National RADIO-TV NEWS

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Have Courage

Many people think of courage as a quality to be called upon only in time of physical danger.

There are other forms of courage, kinds that most of us have greater need of.

All of us have some degree of courage. We can profit by using it in our daily lives. Here are a few suggestions for applying it in day-to-day living.

.... Have the courage to dream. The dreams of today can become the achievements of tomorrow.

.... Have the courage to plan. No one wins success without some kind of a plan, any more than one can sail a ship without a rudder.

.... Have the courage to try. Obviously, you cannot accomplish anything unless you try. You'll never know your own strength until you test it—and in the testing you'll increase it.

.... Have the courage to be different and to dare. This is the pioneer spirit behind every new advance. Not many years ago automobiles were painted only one color: black. One manufacturer dared to paint his cars in different colors. His sales made history.

.... Have the courage to grow. Grow in your job—always strive to do it better—and your opportunities will grow along with you.

You have the courage. Use it.

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James J. Kelly

WHAT TEST EQUIPMENT SPECIFICATIONS MEAN TO YOU

By JAMES J. KELLY
NRI Consultant

For every Radio servicing instrument made there are certain specifications that tell exactly what it will do and how well it will do its job. Most advertisements and brochures about an instrument include some, if not all, of its specifications. To men first entering the field of electronics, specifications often appear as a myriad of meaningless numbers and they are often overlooked. However, a thorough understanding of the meaning of the specifications is very important to the man who is about to purchase a piece of test equipment.

In recent years, the trend in some advertising has been to emphasize the superficial features and eye-catching gadgets which give no true indication of the ability of the instrument. Fortunately, there are basic specifications for instruments that tell precisely what the instrument will do and how well it will do it. It is these specifications that should be used as a guide in determining the best instrument to purchase. Actually, it is not difficult to learn to get the information you want from specifications, and this will enable you to judge for yourself the worth of a test instrument and how useful it will be to you.

Before going into the individual instruments and their specifications, let us set up two categories and place the test instruments in them. In the first category we will consider the instruments that are definitely needed in servicing work. Without these instruments it would be difficult if not impossible to handle many servicing jobs. In the second category, we will place the instruments that are helpful but not absolutely necessary. These are instruments that you will want when you have a considerable volume of business. Although you can get along without them, they do speed up servicing jobs, and when you start getting a large volume of business, speed in servicing is important. Needless to say, the instruments you must have are those with which we are most concerned. These are the instruments that you should get first.

The most basic instrument of all is the one with which you make voltage, resistance and perhaps current measurements. There are two basic types of Multimeters, as they are commonly called. The most popular is the Vacuum Tube Voltmeter (VTVM) and it has almost entirely replaced the older Volt-Ohm-Milliammeter (VOM). The chief difference between the two is that with the VOM, current from the circuit under test actually flows through the meter movement. The VTVM meter draws its current from a special vacuum tube which in turn is operated from the circuit being tested.

A low sensitivity VOM will be of little use in many measurements even though it would at first appear that the instrument can be used to do the job. The *sensitivity* of a VOM is a specification of prime concern. Sensitivity is measured in ohms per volt; let us see exactly what this means and what this tells us. Sensitivity depends on the basic range of the meter around which the instrument is built. The less current the meter must take from the circuit under test the greater its sensitivity and the less it will change actual circuit voltages. The ideal meter would need no current to operate and connecting it to a circuit would cause no change in the circuit voltage.

Simpson Model 260 VOMA

The meters used in all VOM's deflect in accordance with the current that flows through their coils. From this we can draw up a system of indicating sensitivity in which we state how much current must pass through the coil to cause the meter to deflect to the full scale position. This will give us an indication of the load put on the circuit by the voltmeter. A particular meter might require 1 milliampere of current through its coil to cause it to deflect to the full scale position. We would call this a 1-milliampere movement. Another meter may require 10 milliamperes of current for full scale deflection. This is a 10-milliampere movement. Clearly the meter that will deflect to full scale with only 1 milliampere of current is ten times as sensitive as the meter that requires 10 milliamperes of current.

This system of measuring the sensitivity seems simple to understand and to be accurate. Therefore you may ask, "Why go to more complex systems of indicating sensitivity?" The current drawn by the meter is variable because it depends on the amount of voltage being measured. The meter resistance, which loads the circuit, is not affected by the voltage under test and is constant for each range of the meter. The resistance is given in terms of ohms per volt. This does not refer to the voltage being measured but to the range of the meter. The meter resistance is equal to the highest voltage on the range multiplied by the ohms-per-volt rating. The higher the meter resistance the less loading there is on the receiver circuit. Therefore, the meter with the highest ohms per volt is the most sensitive.

If we wish to advance the range of the voltmeter so that a higher voltage will be indicated by a full scale deflection of the meter, the internal resistance of the measuring device must be increased proportionately. For example, let us suppose we have a meter with a 1-milliampere movement. This is a 1000 ohms-per-volt meter. If we wish to have 3 volts indicated by a full scale deflection of the meter, the internal resistance of the measuring device must be 3000 ohms. If we wish to advance this voltage range so that a full scale deflection of the meter indicates 30 volts, we must increase the internal resistance of the measuring device to 30,000 ohms. The internal resistance of a measuring device has then increased proportionately with the increase in the voltage range. You will notice that when 3 volts is applied across the internal resistance of 3000 ohms and when 30 volts is applied across the internal resistance of 30,000 ohms, the current that will flow through the measuring device will be 1 milliampere in each case which is the amount of current required for a full scale deflection of the meter.

Since the number of ohms per volt is determined by the amount of current that the meter must have for full scale deflection, and the amount of current is in turn the factor that controls the sensitivity, we can measure the sensitivity in terms of ohms per volt.

Now then, let us get to the big question of why sensitivity is important. The fact of the matter is we are not really concerned with how small a quantity the instrument will measure. In normal servicing work there is no problem of attempting to measure a voltage that is so small the meter range is not low enough to measure it. The important thing is that the internal resistance of the meter is in proportion to its sensitivity. More sensitive meters will have a greater internal resistance. This internal resistance indicated by the ohms-per-volt rating is vitally important in determining in what circuits the meter can be used.

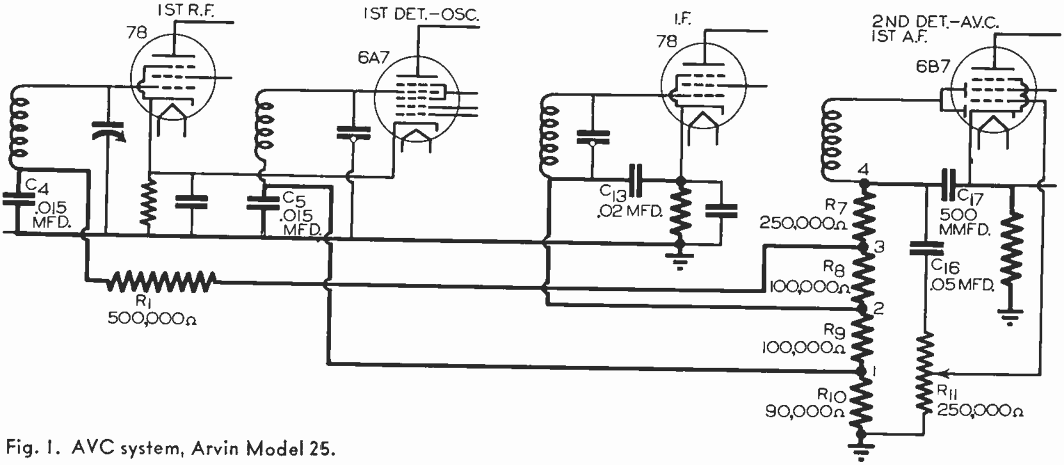


Fig. 1. AVC system, Arvin Model 25.

Never lose sight of the fact that when you connect a voltmeter across a circuit you are actually connecting an additional resistor across the circuit. The value of this resistor is the internal resistance of the meter. The basic law for parallel circuits tells us that in any parallel circuit the over-all resistance will be lower than that of the smallest single resistor. In the case of an insensitive meter, its internal resistance will be relatively low. If you attempt to measure voltage in a circuit fed through a high value of resistance, you will be connecting the low internal resistance of the meter across the circuit and causing a higher than normal flow of current through the series resistance. The over-all resistance of this parallel combination will be low, lower than the internal resistance of the meter. You will have greatly altered the resistance of the circuit in which you are attempting to make a measurement, and as a result, the circuit voltage will change because of the increased voltage drop across the series resistance. The voltage measurement that you make under this condition is of little use.

