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Radio Is An Essential Industry

In these days of great national emergency, men and women are literally glued to their radios. Not only do they listen for news of developments in the war, but, more important, for news of dangers because of the war. No one need emphasize the great value of radio as a service to the public in the world of today.

With governmental restrictions on the building of new receivers because essential materials are more urgently needed for military purposes, and with the tremendous increase in listener interest, many neglected receivers are being brought back into service. These receivers need attention. The radio serviceman is finding a greater demand for his services, as well as a greater appreciation of his ability.

Radio operators are needed in many branches of civilian and governmental services. Radio technicians are needed in laboratories.

Radio, a fascinating plaything of a decade ago, is today a vital, indispensable communication system. To N.R.I. students and graduates who are serving the public and our government, I say—more power to you. You are an important cog in our victory program. To you who are preparing for these jobs, I say—give all possible time to your studies and prepare yourself for great opportunities to serve your community and your country.

J. E. SMITH,
President.

Applications of a Vacuum Tube Voltmeter in Radio Servicing

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THE vacuum tube voltmeter was originally used in design laboratories. As a result, when the instrument was first introduced to radio servicemen, the instructions in many instances dealt more with design work than with servicing problems. This fact, together with a lack of understanding of the basic circuits involved, discouraged the use of the instrument to a great extent.

In this article, I shall deal primarily with actual servicing problems where a vacuum tube voltmeter can be used. Of course, I do not mean that one should ignore the instructions accompanying a vacuum tube voltmeter—on the contrary they should be read thoroughly. It is particularly important to analyze the instrument and determine what type of instrument it is, so that the greatest use can be obtained from it.

While I am going to indicate just where the instrument can be used, in many instances it will not be the best instrument to use. I shall point out such uses as they come up.

D.C. Vacuum Tube Voltmeters

First, let us deal with a d.c. type vacuum tube voltmeter. This is an instrument of high sensitivity, capable of measuring d.c. voltages.

It is obvious that an instrument of this type can be used to measure the operating voltages throughout a radio receiver. For measuring the ordinary d.c. voltages, such as the output of the power supply, or the plate voltage of any tube not in a resistance coupled amplifier, the instrument is undoubtedly harder to use than an ordinary multimeter. The V.T.V.M. must be frequently recalibrated, it may be affected by signal voltages and the instrument is not usually as rugged (is less portable) as an ordinary multimeter. Most measurements of this type would be made in the home of the customer, where you are looking for some basic defect in order to make a quotation. Therefore, although a d.c. type vacuum tube voltmeter can be used for these measurements, an ordinary multimeter is usually just as good or better.

In high resistance circuits, such as resistance coupled amplifiers, A.V.C. circuits and high resistance grid circuits, the ordinary multimeter does not indicate the proper operating voltages. Of course, the small reading it gives does indicate continuity but not the actual operating voltages. The low resistance of the meter draws current through the circuit resistances thus upsetting the voltage distribution. Here, we have a case where the vacuum tube voltmeter should be used. Practically all d.c. type vacuum tube voltmeters have an extremely high input resistance, so that the effect on an average receiving circuit is negligible.

Furthermore, a d.c. type V.T.V.M. instrument can in many instances remain connected to any circuit which is operating without adversely affecting the circuit providing the shunting capacity is not too high. This is helpful in cases where intermittent receivers are being serviced, as you can thus observe any variation in the operating voltage.

Of course, when we are comparing the readings obtained by a vacuum tube voltmeter to the manufacturer's voltage table, we must be sure to observe whether the manufacturer is indicating actual operating potentials or voltages as measured by an ordinary multimeter. Many voltage tables in the past have been taken using an ordinary multimeter, and do not give the actual operating potentials. Therefore the vacuum tube voltmeter readings may be quite different.

When attempting to measure voltages which are negative with respect to ground, our d.c. type instrument must either be free from any direct ground connection so the leads can be reversed, or must be one of the types having a meter with zero in the center. (The zero center type is found commonly in vacuum tube voltmeters operated from the power line.) It is particularly important that the d.c. type instrument be capable of making these measurements as they include a.v.c. voltages as well as grid voltages.

The ability of the instrument to measure grid voltage has a very practical use in the case of an oscillator stage. The measurement of the grid voltage produced across the oscillator grid leak indicates whether the circuit is oscillating. If you find no voltage here, you can assume the oscillator is definitely not working.

A d.c. type vacuum tube voltmeter can also be used to find leaky coupling condensers in resistance coupled amplifiers. In the standard amplifier, the plate circuit of one tube is fed through a resistor from the power supply. Then, a coupling condenser couples to the next grid circuit, which uses a grid resistor. This coupling condenser may become leaky, which means that it passes some d.c. current. This current flow through the grid resistor is in such a direction that the grid end of the resistor is positive and thus upsets the bias on the following tube stage. This results in a rather severe distortion.

There should be no d.c. voltage developed across this resistor; hence, using a d.c. voltmeter and measuring across the resistor for a d.c. voltage drop is an indication of trouble of this type.

It so happens that a gassy tube will also cause current to flow through this resistor, so you must determine whether the trouble is the coupling condenser or the tube by removing one or the other. If you remove the tube and find the voltage is still there, then the condenser is leaky. On the other hand, if the item you disconnect causes the voltage to disappear, then that is the defective item.

Ohmmeter Ranges

By proper design, a d.c. type V.T.V.M. can be made into an ohmmeter of extremely wide range. With a standard multimeter, readings of but a few megohms are usually possible. However, with a properly designed V.T.V.M., readings of several hundred megohms can be made.

It is true that the average serviceman has little use for such an extremely high range, but once in a while a real use will come up. One practical case is where leakage across insulation or between wires has developed. Such leakage may not be enough to be detected by an ordinary ohmmeter, but if this leakage exists in a high voltage or high impedance circuit, in many instances it can upset operations considerably.

Of course, such ohmmeter ranges can be used to check leaky condensers and for any other ordinary ohmmeter uses by switching to an appropriate range.

Advantages and Disadvantages of D.C. Types

Let us now sum up for the d.c. type vacuum tube voltmeter. It can measure operating potentials anywhere in the set. It has the advantage of being more accurate than an ordinary meter in any circuit containing high resistance. If the input capacity is not high, it can be left connected to an operating stage without greatly affecting operation, which is of importance in locating intermittent troubles. Some types have a 1 megohm resistor in the test probe tip which effectively lowers the input capacity shunting effects.

The V.T.V.M. has the desirable quality of protecting its own meter. In other words, an overload on an ordinary multimeter will frequently damage the meter or burn it out entirely. With a V.T.V.M., an overload causes the plate current of the tube to rise. If the circuit is properly designed, however, the plate current of the tube can seldom rise to a point where there is much danger of burning out the meter. The meter pointer may be bent and the tube may be paralyzed momentarily, but usually no serious damage would occur in such a case. Some types use a resistor in series with the grid of the tube. An overload causes grid current to flow. This current through the series resistor biases the grid negatively which automatically limits the plate current increase.

It is only fair to also give the disadvantages of the D.C. type V.T.V.M. These include the necessity for frequent recalibration. If the input circuit is not adequately by-passed, then this meter will also indicate signal voltages in many instances, which may prove upsetting when we are trying to just read the d.c. operating voltages. On the other hand, if the input is by-passed so that signals will not affect the unit, then it cannot be used in a signal circuit to observe voltages continuously as the signals would be by-passed. Further, many of the readings can be taken more quickly and with equal satisfaction, using ordinary multimeters with sensitivities from 1,000 to 25,000 ohms per volt.

A.C. Types

Now, let's investigate the a.c. types of vacuum tube voltmeters. It is here that we find the widest difference in instruments. Some are capable of covering an extremely wide band of frequencies, while others are definitely limited. Some have tuned circuits associated with them, while others do not. Some will respond to the peak value of voltage, while others may respond to the average or the r.m.s. value. They may be even calibrated differently. Therefore, it is important to know your instrument thoroughly, both in regard to type and just what it was designed for.

When purchasing a vacuum tube voltmeter of the a.c. type, it is desirable to obtain one with a wide frequency range. It should definitely cover the audio frequency, intermediate frequency and broadcast bands as a minimum and should go into the short wave bands if possible.

For measuring ordinary a.c. voltages at power line frequencies, such as filament voltage in an a.c. operated radio, of course an ordinary type multimeter can be used. As the frequency goes up into the higher audio frequencies and into radio frequency values, however, the vacuum tube voltmeter is a requirement. The ordinary copper oxide type rectifier instrument cannot be used here at all.

Signal Tracing

The ability of an a.c. type V.T.V.M. to measure signal voltages is of considerable importance to a serviceman. With an instrument of this type, we can trace the signal from the antenna through the set to the output. Hence, the instrument is a signal tracer. Besides this, the ability of a vacuum tube voltmeter to indicate the amount of signal, or at least changes in signal, will permit us to determine the gain of tuned circuits and transformers, as well as complete stages. This is of particular importance where we have some obscure trouble such as weak reception.

Suppose we have a radio and wish to follow the signal from the antenna circuit through the set. If the input signal from the broadcast station or from a signal generator is very strong, we can even measure it at the antenna terminals. However, there is no selectivity or tuning at this point, so we cannot be certain that we are measuring the desired signal alone unless the input circuit to the vacuum tube voltmeter is itself tuned.

By making the connection at the grid of the first tube, which is usually a radio frequency tube or is the first detector in small superheterodynes, we have the selectivity of the pre-selector to separate out the signal we are trying to measure. Thus, we get rid of one possible error but we introduce another at the same time.

When we connect a vacuum tube voltmeter across a tuned circuit, the input capacity of the instrument will detune that circuit. The amount of this detuning will depend on the type of V.T.V.M.—whether it has separate leads, a shielded lead, or a tube at the end of a probe. In any event, this detuning effect will require that we retune this particular circuit if we are trying to obtain a reading of the amount of signal present at the point where we are making measurements.

If we change the tuning of a particular stage while the V.T.V.M. is connected to it, then when we go on to some other point, we must restore the original tuning of that first stage. Naturally, the V.T.V.M. types having very low input capacities will affect the circuit the least. Instruments of proper design will have almost negligible effect on the circuit at intermediate frequency and broadcast band frequencies. However, at the higher frequencies, even the best instrument will detune the circuit somewhat.

The input capacity of a vacuum tube voltmeter will lower the input impedance as the frequency goes up, so it is possible for a vacuum tube voltmeter to load a high impedance circuit considerably. Of course as I mentioned above, when across a resonant circuit, we can retune the circuit and thus eliminate this effect, providing the retuning does not affect some other circuit operation. There are instances however, where impedance coupling may be used at radio frequencies, where the shunt capacity will cause a false reading due to this loading condition.

Going back to our signal tracing procedure, we may trace the signal through the first tuned circuit alone by connecting the V.T.V.M. to the grid of the tube, or we might go to the plate of that tube. When we move to the plate, we also include the amplification of the tube. Incidentally, where tuned circuits are in the grid circuit, by connecting to the plate of the tube, the tube itself will act as a decoupler and we do not appreciably detune the tuning circuit. Hence, we can move from plate to plate if we are just tracing a signal to find out where it stops, and obtain all the indications we need in many instances. Of course, we still have the problem of separating desired and undesired signals. This means if we connect at points where more than one signal exists, the vacuum tube voltmeter cannot separate them unless it is one of the type having a tuned input circuit.

Naturally, if we are using one of the type having a tuned input circuit, then that circuit must be adjusted for the frequency of the signal as it exists at various points through the radio. In other words, we must tune to the incoming signal in the pre-selector stages, to the i.f. signal in the i.f. amplifier and of course must use an audio channel in the audio amplifier. When testing the oscillator of a superheterodyne, then we must find that signal also. This type will therefore indicate the frequency produced by the oscillator if it is calibrated accurately.

When the vacuum tube voltmeter is connected across the oscillator circuit of a superheterodyne, it detunes the circuit, but here the detuning does not matter. We want to know if the oscillator oscillates over the entire band anyhow, so the detuning will not matter, as long as we are not trying to pick up a signal at the same time. In other words if we just want to see whether the oscillator is working or not, we can just go ahead and make the measurements without having to retune that particular circuit. The increased capacity just tunes the oscillator to a lower frequency if we are across the resonant circuit.

So far, we have just dealt with the problem of tracing a signal from the input to the output of the radio. By proceeding in a stage by stage manner, we can determine where the signal exists. In such a case, we are usually not even interested in how much signal exists at each point, just so the signal passes from stage to stage.

