or TV receiver.

8. If a set has too simple a trouble, the profit may be too small to provide for a possible recall. A tube test here serves a dual function. It reduces the possibility of a recall, and also increases the profit to enable the technician to accept a recall on this set with better grace.

9. Sometimes a technician will gamble a new tube rather than pull the chassis, and he will replace a tube that might have been caused to go by a defective component. If the tube tester is handy and the new tube is tested before insertion, the technician will know if he has lost the gamble. Thus he will not wonder whether the new tube was bad in the carton.

10. When selling a tube over the counter, it is wise to test the new tube. This improves goodwill by preventing the sale of defective tubes. If the tube is of a type number that is often blown by defective components (such as a 35Z5), the customer should be warned of the possibility. This will avoid arguments over tubes burned out by the customer and should bring the set to the shop.

The tube tester is also a very valuable psychological tool. Most technicians detest having the customer look over their shoulder when they are working. If the customer insists on watching while the technician takes a look at his set, the tester gives the service technician something to do while inspecting the set for an estimate. A tube test is a much more satisfying show for the customer than the spectacle of a man probing around with a test prod, apparently aimlessly.

Thus, if the technician thoroughly understands what the tube tester actually does and how it does it, the results he obtains will not be mystifying. In addition, this knowledge will enable him to use it in original ways, developed to fit the circumstances of a particular situation.

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Question!

If a dog can make friends, why do some people have to take a $25 course of lectures to learn how?

Technical Ramblings

By B. VAN SUTPHIN

NRI Consultant

Subject: THINK

In previous Technical Ramblings columns, we have discussed many different technical topics—how a tube amplifies, how a capacitor operates, and others. This one is different.

This column deals with the topic that is the reason for the serviceman having technical knowledge about how a tube amplifies, how a capacitor operates, and all the other technical points that he must understand. This column deals with servicing methods — the way the serviceman actually attacks the problem of repairing a piece of equipment.

In the early days of Radio, there were three distinct servicing methods. Each particular serviceman chose the method that he liked best and used that one in repairing equipment. Let's discuss these three methods for a moment.

The first one is voltage analysis. Actually, this covered both voltage and current measurements. In this servicing method, the set was plugged in, turned on, and the voltage and current for each tube electrode was then measured. A device called an analyser was used. By consulting the service information, and noting any differences between the values, specified, and the actual values found, the trouble was isolated.

The second method was resistance analysis. In this method, the set was not turned on. Instead, it was removed from the cabinet and turned upside-down on the bench, then the resistance between certain key points in the circuit was checked. If an incorrect reading was found, further resistance tests were used to locate the defective component.

The third important method practiced by Radio Mechanics, was simple parts replacement. The serviceman simply replaced parts until the receiver started playing again, and he then wrapped it up and took it back to the customer with a bill for the parts that had been installed. The radio mechanic also popularized the "brute force" method of servicing which consisted of pounding on the cabinet and pulling on leads in an attempt to find the trouble.

The modern method of servicing is somewhat different. It includes parts of the three original methods, plus the added feature of stage isolation tests to quickly locate the defective section of the receiver before individual parts are tested. One writer has called this modern method of servicing the "look, listen, and think" method.

In servicing a small set, the modern serviceman will first turn the set on, turn the volume all the way up, and tune across the broadcast band. The way the set acts gives the serviceman some idea of what is wrong—at least to the extent of telling him that certain circuits are operating normally. If there is faint hum from the speaker, he knows that the power supply is working, and that the plate circuit of the audio output tube is working. The next step is touching the center tap of the volume control. If a loud buzz is produced, the serviceman knows that the entire audio circuit is working normally, and that the power supply has sufficient output voltage to operate the audio circuits. Then the serviceman will check the voltages in the i-f amplifier stage and the oscillator-mixer stage of the set, noting the noise produced as he touches the test prod to each plate and grid terminal. The strength of the "pop" produced tells him whether those circuits are working. Assuming he finds no plate voltage on the oscillator-mixer tube, he turns the set off and goes to the second method of servicing—resistance tests. A quick measurement between the B+ terminal in the set and the plate pin of the oscillator-mixer tube socket shows that the primary of the first i-f transformer is open. With the installation of a new i-f transformer the set returns to normal operation.