For example, let us look at the diagram of the Arvin Model 25 auto receiver shown in Fig. 1. This is a simplified diagram showing only the avc system. You will notice in the second detector-avc stage, that there is a voltage divider made up of resistors R7, R8, R9 and R10. This divides the avc voltage so that different voltages are applied to the grid circuits of the three controlled tubes. Let us suppose you wanted to measure the dc-avc voltage that is applied to the control grid of the i-f amplifier stage and you have a voltmeter with a sensitivity of only 1000 ohms per volt. Since this voltage is quite low, you must use the 3-volt range of the meter. When the 3-volt range of a 1000 ohms-per-volt meter is used, the internal resistance of the meter becomes 3000 ohms. Now then, when this meter is connected from point 2, its internal resistance is in parallel with R9 and R10. So you see, in making the voltage measurement you have connected a resistance of 3000 ohms in parallel with the resistance that is normally between point 2 and ground which is 190,000 ohms. By using the basic formula of parallel circuits we find that when 3000 ohms is connected in parallel with 190,000 ohms, the over-all resistance of the parallel circuit will be 2950 ohms. Therefore, when the 1000 ohms-per-volt meter was connected across the grid of the i-f tube and ground, the resistance between point 2 and ground in the voltage divider was reduced to less than 2% of its normal value. This drop in the resistance between point 2 and ground will completely upset the voltage divider so that the voltage division that takes place across it is totally incorrect. As a result of this, any voltage measurements that you take in the system under these conditions are completely worthless. As a matter of fact, in this specific case connecting the low sensitivity voltmeter across the grid of the i-f tube and ground will result in the dc voltage that is normally present here disappearing.

Now let us look at this same circuit when we are using an extremely sensitive voltmeter with an input resistance of approximately 100,000 ohms. When we connect this meter into the circuit, we are connecting a resistance of 100K ohms across point 2 and ground. When 100K ohms is connected in parallel with 190,000 ohms, the over-all resistance of the parallel circuit becomes 66,000 ohms which is only a moderate change in over-all resistance. From this example, we can see that there will be situations in which a meter with low sensitivity cannot be used in making measurements in a particular circuit.

A top quality VOM for servicing work will have a sensitivity of 20,000 ohms-per-volt. There are more sensitive instruments than this, but these are not generally used in service work. They are used in laboratories. There will be few instances in which this high sensitivity will not be adequate. You will usually find that the ac sensitivity of meters is lower than the dc sensitivity. You need not be concerned about this, because you will seldom have need of measuring ac voltages in high impedance circuits. AC sensitivity is also measured in ohms per volt.

A VOM with a sensitivity of 10,000 ohms-per-volt is moderate in its sensitivity, and a sensitivity of 1000 ohms-per-volt is the minimum sensitivity that can be accepted for most Radio work. A 1000 ohms-per-volt meter will be limited in its use. In most circuits, the low sensitivity meter will not rènder the circuit completely inoperative. However, it will upset the normal balance of the circuit to some degree causing an appreciable variation in voltage which may suggest a defect that does not exist.

In addition to the sensitivity of a VOM, there are a number of other specifications that we must consider. The meter should be capable of measuring voltages to at least 600 volts in several overlapping ranges. You can expect to meet voltages within this range in normal servicing work. Higher voltages can be measured with a special probe.

The specifications will give the resistances that the ohmmeter in the instrument is capable of measuring. There will be a maximum limit of resistance beyond which the meter cannot measure. The resistance range of a VOM will be directly proportional to its sensitivity. The specifications will also tell you if the instrument will make decibel measurements. This type of measurement is of minor importance and a serviceman should not be influenced by the presence or absence of a db scale. Another factor is the various current ranges that the instrument will handle. Because the busy serviceman will not take the time and trouble to make current measurements the presence or absence of current ranges is of little importance.

If the sensitivity of a VOM is not given, do not consider buying the instrument. VTVM sensitivity is constant regardless of the range used so with it the ohms-per-volt method of indicating sensitivity is not used. Do not consider an instrument to be a VTVM because no ohms-per-volt rating is given. Such an instrument is probably a 1000 ohms-per-volt VOM. A power cord showing around the instrument does not mean it is a VTVM. You will know this only if the specifications state that the instrument is a VTVM.

In the past decade the vacuum tube voltmeter has come into prominence because of its very high sensitivity and has practically replaced the VOM. In a vacuum tube voltmeter the voltage under test is applied through a voltage divider to the grid circuit of a vacuum tube. The vacuum tube is then used to drive the meter. Comparing this to the basic voltmeter in which the voltage under test is applied directly to the meter movement through a series resistance will tell us much about the characteristics and specifications of a VTVM.

In a conventional VOM, the sensitivity of the instrument depends solely on the quality of the meter movement. This is not so in a VTVM. Since the meter movement is separated from the voltage being measured by a vacuum tube, the rating of the meter movement no longer determines the sensitivity. A relatively inexpensive meter can be used in a vacuum tube voltmeter circuit, and the test instrument will still have high sensitivity.

Since the voltage under test is applied to the grid circuit of a vacuum tube, you would expect a sizable increase in sensitivity. This is definitely so. We said earlier that when we speak of meter sensitivity we are primarily concerned with how much resistance the meter presents to the circuit in which the measurement is made. Meters with higher sensitivity present a higher resistance to the circuit and thereby draw less current from the circuit. We will find that the average VTVM has an inupt impedance of at least 11 megohms on all ranges.

This impedance is considerably greater than the input resistance of 60,000 ohms which is present in the best VOM (20,000 ohms-per-volt) when used in the 3-volt range. From this it can be seen that the outstanding characteeristic of a vacuum tube type voltmeter is its high sensitivity. Since the meter is separated from the voltage under test by a vacuum tube, the input resistance of the meter no longer changes when you change the meter range. There is no longer a direct relationship between the voltage being measured and the internal resistance of the meter, because in a VTVM we do not rely on the amount of current flowing through the instrument to give an indication of the voltage present. A vacuum tube grid circuit responds to voltage alone. Instead of an ohms-per-volt rating, the sensitivity of a VTVM is referred to merely in terms of the input resistance. The higher the input resistance, the more sensitive the VTVM.

In a VOM, the input resistance changes when you change the voltage rating. The instrument is least sensitive (its internal resistance is lowest) on the lowest voltage range. This situation is definitely not so in the case of a vacuum tube type voltmeter. Its internal resistance remains the same regardless of the voltage range. A typical vacuum tube voltmeter will have an internal resistance of 11 megohms when set up to operate in the 3-volt range and will also have an internal resistance of 11 megohms when set up to operate on the 600-volt range.

The specifications for a VTVM will also tell you the various voltage ranges. Just as with the VOM, it is desirable that the instrument be capable of measuring voltages at least as high as 600 volts. The specifications also tell the ac voltage ranges, and whether or not the instrument has a peak-to-peak scale in addition to an rms ac scale. Actually, this is of minor importance. If an instrument has only an rms scale and you wish to know the peak-to-peak voltage all that is necessary is that you multiply the rms value by 2.8. If the ac voltage present is not a pure sine wave, the peak-to-peak value that you obtain by multiplication will be in error. This means that such an instrument cannot measure the various peak-to-peak voltages in TV receivers. For this purpose a cathode ray oscilloscope is used. Thus a peak-to-peak scale based on the rms ac scales is just an extra feature. There are special VTVM circuits which will measure peak-to-peak voltages with any wave shape but the added expense is questionable since the cathode ray oscilloscope not only measures the voltage but also shows the wave shape and since you might have the correct voltage with the wrong wave shape, such a measurement could lead you away from rather than towards the trouble. However, don't turn down an instrument because it has a peak-to-peak scale because they can be useful.

VTVM specifications will indicate the various ohmmeter ranges. You will find that the maximum resistance that a VTVM will measure will be far higher than the maximum resistance that a VOM will measure. This is to be expected since the VTVM is far more sensitive. You will be told whether or not the VTVM has a decibel scale. Ordinarily the more features the instrument has, the better. However, little weight need be given to this in evaluating various instruments. The average serviceman has little use for a decibel scale. A similar situation is true of a zero center voltage scale. If a VTVM does not have a special provision for zero center operation, this mode of operation can be obtained simply by bringing the indicator to the mid-scale position with the zero control knob. A voltage polarity reversing switch is a useful feature found in practically every VTVM. By use of this switch, you can measure either positive or negative voltage without reversing the test probes. This will allow you to leave the ground probe attached to the chassis on which you are working. Another useful but not essential feature is whether or not the VTVM will measure current. Most VTVM's do not have provisions for measuring current. This is not important since you can always determine current by measuring the voltage across a resistor and using Ohm's Law.

In both VOM's and VTVM's an important feature is simplicity of operation. You will want to give full attention to the servicing job at hand and a minimum of attention to manipulating the test instrument. For example, it is best to have two test leads instead of three; the fewer scales on the meter face the better.

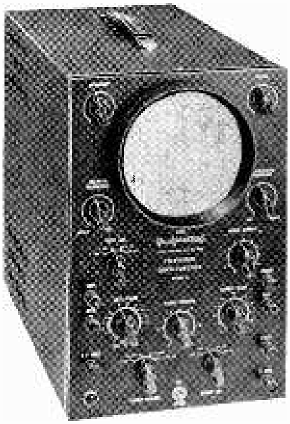
The balanced bridge circuit is the most stable VTVM circuit. The tolerance of the resistors in the instrument tell you the accuracy. Do not confuse accuracy with sensitivity. Sensitivity, which is the most important of the two, tells you how much the instrument will load down the circuit in which a measurement is made. Accuracy on the other hand tells how much error you can expect in the measurements. This is dependent primarily on the tolerance of the resistors used in the voltage divider and the meter accuracy. This is true in VTVM's and VOM's. If the instrument will measure within 5% of the actual voltage under test it is quite accurate for service work.