Gain Measurements

As the vacuum tube voltmeter will measure signal voltages, however, we can measure the amplification of radio stages. The gain of a stage is the output signal voltage divided by the input signal voltage. This gives the number of times the input signal voltage is amplified.

A vacuum tube voltmeter can indicate a ratio of this type accurately, even though there may be considerable error in the absolute value of measurements. In other words, we cannot always be certain that the input voltage measured is exactly the amount in volts indicated, but if there is any error, it will usually exist in both measurements to the same degree and will be cancelled out. Thus, we can determine the ratio between the output and input voltages even though we may not always be able to measure either voltage exactly. This seems peculiar until the characteristics of the signals are considered.

First, the vacuum tube voltmeter may be designed to respond to either the peak, average or r.m.s. value of the voltage being measured. This does not sound important, until we realize that if the wave shape changes these values would change greatly with respect to each other. If we have an ordinary sine wave, the r.m.s. voltage would be about .7 of the peak value. If the wave shape changes to a square wave or some other shape, then this relationship is no longer true.

As long as the vacuum tube voltmeter is calibrated to read in terms of the voltage which it normally indicates, then not much trouble will be experienced in this respect. However, many are calibrated to read peak or r.m.s. values, although they may be designed to respond to some other value. In other words, they may respond according to the r.m.s. value but the meter may be calibrated to read the peak value.

In a case of this type, the relationship between the peak, average or r.m.s. values would be determined mathematically in plotting the meter scale. As mentioned above, if this factor changes due to a change in the wave shape, then the calibration definitely will have considerable error.

The wave shape will depend upon the amount of distortion introduced by the stage, as well as the original wave shape of the signal source. In other words, if the stage adds harmonics or introduces phase distortion due to a non-linear characteristic, then the wave shape does change.

By studying the vacuum tube voltmeter, you can sometimes determine with fair accuracy what type of voltage it is going to indicate. If the detection point is designed to be somewhere in the square law region of the characteristic curve, the device usually will be an r.m.s. instrument. A linear detector will sometimes be an average voltage indicator, although the meter may be otherwise calibrated. The types having the operating points beyond cut-off, particularly the slide-back type, will usually be a peak voltage indicator. However, this definitely depends upon the design of the circuit. A grid leak-condenser circuit may be either a peak or r.m.s. indicator, depending on the value of the grid leak and condenser. Hence, it is best to determine if possible from the literature of the manufacturer just what type of instrument you have, and how it is calibrated, if you are interested in determining the exact amount of voltage.

Further, when attempting to measure voltages exactly, it is always advisable to have the signal source deliver as pure a sine wave as possible.

Fortunately, for ordinary service work, we are seldom interested in the exact values of voltage at any point. Therefore, even if our wave form is distorted, and we measure a certain signal into a stage, if the stage itself does not seriously distort the signal then the output voltage will not have any greater error and the voltage ratio between output and input will be correct.

Of course, since we can determine the gain of an entire tube stage, we can also determine the gain or Q factor of a tuned circuit in that stage. One of the most common reasons of a loss of sensitivity is moisture absorption in one or more of the coils. By making a check of this type, to determine the gain in each coil circuit, we can spot any circuit where the gain is below normal. This definitely indicates where the trouble probably exists. Of course, besides coils, we can have dust or leakage paths between the plates of the tuning condenser or across insulation which will also produce a similar effect. However, in any event, it is possible for us to determine the ratio of signals between practically any two points where there is enough signal to measure.

Another common cause for low gain in a circuit, particularly an i.f. transformer, would be a short circuited turn in one of the transformers. Again, the relative gain of the transformer will be a good means of indicating where the trouble may exist.

Of course, there are precautions to be observed. We cannot expect a radio having parts which may vary 10 or 20% and tubes which may vary 25% to give the same gain in each similar stage. We should expect wide variations. You will probably have to obtain considerable practical experience in making measurements of this type before you can learn to recognize when a difference in reading is to be expected and when it indicates trouble. The gain of a particular type of stage may be anywhere from 10 to two hundred, depending on the design of the stage and its condition.

Recently, several set manufacturers have begun to put information in regard to the average gain on their receiver diagrams and in the service notes to help in making tests of this type.

When making gain measurements, it is well to remember that there may be some stages where an actual loss may be experienced. That is, you may find circuits where there is less output than input. In some instances this is deliberately designed, which requires that you have a fair knowledge of radio theory. A case to the point would be in a band pass preselector or i.f. coupler, particularly of the double tuned variety. Here, the voltage across the second tuned circuit may be less than that across the first tuned circuit.

Alignment Indicators

Vacuum tube voltmeters can be used as alignment indicators in many different ways. You can actually align each individual stage or group of stages by using the vacuum tube voltmeter as an r.f. voltage indicator, connected a stage or two ahead of the point where alignments are being made. Of course, you can use it like an ordinary output meter, measuring the audio voltage at some point. If the instrument is a d.c. type, then it can be used in the a.v.c. network, to indicate the increase in a.v.c. voltage as the alignment adjustments are performed.

In a receiver with automatic frequency control, a d.c. type V.T.V.M. is helpful in making the proper adjustment. In most of these systems, the control voltage must be balanced to zero across the discriminator output. By having a sensitive d.c. meter of this type, which has high sensitivity along with high input resistance, it is possible to make an accurate measurement across this circuit for this balance.

Special Uses

There are several special tests which can be performed quite effectively with the vacuum tube voltmeter.

For instance, it is possible to determine the impedance of a part or circuit if you have available a signal generator capable of supplying the frequency at which the measurement is to be made. We only need a non-inductive variable resistor or potentiometer of some value higher than the expected impedance of the part or circuit being checked. This resistor is placed in series with the part or circuit, and the combination is then connected to the output of the signal generator. The vacuum tube voltmeter is used to measure the voltage drop across the resistor and across the impedance. By adjusting the resistor, we can make the voltage drops equal. When this occurs, the amount of resistance is exactly equal to the impedance. The resistance can now be checked with an ordinary ohmmeter. Notice that this checks impedance, and not reactance or inductance.

If a D.C. current normally flows through the impedance device being checked, then the same amount of D.C. current must be passing through it when it is checked. This requires a high capacity paper by-pass condenser to block D.C. from the resistor and signal generator.

A vacuum tube voltmeter can be used to indicate the overload point of a grid circuit if it indicates peak voltages, or if you will multiply its voltage by the proper number to get the peak. For instance, we know that in a class A amplifier, the peak signal input should not exceed the bias voltage. By measuring the peak signal fed into a stage, we can adjust this input to a point where it is under the bias voltage value. This is definitely a special test, but is found useful in public address work in many instances.

The turns ratio of a transformer can be determined by feeding a measured voltage to the primary and then measuring the voltage across the secondary. The ratio of the voltages measured gives the turns ratio.

As a vacuum tube voltmeter can be used over a wide frequency range, it can be used to check the response of an amplifier. By feeding measured voltages into an amplifier, and then measuring the output, we can easily make up response curves, indicating the selectivity and sensitivity in the case of an r.f. amplifier or the fidelity in the case of an audio amplifier.

Another practical use for this device and its ability to measure signal voltages would be in balancing phase inverter stages. As you know, a push-pull output stage requires that the push-pull grids be fed with voltages 180 degrees out of phase. This is usually accomplished through the use of a push-pull input transformer. This transformer has a center tap, and is so arranged that when one grid is becoming positive the other is becoming negative at the same instant and are thus 180 degrees out of phase.

We can eliminate this transformer by using an extra tube. A tube reverses the phase of the signal fed to its grid circuit 180 degrees when it appears in the plate circuit. Thus, by adding an extra stage to feed one push-pull tube grid, we can get our phase inversion. However, it is also necessary that the signal voltages fed to the output tube grids be equal. Therefore, the phase inverter must be adjusted so that it does not amplify, that is, it is given a small signal, so that its normal amount of amplification just brings the signal up to the level of that fed to the other output tube grid. Due to changes in part values and tube characteristics, it is very easy for this stage to get out of adjustment so that the push-pull tubes no longer receive exactly the same signal. This can result in some distortion, and will result in an increased hum level in the output particularly. By measuring the actual amount of signal voltage fed to each grid, we can determine if such an unbalance exists. If it does, we can make the proper adjustments in tubes or part values to restore the original balance.

If for any reason a by-pass condenser is suspected of being ineffective, we can use the vacuum tube voltmeter to measure the signal voltages across it. Ordinarily, a by-pass condenser is intended to by-pass all of the signal at the point where it is connected or to act practically like a short circuit. If we measure across it and find that a considerable signal voltage exists at the points where it is connected, then it is not acting as a by-pass condenser. It may be too small in value, or it may be open. In any event, we can add other condensers or replace it until the proper observations are obtained at that particular point. Of course some care is necessary here, as in many instances the condenser might not be intended to act as a by-pass condenser due to its connections in the radio, and further, in some instances a condenser is deliberately chosen so it will not by-pass all of the energy. This is particularly true where some degeneration is desired in the radio.

In some instances, you may have a vacuum tube voltmeter with an insufficient range for the voltages to be measured. If the range is to be extended for d.c. voltages, we need only make up a voltage divider. For instance, if the input resistance of our V.T.V.M. is 10 megohms, and we connect a 10 megohm resistor in series with it, then the scale range is doubled and all readings should be doubled. In this manner we can extend the d.c. range as much as we might desire.

For a.c. voltages, particularly at r.f. values, a resistor voltage divider does not work out so well. Here, a capacity voltage divider is better. If the V.T.V.M. has considerable input capacity or has a capacity voltage divider, then a series condenser can be placed in the hot lead. This can be adjusted if we have a known voltage which is still within the range of our tester. For instance, we can get a particular reading without the condenser placed in the circuit. Then, the condenser is placed in series and is varied until the reading goes down to some particular value. If the voltage reads to one-half what it was before, then the scale has again been doubled. Of course, a condenser of this type will usually be a fairly small value so a small trimmer condenser is a practical means of extending ranges in this manner.

If the V.T.V.M. has a condenser in series with the test lead already, then a shunting capacity can be added across the input terminals within the V.T.V.M. This capacity is harder to figure, however, and cannot be made large except where the series condenser is very small.

Naturally, unless care is exercised in all this, the readings are going to be made somewhat less accurate. As I have pointed out before, however, the accuracy of reading is not as important as the ability of the instrument to indicate that a signal does exist or that a change occurs.

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All Out For Victory

In the technique of modern warfare, radio serves the same purpose as the nerves which connect the eyes and muscles of a boxer with his brain.

Hitting power and mobility, indispensable to armies, navies and boxers alike, can function only when instant, accurate communications are maintained—communications between fighting or observation units and headquarters, between body and mind.

Behind the fighting lines, radio maintains the morale of the people, brings them the voices of their leaders, keeps them informed, warns them of danger.

Radio keeps open the channels of communication between continents and nations, bringing confidence to friends and courage to the oppressed.

"Many months ago, the radio industry of America pledged its best efforts in the interests of national defense. Today those efforts are unreservedly ALL OUT FOR VICTORY."

The above is the introduction in the January 1942 issue of RADIO NEWS, *by David Sarnoff, President, Radio Corporation of America.*

A RADIO SERVICE CALL

IMAGINE we are going along with a Radiotrician who has just received a call from Mrs. Jones, saying her radio suddenly stopped playing. *"It was smoking and smelling up the whole house, so I turned it off,"* she explained over the phone.

Arriving at the home of Mrs. Jones, the Radiotrician doesn't even have to sniff the air to recognize that unmistakable power transformer smell.

Setting his tube tester on the floor, he plugs it into a wall outlet and proceeds to test the tubes one at a time. The rectifier tube is bad, so his estimate of the charge will have to include the price of one new tube.

But he's not satisfied yet. With another test instrument, he makes one simple measurement between the cathode of the rectifier tube and the chassis, and nods his head as if the result was exactly what he expected. Now at last he turns to Mrs. Jones, who has been anxiously watching and waiting.

"Mrs. Jones, the main trouble in your set is a burned-out power transformer, but it failed because one of the electrolytic filter condensers broke down and shorted the rectifier tube. This, in turn, overloaded the power transformer and made it fail.

"Now let's see — we'll need one new rectifier tube, a new electrolytic condenser, and a new power transformer. In addition to these three things, Mrs. Jones, your set needs a complete overhaul—checking of all connections, examination of all those small parts underneath the chassis, blowing out of all dust, and realignment of all the tuning circuits.