Consider the modern serviceman handling a somewhat different problem. When he turns the set on and allows it to heat up, only a loud hum is produced. From experience, and from his training, he knows that the most likely reason for the particular complaint is a defective filter capacitor. He knows that voltage measurements would be virtually useless, and that there is no real reason for resistance measurements. Therefore, he uses the temporary substitution method of testing. Bridging the output filter capacitor returns the set to normal operation and the problem is solved. After installing the new filter capacitor permanently, he may check the voltages in the circuit just to be sure that everything is operating normally.

Consider the extreme case of trying to repair a 20-tube TV receiver by any one of the old methods alone. He might perform voltage-current analysis tests in nineteen stages before he located the one with the defect. With only resistance tests, the task would be equally difficult. He might have to make fifty different resistance tests to locate the trouble. With between two-hundred and four-hundred parts in the set, parts substitution would be impossible as a testing method.

How does the modern serviceman repair a complex TV receiver? He thinks about the trouble and tries to isolate the defective circuit as quickly as possible.

The defect itself usually gives a clue. Suppose that the sound is normal, the screen lights, but there is no picture. The serviceman immediately knows the power supply is working, the audio stages are normal, and the sweep circuits are working. He can't be sure about the sync stages, but defects there rarely remove the picture signal entirely. The trouble is in some circuit used only for picture signal—in a modern receiver, this leaves only one stage: the video amplifier.

This process of thinking out the problem is carried on so quickly that the serviceman often forgets how many possibilities he has considered, and discarded, in arriving at the solution.

Temporary substitution is used next. If plugging in a new video amplifier tube does not solve the problem the serviceman removes the set from its case to make voltage and resistance tests in only a small section of the receiver.

Perhaps the most important difference about the modern method of servicing is the fact that the service man knows that he cannot stick to any one system all the time. As the problem demands, he must change tactics. That is, he learns to skip steps wherever possible, use short cuts, and, above all, think about the problem.

Servicing electronic equipment is not a simple task. The serviceman must be adaptable. He must be willing to use all the methods at his command, and use them effectively. If one particular test, or group of tests, does not lead to the solution of the problem, he then changes over and tries another group of tests. This is very important.

When talking with "old timers" in the business of radio servicing you may hear that a certain method of servicing is the only one to use—all others are a waste of time. Of course, this is not true. All methods of servicing have their good points. For this reason, the modern method includes part of all the older systems. We still use voltage tests, point-to-point resistance measurements and even the brute force method of pulling leads and tapping components. All these are important.

The modern "look, listen and think" system of servicing includes them all with the accent on **THINK!**

———*n r i*———

Listen Americans!

Who owns American big business? The Communist and Socialist agitators would reply "Wall Street, or a few rich capitalists!" The homegrown political demagogue would say: "The selfish vested interests, the privileged few." The well-intentioned do-gooder would say: "The fortunate wealthy people." What would you say? The answer is vitally important because in the world we live in, a combination of forces seeks to drastically change the American economic and political structure — with our individual freedom at stake.

Here's the answer: American big business is owned by 8,630,000 men and women, most of them with incomes of less than $7,500 a year and living in the small towns of America. When all business in America is counted — big, medium-sized and little—there are nearly 18,000,000 owners.

A recent study of the question "Who Owns American Business" showed that approximately one out of every 12 adults in America owns an interest in some corporation whose stocks are listed in Wall Street, and that about one out of every five or six employed persons in America have a financial interest in some company.

by Dr. George S. Benson
Director, National Education Program

N.R.I. ALUMNI NEWS

Chapter Chatter

Detroit Chapter, in anticipation of the fact that transistors are going to be more widely used in Radio and Television receivers and the fact that the serviceman will be called upon to service them, has decided to obtain a couple of transistor Radio kits, assemble them in a manner that will give Chapter members some experience in the servicing and maintenance of them, then raffle off the sets to its members. This is definitely a worthwhile project, one that will give members first-hand valuable experience.

National Headquarters was delighted with a surprise visit from Vice-President Earl Oliver and Mrs. Oliver when they dropped in at the Institute upon their return from a six-day vacation trip to Bermuda. Executive Secretary Ted Rose had the pleasure of showing them NRI's new building, which is now expected to be ready for occupancy in May.

But Mr. and Mrs. Oliver were on their way to Florida and interrupted their trip in Washington only long enough to drop by the Institute. Their visit was therefore altogether too short in spite of the fact that it was Mr. Oliver's first visit to NRI in over thirteen years. Let's hope, Earl, that it will not be that long until your next visit.