There is one thing you should know about accuracy ratings. They refer to the full scale range of the meter. If you are considering the 100-volt range of a ±5% instrument, the greatest possible error is 5% of 100. To work this out multiply 100 by .05 which is equal to 5 volts. The error will be 5 volts *anywhere* on this range. The meter may read 5 volts higher or 5 volts lower than the actual voltage under test. Best accuracy is obtained when you use a range giving near full scale deflection. However, in service work this is of little importance. Due to the tolerance of the parts in the circuit under test, voltage variations of 10% or 20% from receiver to receiver are common. The main purpose in measuring a voltage is to see if there is no voltage or a big change in voltage, which will point to a possible defect. Sensitivity is a much more important rating than accuracy.

VTVM's and VOM's also have frequency response. When used as ac meters there is a maximum and a minimum frequency which the instrument can measure accurately. Little attention is given to the minimum frequency because virtually all instruments will measure frequencies as low as 20 or 40 cycles, and the serviceman has little need for measurements of frequencies below this. If it is frequently necessary to measure rf voltages, you should use an rf probe with the meter and not rely on the instrument by itself to make the measurement. All basic instruments will have a tendency to be inaccurate at high rf frequencies. Moreover, the input capacity of the VTVM or VOM will have a bad effect on rf circuits in which measurements are made.

A frequent question asked today is "Which is the best instrument, a VOM or a VTVM?" By considering the specifications and the basic principles of operation, we can see that each instrument is best suited for a particular type of work. The VOM is highly portable. There is no power cord to get in the way or necessity for a power outlet. No warm-up time is required and no preliminary adjustment of the meter is required. A good VOM is sufficiently sensitive to be used in most circuits. All of these factors point out that the VOM is highly suitable in situations where the serviceman will be moving about and working at different locations.

The prime advantage of the VTVM is its very high sensitivity. This is particularly desirable when working in many high impedance TV circuits, avc, and grid circuits. Also, the VTVM cannot be seriously damaged by improper use, whereas improper use of a VOM can result in the very expensive milliammeter being burned out. These factors point out that the VTVM is a more desirable instrument in situations where it will remain on one workbench and there is little need for portability.



Model 56 NRI Professional TV Oscilloscope

In the case of VTVM's sold in kit form, you will be told whether or not a printed circuit is used. A printed circuit makes the kit easier to assemble. However, it also makes the instrument much more difficult to repair in the event that it becomes defective. The use of the printed circuit has little bearing on the performance of the instrument.

When the serviceman progresses from Radio servicing to Television servicing, the oscilloscope becomes very essential. A loudspeaker will give no satisfactory indication of the presence of a video signal, sync pulse, or sweep signal. In TV, the oscilloscope must be called upon for signal tracing; it will give a visual display of the signal. Not only is the oscilloscope important in checking circuits in which the video signal is present, but it is even more important in checking the sweep and synchronizing circuits. You are not only concerned with the presence of signal in these circuits but also the waveform of the signal. Only an oscilloscope will show you the shape of the voltage present.

An oscilloscope has numerous characteristics that must be considered. All of these characteristics are described in the specifications for the instrument. Here again a prime consideration is the sensitivity. However, the sensitivity of an oscilloscope gives no indication of its input impedance. The input impedance of an oscilloscope is described independently of the sensitivity. The input impedance of an oscilloscope will be lower than that of a VTVM. When we speak of sensitivity in an oscilloscope we are referring to how small a signal can be displayed on the instrument. We measure this in terms of volts per inch. In other words, how many volts of signal is required to cause a 1-inch deflection on the screen of the oscilloscope. The smaller the voltage required for a 1-inch deflection, the more sensitive the instrument. Good oscilloscopes for TV servicing should have a sensitivity of 35 millivolts (.035 volts) per inch or less. The NRI Professional Wide-Band TV Oscilloscope for example has a sensitivity of 14 millivolts per inch. In all cases, we are speaking in terms of rms volts and not peak-to-peak volts. Oscilloscopes can give an indication of extremely low voltages because they contain amplifiers through which the signal must pass before being applied to the cathode ray tube.

Another highly important factor is the frequency response. This does not merely tell us what frequencies will be handled by the instrument, but more specifically what frequencies will be handled uniformly. It is desirable that the instrument not only be capable of handling certain frequencies, but also that it handle them equally well. If the instrument passed some frequencies more efficiently than others, frequency distortion would take place, and the display on the cathode ray tube screen would be distorted accordingly. Flatness of response is measured in decibels. This is simply a special method of comparing two quantities. In indicating how flat the response is, we merely compare the maximum amplification that the signal at some frequency will receive to the minimum amplification at some point within the scope frequency range. When the maximum amplification is no more than 40 per cent greater than the minimum, we say that the comparison of the two is 3 decibels. The variation in amplification in a good oscilloscope should not be greater than 3 decibels throughout the frequency range if the frequency response is to be essentially flat.

For example, a top quality oscilloscope such as the NRI scope that I have mentioned earlier has a frequency response within 3 decibels from 10 cycles to 4.5 megacycles. This does not mean that signals whose frequency is above 4.5 megacycles will not be passed. However, it does mean that the amplification that these signals receive will be considerably less than the amplification given to signals within the frequency range of the instrument. Beyond 4.5 megacycles, the variation will be greater than 3 decibels. A video (television) signal will have frequencies as high as 4.5 megacycles. If an oscilloscope is to display video signals without frequency distortion, it too must have a frequency response up to 4.5 megacycles. Some oscilloscopes will have frequency responses that are short of 4.5 megacycles. If the oscilloscope has a frequency response of at least one-half megacycle, it can be used in television work. However, the frequency response of the instrument tells us that it will distort the signal. In regard to distortion, it is also desirable that the oscilloscope have a push-pull output stage. The even harmonic distortion is reduced appreciably by the use of a push-pull stage.

For television work, it is very desirable that the sweep circuit can be adjusted either to the vertical or the horizontal frequencies of the television signal. This means that it must be able to go down to 60 cycles and up to 15,750 cycles. Virtually all commercial oscilloscopes have frequency responses in excess of these limits.

There are, of course, numerous other factors about an oscilloscope indicated in the specifications, but sensitivity and frequency response are the foremost and the specifications that should be considered in selecting an oscilloscope.

The next item that falls into the category of essential test instruments is the signal generator. A serviceman will need this instrument if he is to align a set, either Radio or Television. Alignment can seldom be done without this instrument. For general servicing work, the requirements on the quality of a signal generator are not as stringent as those on the other instruments that we have discussed thus far. There are just a few factors that must be taken into account in determining what a signal generator will do for you. Most of these factors are readily apparent.

The first and most obvious characteristic is the range of frequencies which the instrument will cover. It is obviously desirable that the instrument will go down to 200 kilocycles which takes in the i-f frequencies of some automobile broadcast receivers. The high frequency limit of the signal generator is the item to which special attention should be given. In signal generators not intended for Television work, the maximum frequency produced may be below 30 megacycles. A signal generator should go to at least 65 megacycles if it is to be used in Television alignment. It is not necessary for the signal generator to produce frequencies in the Television broadcast band, since signal generators are seldom used to align the front end of a TV set. It is the television i-f frequencies that are necessary.

It is desirable that the signal generator go up to 60 megacycles in fundamentals and not in harmonics. When I say going to the frequency in fundamentals I mean that the frequency of the signal at the output of the signal generator is the actual frequency being created in the oscillator within the signal generator. In some cases, the output of the signal generator will not be the same as the frequency of the oscillator within the signal generator, it will be a harmonic. The second harmonic, which is most often used, is exactly twice the frequency of the fundamental. Thus if the signal generator is set to produce a frequency of 30 megacycles it is also feeding a 60-megacycle signal to the circuit. Harmonics are always weaker than fundamentals.

Model 89 NRI Prof. AM-FM-TV Signal Generator and Marker

The next important item to consider is the output. A number of signal generators that have been tried have been found to have very low output which limits their use. Unfortunately, this information is seldom included in the specifications of an instrument. The best procedure here is to purchase the instrument from a reliable source. The output of the instrument should go to at least .1 volt (100 millivolts). For TV alignment, 1 volt is desirable.

The accuracy of a signal generator is also important. It is figured for the highest frequency on each range just like a VOM or a VTVM. Additional factors to look for in a signal generator are that both modulated and unmodulated signals are available and there are two attenuators, coarse and fine.

There are, of course, numerous other signal generators such as square wave generators, television linearity generators, etc. However, these generators designed for unique jobs are not essential in a service shop, and since this is so we will not consider them at this time.