"You have a fine receiver, and this complete overhaul will make it play like a new set. I'll guarantee my work and the new parts for three months, which is just as long as the manufacturer guaranteed your set when it was new. The total for all this work will be only $14.75, and you can take my word for it you'll have a practically brand-new receiver when it comes back to you."

Mrs. Jones says, *"That sounds reasonable enough, so go right ahead!"*

This little story illustrates one important fact which even expert radio servicemen sometimes overlook — *that failure of one part in a receiver can be due to failure of one or more other parts.*

The alert radio man avoids this pitfall by asking himself one simple question: *"Was the failure of this part due to failure of some other part?"* From his knowledge of radio parts and circuit actions, he then figures out what to test in order to find out if the cause was just natural aging or was overloading due to failure of some other part.

In cases where there is reasonable doubt concerning the final cost of the repair job, the serviceman should so advise the customer or else allow a safe "margin" which will permit him to make the main repair in addition to incidental correction of small defects. For example, with new transformer, rectifier and filter condenser installed, the receiver may work but be noisy due to a bad tube, resistor or coil. Under such circumstances the extra work must be done at no increase above the original estimate if customer satisfaction is to be gained. Therefore, in your estimate on a repair, always leave a safe amount of "leeway" so that you will not lose money on a job nor, equally important, will not overcharge the customer.

Good judgment, discretion and tact are just as essential to the serviceman as to any other professional worker.

IN THE CONTROL ROOM

by T. R. WISEMAN

This article originally appeared in a recent issue of Radio News. We are grateful to Radio News for permission to reprint it here, in condensed form.

THE control room is the heart—the real romance and drama—of radio. The monitor operator is not only a mechanical genius who understands electricity, but he must have an ear for good tone, in order to graduate the volume of sound which reaches the public. He advises and rehearses all local programs, in collaboration with the announcer, the director and the cast, whether singing or speaking. He helps adjust programs to the time allotted for each one.

A control room engineer can bring out a tone which is too soft, and he can lower a tone which is too loud, by use of his volume controls, but he has no way to sweeten a sour note.

The microphone or mike as it is commonly called, cannot pick up notes above a certain range. If a soprano is singing a very high, rather sharp, brilliant note, she should be taught to fade that note slightly away from the mike so that it will not sound shrill to the listeners. Very low bass tones are also outside the range of the average mike pick-up. Violin players especially, take note of this! Occasionally a singer will lose a note, caused frequently by faulty breath technique. The mike will portray these frantic gasps as well as the gap caused by the lost note.

During odd moments it is part of control room work to test and cut transcription records to be used at another time. The material for most of these transcriptions comes in on the network, although records are also made from studio programs. Other transcriptions are kept on file by the stations for use in case of difficulties with a scheduled studio program or if the network is cut off unexpectedly because of wire trouble.

These transcription records are used for sound effects, as well as for short program announcements. An embarrassing moment for an engineer occurred once, when a bugle was required for sound effect. There were at that time two transcription record machines in use. One which spun the record at a rate of thirty-three and a third revolutions per minute and the other at seventy-eight revolutions per minute. The operator, by mistake, used the thirty-three and a third when he should have used the faster machine. As a result, the bugle sounded like a rheumatic trombone.

Another amusing instance of a control room engineer's troubles, is illustrated by a local program's effort to give extra service to its listeners. A famous national figure, a stormy petrel, was on the verge of death. A news bulletin of his passing was expected momentarily and when the station signed off at midnight, the announcer was authorized to tell his listeners that if they wished to listen in, the station would broadcast news of the public man's death, during the night.

In the wee small hours, the newsman was notified of the message, and called the control room, located on the edge of town, instructing the engineer to start up his transmitter. So the engineer "warmed" things up. When the announcer had finished giving the news-cast, he concluded with the words, "We will finish with a short transcribed program."

The engineer out on the hill was caught off guard. No one had mentioned the transcription and he had only an instant to get the record and start the machine. Reaching quickly behind him into the case where transcribed records for emergency use were kept, he took one out without glancing at the title and started it off. He was horrified to hear a male quartet singing, "I'll be glad when you're dead, you rascal, you!"

Another reason for the fascination of control room work is the intimacy between the control room engineer and his audience. There is nothing between the control room and the private life of the world, except the click of a switch. He is responsible for his audiences' enjoyment, even more than an actor upon a stage. Even the most marvelous song by John Charles Thomas or Rosa Ponselle, cannot reach radio listeners, in perfection of loveliness, unless the control engineer is on the job. And like the stage, the control room has the motto, "The show must go on!"

Since the duties of the control room are multiple, and sometimes an emergency is a matter of split seconds, every part of his equipment must be directly under the engineer's hand. It is frequently necessary to change a connection from one board to another without loss of time. Occasionally one man will hold the controls for four programs under his hand at the same time: the network, through the leased wires, the announcer for network "breaks" in studio A, a rehearsal in studio B, and a transcription which he is taking through the leased wire, for use later in the day.

Many listeners do not realize that the network programs come through the station on a telephone company service leased wire. These are put through the radio station control board and released on the local radio station hook-up. In installing a board for this station work, a wire trouble called "cross talk" is one of the most difficult problems to be overcome by the radio station.

Cross talk is caused when a high level line and a low level line are too closely connected on the control board. If sufficient air space separates these wires, the air will act as a further insulation to the current. But if they are too closely connected on the board, the voice current carried by one pair of wires will be inducted into adjacent pairs. Standard equipment is very carefully insulated. These copper wires, carrying low voltage, are first insulated with ordinary thread insulation. After this another ordinary insulation is used and the heavy tarred covering used to protect all telephone wires covers the outside. In spite of this heavy shielding, cross talk is a very serious problem.

Breaking the connection in another way, by crossing the line with a test set, is also called "cross talk." Many funny and (to the transgressor) tragic instances have occurred in this way. A crew of linemen were working between Kansas City and St. Joseph, looking for trouble on a service line. One of the men was ordered up a pole to test lines numbered 1197 and 1198. He hooked his clips over the two wires. His head phone was right in front of his mouth and without thinking, he bawled down to the foreman, on the ground, with a usual lineman's profanity:

"Guess this ain't the one, Joe. The ——- thing's got a lot of ——— music coming through." The profane embroidery was clearly audible to listeners who were tuned in on the Philharmonic Symphony orchestra! And they say the lineman's last pay-check was made out in the office before he could climb down the pole.

Another telephone employee who had worked for the company for over thirty years wanted to hear one of the championship fights. He picked himself a quiet corner behind the board, borrowed a head-set and clipped in on the wire. He enjoyed the fight for about half an hour, cutting off the station listeners completely, while the rest of the staff went crazy trying to answer telephone complaints and nearly taking the telephone building apart, trying to find the short which he was causing. He also found his pay-check ready for him.

Among other duties the engineer is responsible for checking the log. Each station is required to keep a log of programs, timed to the second, including all announcer's words, station breaks, the number of words used, length of individual programs, names of sponsors and any changes made from the detailed program planned for the time, as well as the reason for the change. This log is filed and must be sent to the Federal Communications Commission in Washington, if demanded. Loss of license may follow any offense against the Commission's rulings.

Stations must stay on the air unless given permission by the Federal Communications Commission to cease operating. While running a small station in Kansas, back in the early days of radio, an operator found his crystal had gone bad and he could not continue to transmit programs. The crystal is used to keep a station on its proper frequency. Any attempt to broadcast would be ruinous. But he could not go on the air until he got a new crystal and he could not stop until he had Federal Communications Commission permission. Although he was already stopped, he wired the Commission in Washington for permission to cease operation until he could get a new crystal.

Control room engineers are nearly all young men. Perfect co-ordination is an essential, they must be on their toes, every moment on duty. Only the young men can keep going, constantly, smoothly, during eight hours' duty every day. A second's delay in timing "station breaks" on the network program is very awkward. A man's mind must be free from all outside worry, such as the air-line pilots call "home-work" or "human cargo." Such worries prevent precision of mental effort and are responsible for most mistakes. Mistakes on the radio, particularly carelessness, are costly.

The stations, operate on the theory that their first duty is to serve the public. The motive force—the heart of the entire service—originates in the control room, where every split second is alive and crackling with the spirit of that same devotion to Radio as a free public service.

WHAT TO CHARGE AND HOW TO BILL YOUR CUSTOMER

If you have either a full-time or part-time radio service business of your own, you can build customer confidence and increase your earnings through the use of the new RMS standard service charges. (See opposite page). This system of charges takes into account the skill required to *locate* trouble in a radio, and shows a customer that the actual *labor* involved in replacing a part is the least expensive part of radio service work. This one feature alone will make the new RMS standard service charges the greatest help you have ever had in getting the consumer to appreciate fully the value of your professional services.

Like any other system of professional charges, the suggested RMS standard service charges were intended for average conditions, but can be adapted to extreme cases requiring a minimum or a maximum amount of time.

For example, the suggested charge for replacing a volume control, while satisfactory for the average case in which the faulty control is detected immediately through noisy or erratic operation, might be insufficient for locating trouble in a volume control involving considerable testing. In receivers using the volume control as part of the AVC network, an open circuit or excessive resistance in the control causes other effects than noisy operation. For the additional time used in *tracing* trouble to the control, the service charge covering "Automatic Volume Control System—resistor or condenser replacement, wiring repairs" might be used in addition to the charge for "Volume Control—replacement."

On the other hand, the usual charge for replacing the volume control may prove excessive for a set requiring a new volume control in addition to several other repairs or general tune-up charges for alignment, etc. In such cases, a serviceman may wish to reduce or eliminate the separate charge for the replacement of the volume control. Other similar exceptions to the general rule will be found by servicemen in the course of adapting the RMS standard service charges to their business.

In looking over these service charges, you will note that the lowest priced items are those requiring no testing to locate the faulty part, such as "Dial Drive Cable—replacement," "Dial Scale—replacement," etc. Furthermore, a charge for minor repairs such as replacing a resistor or condenser, or repairing a short or open circuit in wiring is priced according to the amount of testing required to locate such faults. Thus a repair of this kind in the power supply circuit is listed at $2.00, in the audio amplifier at $2.50, and in the discriminator circuit at $3.00.

The minimum charge will be useful in many ways to cover minor operations, depending upon the service policy of individual servicemen. For example, the minimum charge on outside service calls would be justified in the case of a simple single operation such as replacing a pilot lamp, whereas a similar replacement performed in the shop where no additional time would be required, might be covered by the standard charge for this operation.

Aligning charges have been broken down into separate operations, some of which are never performed separately. This has been done to enable the serviceman to make up a composite charge according to the type of radio and the number of aligning operations required. Thus, it is possible with this arrangement to make up a total aligning charge for sets with different numbers of short wave bands, or sets with additional features such as FM, AFC, etc.

Here are two examples of bills made up from the RMS standard service charges.

Example of charge for repairing home radio with open oscillator coil:

Testing set and replacing oscillator coil	$2.75
Aligning intermediate frequency stages	.50
Aligning broadcast band	1.00
Philco Part No. .... oscillator coil	2.50
Total Charge	$6.75

Example of charge for repairing auto radio with worn-out vibrator:

Removing set from car and reinstalling	$1.00
Testing set and replacing vibrator	1.50
Philco Part No. .... vibrator	2.50
	$5.00

A 12" by 16" metal plaque with beveled edges, containing the complete list of RMS standard service charges lithographed in ivory, blue and gold, is available to RMS Members at a price of only 28¢. Displayed in your store or shop, this plaque will help impress customers with the business-like manner in which your service work is handled. For information on RMS membership, see your local Philco distributor or write to Radio Manufacturers Service, Tioga and C Streets, Philadelphia, Penna. Do not write to N. R. I. for the plaques or for this information. Write direct to R. M. S., as suggested.

STANDARD CHARGES FOR RADIO SERVICE

The standard radio service charges listed below are officially recommended by Radio Manufacturers' Service (RMS), a nation-wide organization of radio servicemen under the sponsorship of Philco Radio & Television Corp. These charges include only the work done on a radio in the shop or in the home. On outside service calls an additional charge is made for travelling time and for transportation, depending upon distance and the number of trips required to complete the work. On automobile radios brought to shop in cars an additional charge of $1.00 will be made for removal and reinstallation.

REPLACEMENTS AND REPAIRS

These standard charges cover service only and include all testing required to locate trouble. Prices for materials used are extra and are listed in the Philco Catalog of Parts, Accessories, Tubes and Batteries.