In addition to new members the Detroit Chapter is managing to have quite a few visitors at their meetings. Excellent! The more, the better.

Not the least of these meetings is the diversion afforded by John Stanish—who keeps members and visitors alike amused with his tall stories and quick wit—and the delicious refreshments served at the end of the meetings. Your Executive Secretary can testify to the excellence and abundance of these refreshments.

All NRI students and graduates in or near Detroit are urged to attend these meetings. Get in touch with Secretary James Kelly, 1140 Livernois, Detroit. The Chapter meets at 8:00 P.M. on the second and fourth Friday of each month at St. Andrews Hall, 431 East Congress, Detroit.

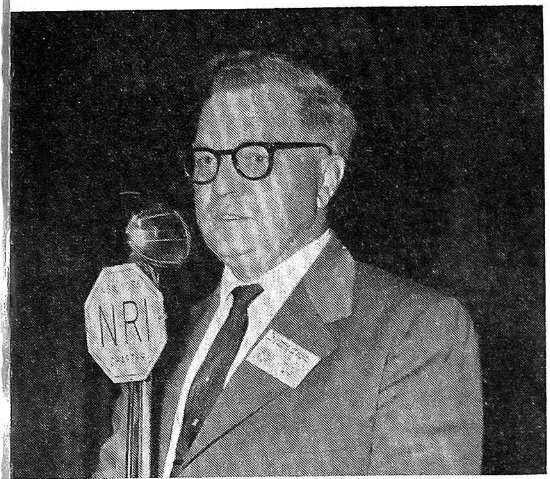
New York City Chapter has for some time past been hard at work on a new set of by-laws for the operation of the Chapter. Much time and study were given the proposed by-laws, which were framed in accordance with those suggested by National Headquarters. One of the important features of the proposed by-laws was the provision for an Executive Chairman and a Second Vice-Chairman. Secretary Emil Paul was appointed Parliamentarian to act when called upon when problems of procedure arose.

Drafts of the proposed by-laws were read at two different meetings and were discussed at length by the Chapter members, who offered amendments and suggestions. The by-laws were finally approved and adopted by the Chapter membership. Secretary Emil Paul was awarded a well-deserved vote of thanks for the hard work and the excellent job that he did on the new by-laws.

This is rather belated recognition in these columns of three new members of the New York City Chapter: James McGrath, Astoria, Alexander Jemmoth, Brooklyn, and Alvin Carter, Brooklyn. A hearty welcome to all three of these new members!

There are so many things going on at the New York City Chapter meetings that limited space prohibits mention of them all or of the individual members taking part in them. The Chapter has developed a considerable number of speakers from among its members — practical Radio TV Servicemen with extensive experience who are able to lecture on service problems and how to meet them. It is not an exaggeration to say that when a member misses a meeting of this Chapter, it can be a real loss to his fund of Radio-TV servicing know-how.

Tom Hull has stepped down as Chairman. Just



New York City Chapter's dynamic Tom Hull, addressing a meeting of the chapter.

prior to nominations for officers to serve the Chapter in 1957, Tom announced that he would not be a candidate for re-election. He explained that he feels the Chairmanship is a full-time job, that because of overtime and a heavy workload in his regular job he would need more time than he has available to continue as Chairman and also to continue his lecture series—that he felt he could do more good as Executive Chairman, who directs the speakers' program and educational committee. Tom has done an outstanding job as Chairman. In his new capacity as Executive Chairman his services to the Chapter will continue to be of great importance and value to the members.

The members elected to serve the Chapter's officers for 1957 are as follows:

Edward McAdams, Chairman
Tom Hull, Executive Chairman
Frank Zimmer, First Vice-Chairman
Emil Ruocco, Second Vice-Chairman
Emil Paul, Secretary
Frank Catalano, Treasurer

Congratulations to these officers and best wishes for success in the performance of their duties to the Chapter.

The New York City Chapter meets at St. Marks Community Center, 12 St. Mark's Place, New York City, on the first and third Thursday of each month. Students and graduates who would like to attend a meeting should get in touch with Secretary Emil Paul, 6 Gateway, Bethpage, Long Island, New York.

Milwaukee Chapter celebrated its third anniversary at its December 17 meeting and elected its slate of officers for 1957:

Erwin Kapheim, Chairman
Slavko Petrich, Vice-Chairman
Robert Krauss, Secretary
Louis Sponer, Treasurer
August Piechowski, Sergeant at Arms.