One of the first items that many men think of when they first enter Radio work is the tube tester. Actually, it is a matter of debate whether or not a tube tester is an essential instrument. Although a voltmeter is absolutely essential, servicing work can be done without a tube tester. This brings us to the fact that in modern servicing work, a great deal of tube checking is done not with a tube tester but by substitution. The serviceman instead of having a tube tester has a complete stock of tubes that he expects to encounter in a set. If he suspects that a tube is bad he tests it by substituting a brand new tube in its place. This practice is particularly prevalent in TV service calls. Most technicians carry a full

(Continued on page 23)

How To Follow-Up TV Receiver Trouble Symptoms

By JOE SCHEK

NRI Consultant

Joseph Schek

The successful and experienced service technician strives to develop a direct, fast approach in servicing television receivers. To do this he must be thoroughly familiar with the probable causes of various symptoms so he can concentrate his efforts on the defective stage or section. In TV work part substitution is used far more than in radio work but this is not an aimless trial of new parts. From his knowledge of TV circuitry the serviceman knows that a certain defect in a certain part will result in a particular trouble. A new part is often tried because when operating voltages are not applied, routine tests may not show up the part defect. This test procedure requires an adequate stock of replacement parts. Here we will discuss general trouble-shooting steps as determined by analyzing the symptoms and using effect-to-cause reasoning.

Sound, but No Raster

Lack of high voltage is the most common cause for no raster on the picture tube. The development of high voltage depends on proper functioning of the following stages that comprise the sweep section; horizontal oscillator, horizontal output, high voltage rectifier, and the damper stages. The usual arrangement of these stages is shown in Fig. 1.

For good over-all performance of these circuits the B+ output from the low voltage supply must be normal. In this case the low voltage supply furnishes 250 volts.

Making top chassis tests first is easiest and may uncover the cause of the circuit trouble. Check to see that all filaments glow and that the ion trap has been correctly set. Test for picture tube high voltage by using a long screwdriver blade to contact a support bracket. Then slide the blade along until the end is close enough to the picture tube high voltage connection to permit an arc to jump across the gap. A normal arc here is usually about one-quarter of an inch long. Should a strong arc be evident then suspect either the picture tube or incorrect voltage on the various picture tube electrodes. Figs. 2A and 2B show the circuits normally found in the picture tube signal and low voltage supply systems.

To check the picture tube circuits carefully remove the picture tube socket (hold the tube base to resist the socket pull) and measure the tube cathode voltage at socket pin 11 and grid two which is socket pin 10. Place the meter positive test lead in the socket hole and the negative test lead on the chassis to take these measurements. Normally, the voltage at grid two should be about twice that at pin 11.

Excessive voltage at the cathode will increase the negative control grid to cathode voltage and prevent the electron beam from reaching the screen. Either excessive or insufficient cathode voltage will be a result of a shorted input video coupling condenser or a faulty video amplifier output tube.

When there is no high voltage between chassis and the picture tube anode, substitution of the horizontal sync and sweep tubes as well as the high voltage rectifier tube in Fig. 1 is your next step. Unfortunately, a tube checker is not always reliable when checking the tubes in these circuits. The set itself, therefore, becomes the tube checker and the set response will indicate

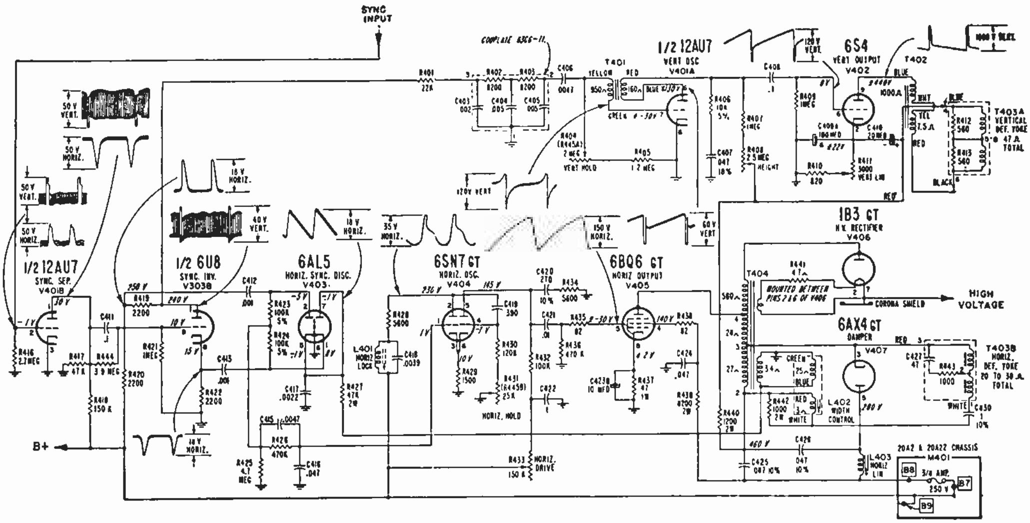


FIG. 1. The sync and sweep circuits of a typical TV receiver.

the condition of the replaced tube. In addition to horizontal sweep tube substitution, do not overlook the low voltage rectifier, video output and sync discriminator tubes. A weak rectifier (tube or selenium) will fail to provide enough voltage for the horizontal sweep system and the high voltage will be low or absent entirely. A faulty video output tube may increase the picture tube bias and cut off the electron beam. A faulty, sync discriminator tube may prevent the oscillator circuit from functioning. When tube and, if necessary, fuse substitution does not produce either high voltage at the picture tube anode or an arc at the high voltage rectifier plate cap then circuit operation and circuit components shall be checked next. Incidentally, if the set you are servicing is a 17-inch Motorola, check for a burned out 100K resistor connected across the horizontal yoke winding and located immediately behind the cardboard yoke cover.

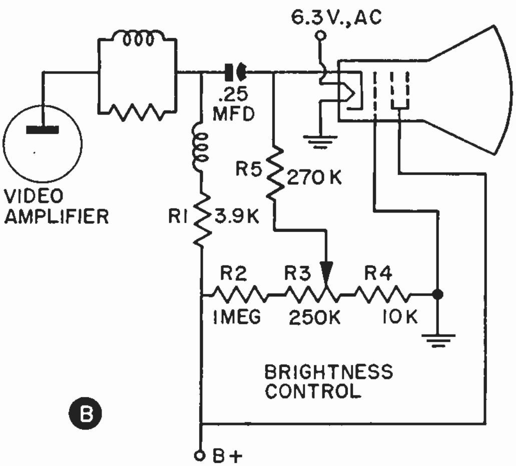


FIG. 2A. Capacitively-coupled picture tube showing brightness control.

Remove the set chassis and expose its circuit wiring. If necessary, use wood blocks as supports when tilting the chassis over on its side. Turn the set on and set the voltmeter for a negative dc voltage with the Range switch set to 100 volts or its closest equivalent. Temporarily remove the horizontal output plate cap and measure the bias voltage across the grid leak of this stage. This resistor is R436 in Fig. 1. In seeking to localize the stage that has the circuit defect, this key measurement is very important in indicating whether the trouble lies

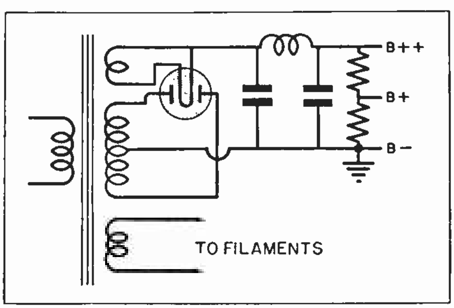


FIG. 2B. Basic low voltage full-wave rectifier circuit.

in the horizontal oscillator stage or in the horizontal output circuits. This output drive voltage can only be supplied when the horizontal oscillator is operating properly. Normal voltages may vary between 20 and 30 volts negative; no voltage will be present if the horizontal oscillator is not working.

If there is normal drive voltage across the horizontal output grid leak then take another drive voltage reading with the horizontal output plate cap replaced. If the drive voltage decreases more than half, then you can be reasonably certain that a defective flyback transformer or

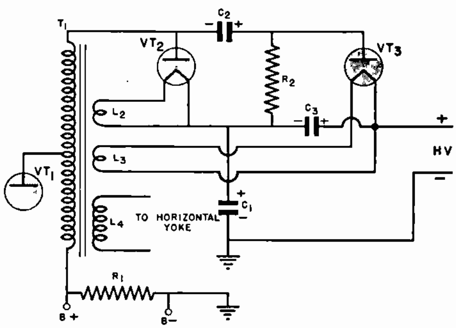


FIG. 3. A voltage doubler circuit.

possibly a defective yoke is killing the high voltage. Unless you have access to a flyback and yoke tester, substitution of these parts is the only positive way of checking their condition. Other possible power failures that should be thoroughly tested in the horizontal output stage include the screen resistor, screen bypass condenser and cathode resistor. These parts are shown as R439, C424 and R437 respectively in Fig. 1.

The damper circuit includes the horizontal linearity coil R403 and its boost condensers C425 and C426. Carefully inspect the coil for evidence of overheating or an open circuit and check the condensers for a possible short. Since the voltage developed across the boost condensers will contribute to the proper voltage for the horizontal output, keep in mind that an open boost condenser will reduce the normal horizontal output voltage.

All high voltage rectifier filament circuits consist of several turns of well-insulated wire coupled to the flyback transformer. Only when high voltage is present in the flyback will sufficient filament power be available for the rectifier filament. Note that should R441 open, no current will flow in the rectifier filament.

Some high voltage rectifier circuits use a 500K to 1-meg filter resistor in series with the picture tube anode lead. Should this resistor open, the symptoms will be: normal ⅜-inch arc at the high voltage rectifier plate and rectifier filament glow but no picture tube anode voltage.