Aerial (Built-in Loop)—replacement or repair	$3.00
Audio Amplifier—resistor or condenser replacement, wiring repairs	2.50
Audio Transformer—replacement	3.00
Automatic Frequency Control System—resistor or condenser replacement, wiring repairs	3.00
Automatic Record Changer—cleaning, adjustment and lubrication	3.50
Automatic Volume Control System—resistor or condenser replacement, wiring repairs	2.75
Batteries (Portable Radio)—replacement	1.00
Condenser (Main Filter)—replacement	2.50
Condenser (Compensator)—replacement	3.00
Condenser (Tuning Gang)—adjustment	2.50
Condenser (Tuning Gang)—replacement	3.50
Detector Circuit (First)—resistor or condenser replacement, wiring repairs	2.50
Detector Circuit (Second)—resistor or condenser replacement, wiring repairs	2.75
Dial Drive Cable—replacement	1.75
Dial Drive Mechanism—replacement or repair	1.50
Dial Lamp—replacement	.50
Dial Pointer—replacement	.50
Dial Scale—replacement	1.00
Discriminator Circuit—resistor or condenser replacement, wiring repairs	3.00
Discriminator Transformer—replacement	3.50
Filter Choke—replacement	2.25
Intermediate Frequency Amplifier—resistor or condenser replacement, wiring repairs	2.00
Intermediate Frequency Transformer—replacement	2.50
Limiter Circuit—resistor or condenser replacement, wiring repairs	2.00
Oscillator Circuit—resistor or condenser replacement, wiring repairs	2.25
Oscillator Coil—replacement	2.75
Phonograph Motor—cleaning and lubrication	2.75
Phonograph Motor—replacement	2.00
Phonograph Pickup—replacement or adjustment	1.75
Power Supply Circuit—resistor replacement, wiring repairs	2.00
Power Transformer—replacement	3.50
Radio Frequency Amplifier—resistor or condenser replacement, wiring repairs	2.50
Radio Frequency Transformer—replacement	3.00
Resistor (Voltage Divider)—replacement	2.50
Shadow Tuning Meter—replacement or repair	2.00
Speaker Cone—recentering	1.00
Speaker Cone—replacement	2.00
Speaker Field Coil Assembly—replacement	3.00
Station Selector System (Mechanical)—adjustment and lubrication	1.50
Switch (Off-On)—replacement	1.50
Switch (Push Button)—cleaning and lubrication	2.00
Switch (Push Button)—replacement	2.75
Switch (Radio-Phono)—replacement	1.75
Switch (Wave Band—Single Section)—cleaning and lubrication	2.00
Switch (Wave Band—Single Section)—replacement	2.75
Switch (Wave Band—Multiple Section)—cleaning and lubrication	2.50
Switch (Wave Band—Multiple Section)—replacement	4.00
Tone Control—replacement	2.25
Tubes—replacement	1.00
Tube Socket—replacement	3.00
Tube Socket—repair contacts	2.00
Vibrator—replacement	1.50
Volume Control—replacement	2.25
Volume Expansion Amplifier—resistor or condenser replacement, wiring repairs	3.00
Wireless Remote Control Amplifier—resistor or condenser replacement, wiring repairs	3.50
Wireless Remote Control Transformer—replacement	4.00
Wireless Remote Control Stepper—replacement	4.50

ALIGNMENT OF TUNED CIRCUITS

Including Dial Calibration

Intermediate Frequency Stages	.50
Intermediate Frequency Stages (High Fidelity)	1.50
Standard Broadcast Band	1.00
Short Wave Band (each)	1.00
Automatic Frequency Control	1.75
Wireless Remote Control Amplifier	2.50
Frequency Modulation System	3.00

AUTOMATIC TUNING ADJUSTMENTS

Push Button Type	1.50
Motor Operated Type	2.00

The above prices are based on the correction of trouble that appears continuously and without interruption. For correcting trouble which occurs intermittently, requiring additional testing over a period of time, prices will be higher than those listed, depending upon the amount of additional time required.

All parts, tubes and batteries replaced are returned to customer—be sure to ask for them.

MINIMUM CHARGES:

$1.00 ON ALL RADIOS BROUGHT TO SHOP
$1.50 PLUS TRANSPORTATION ON OUTSIDE CALLS

FM SIGNALS GET INTO

BY WILL WHITMORE

This non-technical article about the peculiarities of frequency modulation is reprinted from the magazine "Pick-Ups" through the courtesy of the Western Electric Co. The illustrations are from the original article.

WHEN radio station WOR (Newark, New Jersey) went on the air with its Western Electric one-kilowatt synchronized FM transmitter, it seemed like a good time to place FM on the spot. *"Let's put that transmitter of yours through its paces,"* we told Jack Poppele, WOR's chief engineer. *"For once, let's forget all about your elaborate signal measuring equipment, and make a test entirely from the listener's point of view. We won't bother about millivolts and the rest of your fine engineering lingo, little or none of which is understood by the public who will in the end put thumbs up or down to FM. Let's make the test as tough as possible for FM and see what happens."*

"Okay," said Jack. *"Name your own poison and we'll supply you with it."*

"What we want is an outfit on wheels with which we can come as close as possible to duplicating average conditions to be encountered by the average listener," we told him. *"Give us a medium-priced FM receiver hooked up in a car with some sort of antenna no more elaborate than our average listener can hang on the side of his house on a Saturday afternoon."*

Well that's exactly what we got. The receiver was a small table model set retailing for seventy dollars, modified to operate from the car storage battery and dry cell B batteries. The receiver was connected through a short transmission line to an untuned di-pole antenna mounted slap-dab against the rear side of a big sedan.

Under this bridge the AM signal from WOR took a nose dive, but W2XOR's FM signal came through loud and clear.

The expedition headed out Queens Boulevard and thence to Grand Central Parkway. Cars whizzed by us on this busy four-lane highway. W2XOR was coming in on the FM receiver like a house afire. A huge metal armored payroll truck pulled along side and continued to keep pace with us for a mile or so. Our antenna was on the side of the car opposite the van and not more than an arm's length away. Result: same old signal without a trace of ignition. As we continued out on Long Island we passed under numerous steel reinforced bridges. Each time we passed under a bridge, background noise increased in the standard car receiver tuned to WOR's 50-kw. transmitter. But our FM signal came through the same as ever. To the ear, at least, these bridges cast no shadow whatsoever for FM.

Twelve miles from New York we passed over a large bridge. Here was just the opportunity we were seeking. We turned off the highway and circled around until we were directly under the bridge. The bridge cast a sharp shadow. As we entered it, the WOR signal went from high volume to complete unintelligibility within two or three feet. The FM signal from W2XOR showed no change whatsoever even though we explored every nook and cranny of the AM shadow.

Driving further along the Island, we had the feeling of a criminal trying to escape trailing bloodhounds. It seemed impossible to lose the signal. It became apparent that we would have to resort to the ace I had been holding up my sleeve. *"Let's give it the sand pit treatment,"* I told Charlie. *"If that doesn't put a damper on your signal, we might just as well shut down and go home."*

The sand pit I had in mind is approximately 25 miles from New York. Close to the shore of Hempstead Harbor lies a high ridge ranging from 50 to 150 feet above sea level. Into this ridge steam shovels have

NEW YORK'S TOUGH SPOTS

FM signals followed the car right down into this 125-foot deep sand pit on Long Island.

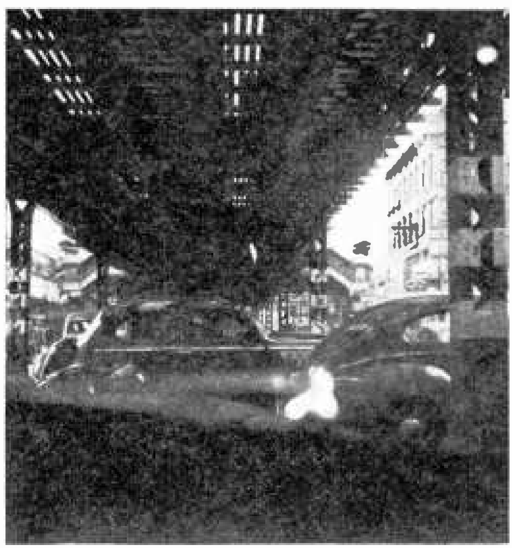
gouged out a miniature "grand canyon." As we neared it, Singer took one look at it and remarked that if the signal didn't die a sudden death there, he would have to toss out his last remaining conception of FM's limitations. The perpendicular wall of the pit lay directly between us and W2XOR. We drove our car right up to the foot of the wall. Steam shovels and trucks worked all around us. We turned on the receiver. There was W2XOR practically the same as ever, the only noticeable difference being a slight decrease in level, but the signal was more than acceptable from a listener's point of view. We drove the car around the bottom of the pit trying to find at least one shadow in which to hide from the signal, but it searched us out wherever we moved.

Then we raised another di-pole on a wooden rod mounted on the front of the car. Although the di-pole reached about twice as high as the permanent antenna on the rear, we could discern little difference in signal strength. When the di-pole was rotated to provide horizontal polarization and turned directionally for maximum signal, there was no noticeable difference between it and the rear antenna. It was sharply directional, however, and at the minimum signal point the receiver response was considerably reduced.

Returning to New York, we cruised under elevated railway lines, through streets lined with New York's highest buildings and filled with rush hour traffic. There was no variation whatsoever in signal strength.

As I write this, the same receiver is bringing me the music of W2XOR in my home in Manhasset, Long Island, 18 miles from the transmitter. The receiver is connected to an eight foot piece of bell wire which hangs down from the second story window. The vacuum cleaner, electric razor, and oil heater have absolutely no effect on it.

From this report of a test of FM, unscientific and unrehearsed as it was, you may read any significance or none at all. To us, this practical test indicates that FM is perfectly capable of serving the entire metropolitan area of the greatest city on earth. It further indicates that the average listener may receive his FM programs irrespective of location and without an elaborate antenna array.



Not even the steel structure of a New York City elevated line affected FM signals.

CIRCUIT ANALYSIS

OF A

MIDGET SUPERHETERODYNE RECEIVER

BY J. B. STRAUGHN

N.R.I. Service Consultant

General Description

The Philco Model 37-84 is a four-tube a.c.-operated superheterodyne receiver. It uses a type 6J7G as the detector-oscillator, another 6J7G as the second detector, a 6F6G output tube and a 5Y4G rectifier.

In the receiver, r.f. voltage gain is obtained by resonance step-up in the tuned secondary of the antenna coil, while most of the r.f. gain is the result of conversion gain of the detector-oscillator and regeneration in the second detector. A.F. gain is due to the amplification of the audio signal in the second detector and by the amplification afforded by the 6F6G output tube.

An examination of the schematic on page 19 shows this receiver to be unique, in that it does not use a stage of intermediate frequency amplification. This circuit is typical of a great number of midget superheterodyne receivers. The output of the first detector feeds through an i.f. transformer into the input of the second detector. Both the first and second detectors are regenerative, which tends to make up for the loss in sensitivity, the result of omission of the usual i.f. stage.

Signal Circuits

Signals picked up by the antenna cause a current to flow through the 20,000-ohm volume control, marked *1* in the diagram. By adjusting the position of the slider on the control, any amount of the signal voltage may be taken off and fed to the primary of the antenna coil marked 2 in the diagram. By mutual induction a voltage will be induced into the secondary of this coil and only a signal tuned in will undergo resonance step-up. The resonant circuit consists of the secondary of the coil, the tuning condenser, and trimmer condenser 5 shunting it. The signal is applied to the grid and cathode of the tube, the cathode connection being through the oscillator feed-back coil, having terminals marked 4 to 1, and through the cathode by-pass condenser marked 7.

Regeneration is obtained by means of condenser 3, connected between the primary of antenna coil 2 and through condenser 7 to terminal 4 of the oscillator pick up coil. All i.f., oscillator and r.f. signals across terminals 4-1 of coil 10 are fed back to the primary of coil 2 through condenser 3. These signals are induced into the secondary but the secondary is tuned only to the r.f. signal. Other signals do not undergo resonance step-up and hence feed-back occurs only at r.f. Condenser 3 is known to radio men as a "gimmick," simply consisting of two insulated wires twisted together.

The oscillator is of the tuned plate type. The oscillator energy is fed to the tank coil through i.f. trimmer condenser 11. The tank (coil winding 2-1 of 10, the tuning condenser and trimmer 13) is coupled into the cathode circuit by mutual induction through pick-up coil 4-1 of coil 10. The voltage induced into this coil causes the grid-cathode bias of the tube to vary at the oscillator rate. In this way, oscillation is maintained.