Newly-elected Chairman Kapheim appointed Mr. Edgerton and Mr. Rinke to serve as the Financial Committee. Ernie Bettencourt will continue as Editor of the Chapter's fine monthly publication, the NRIAA Milwaukee Chapter News.

In his acceptance speech, Chairman Kapheim emphasized the importance of increasing attendance at the Chapter meetings—indicated that members should all work together in closer contact and telephone each other more often to bring about a closer-knit organization and improve the spirit of the chapter.

One program toward this objective is already underway: Chapter members will experiment on old TV sets to try to get them in working order. For a start, Mr. Petrich contributed an old Westinghouse with just a horizontal line on the picture tube. With the help of a diagram to trace the circuit, it is hoped that the trouble will be determined and corrected for the benefit of the members.

It is the custom of the Milwaukee Chapter to serve refreshments at the termination of its meetings. Philip Rinke is in charge of the refreshments.

Students and graduates in the Milwaukee area are cordially invited to attend meetings. Write or telephone Secretary Robert Krauss, 2467 North 29th Street, Milwaukee. Meetings are held on the third Monday of each month at the Radio-TV store and shop of S. J. Petrich, 5901 West Vliet Street, Milwaukee.

Minneapolis-St. Paul (Twin City) Chapter had something to celebrate: the election of one of its most active and industrious members, John Babcock, as Vice-President of the NRI Alumni Association. The oath of office was administered to John and he received the sincere congratulations of all the members of the Chapter.

The scheduled guest speaker for this occasion was unable to attend the meeting so the main portion of the meeting consisted of the showing of four films, "Mobile Telephones," "Co-axial Cable and Microwave Miracles," "Communications for Civil Defense," all donated by North Western Bell Telephone Company, and "First Choice," donated by the F. C. Hayer Company, RCA Distributors for the State of Minnesota.

The drawing for the Chapter's big door prize was won by Eldon Thyr. Mr. Thyr was not present at the meeting so the Chapter members do not know what he plans to buy in the way of test equipment.

On the day following this meeting a group of the Chapter members attended a service meeting conducted by the Cornell-Dubilier Company and the Lew Bonn Company, distributors of electronic parts in the Minneapolis-St. Paul area. The speaker, Mr. Ashby of the Cornell-Dubilier Company, is one well worth listening to. Chapter members agreed that all NRI men in the area should make every effort to attend one of his lectures on "The Service Business." John Berka walked off with the door prize on this occasion — a Cornell-Dubilier electrolytic condenser kit.

The Chapter extends a cordial invitation to all NRI students and graduates in the Minneapolis-St. Paul area to attend its meetings as guests or potential members. The Chapter meets on the second Thursday of each month at the St. Paul Midway YMCA. The Chairman is Paul Donatell, 933 Burr Street, St. Paul. The secretary is Charles Goodell, 19 West 38th Street, Minneapolis.

Philadelphia-Camden Chapter was recently visited by Ted Rose, Executive Secretary of the NRI Alumni Association. He was given the customary warm welcome and was almost overwhelmed by the enthusiasm and good fellowship of this high-spirited group.

The main event at this meeting was the election of officers for 1957. The officers are:

John Pirrung, Chairman
Fred Seganti, Vice-Chairman
Jules Cohen, Recording Secretary
Joe Burke, Financial Secretary
Charles Fehn, Treasurer
Jonathan O'Donnell, Librarian
John Krepol, Sergeant-at-Arms

Ted Rose extended his congratulations to the newly-elected officers and administered the oath of office.

As customary, the meeting wound up with a buffet supper, the chief feature of which was hot dogs and sauerkraut. Boy, what a spread!

The Philadelphia-Camden Chapter is so full of plans that it's hard to keep up with them. This group always has the pot boiling with programs for guest speakers, exhibitions, trips and various other activities—all of which keeps the interest and enthusiasm of its members at a high pitch. No wonder this Chapter enjoys such well-attended meetings.

NRI students and graduates in the vicinity who are not attending the meetings are really missing out on a good thing. They should write or telephone the secretary and arrange with him to come to a meeting as a guest. The secretary is Jules Cohen, 7124 Souder Street, Philadelphia. The Chapter meetings are held on the second and fourth Monday of each month at the Knights of Columbus Hall, Tulip and Tyson Street, Philadelphia.