Frequently you will come across high voltage doubler or tripler circuits using at least two high voltage rectifiers. Typical high voltage doubler and tripler circuits are shown in Figs. 3 and 4. A common trouble with these circuits consists of failures in the high voltage filter condensers and the high value isolating resistors. These resistors, R2 in Fig. 3 and R1-R2 in Fig. 4, generally have a value of 2 megohms. Though a defect in these parts may not show up in normal testing, it is accepted service procedure to try new parts to find the condition of each suspected filter condenser and isolating resistor. The symptoms if a defect exists in these resistors and condensers would be normal horizontal output grid drive and a fairly respectable arc at the plate of the first high voltage rectifier which connects directly to the flyback transformer. However, there will be very little high voltage at the plate cap of the next high voltage rectifier tube. With these symptoms, you should strongly suspect either one or all of the filter condensers as well as the isolating resistor. Substitution of the defective parts will restore high voltage.

Returning to the horizontal oscillator stage in Fig. 1, should no drive voltage be present across R436 (with or without the 6BQ6 plate cap connected) proceed to test the circuits and components that make up the horizontal oscillator stage. An open in any of the following plate

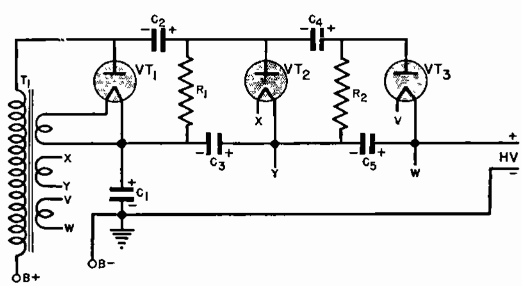


FIG. 4. A voltage tripler circuit.

loads—L401, R428, R432 and R433—will disable the oscillator. A shorted decoupler, C422, will remove plate voltage. When testing resistors, be on the lookout for a change from the color-coded or marked value. As an example, you may find a resistor marked as 10K measuring 1 meg or more. When you do, don't suspect your ohmmeter—install a new resistor. When the horizontal oscillator stops, a negative voltage will not be developed across the grid resistor of the horizontal output tube. As a result the plate current will rise until the plate of the horizontal output tube glows a cherry red. Since the horizontal output tube and flyback transformer can be damaged by this excessive current flow, do not operate the defective circuit longer than necessary to make tests.

Another less common cause of excessive horizontal output current is leakage in coupling condenser C421. This places a positive voltage on the control grid of the horizontal output tube. When narrowing down the possibility of component failure in the horizontal oscillator circuit, test by substitution the horizontal lock coil L401 and the horizontal sync discriminator input condensers C412 and C413. Any partial short in the horizontal lock coil or these condensers will disable the circuit.

Low B supply voltage will prevent normal horizontal oscillator operation and may be caused by either a weak rectifier tube or selenium rectifiers. Measure the power supply output and compare your values with the service data.

Horizontal Width Troubles

Inadequate width is almost always caused by either a weak low voltage rectifier, damper, horizontal output or horizontal oscillator tube. If new tubes don't bring the width out to normal, I have usually found the trouble to be due to the following defects: change in value of the horizontal output tube screen grid resistor, reduced efficiency of the flyback transformer, defective horizontal linearity coil or its boost condensers and a shorted horizontal yoke winding.

A fault in the yoke horizontal winding will produce the "keystone" effect where the raster will be wider across either top or bottom as compared with the other end. This will clearly indicate the need for a replacement yoke. Remember that each yoke is designed to both correctly match a given type of flyback transformer and also to provide the required picture tube beam deflection. An incorrect replacement yoke will straighten the raster sides but the picture will be too narrow.

When substitution and tests have proven that the circuit components are not at fault, try the following circuit modifications, widely used by professional service technicians, to give increased width. The basis of these circuit changes is to reduce the picture tube anode voltage and in this way make it easier to sweep the picture tube beam.

Connect a .005-mfd, 600-volt paper condenser across the width coil; this should increase the horizontal width. High capacity values will increase the width but a point will be reached where the raster brightness is noticeably reduced at the same time. Experiment with several values and use the one that will allow the greatest width consistent with adequate brightness.

With some flyback transformer circuits, the width coil may be disconnected entirely to produce a width increase. In some model receivers, the manufacturer has placed a 68-mmf, 5000-volt ceramic condenser between chassis and horizontal output plate or between the cathode and plate of the damper tube. You can use this idea to increase the horizontal width, but be sure that the condenser is rated at 5000 volts.

Horizontal Instability

Horizontal bending due to weak sync pulses is usually caused by a faulty component in the sync circuit. The first step should be complete tube substitution of all tubes in the sync section as well as the tuner and video stages. Substitute the tubes one at a time and check the picture response after each tube replacement. Should tube substitution not improve the condition, carefully check the components in the horizontal oscillator and sync stages. Referring to Fig. 1, defects in the following circuit parts or their equivalent may well cause horizontal instability: C412, C413, C415, C417, C416, C419, C420, R422, R419, R423, R424, R426, R427, R429, R430 and R436.

Because the circuits involved are critical these components cannot undergo a change from their original value without affecting the proper performance of the television receiver. Professional servicemen use the part substitution method when testing components that are suspected of failing under actual circuit operation. A handy tester for rapid part replacement is the resistor and condenser substitution box. These are available in kit form from either the Heath Kit Company or from the Allied Radio Corporation.

Interaction between vertical and horizontal circuits may cause horizontal instability. This may be caused by faulty filters common to both circuits. For example, should C410 connected to the cathode of V402 in Fig. 1 open, the vertical pulse could affect the horizontal sweep and cause "bending" or "tearing" of the picture.

Poor horizontal hold accompanied by sharp lines running across the picture is usually caused by high voltage leakage. Hard-to-find leakage paths can in most cases be located by operating the set in darkness. Where the insulation of a nigh voltage lead has dry-rotted, and is arcing to a metal surface, replace the lead. Other leakage paths are found in high voltage condensers, or across its porcelain or composition support. Re-coating the picture tube for more positive grounding by applying a fresh coating of aquadag often helps reduce arcing.

Horizontal Frequency Drift

In most cases, horizontal frequency drift can be stopped by locating and replacing the faulty condenser in the frequency determining network of the horizontal oscillator or control circuit. These parts are located in the input control grid circuit of the oscillator stage, the 6AL5 sync discriminator and its associated parts. Horizontal oscillator coil circuits use a parallel connected condenser that if faulty changes the operating frequency. When replacing these condensers, use units of 5 per cent tolerance because of the critical operation of these circuits and the possibility of drift.

The synchroguide type horizontal oscillator uses two tuned circuits. One is called the oscillator frequency control and the other is identified as the phase adjustment. A common symptom requiring phase adjustment is the so-called Christmas tree effect where the picture intermittently breaks up in jagged fashion. Though most manufacturers recommend and prescribe a precise oscilloscope alignment of these tuned circuits, acceptable results may be obtained by carefully adjusting the horizontal phase control, a turn or less, until maximum stability is achieved. When satisfactory stability is obtained, the channels can be rapidly changed with no apparent loss of horizontal sync.

Vertical Sweep Troubles

A typical vertical sweep circuit is shown in Fig. 1. We see the input resistor R401 connected to the vertical integrator network (couplate 6.C6-11) which connects to the vertical oscillator transformer through C406. V401A is made to block at approximately 60 cps by adjusting hold control R404. The sync pulses fed through C406 cause the oscillator to lock in at the desired frequency.

The vertical oscillator is capacitively coupled to amplifier tube V402. The high plate impedance of V402 is matched to the low impedance yoke through vertical output transformer T402.

Other than tubes, complete lack of (or very little) vertical deflection is usually caused by a faulty vertical output transformer. Though its windings may show apparently normal resistance this is no positive indication of the transformer condition. Shorted turns in this or any transformer are almost impossible to detect with an ohmmeter. Here again part substitution is

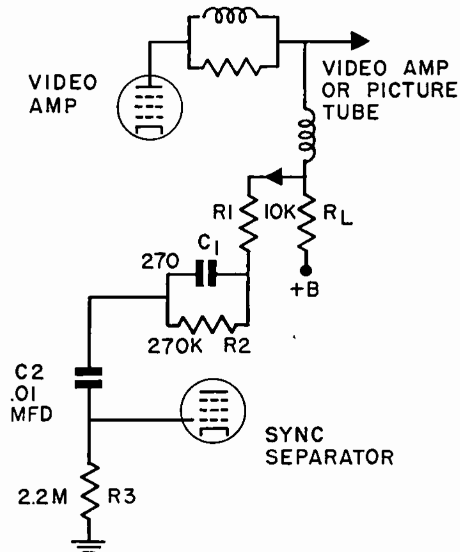


FIG. 5. Sync take-off method.

the only way of testing the condition of a suspected transformer.

A frequent complaint is a slow vertical roll after the set has been on for a length of time. This frequency change of the vertical oscillator could be caused by a gradual change in the values of the frequency determining parts. In Fig. 1, they are R404, R405 and C406.