The incoming signal and the local oscillator signal are mixed inside of the tube and, as a result, we have the intermediate frequency of 470 kc. existing in the plate circuit. Since the primary of the i.f. transformer and its associated trimmer offer a high impedance at the intermediate frequency, we have a large i.f. voltage existing across the primary and trimmer condenser 11. At the intermediate frequency the oscillator tuning coil acts as a low reactance path. Trimmer condenser 11 connects to the white lead of the primary of coil 14, through oscillator tuning coil 10 to chassis and then through condensers 28 and 29.

An i.f. voltage is induced into the secondary of i.f. transformer 14. You will note that the secondary having leads colored brown and black-white tracer is tuned to resonance by means of trimmer condenser 15.

The signal is now applied between the grid and cathode of the second detector, the direct grid connection being through the 4-megohm grid resistor. The gimmick shown connected to the grid of the second detector forms a capacity across the 4-megohm resistor, thus more effectively coupling the resonated signal to the grid and at the same time makes the 6J7 detector an ordinary grid leak and condenser type detector.

The tube will amplify the i.f. signal applied to its input. Resistor 19 acts as the i.f. plate load, the end connected to a.f. plate load 22 being at chassis potential as far as i.f. signals are concerned because of .001 condenser 20 which has low reactance at i.f. values and high reactance at a.f. The i.f. signal across resistor 19 is fed back through regeneration control condenser 17 and the lower tapped portion of the i.f. secondary whose leads are colored green and black-white tracer. The phase of the feed-back voltage induced into the tuned secondary is such that it aids the original signal. This greatly strengthens the signal applied to the grid-cathode input of the 6J7G second detector. In other words, we have regeneration of the i.f. signal.

Condenser 17 is adjustable, so that we can feed back into the grid circuit more or less of the energy developed across resistor 19. Increasing the capacity of 17 results in more feed-back and increased regeneration. Too great an increase will cause oscillation and receiver squealing.

With the strengthened i.f. signal applied to the input of the second detector, satisfactory rectification will take place in the grid circuit. When the signal makes the grid positive, electrons will flow from the cathode to the control grid, through the 4-megohm resistor and back through the secondary of the i.f. transformer to the chassis and cathode. As a result, we will have the audio signal voltage appearing across the 4-megohm resistor. The i.f. variations are by-passed across the resistor by means of the gimmick condenser.

This audio voltage, as you can see, is in the grid input circuit of the second detector. The tube amplifies the audio signal and large variations occur in the plate current at an audio rate. The amplified audio signal voltage appears across plate load resistors 19 and 22, and all i.f. variations are by-passed around load 22 by the .001 mfd. condenser marked 20. The audio signal voltage across 19 is not transferred to the 6F6G tube and hence is wasted or lost. Resistor 22 is 24 times larger than 19 and will have 24 times as much a.f. across it. Hence the a.f. loss in resistor 19 is relatively small and can be neglected.

The audio signal across plate load resistor 22 appears across the 6F6G grid resistor marked 23 in the diagram. The signal is applied across this resistor through audio coupling condenser 20, having a capacity of .015 mfd. and through the 4-mfd. output filter condenser marked 29. The voltage across resistor 23 is applied directly to the 6F6G grid and to the cathode through by-pass condenser 28.

The variation in the grid voltage of the 6F6G output tube causes a large variation in plate current through the primary of output transformer 25. This transformer has the correct turns ratio to match the speaker voice coil impedance to the plate resistance of the output tube. The voltage induced into the secondary causes a large flow of current through the voice coil and, as a result, the voice coil and attached cone moves in and out, thus producing sound.

Condenser 24, connected to the plate of the output tube, by-passes around the plate load high audio frequencies which otherwise might feed back into the control grid circuit and cause audio oscillation.

Voltage Supply Circuits

The bias voltage for the detector-oscillator tube is obtained by means of the drop occurring across cathode bias resistor 6. The screen voltage for the detector-oscillator tube is obtained from a voltage divider which consists of resistors 12 and 8. The screen of the tube is kept at r.f. ground potential by means of screen by-pass condenser 9 because this condenser acts as a short circuit as far as r.f. is concerned.

The plate of the tube is supplied from the output of the power pack through the primary of i.f. transformer 14.

Self-bias, due to grid current flow, is employed in the second detector circuit. When no signal is tuned in, the control grid of the second detector receives an initial negative bias due to convection current caused by electrons striking and staying on the grid, instead of passing on to the plate. These electrons then flow through resistor 16, producing a voltage drop across it. The number of these electrons are few but the high value of 16 makes the result appreciable.

When an i.f. signal is applied to the tube input the grid shows current whenever the signal makes the grid positive with respect to the cathode. The grid current will vary as does the strength of the signal. The greater the grid current flow, the more negative the grid-cathode voltage becomes.

The screen grid of the second detector tube is supplied through resistor 18 and is kept at r.f. ground potential by the .09-mfd. condenser which like the first detector screen by-pass is marked

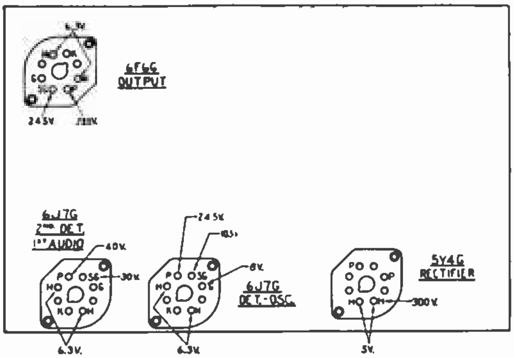
9. Thus we know that the two .05-mfd. screen by-pass condensers for the first and second detectors are in the same container.

The plate of the second detector is supplied through resistors 19 and 22, number 19 acting as an i.f. filter resistor and 22 as the plate a.f. load.

The grid bias for the 6F6G output tube is obtained by means of the voltage drop occurring across the 325-ohm bleeder resistor marked 30 and the polarity of this voltage is indicated on the diagram. The cathode currents of all tubes and the bleeder current through resistors 12 and 8 flow through resistor 30. The ungrounded end of the resistor is negative with respect to chassis. Since the grid return of the 6F6G tube is connected to the ungrounded end of resistor 30 and the cathode is connected to the grounded end, the voltage across resistor 30 is applied to the grid-cathode of the 6F6G tube.

Tube Socket Voltage

(Measured from Tube Contact to Chassis)



Tubes as viewed from underside of Chassis.

The voltages at the points indicated by the arrows above were obtained with a Philco type 025 Circuit Tester which contains a high resistance (1000 ohms per volt) voltmeter.

The screen of the output tube is supplied directly from the positive side of the power pack marked B+. From B— the electrons flow through the various receiving tubes and bleeder resistors and back to B+. The electrons then flow through the speaker field marked 27 in the diagram and to the rectifier filament. From there they go to that plate which happens to be positive.

The Power Pack Filter

The speaker field is used as the filter choke and in conjunction with the electrolytic condensers marked 29 serves to reduce the 120-cycle ripple at the output of the power unit.

Considerable ripple current, however, flows through the field and results in a 120-cycle variation in the magnetic flux. Ordinarily this would cause the voice coil to move the cone back and forth and give rise to hum. You will note from the diagram that there is a coil directly in series with the voice coil and shown to be wound in an opposite direction.

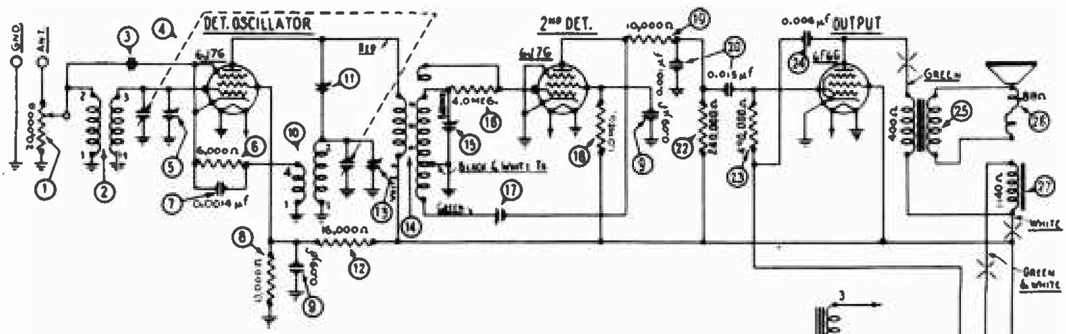
This is known as the hum-bucking coil and is wound over a section of the speaker field. Therefore, we will have hum voltage induced both into the hum-bucking coil and into the voice coil. Since these coils are wound in opposite directions, the voltages induced into them will be of opposite polarity and as a result will cause no hum current to flow through the circuit since the voltages are not only opposite, but are also equal. Since no current due to the speaker field flux variation flows through the voice coil at the 120-cycle frequency, there will not be any tendency for the cone to move back and forth and no hum is produced by this hum source. In this way the hum-bucking coil actually bucks out any hum voltage induced into the voice coil from the speaker field.

Condenser 28, the one connected from the primary of the power transformer to the chassis, serves to prevent r.f. signals entering the power line from getting into the receiver.

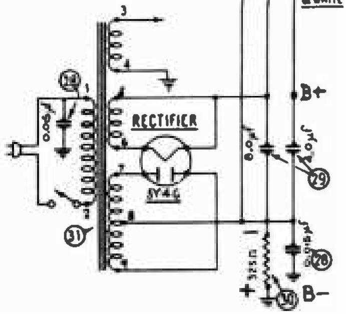
You will note that one side of each receiving tube filament is directly grounded, as is terminal 4 on the power transformer filament winding. The other leads terminating in an arrow connect to terminal 3 on the filament winding, as does the ungrounded lead of the pilot lamp. By grounding one side of the filament circuit in this manner, coupling between the different stages is eliminated, since a high r.f. or a.f. potential can not build up between the ungrounded side of the filament circuit and chassis. This is due to the fact that the resistance between the ungrounded side of the filament and the chassis is quite low. Any small hum or r.f. currents getting into the circuit will build up voltages which are very small since voltage equals current multiplied by resistance. If we fail to ground one side of the filament circuit the resistance from the filament to chassis will be many megohms and a fairly large voltage will build up due to minute current flow.

Receiver Alignment

The alignment of this receiver is quite simple. First the i.f. amplifier is aligned. This is done by feeding the output of the signal generator, tuned to 470 kc., which the factory manual states is the i.f. frequency, into the aerial and ground posts of the receiver. The dial of the receiver should be turned to the lowest frequency, tuning



Illustrations, Courtesy, Philco Radio & Television Corp.



condenser in mesh, as this will have less attenuation effect on the signal generator frequency. The modulated tone of the signal generator will then be heard in the loudspeaker.

If an output meter is used, it may be connected across the voice coil of the receiver. All adjustments are to be made for maximum output. First, trimmer condenser 15 is adjusted for maximum output and then condenser 11 is adjusted. Regeneration control 17 should then be turned clockwise (increase capacity) to a point where a squeal is heard. Back off the control by turning it counter-clockwise about ⅛ turn until the oscillation (squeal) disappears.

Repeat trimmer condenser adjustments 11 and 15 and, if regeneration results, again back off control 17.

Go over these adjustments two or three times to secure maximum sensitivity and selectivity. After this don't touch the adjustments again.

Reset signal generator frequency to 1700 kc. and adjust oscillator trimmer 13 mounted on the condenser gang for maximum output. Then tune the signal generator to 1400 kc. and tune the receiver to the same point for maximum output. The antenna trimmer marked 5 in the diagram should then be adjusted for greatest reading on the output meter. This completes the alignment, as no oscillator low-frequency padder is used. Tracking is obtained by means of specially cut plates. Incorrect tracking is an indication that the i.f. is aligned at the wrong frequency.

Voltage Measurements

In checking the operating voltages, be guided by the tube socket layout. While the factory manual states that these voltages are to be measured from the tube contacts to the chassis, you can see that in the case of the rectifier heater voltage, you should connect the test probes to the heater socket terminals. This is necessary since the rectifier filament is at a very high potential with respect to the chassis.

All of the d.c. voltages are to be measured from the points indicated to the chassis.

With the exception of the heaters all measurements were taken with a d.c. voltmeter having a sensitivity of 1000-ohms-per-volt. The majority of multimeters now in use have a sensitivity greater than this; therefore, somewhat higher voltages are to be expected when checking circuits containing a high value of resistance such as the plate and screen of the second detector tube.