Pittsburgh Chapter was also host to Ted Rose, Executive Secretary of the NRI Alumni Association, at its December meeting. Most of the regular business was dispensed with at the meeting so that the members could enjoy an evening of chatter, good fellowship and jokes (of which the most reprehensible were inflicted on the members by Ted Rose).

But one important matter of business was transacted—that is, the election of officers for 1957. It was quite a lively election. The newly-elected officers were not installed, however, that being reserved for the January meeting. The officers elected to serve for 1957 are:

Frank Skolnik, Chairman
William Lundy, Vice-Chairman
William Roberts, Secretary
Earl Uhl, Treasurer
David Benes, Executive Committee
Stanley Huczko, Executive Committee
Howard Tate, Executive Committee

Following the elections, a groaning buffet supper table was set before the members—and you should have seen them compete with each other in inventing dagwoods! And you should have seen the Executive Secretary right in there pitching with the best of them!

The Pittsburgh Chapter will welcome all NRI students and graduates interested in attending its meetings, which are held at 8:00 P.M. on the first Thursday of each month at 134 Market Street. Interested students and graduates should write or telephone Chairman Frank Skolnik, 932 Spring Garden Avenue, Pittsburgh 12.

Chicago Chapter has had two important features

Pittsburgh's Chapter's officers for 1957. William Lundy, Vice Chairman; Howard Tate, Stanley Huczko, Executive Committee; Frank Skolnik, Chairman; William Roberts, Secretary; Ted Rose, Executive Secretary of the NRI Alumni Association; Earl Uhl, Treasurer; David Benes, Executive Committee.

under way: (1) the Oscilloscope—how it works, what it does for the serviceman in servicing electronic units, how the signal appears on the CRT screen, in fact everything the technician should know about the operation of a scope and how it will speed up servicing and solve the tough problems; (2) the demonstration of two important products of the Bell Laboratory by a representative of the Illinois Bell Telephone Company. One of these products was the Bell Solar Battery, which creates usable energy from the sun's rays. The other product demonstrated was a simple, compact device which can remember or forget on command.

The Chapter has reported its election of officers to serve for 1957, as follows:

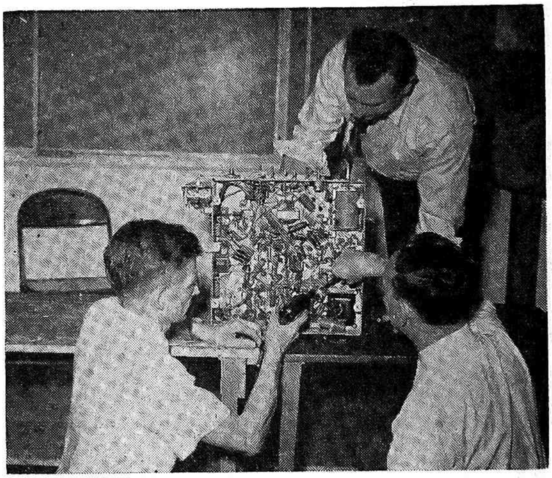
Walter Nicely, Chairman
Charles Mead, Secretary
Gordon Hull, Treasurer
Louis Schnick, Librarian
Frank Raica, Sergeant at Arms

At the close of elections, Chapter members were favored with a comprehensive lecture on the function and use of the Signal Generator, its proper use and application as a valuable instrument in servicing and aligning the various stages of a receiver. The lecture was accompanied by blackboard sketches and a full explanation of the intricacies of signal generators. The members present expressed their appreciation to Chairman Nicely for his very able presentation of this lecture.

Like all other NRIAA local chapters, the Chicago Chapter cordially invites all students in its area to attend its meetings. Get in touch with Secretary Charles Mead, 666 Lakeshore Drive, Room 228, Chicago. The Chapter holds its meetings at 666 Lakeshore Drive, West Entrance, 33rd Floor, on the second and fourth Wednesday of each month.

Springfield, Mass., Chapter has undertaken an ambitious project: the construction of a TV Demonstration Panel along the lines of the old RCA Radio Demonstration Panel. It is believed that this is the first attempt to make such a panel, at least outside the production industry. The chapter's resourceful technical advisor, Lyman Brown, is directing the project, ably assisted by Arnold Wilder, who donated the chassis for the parts it contains.

The panel will be constructed of ⅝-inch plywood and the parts from the dismantled chassis will be mounted thereon. All parts will have terminations on the front of the panel. Such parts as resistors, capacitors, peaking coils, etc., will be so mounted that different parts may be easily substituted to show the effects of change of value. The complete circuit from point to point will be drawn on the front of the panel so that the circuitry may be easily followed.