A vertical roll may also be caused by a decrease in the amplitude of the vertical sync pulses. Before checking additional circuit parts for this trouble, substitute tubes in the rf amplifier, the video i-f amplifier, the video amplifier and agc tube and the sync tubes. Low emission in any one of these tubes, internal gas or heater-to-cathode leakage will clip or compress the sync portion of the incoming signal. Should it be necessary for you to test the circuit parts, after tube substitution has failed, start with the "printed" integrator circuit. Fig. 1 shows the equivalent individual part values of this integrator circuit, so that it should not be difficult to replace the entire circuit of the suspected network with separate parts.

The sync separator tube input is applied from the plate circuit of the video amplifier through a coupling condenser. Fig. 5 shows a typical sync take-off method. Where additional circuit testing is necessary, carefully check the sync stage, its coupling condenser, and compare the measured resistance values in this stage with the service data. Leakage in C2 of Fig. 5 will result in clipping of the sync pulses. Make sure that the voltage at the sync separator input grid is negative as shown at pin 2 of V401B, in Fig. 1.

Leaky condensers in the sync stage and off-value resistors are the most common causes, other than tubes, of abnormal sync amplification and separation. Instead of testing condensers for leakage with an ohmmeter, it is frequently more convenient to use a voltmeter. If one condenser lead is connected to a voltage point such as a plate circuit, temporarily disconnect the other or "cold" end. Now touch the negative dc voltmeter test lead to B— and the positive test lead to the free lead of the condenser. Any leakage in the condenser will cause a steady meter deflection. A momentary meter pointer flicker is normal and can be disregarded. Leakage of even a few volts through coupling condensers will prevent normal circuit operation.

Troubles in Video I-F and Detector Stages

Since the composite sound, video and sync signals pass through the video i-f, detector and video amplifier stages a variety of troubles arise as the circuits become faulty. The following symptoms are often found: Raster and No Picture; Picture Ringing (appearing as ghosts); Poor Vertical Synchronization; Picture Pulling; Lack of Picture Contrast; Sound Buzz; Negative Picture; Hum in Picture (dark horizontal bars); Intermittent Troubles; Smeared Picture.

Raster and No Picture. A dead video i-f tube, an open cathode or plate circuit will kill the picture and sound. Many modern TV receivers use the power audio amplifier as a B+ voltage dropping resistor to feed low plate and screen voltage to the video i-f stages. Fig. 6 shows the basic arrangement for this type of circuit. Any component failure in the audio output stage will, therefore, disable the entire video i-f strip. Component failure may include a faulty tube, shorted filter capacitor, leaky or open input coupling capacitor or open resistor.

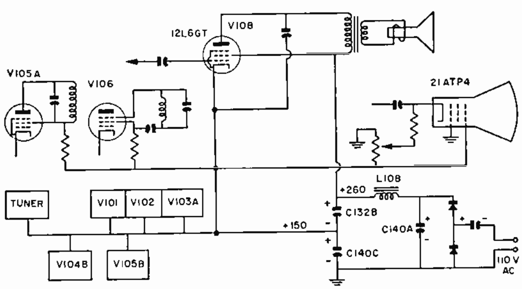


FIG. 6. Simplified diagram of circuit in which audio output tube is used as voltage divider for audio and video i-f's, tuner, and focus electrode of CRT. Loss of conduction in V108 will disable all of the tubes connected in its cathode circuit.

Picture Ringing. Ringing in the picture has the appearance of ghosts but will be more affected by the adjustment of the fine tuning control than true ghosts which are the result of more than one signal picked up by the antenna. With ghosts due to ringing, various settings of the fine tuning control change the number of extra images. The most common cause of ringing is a faulty video amplifier tube. However, an open condition in any decoupling or bypass capacitor in the screen, plate or cathode circuits will cause stage oscillation and resulting multiple images.

Poor Vertical Sync. Experienced servicemen have found that it is well worth while to substitute each tuner and video i-f tube when checking for a cause of poor vertical sync. Heater-to-cathode leakage or gas are common tube troubles that clip off the vertical sync pulses. Any circuit condition causing overloading will clip sync pulses. Stages with low plate or screen voltages, low bias voltage or open screen grid bypass condensers will easily overload and result in partial or complete loss of the vertical sync pulses.

Picture Pulling. Horizontal picture pulling is usually due to heater-to-cathode leakage. The defective tube may be in the tuner, video i-f, detector, video amplifier, sync or horizontal sweep circuits. Defective filter and leaky coupling condensers are frequent causes of picture pulling. Do not overlook the possibility that leaky coupling condensers between the video i-f stages will cause weak sync pulses to reach the oscillator sweep circuits and cause pulling.

Poor Contrast. Other than weak signal tubes, lack of picture contrast is due to faulty components in the video detector and amplifier circuits. Carefully check the continuity of the video detector and amplifier peaking coils. They sometimes open and can greatly affect the frequency response of the stages. A frequent offender causing a weak or no video condition is a complete or partial high resistance open of the video amplifier plate resistors. Do not overlook the video detector diode which may need replacing. Check to see if the video detector load has changed value.

Sound Buzz. Intercarrier buzz can be minimized by carefully readjusting the sound i-f discriminator transformer. Heater-to-cathode leakage, particularly in the mixer stage, will cause buzz or hum in the audio signal. In some receivers, buzz can be expected where the contrast is increased excessively. Look for a misadjusted audio or buzz level control in receivers using gated beam detectors.

Negative Picture. In a negative or reversed picture, the blacks show up as whites and the whites show up as blacks.

A faulty picture tube or a trouble within the video-amplifier stages are familiar causes of a negative picture. A negative picture that originates from trouble within the video i-f system will generally be caused by overloading of the last i-f stage or of the detector stage, but the actual source of the trouble may be in any of the stages.

Possible causes of a negative picture are: weak or gassy tubes in the i-f, detector or amplifier stages, low plate and screen voltage in an i-f stage or faulty crystal detector.

Hum in Picture. Dark picture areas accompanying sound distortion, picture pulling and poor vertical sync are almost invariably caused by heater-to-cathode leakage in one of the signal tubes. Of course, faulty power supply filters will permit signal modulation by the 120-cycle power supply ripple. This will produce two dark bars rather than a single bar caused by 60-cycle interference. The intensity of the shaded areas or bars depends upon the amount of ac getting into the signal circuits.

Intermittent Troubles. These troubles usually are more difficult to locate and correct because symptoms will not always be present during the operation of the receiver. Chief among the many possible causes of intermittent operation are: tubes, crystal diodes, loose connections, cold solder joints, resistors which have changed in value, and condensers that may open or short with temperature changes. Loose contacts either within a tube or part or faulty soldering will result in intermittent microphonics. Microphonic symptoms may be a thin ringing sound or a wave in the picture, corresponding to the varying signal. Tapping circuit parts and connections with the eraser end of a pencil will help to locate the cause of the microphonic condition.

Smeared Picture. Possible causes of smeared pictures are: a defective video i-f or video detector or faulty detector crystal as well as any change in the condition or values of the components used in the video detector amplifier stages. Some service records indicate that an open in the last video i-f cathode bypass condenser will affect the frequency response of this stage. Carefully check the condition of the video peaking coils and the plate load resistors as well as screen or other decoupling condensers. Keep in mind that poor frequency response of the video amplifier stages will also prevent full amplification of the sync pulses that are part of the composite signal. This may result in faulty operation of the sync separator and amplifier circuits.

AGC Faults

The agc circuit supplies varying control grid voltage for tuner and video i-f stages. This negative voltage should increase in value as the input signal strength increases and decrease as signal strength decreases. When the circuit does not act in this manner, overloading occurs with various disagreeable symptoms. These are excessive picture contrast, poor sync or under some conditions the video will disappear after several seconds of initial playing time. The agc control may be either ineffective or erratic in controlling picture contrast. In most cases, a faulty video i-f or agc tube will be responsible for the symptoms. However, should tube substitution not improve operation then carefully test, by part substitution, for leaky or shorted agc bypass condensers.

Leaky inter-video i-f stage coupling condensers or a partial short between i-f transformer windings will block normal agc operation. Carefully test the agc voltage and components connected to the agc line. A keyed agc tube conducts each time the flyback transformer feeds back a pulse. Coupling is usually through a flyback transformer winding or a section of the width coil. This winding or parts leading to the agc tube frequently fail and should be tested accordingly.

Sound Channel Troubles

Faulty sound discriminator transformers have a long history of producing distortion, fading and low volume. The ratio detector output circuit uses a low value electrolytic condenser that has been found to frequently become defective and cause low volume with excessive buzz. The first audio amplifier plate circuit may use a decoupling bypass condenser and resistor. You may find a defective part in this circuit causing very weak audio. As discussed previously, a faulty audio output tube or circuit may disable both the audio output and the video i-f sections whose plate supply is obtained from the cathode of the output tube. Careful realignment of the sound i-f transformers will do much in reducing audible sound buzz and hum.

Tuner Troubles

Considering their many points of mechanical stress and the high operating voltages, tuners give remarkable trouble-free service. However, tuner assemblies will require periodic service.

Most tuners use silver-plated switch contacts for low loss operation. Over a period of time the contact surfaces become tarnished or dirty and cause the picture and sound to show extreme instability. Picture flashing as the tuner shaft is manipulated is a common symptom.