Your voltage measurements, if properly interpreted, can often lead you directly to the source of the trouble. For example, if all of the d.c. voltages are abnormally low, you would suspect defective electrolytic condensers, particularly the 8-mfd. input filter condenser. Lack of voltage on the screen of the detector-oscillator tube would be due, in all probability, to a short in the .09-mfd. screen by-pass condenser and perhaps to an open in the 16,000-ohm screen supply resistor marked 12. Abnormally high voltage on the screen coupled with the complaint of squealing would be due to an open in the 13,000-ohm bleeder marked 8 in the diagram.

Lack of voltage on the screen of the second detector could be due to a breakdown in the screen by-pass. A breakdown in this by-pass condenser wouldn't, in all probability, cause the 1-megohm screen supply resistor to burn out, since its value is so high that even the full voltage of the power pack could not cause a great deal of current to flow through it. However, if the condenser is not shorted resistor 18 should be checked with an ohmmeter. The resistor may be open.

Lack of plate voltage on the second detector would lead you to suspect resistors 19 and 22 and the .001-mfd. plate by-pass condenser marked 20.

Screen voltage on the output tube but no plate voltage would be due either to a short in plate by-pass condenser 24 or to an open in the primary of the output transformer. If by-pass condenser 24 breaks down to the point where it has no resistance the power pack may be damaged or the output transformer primary may burn out. Power pack damage would be limited to the rectifier tube, the power transformer and to R30. The speaker field is in the circuit but is sufficiently husky so that damage to it would be unlikely.

Lack of d.c. voltages at any point, when the rectifier, power transformer and filter condensers are in good condition, would be due either to an open in the speaker field or an open in C bias resistor 30.

In your study of previous diagrams, you have learned that all tube electrodes at a positive potential should trace back to the rectifier filament, while those at a negative potential should trace back to either plate of the rectifier.

Practice this: On each receiving tube trace all of the electrodes at a positive potential back to the rectifier filament, and all those at a negative potential back to either plate of the rectifier.

Common Causes of Typical Troubles

The common troubles encountered in receivers of this type are low operating voltages due to defective filter condensers and intermittent reception due to a change in value of the volume control (disconnect the slider and check the volume control with an ohmmeter). Oscillation is generally due to excess capacity (caused by incorrect adjustment) in regeneration condenser 17, although screen bleeder number 8 sometimes opens up, as does the detector-oscillator screen by-pass condenser.

A more than average amount of trouble is encountered in oscillator circuits of this type. Frequently, the oscillator refuses to function at the low-frequency end of the dial. The first thing to do is to try a new detector-oscillator tube or interchange this one with the second detector which is of the same type. As the gain of the tube falls off, due to loss in cathode emission, it is harder for the oscillator to work at the low-frequency end of the dial.

When a new tube does not clear up the trouble, excessively high bias is indicated. This can be corrected by reducing the value of the cathode bias resistor 6 in the diagram to approximately 4000 ohms. The rule is to use a replacement resistor having about one-third less resistance than the original.

If continued trouble is experienced, go over all connections in the oscillator circuit with a hot soldering iron. Where bolts are used to hold the stators of the tuning condensers in place, loosen and tighten these bolts one at a time, as a high-resistance joint sometimes occurs at this point and movement of the bolts will eliminate the corrosion which caused the high resistance.

If the oscillator refuses to function at the high-frequency end of the dial, this in practically every case indicates moisture absorption by the oscillator coil. The remedy is to install a new oscillator coil. It is always a good idea to draw a picture diagram showing the connections to an old coil. This will prevent you from making a mistake when installing the new coil.

Audio squealing may be due to opening up of the 6F6G plate by-pass marked 24 or the C bias by-pass condenser marked 28, connected across bias resistor 30.

Distortion in this receiver is often due to leakage in the a.f. coupling condenser marked 20 having a capacity of .015-mfd. Check for leakage at this point by measuring for voltage across resistor 23. A d.c. voltage will not normally exist across this resistor. If it does, remove the output tube. If the voltage drops with the tube out of the circuit, the tube is gassy. If d.c. voltage remains, with the tube removed, the coupling condenser is leaky.

As indicated in the diagram, the .001-mfd. plate by-pass and .015-mfd. coupling condensers are in a single container. Either can be replaced with a separate condenser, while the remaining good section can be left in the circuit.

———*n r i*———

N. R. I. Graduate Sends Greetings From India By Radiogram

RCA RADIOGRAM XLT WB170CL BOMBAY 18 30
XLT MR J E SMITH PRESIDENT
NATIONAL RADIO INSTITUTE
WASHINGTON D. C.
NEW YEAR GREETINGS VICTORY FOR DEMOCRACIES.

MELLI PANDAY
BOMBAY, INDIA

Novel Radio Items

—BY L. J. MARKUS—

Radio engineer Neel McGinnis of Station KSTP in St. Paul, Minn., carried 250 lbs. of recording equipment to the local zoo and recorded quacks of ducks there. He planned to use his transcription to lure wild ducks down to his artificial decoys during the hunting season. At the last minute, however, game wardens decreed that a transcription of the ducks' voices was equivalent to the illegal method of using live decoys, so the brilliant scheme was outlawed.

——————*n r i*——————

A steeplejack working on the transmitting antenna towers of a southern Radio station, narrowly escaped death when the 260-foot pole atop which he was working snapped off. He rode the falling pole almost to the ground and then jumped clear, getting two broken legs and possible internal injuries but remaining conscious.

——————*n r i*——————

A newly-invented radio receiver permits listening in to a dozen or more different stations at the same time. Listeners of one station could check the programs of other stations without tuning them in. In warfare, a pilot could listen in on a dozen wavelengths, to detect the presence of enemy signals or navigation guides.

——————*n r i*——————

Instead of waiting for transmitting tubes to give trouble, engineers of Station KSTP in St. Paul have set up a specially designed X-ray machine at the 50,000-watt transmitter, and are using it both for fluoroscopic and photographic examination of tubes. Filaments unhooked from their fastenings, as well as heat-warped grids, have been revealed before the tubes showed outward signs of trouble.

——————*n r i*——————

A Blackout-Panel Oscillograph which can be used in total blackness is announced by DuMont Laboratories. The specially processed steel panel is treated with luminous paint that retains its luminosity sufficiently for comfortable observation at least an hour after exposure to ordinary light.

——————*n r i*——————

Radio equipment generating 300,000 watts of power at 1,500 kc. is being used to set the glue in 14-inch high stacks of 4'x8' plywood sheets. Radio glue-setting takes 5 to 10 minutes, whereas the former cold press method took 8 hours. The radio apparatus used for broadcasting the heat or "fever" waves through the plywood is six times more powerful than the largest broadcast band transmitter in this country.

——————*n r i*——————

A steel ball suspended magnetically in a vacuum has been rotated at the terrific speed of 6,600,000 revolutions per minute during bursting strength tests of various metals. Four coils connected to a high-frequency oscillator and r.f. amplifier provide the rotating magnetic field which spins the ball. Many steel balls have burst long before reaching this record speed.

——————*n r i*——————

Radio receiver salesmen have found that it is difficult to sell a set which does not overload raucously at the maximum volume control setting. Therefore, this type of distortion is being intentionally introduced in some sets by receiver designers to give the illusion that a set has high power output. The deception is harmless because the sets are never operated at this level in actual use.

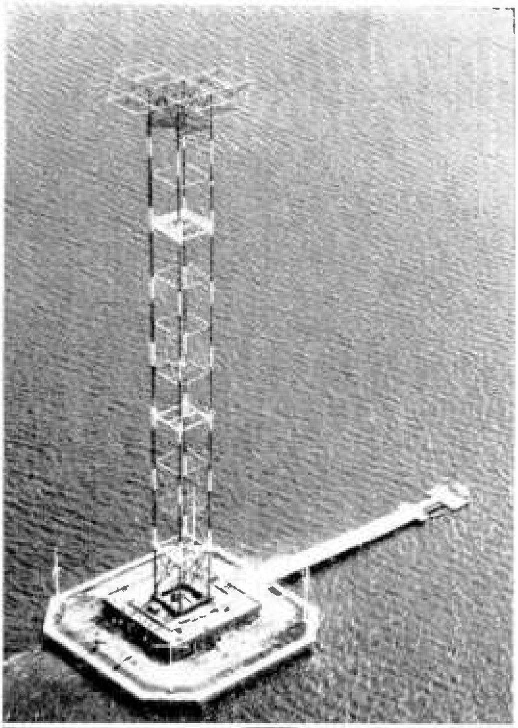
——————*n r i*——————

With a bit of organization among listeners, a private radio station located in the dormitory of an eastern university became a unique and effective public address system. All radios in a row of dormitories facing a city street were tuned to the campus station. From a vantage point overlooking the street the announcer and all the radio receivers would hail in unison any girls passing by. Campus police ended the experiment.

——————*n r i*——————

When weird and colorful Northern Lights caused great magnetic storms which interrupted shortwave radio communications to Europe, engineers of RCA Communications outwitted nature in two ways. By sending European messages from New York to Buenos Aires and then rebroadcasting them to London without a stop-over, they were able to get around the magnetic storm area. The other "ace in the hole" was the set of longwave alternators dating back to 1918. These veteran long-wave alternators produce carrier frequencies of about 22,000 cycles, just above the audio range, and these signals can usually get through the trans-Atlantic radio lanes when short-wave channels are blocked. Magnetic storms usually have a minimum effect on low carrier frequencies.

New WABC Transmitter is Built on Truck-Size Island



Courtesy, Columbia Broadcasting System

Above: This Fairchild aerial photograph shows the 75-foot square building and 410-foot high tower of the new WABC transmitter, built on a granite rock in Long Island Sound.

Below: Transmitter room of WABC's new 50,000-watt transmitter, with operator at control desk.

UP to last year, Columbia Island in Long Island Sound was just a granite rock, appearing at high tide to be no larger than a 10-ton truck. That was before Columbia Broadcasting System engineers selected it for the site of radio station WABC's new 50,000-watt transmitter.

Today, this rock is covered by a man-made island 150 feet square, with a boat pier extending into deep water off one side. A 410-foot high self-supporting transmitting antenna rises from the center of the transmitter building, resting on yard-thick concrete pillars which go through the building without touching it.

The steel tower wears a "top hat," an 85-foot diameter circular steel ring which tunes the antenna to the station frequency by adding capacity.

Within the transmitter building is the main 50-kw. transmitter and a complete auxiliary 5-kw. transmitter for use in emergencies. Normally, the radio operator on duty has complete control of the main transmitter from his desk. Only in an emergency would it be necessary to swing open the panels and operate the transmitter directly by means of the controls and meters mounted behind the panels.

Both power and program lines to this island transmitter are encased in steel-armored cable laid under water. A gas engine-driven generator can operate the transmitter in event of power line failure, and ultra-high frequency radio equipment is available to link the transmitter with the New York City studio in case of program line failure.

A 30-foot WABC ferry launch carries employees to and from the island, which is a mile off shore from New Rochelle, New York.

Front Cover Photo: James Middlebrooks, engineer in charge of construction for the new station, connects the shielded leads to the high power vacuum tubes in the final stage of the transmitter. These water-cooled tubes feed 50,000 watts of signal power to the transmitting antenna.

STRUGGLES AGAINST ODDS---NOW HAS RADIO SHOP

This story which recently appeared in the Columbus Dispatch, a leading newspaper in Columbus, Ohio, is reprinted in its original form, with permission from both Mr. Amsbaugh and the newspaper, which also supplied the photograph showing Mr. Amsbaugh at work in his Radio shop. This courtesy is gratefully acknowledged.

SWINGING idly in the wind in front of 244 East Oakland Avenue, in Columbus, Ohio, is a sign bearing the label, "Friendly Radio Service."

Behind those words lies a 27-year struggle which has lifted John Amsbaugh beyond the solicitous clucks of his elders to man's status in a fiercely competitive world.

When John was born his spine was injured. The motor nerves were twisted, depriving him of the full use of his limbs and even impeding his speech. John Amsbaugh bent before the blast of his misfortune but he didn't break. Rather he began an uphill battle which, though it has not precipitated him to success, has kept his head above the waves.

Unable to hold a pencil, John nevertheless was enrolled in the school for handicapped children. He learned to operate a typewriter, becoming so proficient that he since has used it for all written work. Later he attended Franklin Junior High School, then Gahanna High School and finally Reynoldsburg High School from which he was graduated in 1934 under the name of John Teaff, his stepfather's name.