Lyman Brown, Arnold Wilder and Joseph Gaze dismantling the chassis for parts to be used in the demonstration panel.

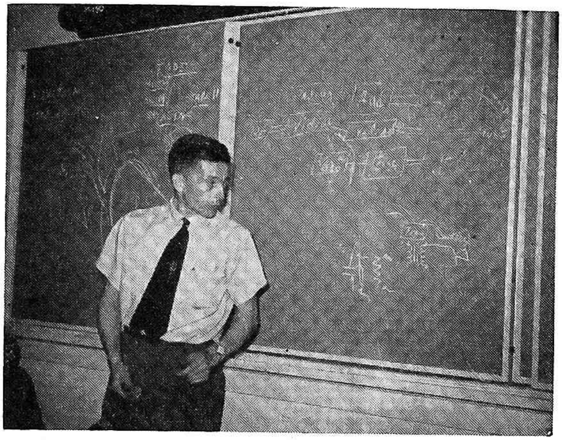
There will of course be difficulties due to expanding the circuits to panel size, but Lyman Brown is confident these difficulties can be overcome.

All members of the chapter will have a hand in dismantling the original chassis and remounting them on the demonstration panel. As work progresses each step will be thoroughly explained so that all members, graduates and students, will understand the operation of each section of a TV receiver. When completed all members taking part in this project should have a complete understanding of TV circuitry.

This project is bound to create a great deal of interest. Undoubtedly other chapters will want to consider the construction of such a TV Demonstration Panel for the great benefit it can be to members in acquiring a better understanding of TV circuitry.

Incidentally, there could be no stronger incentive for NRI students and graduates in or near Springfield to take advantage of the Chapter's invitation to attend its meetings. All those interested should get in touch either with the Chairman or the Secretary.

The Springfield Chapter makes a big thing of its annual Christmas Party. But this year the Chapter was the victim of misfortune, for on the night they held the Christmas Party the area was visited with the most miserable weather of any meeting night to date. The entertainment committee did a wonderful job but attendance was low due to the weather. Members from out of town—and even many of those in town—just could not get there. But in spite of it all about twenty members did show up.



Lyman Brown, Springfield Chapter's technical advisor, giving an outline of construction plans for the TV demonstration panel.

At Yuletide the Springfield Chapter also holds its Christmas Joy Clinic at which the members repair sets for the needy. This was even a greater success than last year's, largely because of the fine leadership of Lyman Brown, who succeeded in getting a good deal of publicity about the clinic in the local newspapers and on the air. Even the Hartford newspapers and Radio commentators broadcast stories about the clinic. The editor of Electrical Merchandising telephoned from New York City asking for a story about it, so we can expect to see an article about it in a forthcoming issue of that publication. Three of the members opened their shops so that all members taking part in the clinic could work there instead of at the Chapter's meeting place, thus giving everyone the benefit of much-needed test equipment.

Chapter members also donated $17 to the Toy for Joy fund sponsored by the local newspapers to give toys to destitute children.

At its last meeting in December the Chapter elected its officers for 1957, as follows:

Howard B. Smith, Chairman; Joseph Gaze, Vice-Chairman; Marcellus Reed, Secretary; Rupert McLellan, Treasurer; Lyman Brown, Executive Committee; Edward Kazunas, Executive Committee; Walter Zajchowski, Executive Committee

The Chapter meets at 7:00 P.M. on the first and third Friday of each month at U.S. Army Headquarters Building, East Street, Springfield, Massachusetts.

Baltimore Chapter had a very special occasion to celebrate—the induction into office of one of its oldest members, Mr. Elmer Shue, as National President of the NRI Alumni Association for 1957.

In order to give this event due recognition, Chairman Joseph Dolivka convened a representative group of members from the Baltimore Chapter at Munder's Restaurant on December 27 for a banquet in honor of Mr. Shue. The group consisted of Percy Marsh, Wilbur Kidd, James Hurka, John Harp, Claude Keller, Joseph Dolivka, Ernie Gosnell, and of course the guest of honor. Elmer Shue. Also, present at the Chapter's invitation were J. B. Straughn of the NRI Staff and Ted Rose, Executive Secretary of the NRIAA.