Where contact surfaces are exposed, its shine may be easily restored by using an eraser to rub away the dirt or tarnish. With wafer decks a cleaner spray is of great help in doing a fast, effective job in reaching out-of-the-way switch contacts. This cleaner fluid should also be applied to points where the shaft touches the chassis to insure low loss grounding.

Cascode tuners using 6BK7, 6BQ7 or 6BZ7 rf amplifier tubes require service far more often than tuners using straight pentode tubes. Cascode connected tubes fail frequently and regularly, and have provided an unexpected source of revenue for servicemen. Unfortunately, a tube short in some cases will overload and burn out its decoupling plate circuit resistors. To repair this trouble, the tuner will need to be dismantled and the damaged resistors carefully replaced, as well as the tube. The value of the decoupling resistors is usually either 680 or 1000 ohms.

Because of its triode construction, a low capacity is used to neutralize the control grid to plate capacity which is kept at a low value by the screen grid in pentode type tubes. Although it is not common, this condenser may short and in chain reaction fashion, ruin the tube and cause its decoupling resistors to burn out. A weak signal with excessive snow very frequently is caused by a defective rf amplifier stage. When tube replacement will not restore the set to its normal sensitivity, then you will need to further check into the circuits, especially the plate decoupling resistors.

A faulty oscillator tube or oscillator section of the mixer tube may prevent reception on one or more channels. Where a tube replacement does not restore normal oscillator operation then carefully check the components of the mixer. Concentrate on the oscillator circuits. There a common defect is a change in the value of the oscillator plate load and grid resistors. Hard-to-locate oscillator circuit faults may force the service technician to exchange the entire tuner section. These substitute tuners are usually available as factory replacements through the local set distributor.

When oscillator operation is restored by replacing the mixer tube, the oscillator must be realigned, particularly on the high frequency channels. Carefully adjust the individual oscillator slugs so that each channel will be tuned in best with the fine tuner in its center range.

Use of Signal Generator for Signal Substitution

Where video appears very weak, the faulty stage may be quickly located by using the signal generator audio modulation for display and inspection on the screen. Use the audio jack to feed the audio oscillator 400-cycle output to the video amplifier, connecting the generator cable between B— and the control grid on the stage. The audio signal should appear as several black bars on the screen. If its intensity is unsatisfactory, then concentrate on this stage.

Should response prove normal, then set the generator at the video i-f frequency and use the rf output jack. If necessary, use a series 10,000-ohm decoupling resistor when applying the generator output to each video i-f stage control grid. This insures minimum i-f detuning.

Start with the last video i-f stage and work toward the tuner. Shift the signal generator frequency at the input of each stage to give maximum bar intensity on the picture tube screen. The faulty stage will prevent normal amplification of the video i-f generator signal as the comparative intensity of the bars will indicate.

In concluding this article concerning the diagnosis of the more frequent troubles you will encounter in television receivers, I would like to again emphasize the value of part substitution in suspected circuits. The close tolerance of normally operating circuits often makes this necessary.

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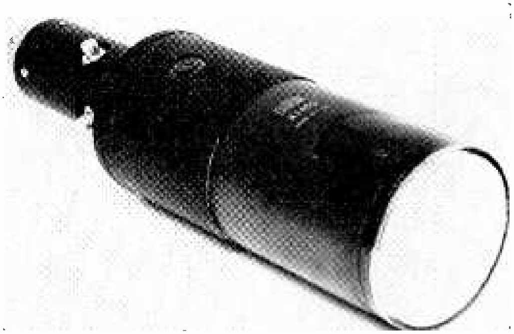

By "writing" faster than the speed of light, this cathode-ray tube developed by Allen B. Du Mont Laboratories, Inc. presents on its screen patterns of nuclear phenomena never before observed. By studying these patterns which signify instantaneous physical change in nuclear reactions, scientists are able to resolve many of the enigmas of this atomic age.

SERVICING THE PULSE-WIDTH HORIZONTAL OSCILLATOR-AFC SYSTEM

By JOHN DODGSON

NRI Consultant

As every serviceman knows, one of the more common trouble spots in a television receiver is the horizontal oscillator-afc stages. Although various types of circuits are used in these stages, one of the most popular is the pulse width or "Syncro-Guide" circuit shown in Fig. 1.

This particular circuit generally uses a dual triode type tube with one triode acting as a blocking oscillator and the other as a control tube. The blocking oscillator uses an auto-transformer (T1-L1) arrangement to obtain feedback between the plate and grid circuits.

The frequency of this blocking oscillator is regulated by the dc charge placed on capacitor C2 by the control tube. Resistors R1 and R2 act as a voltage divider across this capacitor .nd supply the proper dc voltage level through resistor R3 to the grid of the blocking occillator tube.

The hold control determines the plate voltage of the control tube, the amount of dc current drawn by the tube and, therefore, the dc charge placed on capacitor C2. The charge on capacitor C2 is also affected by the duration of the pulse applied to the grid of the control tube. The duration of this pulse, in turn, is determined by the frequency and phase relationship between the incoming horizontal sync pulses and the locally generated signal (fed back by way of capacitor C4 and resistor R4).

The control tube is biased near cut-off so the plate current flows only during the positive peak of the signal applied to the grid. This peak occurs as the sync pulse arrives, so the sync pulse actually determines the charge placed on capacitor C2.

The charge placed on the capacitor is determined by the length of time the control tube conducts. This, in turn, depends on the phase relationship between the sync pulse and the feedback signal applied to the grid.

The signal applied to the grid of the control tube is made up of the incoming sync pulse, the sawtooth wave developed at the output circuit of the oscillator, and a sine-wave component contributed by the output resonant circuit of the

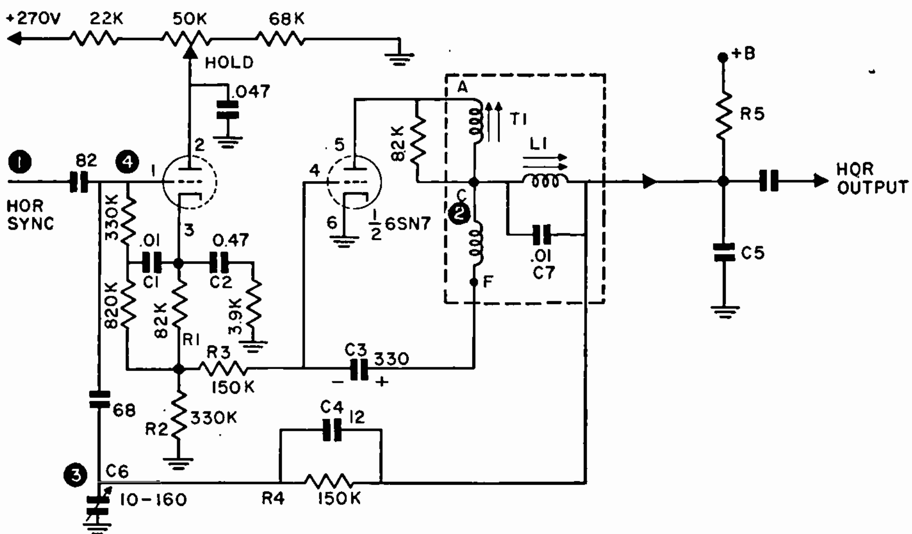

FIG. 1. A typical pulse width horizontal oscillator-afc system.

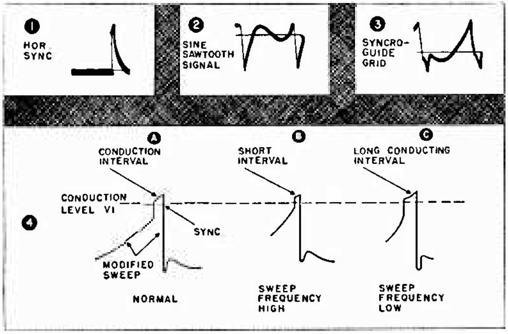

FIG. 2. Waveforms found in pulse width circuit. The numbers on the diagram in Fig. 1 correspond to the numbers on the waveforms.

transformer (winding L1 and capacitor C7). The sawtooth component is shaped by resistor R4 and capacitor C6, to form a partial parabolic wave (3 of Fig. 2) that emphasizes the retrace portion of the generated sawtooth. The sine-wave component is added in proper phase by the tuned circuit, to further emphasize the retrace portion of the incoming signal. It is desirable to use the fast retrace portion to minimize any time delay between the video signal and the horizontal sweep signal which would otherwise cause fold-over.

The length of time the control tube conducts determines the amplitude of the charge placed on the cathode capacitor C2. The time the tube conducts depends upon the position of the sync pulse with respect to the modified waveform. In other words, the phase relationship between the modified waveform and the incoming sync pulse.

In waveform A of Fig. 2,, the sync pulse is above cut-off the proper length of time to charge the cathode capacitor to the proper voltage, to hold the blocking tube on the correct frequency. Waveform 4B, the horizontal frequency, is too high. The sync pulse therefore arrives somewhat later than in 4A, and a part of the pulse is dropped below cut-off by the sharp decline of the modified waveform which now appears slightly displaced to the left of its original position. Thus, the tube does not conduct for as long an interval, and the charge on the cathode capacitor drops; the blocking tube grid-voltage decreases and the frequency decreases to the same frequency as the sync pulses.