For awhile, John was at a loss. Industry wasn't ready to accept handicapped persons when so many able bodied men were asking for work. But it wasn't long until he was back in the thick of the battle, this time as an employee of the Good Will Industries at Eighteenth Street and Mt. Vernon Avenue where he started in piling up newspapers. When he left his job several months later he was doing electrical work which gave him the idea for his present work.

Through the cooperation of the city and various interested friends, John was enrolled in a radio correspondence course with the National Radio Institute which specializes in home study courses.

Several weeks ago John started his shop in a garage in the rear of the Oakland Avenue address. He doesn't want pity. He's fiercely positive about that. All he wants is an even break.

Despite his handicaps John Amsbaugh is determined to lead a normal life, marry and rear a family, he will tell you with a grin which backs up his claim as "the Friendly Radio Service."

And he'll do it.

Puzzling Radio Questions From Students

The Facts of Condenser Testing

QUESTION: *Must I disconnect a condenser to check it?*

ANSWER: Just how to check a condenser depends entirely upon the suspected nature of the defect. A condenser can go bad in several ways. First, it can become open. Second, it can break down and short or it can become leaky. These two second defects are inter-related and if a leaky condenser is left in use long enough it will probably break down completely and we then say it is shorted.

To check a condenser which you suspect of being open, simply shunt it with another of about the same size while the receiver is operating. If this clears up the complaint which led you to believe that the condenser is bad, your suspicion is justified. The condenser is definitely open and should be replaced.

On the other hand if you suspect a condenser of being leaky or shorted, you should look at the diagram to see if there is any part connected across the condenser which would give a low resistance ohmmeter reading. If there is not you disconnect the receiver from the power supply and place an ohmmeter across the condenser. A low resistance reading indicates that the condenser is leaky while zero resistance on the ohmmeter shows that the condenser is shorted. In such a case you then disconnect the condenser since it must be replaced if bad. However you test the condenser while it is disconnected to check up on your former test. This is done because there is a possibility that some other part in the receiver across the condenser might have broken down. If the condenser tests good when disconnected you continue your search through the circuit for the short.

These tests apply to all types of condensers.

Record Changer Problem

QUESTION: *I have a record changer with no apparent adjustments. One of the lever arms seems to be too long, causing improper operation. What shall I do?*

ANSWER: The very fact that you have been able to determine the cause of the trouble shows that you have considerable experience with record changers. The remedy in this particular case is to bend the arm which will in effect shorten it. Considerable skill is necessary in doing this and don't be surprised if your first efforts are unsuccessful.

In general it is best to obtain a copy of the manufacturer's service manual as this often shows just how certain types of defects may be remedied.

Why FM Receivers are Noise Free

QUESTION: *Why is it that F.M. receivers do not pick up noise?*

ANSWER: An F.M. receiver does not pick up noise when a sufficiently strong signal is fed to its input due to the design of the set.

Noise can cause two things to happen. First it can vary the amplitude of the signal. Variations in signal amplitude are eliminated in an F.M. receiver by means of the limiter or clipper stage. This stage cuts down all signals to a predetermined level and if the original signal was large enough to be cut down, any amplitude variations on its peak due to noise would thereby be eliminated.

Secondly, noise will cause a variation in frequency. As you know signal frequency variations in an F.M. receiver cause changes in volume.

The amount of frequency variation produced by a noise signal however is relatively slight—say only 3 or 4 kc. With the wide band F.M. receivers now in use, this frequency variation will have little effect on the volume of the program. Therefore because of the wide band reception afforded by a modern F.M. receiver, frequency variations due to noise are not apparent.

These frequency variations however do cause considerable noise when not tuned to an F.M. station. Then the set is running wide open and the slight variations in frequency will cause a great deal of noise. Noise when a strong F.M. transmitter signal is tuned in however is entirely lacking.

Phono-Radio Trouble

QUESTION: *I have a phonograph radio and on phono operation radio signals are faintly heard. What can I do about this?*

ANSWER: In certain receivers the simplest thing to do is to tune the dial so that a station is not picked up. In other sets it may be found that the condenser located between the plate and cathode

Are Answered By N. R. I. Experts

of the tube to which the phono is connected is open circuited. This allows the tube to pick up R.F. signals if improperly shielded and rectify them. The remedy in this case is to install a new by-pass condenser. In other receivers the method of disconnecting the set or disabling the set for phonograph operation and non-pick-up of radio programs is not as good as it should be. In such receivers a slight change in design may be worth while so that operation of the receiver is definitely killed. This could be done by removing the screen voltage from one of the I.F. tubes or by opening the cathode circuit of an I.F. tube.

In receivers employing a system which shorts the aerial to the ground, interference is sometimes picked up by the tubes following the antenna system. Here either detuning the receiver from the signal or changing the design will achieve the desired results.

Advice On Home Made Tube Tester

QUESTION: *I want to build a tube tester—please send me a wiring diagram.*

ANSWER: We do not have a constructional diagram of a satisfactory tube tester. Even if such information was available and you were to wire an instrument which was electrically and mechanically perfect, it would be worthless for you would have no means of calibrating it. Over three hundred different types of tubes are in common use and you can see that it would be impossible for the average man to obtain these tubes in all types of conditions so that he could compare them with good tubes for tester calibration.

In a case of this sort the only thing to do is to buy a modern manufactured tube tester.

About Pilot Lamp Replacements

QUESTION: *I have been told that it is very important to replace a burned out pilot lamp with one of the same type, using the colored glass bead through which the pilot lamp filament passes as identification. Should this rule always be followed?*

ANSWER: If the pilot light is operated directly from a voltage source such as the filament winding on a power transformer, it is only necessary to choose a pilot light designed for that filament voltage. The color of bead which indicates the current consumption of the pilot lamp is then unimportant as far as pilot lamp life is concerned. It is only important to use the correct color bead when the pilot lamp is part of a series circuit or is shunted across a section of a series supply circuit and as such is designed to pass a definite amount of current. In such a circuit use of the incorrect lamp may result in either burning out of the lamp or insufficient light.

This refers to A.C.-D.C. receivers and in such sets, always use an exact duplicate lamp for replacement purposes.

In some battery sets a pilot lamp is used and here again it is important to use the right colored bead. Although the lamp would not be damaged as long as the voltage supply was correct, a lamp which drew excess current would cause the batteries to run down quickly—something which of course must be avoided.

Temporary Repairs

QUESTION: *I have a receiver with a burned out antenna primary and the customer is in a hurry to have the set repaired. What would be a quick and temporary solution to the problem under the circumstances?*

ANSWER: This problem may be solved by slightly changing the design of the receiver so that the antenna is capacitively coupled to the tuned circuit instead of inductively coupled as was the designer's original intent.

This capacity may be obtained by means of a gimmick—two insulated wires, one connected electrically to the antenna binding post and one electrically connected to the stator of the R.F. tuning condenser. The insulated portions of the wires are twisted together.

The receiver is then tuned to about the middle of the band and a little of the wire clipped off at a time until maximum output is obtained. The twist at the start should be about 3 inches long.

If you cut off a little too much thereby reducing the output slightly, don't worry as the results over the entire band will be fairly good.

Another way of doing this would be to take an ordinary trimmer condenser and connect it between the antenna lead and the tuned circuit. The condenser capacity could then be adjusted for best results at about the middle of the band.

In either case the trimmer across the first R.F. tuned circuit should be readjusted afterwards for maximum results at the high frequency end of the band when the receiver is connected to its regular antenna.

FOUR PROFIT-BOOSTING POSTERS

IN an effort to aid service men to secure and hold the confidence of their customers, NATIONAL UNION RADIO CORP., has prepared a series of four display cards which can be put up in radio service shops.

These cards are designed to impress the radio customer with the fact that the shop has been inspected, is conducted along strictly business-like methods, that all charges are legitimate, that locating radio trouble may take more time than it is possible to predict and that in such cases a nominal inspection charge will be made, that a charge is made for testing tubes unless new tubes are purchased to replace those that are defective.

One card is a reprint of an article which appeared in the August 1941 issue of *Reader's Digest*, which received wide-spread publicity. The purpose of this card is to build up in the mind of the prospective customer the fact that the service man realizes some of the practices of unscrupulous radio shops, and that knowing them, he wishes his customers to understand that they may deal with him, confident that "This Shop is Pledged to Truth in Radio Service."

Another card is a *Certificate of Award for Up-To-Date Radio Test Equipment*, attesting to the fact that the shop was inspected by a NATIONAL UNION representative and found to contain all essential testing equipment.

Two other cards indicate that a nominal inspection charge will be made if the customer decides not to have his receiver repaired, and a charge of 5¢ will be made for testing each tube if the customer decides not to buy the required new tubes.

The cards are specifically designed to take advantage of public desire to patronize honest and expert Radiotricians.

For information on how you can obtain these cards, write direct to NATIONAL UNION RADIO CORP., 57 State Street, Newark, N. J.

N.R.I. ALUMNI NEWS

Edward B. Sorg .... President
John Stanish .... Vice-Pres.
Peter J. Dunn .... Vice-Pres.
Louis J. Kunert .... Vice-Pres.
Chas. J. Fehn .... Vice-Pres.
Earl Merryman .... Secretary
Louis L. Menne .... Executive-Secretary

Edward B. Sorg of Chicago is Elected President of the N. R. I. A. A. for 1942

Stanish, Dunn, Kunert and Fehn are Vice-Presidents

EDWARD B. SORG of Chicago is President of the N. R. I. Alumni Association for 1942. In a friendly contest with F. Earl Oliver of Detroit, Ed Sorg came out on top. Both candidates were well supported. This was Sorg's year.

So, congratulations to you, Ed Sorg. You have been elevated to the highest office within the gift of our members. You have been rewarded with this honor because you served our Alumni Association well, as Vice-President in 1941 and as Chairman of Chicago Chapter in 1939.

And to you Earl Oliver, congratulations too. The vote was close. Your many years of fine work as Vice-President of our Alumni Association, as former Chairman of Detroit Chapter and as Secretary of your local, has won many friends for you. Your year as President will come, too. We know the result of the election is no disappointment to you because we remember your remarks when we saw you in Detroit. "Sorg deserves the honor this year. I am urging my friends to vote for him. There is plenty of time for me." Your every act has been one of unselfish devotion to the organization at large. Yours is indeed the true fraternal spirit.

In the contest for Vice-Presidents, John Stanish of Detroit, Peter J. Dunn of Baltimore, Louis J. Kunert of New York and Chas. J. Fehn of Philadelphia, were elected. These men are so well known through their work as National and Local officers it is not necessary to detail their experiences in the cause of our Alumni Association. Let it be sufficient to say that our members, by their votes, have chosen a very fine group of men who are tremendously interested not only in the welfare of our organization but Radio men everywhere.

Earl Merryman was re-elected Secretary and Louis L. Menne was re-elected Executive Secretary. Merryman, who has a very important assignment with the government, has been Secretary since our Alumni Association was organized. Menne, is well-known through his Alumni work which is brought to your attention through this section of each issue of the News.

Members of the N. R. I. Alumni Association—your new officers greet you. They promise to do everything within their power to cultivate fraternal relations among the Alumni of the National Radio Institute, to promote the welfare of each alumnus by interchange of helpful information, to foster the spirit of unity and loyalty to our Alma Mater, which is the object of our Alumni Association.

Here and There Among Alumni Members

Roger J. Wells of New York State has a very important job with a well known concern, making equipment for the Army. We won't say more about the type of work he is doing because we do not want to reveal any secrets.

—— n r i ——

Remember B. McGehee, "Chief Keeper-Upper of Your Radio", of Arcadia, Florida? He has moved up town to larger quarters. He is doing some work for one of our Flight Training Centers, in addition to his regular Radio business.

—— n r i ——

Jerry McCarthy is again a proud papa—another girl—his fourth. He will soon be caught up with Eddie Cantor.

—— n r i ——

R. H. Rood, former Vice-President of our Alumni Association was a visitor at headquarters. He is in charge of the P.A. system of the City Council in Los Angeles. He took a three months leave of absence for a well deserved vacation. The man who took his place had things so badly messed up the city fathers of Los Angeles welcomed the return of Rood with open arms.

—— n r i ——

For the many holiday greetings cards we received here at headquarters we say, "Thank you, very much." Too numerous to acknowledge individually we use this means to express our great appreciation for your thoughtfulness and for the fine manifestation of sincere friendship.