At the conclusion of the banquet, Ted Rose officiated at the ceremony of administering the oath of office to Mr. Shue, after which the members present warmly congratulated Mr. Shue upon his having been chosen as the President of the NRIAA for the year. At the regular meeting held prior to this celebration the Chapter elected its officers for 1957. They are:

Joseph Dolivka, Chairman; Ernie Gosnell, Vice-Chairman; Joseph Nardi, Secretary; John Harp, Treasurer; Aubrey Hooper, Sergeant at Arms; Wilbur Kidd, Librarian.

The Baltimore Chapter meets at 100 North Paca Street on the second Tuesday of each month. Students and graduates in the area who are interested in attending meetings should get in touch either with Chairman Joseph Dolivka, 717 North Montford Avenue, or Secretary Joseph Nardi, 4157 Eierman Avenue.

——— *n r i* ———

Our Cover Photo

The cover photo for this issue was submitted by Graduate Robert M. Baker of Bayshore, New York, and shows him at work in his well-equipped shop. He writes:

"Practically ever since starting the course, I have been doing Radio and Television Servicing. I now average about three jobs a week and have a large work-bench, fully equipped. I have a large list of regular customers to keep me constantly busy with radio, TV and phono business in my spare time.

I have been seriously thinking of going into Radio-TV repair full time. If I do, I will have NRI to thank for enabling me to pursue this most-interesting and well-paying field. Needless to say, it would have been impossible without the help of your excellent, easy to understand, Radio and TV course."

Our congratulations and thanks to Graduate Baker. Keep up the good work!

Here and There Among Alumni Members

Graduate Dawson Illick of Drummondville, P. Q., Canada, is employed full time as an instrument technician. He tells us that before taking the course he was an office clerk who "didn't know AC from DC."

———*n r i*———

Jerauld S. Hillaker, Davison, Michigan, is engaged in a cooperative plan at Tri-State College. He is a lab technician and also working toward his BS in Radio Engineering. Keep it up, Jerauld!

———*n r i*———

Graduate Roger E. Wilson has his own servicing business in Greensboro, North Carolina. Most of his work is car radio repair and he reports that business is very good.

———*n r i*———

Philip J. Germano, Thornwood, New York, is with the N. Y. Telephone Co. We congratulate him on his promotion from teletypeman to installation foreman.

———*n r i*———

Graduate Harold Craig of Livingston, New Jersey, is also with N. Y. Telephone. He is in his 28th year as a foreman. He says his NRI training has placed him in a position to better advise younger employees about their career in Electronics.

———*n r i*———

Graduate Clyde A. Sprague, after operating a profitable part-time shop, has accepted a position as Electronic Technician at the medical center of Missouri University.

———*n r i*———

Jack B. Sellards, Maybee, Michigan, has a part-time job open in his shop located at 9042 Raisin St. He wants a graduate or qualified student. An opportunity to go into full-time servicing later on.

———*n r i*———

Thomas A. Sperry, Middletown, Virginia, stopped in for a visit with us on a recent trip to Washington. We were all glad to see him and give a "first class" tour of NRI.

———*n r i*———

Graduate Merle J. Graham has an excellent part-time business going in addition to his regular job as city policeman, Marion, Indiana.

———*n r i*———

Leith Paine, now operating "Paine's Professional Radio-TV Service" in Fryeburg, Maine, is doing a good business. He says that the only advertisement he needs is the recommendation of many satisfied customers.

Harry I. Sampson, Inglewood, California, got his start in the Electronics field from his NRI training. He is now a technician in the Digital Computer Research Division of Hughes Aircraft.

———*n r i*———

Graduate Clyde J. Noel, Conneautville, Pennsylvania, is back with us as a student. Upon graduation he plans to open a Radio, TV, Appliance, Service Shop in Florida. We wish him lots of luck in his proposed venture.

———*n r i*———

Joseph Vistica is an Instrument Maintenance Engineer with Tektronix, Inc. He repairs laboratory-type oscilloscope and video test equipment at their plant in Union, New Jersey.

———*n r i*———

A recent grad, Ed Waddell, of Isabel, South Dakota, has just started a part-time shop and has found more work than he can handle. Sounds like you'd better give some thought to full-time, Ed.

———*n r i*———

Grover C. Avera, radio engineer with WGAF, Valdosta, Georgia, says he enrolled with NRI to fill in the gaps he missed in other training. Communications course proved to be just the thing. Best wishes for your continued success, G. C.

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