—— n r i ——

Mr. and Mrs. Harold Z. Snyder of Baltimore announce the arrival of Janet Eleanor Snyder. Harold is the live wire who has been doing so much for Baltimore chapter. His wife, Grace, is one of the nicest little women we're ever met. Baby Janet is all that was needed to make their home one of complete wedded bliss.

—— n r i ——

Clyde D. Kiebach, formerly of Reading, Penna., but now of Washington, D. C., was married on January 3rd, 1942. Clyde graduated in 1932 and has steadily moved forward since then. Our best wishes to this happy couple.

—— n r i ——

Harold S. Pranger is a Radio Operator in our Army. He says his N.R.I. training has been of great help. We won't mention his exact duties or post but you can bet this alumni brother is doing a good job for Uncle Sam.

—— n r i ——

Albert C. Christensen of Sidney, Nebr., is so busy with his Radio servicing work he is required to work until ten to eleven o'clock almost every night. He has been making as high as $75.00 a week—he ought to, with those hours.

—— n r i ——

Don L. Capparelli is Service Manager for Biehl's Inc., Harrisburg, Penna., Philco Distributors for Central Pennsylvania.

Any graduate, who has a radiotelegraph license and who is free to accept a position, should write N.R.I. at once for particulars. Radio operators are urgently needed in several branches of the government.

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John W. Hutchinson is doing very nicely with the Western Auto Supply Co., 1047 E. McMillan St., Cincinnati.

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Back in 1930 Andrew T. Curtis enrolled with N.R.I. After studying seven or eight lessons he dropped out. Some six years later he realized his mistake—started all over—and in a short time was on his feet financially. Today he has a fine radio job in Hopewell, Va., making good money and the future is rosy. He says, "Thanks to N. R. I." We say, "Thank yourself—you studied when the going was hardest."

—— n r i ——

Pete Dunn, past National President, is again attending meetings regularly in Baltimore, now that he is caught up on a special assignment for the city, which kept him busy almost every night of the week. Pete is a power in Baltimore chapter and when he misses a meeting there is a mighty good reason for it.

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Mr. and Mrs. Arnold R. Dilley of Richwood, W. Va., were recent visitors at N.R.I.

—— n r i ——

F. R. Norton, Jr., of Milford, Conn., who has been doing final testing on F.M. sets, recently was promoted by General Electric Co. to the Television Division as final tester trouble shooter on television development.

—— n r i ——

All National Officers of the N.R.I. Alumni Association and chairmen of local chapters were presented with a handsome medallion at the close of 1941 as a token of appreciation for their services.

—— n r i ——

Mr. and Mrs. Louis C. Shaw, Jr., of Galveston, Texas, are having a great time with their baby girl who was born the eleventh hour of the eleventh day of the eleventh month. If they didn't name her Armistice they missed a scoop.

—— n r i ——

James C. Long of New Phila., Ohio, has been bedfast since early in 1940. It is good news indeed to hear that he is up and around again. He is itching to get back into the thick of things.

—— n r i ——

Keeth Rochambeau of Lincoln, Nebr., was hustled out of bed at 4:45 A.M. to welcome the arrival of a baby son.

—— n r i ——

George Adel Beard is employed at the transmitter, Radio Station WMAZ, Macon, Ga.

New York Chapter

Our chapter is really "going to town." Our regular service forum is as popular as ever. The increased attendance is proof of this.

Chairman Gordy gave us an interesting talk on "Simple application of the slide rule in Radio." Gordy always has something good to pass on to us. He is a radio authority in his own right.

At a recent meeting, Mr. J. B. Straughn, N.R.I. Service Consultant, gave us a fine talk on an all-wave combination F.M.-A.M. phono receiver. He analyzed the circuits and discussed servicing problems. After the regular talk Mr. Straughn answered many questions relating to servicing problems. Mr. Straughn is an expert service man, who knows all the answers and who talks the Radio serviceman's language. He has the faculty of making everything clear and understandable.

The high light of this meeting was a visit to our chapter by Mr. J. E. Smith, President of N.R.I. Mr. Smith was given a rousing reception and responded with a stirring talk. He has a magnetic personality and is best described as inspiration in action. We hope he will be able to visit us again soon.

From left to right, L. J. Kunert, Secretary. Alfred E. Stock, Past Chairman and 1941 National Vice President. L. L. Menne, Executive Secretary. Irving Gordy, Chairman. J. B. Straughn, N.R.I. Service Consultant. J. Barrette, Past Chairman and J. E. Smith, President N.R.I., at a recent meeting of New York Chapter.

Mr. Menne, our executive secretary, also spoke. He emphasized the value of fraternal friendship and pointed out the many opportunities which are open for qualified radio men.

About 125 attended this meeting which gives the idea that New York Chapter is going along in great shape. Here is the place to make new friends —real friends who have much in common with other students and graduates. The welcome mat is always out. Drop in on us at 8:30 P.M. any first or third Thursday of the month at Damanzeks Manor, 12 St. Marks Place, New York City, (between 2nd and 3rd Avenue).

Louis J. Kunert, *Secretary.*

Chicago Chapter

What Chicago Chapter is doing is best illustrated when we report that 32 new members have joined us since our last report. This is the result of a drive to build our membership up to a point where we can count on a large attendance at every meeting and thus get the very best speakers.

Chicago Chapter gets good turn-outs too. The Windy City boys packed the hall on this occasion.

Mr. Hill of Supreme Instrument Company, spoke to us at one of our meetings. Mr. Menne also has been a recent visitor and speaker. Our own Earl Bennett is ever ready with practical servicing information as is also our chairman, Stanley Lukes and other members of our chapter.

Our open forum is always part of our program. This is when the fellows have a chance to ask any and all questions on radio servicing and these are answered by members of long radio experience.

Any N.R.I. men in this area who are interested in our meetings are invited to write or telephone the undersigned at 2511 S. Highland Avenue, Berwyn, Illinois. James Cada, *Secretary.*

Baltimore Chapter

Election of officers. The members felt that 1941 was such a successful year the entire slate of officers should be re-elected for 1942 and this was done by unanimous vote—a real compliment. Therefore the officers remain in their chairs, as follows:

Chairman—E. W. Gosnell
Vice Chairman—H. J. Rathbun
Secretary—B. J. Ulrich
Recording Secretary—J. S. Grasser
Editor—L. Arthur
Sgt.-at-arms—A. Hooper

These impressive looking fellows represent Baltimore Chapter.

Harold Snyder, the new papa, and H. J. Rathbun continue their fine work with the N.R.I. experiments. These two men have done wonders with these demonstrations. For the sake of variety we have other speakers quite frequently including our good friend Straughn, from headquarters.

There is always a good program at Baltimore Chapter on every second and fourth Tuesday of the month, at Redmen's Hall, 745 W. Baltimore Street.

B. J. Ulrich, *Secretary.*

Detroit Chapter

Meeting regularly. Attendance good, more interest in Chapter activities than ever.

Don Smith, of Rissi Bros. was our speaker at one of our meetings. He spoke with the use of the R.C.A. Dynamic Demonstrator—a twelve tube radio, containing every type of circuit, including A.V.C., A.F.C., Phase Inversion, Tuning Indicator, an R.F. Stage, separate Oscillator, etc. He showed how to follow the signal through the set, what type of signal to expect at different points in the set. He demonstrated the effect of open and shorted coupling condensers, by-pass condensers and A.V.C. filters. He showed how open resistors in various locations affected the signal. All of these effects were introduced into the set by means of switches and pin packs. Mr. Smith was given a rousing vote of thanks for a very interesting and informative talk.

Mr. Menne, present at this meeting also made an interesting talk as did our effervescent Chairman, John Stanish. We are grateful to Stanish for our fine programs.

Meetings at 8:15 P.M. on the second and fourth Friday of each month at John Stanish's place, 2500 Jos. Campau. You are welcome to visit us anytime.

F. Earl Oliver, *Secretary.*

Philadelphia-Camden Chapter

Officers for 1942 were elected, as follows:

Chairman—Harvey W. Morris
Vice-Chairman—Chas. A. Kuhns
Recording Secretary—Harold S. Strawn
Financial Secretary—Bert R. Champ
Treasurer—Chas. J. Fehn
Librarian—John McCaffery
Sgt.-at-arms—James Sunday

Mr. Morris is the fellow who has given us so many fine radio demonstrations. He is a thoroughly experienced radio man and will give us something worth-while at every meeting.

Mr. Straughn and Mr. Menne called on us recently. We welcomed them with an attendance of 76. Mr. Straughn gave us a splendid technical talk. Then he answered many questions. Menne, Kraft, Stokes and Fehn also spoke briefly. Five door prizes were awarded. Twelve new members joined the chapter. It was a lively session—a typical Phila-Camden meeting.

Our meeting place at 3622 Frankford Avenue, Philadelphia, is ideal for our purposes. We meet on the first and third Thursday of each month, at 8:15 P.M. Visitors are always cordially received.

Harold S. Strawn, *Secretary.*

———— *n r i* ————

On His Way

In a snowstorm in the Northwest, a train load of passengers became snowbound. One of the passengers finally managed to get to the depot and wired: "Will not be at the office today. Not home yesterday yet."

Keeping Records

For some time now I have been promising you details of how I keep my records. I have all such details for EVERY radio that I have repaired.

First, of course, I have each job numbered. Then comes the name and address of my customer. I note the date I receive the set. Then comes the name, model, and serial number of the set. If it is a console, I note whether or not it has a loop antenna. I always note the defect in red. I also note whether I brought the radio home, or whether I tested the tubes in my customer's home.

Cause of complaint—under this heading I note the defects in the set, which lead to the service call. Then comes "Time Required," and here I keep a fairly accurate account of the entire time spent on the set in collecting it, testing it, etc., until I return the set. The overhead expense fluctuates with the jobs at hand. In this overhead item I charge off the cost of my service instruments, car, light, etc.

Then comes a record of how I billed my customer. Here I list my cost of parts installed and the charge I made to my customer for these parts, including my profits. Finally, I note when I returned the radio, and when the bill was paid. My record is rather complete, and none of my customers can say I made an unfair charge for this or that for servicing their set because my record will prove different.

HARRY C. REED,
Steelton, Penna.

— n r i —

Likes Articles

Mr. J. B. Straughn's article "The Analysis of an A.C. Superheterodyne," is a masterpiece and Mr. J. A. Dowie's article, "A Typical Receiver Diagram and How to Analyze It," could not have come at a better time for me. It is very simple to follow and understand.

JOHN F. KIRK,
Spencer, Iowa.

Service Charges

Although I did not hear John F. Rider on the air over WABC—N. Y., his article in the *News* impressed me very much. If we could take time to explain the vast improvements and versatility of modern receivers in comparison with older types, I am sure there would be less dickering over service charges.

BEN KORKLAFSKY,
Brooklyn, N. Y.

— n r i —

Stanish and Oliver

I think we have two mighty fine fellows in our Detroit Chapter in the persons of Chairman John Stanish and Secretary F. E. Oliver. They both take a keen interest in the Chapter and do everything possible to make it interesting and instructive. And I think they are doing a mighty good job of it too.

HARRY R. STEPHENS,
Detroit, Mich.

— n r i —

Wants Jay and Ozzie Again

What has become of Jay and Ozzie? Hope that the draft has not caught them. I think we could stand a good radio yarn every now and then.

PETE J. VARGAS,
Los Angeles, Calif.

— n r i —

Static Neutralizer

The United States Tire Company is manufacturing a product called "Automotive Static Neutralizer," a powder which is injected into the inner tubes by means of a hand pump. One tablespoon of this product is applied to each inner tube. It does a very good job of eliminating wheel static. This must be used in conjunction with the static springs inside the hub caps. I find that it works!

PETER VAN BENDEGOM,
Grand Rapids, Mich.

Donald Duck Quacks for Sylvania

A new Sylvania Radio Tube display poster featuring Donald Duck and his little nephew is now available to radio dealers and servicemen. It is made in two sizes, 36" high for store windows, and 12" high for counters and small shops. The art work was done by the Walt Disney studios, and was reproduced by lithography in eight colors.

The bulletin announcing this poster reflects the whimsey and comedy of the characters portrayed. It says, "Uncle Donald Duck and his little nephew had been quacking wise about what a job they could do for Sylvania tubes. So we finally said okay, you ducks can be the featured bill this time, but if you fail, the duck soup's on you."

Write to Hygrade Sylvania Corp. Emporium, Penna., for particulars regarding these unique displays.

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