In the waveform shown in 4C of Fig. 2, the horizontal frequency is low. The sync pulse therefore arrives too soon, drives the grid into the plate current region, and remains above cut-off for a longer interval because the drop off of the modified waveform is displaced to the right of its in-phase position. This increases the cathode charge, the blocking tube grid voltage rises and causes a compensating increase in the horizontal frequency to match the incoming sync pulses once again.

This method of frequency control, referred to as a pulse-width system, controls the frequency by the length of the pulse duration. The blocking tube frequency is controlled by a dc voltage determined by the horizontal sync pulses. Since it is not controlled only directly by the sync pulses but also by its "average" operating frequency, it is therefore not subject to interference by noise pulses.

Servicing in the Home

A tube defect is, by far, the most common source of trouble in this circuit and can cause such troubles as:

1. Dead oscillator—no raster.
2. Intermittent oscillator action—generally the result of self-blocking.
3. Incorrect oscillator frequency—if too far from 15,750 cps this can cause a loss of raster.
4. Complete or intermittent loss of sync.
5. Lack of width—may also be combined with some of above difficulties.

Unfortunately, all of these troubles can also be due to some other defective component.

With good components, the pulse-width circuit will only function properly when adjusted correctly. Since the adjustments require an oscilloscope, parts replacements, other than the tube, are usually limited to shop work only.

When tube replacement is necessary, some adjustments are often needed and, at any rate, should be checked. Although the manufacturer's recommendations for adjustment should be followed, this information is seldom available on house calls and a general procedure is necessary. One such general procedure consists of:

1. Set the channel selector, fine tuining, contrast, brightness, etc. as close as possible for normal viewing.
2. Set the horizontal hold control to its mid-range position.
3. In receivers using a "horizontal range" trimmer condenser such as C6 in Fig. 1, turn the trimmer to its maximum clockwise position (tight) and then back it off ¼ turn.
4. Adjust the horizontal oscillator transformer frequency slug (T1 of Fig. 1) until the picture falls into sync.
5. Sheck by rotating the hold control from one end of its range to the other. In most sets proper sync will be maintained over the entire range with the entire picture moving according to the hold control position. In other sets, the picture will fall out of sync at either or both

ends of the horizontal hold control range.

6. If necessary repeat the adjustment of the transformer slug (T1) until the above conditions are met.
7. As a final check turn the tuner off the station and/or short-circuit the antenna terminals. When turning back to the station or removing the antenna short, the picture should immediately fall into horizontal sync without any re-adjustment.
8. If the above condition is not met the entire procedure will need to be repeated. If this also proves futile try another tube in the horizontal oscillator-afc stage and again repeat the procedure.

If the above procedure does not enable proper horizontal sync to be obtained there is a definite circuit defect and any other adjustments would be a waste of time.

Incidentally, it is important to try new sync separator-amplifier tubes in the receiver before adjusting the horizontal oscillator. Very often a defective sync tube will prevent proper horizontal sync without affecting the vertical sync.

Servicing in the Shop

Most service shops have definite procedures in regard to the preliminary work, such as tube testing, done on a chassis before the benchman begins to work on it.

If the tube testing shows any defective tubes in the video, sync, or any tube in the horizontal sweep (including the output and damper) to be defective, it has often proven wise to insert new tubes and try readjustment. The new tube should be first checked with a tube tester or in another set.

The next step should be to determine if the trouble actually exists in the sweep section or if it is due to a defect in some other section. One common cause of unstable horizontal sweep is low B+ voltage. The power supply should be checked by measuring the voltages and comparing them to the manufacturer's specifications. This particularly applies to sets using selenium rectifiers especially if the set is somewhat old. In voltage doubler selenium rectifier power supplies, a minimum of 250 volts should be measured at the input filter condenser—any voltage substantially less than this may indicate trouble. Of course, the manufacturer's information should be thoroughly consulted.

If the manufacturer's information is not available on an ac-operated set, check the ac voltage between B— and one of the plates of the rectifier tube. Approximately the same value of dc (B+) should exist between B— and the input filter condenser.

Following this line further check the B+ feed points for the horizontal sweep section. Perhaps a voltage divider or decoupling resistor between B+ and the horizontal sweep has changed value. Temporarily bypassing any decoupling condensers (between the B+ line and ground) can very often locate such trouble.

Incidentally, often the plate voltages for the horizontal oscillator-afc tube are obtained from B+ boost. Of course, improper operation of the horizontal sweep will result in incorrect B+ boost voltage and in such cases this improper B+ voltage for the horizontal oscillator is not due to a power supply defect.

If a scope is available, the incoming sync pulse to the horizontal afc tube should definitely be checked. If the horizontal oscillator is not working at all as indicated by lack of negative grid voltage and a no-raster complaint, the sync pulse can be checked right at the plate of the sync amplifier—at point 1 of Fig. 1. The sync pulse should also be checked at point 4 of Fig. 1. to eliminate the possibility of a short in the grid circuit.

If the horizontal oscillator is working, the sync pulse cannot be validly checked until the sync is disconnected from the horizontal oscillator stage. Of course, this can be easily done by disconnecting the sync pulse feed condenser which in Fig. 1 is the 82-mmf condenser connected to pin 1 of the tube.

The horizontal tube could be removed (in an ac receiver) but this would result in lack of drive at the horizontal output tube and may damage it and the output transformer. Since short overloads are tolerated, many servicemen attach the scope to the point they wish to measure before applying power to the receiver and then turn on the receiver only as long as necessary to observe the scope for the sync pulse, if any. Do not permit the receiver to operate for any length of time with a dead horizontal oscillator.

Even though the signal on the picture tube face may definitely seem to indicate horizontal oscillator-afc trouble, it has often been found that the actual cause of trouble was in a previous stage—particularly the sync amplifier-separator. Make certain the sync separators and amplifiers are functioning properly before wasting time troubleshooting the horizontal oscillator section for a trouble that is not there. It is not wise to rely on the supposition that stable vertical sweep indicates proper functioning of the sync stages. Very often separate tubes are used for vertical and horizontal sync amplifiers and some vertical sweeps are inherently stable.

The pulse width type horizontal sweep system has the unique and annoying distinction in that defective components can usually not be found by voltage or scope observations. The stages work so closely together that a defective component will usually affect all operating voltages and waveforms. This particularly applies to all of the troubles except a dead oscillator. When a completely dead oscillator trouble is encountered it is wise to check for plate, cathode, and grid voltages. For example, an open in the horizontal oscillator transformer winding L1 or in resistor R5 would result in lack of plate voltage at pin 5 of the 6SN7 tube (Fig. 1). A voltage check would readily locate this particular trouble. On the other hand, a short in condenser C7 which shunts this particular winding would not seriously affect the plate voltage but would prevent the oscillator from functioning properly.

Resistor R4 in Fig. 1 is sometimes connected from the horizontal output transformer secondary to the grid circuit of the afc tube instead of from the oscillator plate circuit to the grid of the afc tube. If such a circuit variation is used, the resistor is more likely to break down since it is in a high voltage circuit. In addition to breaking down completely, the resistor is also prone to cause picture tearing due to voltage arcs over portions of the resistor body.

As in most other circuits, any resistors that carry dc current are more likely to break down than those carrying only low amplitude signals. Thtis particularly applies to resistors R1 and R2 in the cathode circuit of the afc tube, the hold control, the 22,000 and 68,000-ohm resistors in the plate circuit of this same tube, and resistor R5 in the plate circuit of the horizontal oscillator tube. Resistor R5, by the way, is a particularly susceptible component and has great effect on the operation of the horizontal oscillator.

Besides the tubes, the components that are most likely due to cause trouble in this horizontal section are the condensers. Not only do they tend to open, short, and become leaky, but the higher heat level in this section often affects them to a great degree. These heat defects often cause intermittent horizontal sync, general horizontal instability, "delayed trouble," and "slow drift." All of these troubles are apparently self-explanatory except perhaps the delayed trouble and slow drift.

The slow drift problem is perhaps the most annoying (and expensive) to the serviceman. Very often, a set will come in with a horizontal sync complaint and yet will play for hours and even days on the bench without any sign of trouble. Of course, the trouble readily develops as soon as the set is delivered to the customer. When the set finally does go out of synchronization readjusting the hold control or the frequency slug of the horizontal oscillator transformer will bring the set back into sync. It will then again work for hours or days until it finally drifts out of sync and again requires readjustment. Eventually it will reach a point where readjustment will not bring it back into sync.

Such troubles are usually due to the heating of components in the set and their gradually changing value. Since it is time-consuming to wait until this happens, and sometimes it won't happen for days, it is common practice to induce additional heat in the receiver to hasten the breakdown. This can be done by several methods; one of the earliest was covering the receiver with a cardboard box or an old blanket. Another more convenient method is to focus a spotlight on the suspected section—generally the "spotlight" consists of a 100-watt bulb in a "goose-neck" lamp. However, the most recent and best method is to hold a soldering iron (or gun) close to the sus-

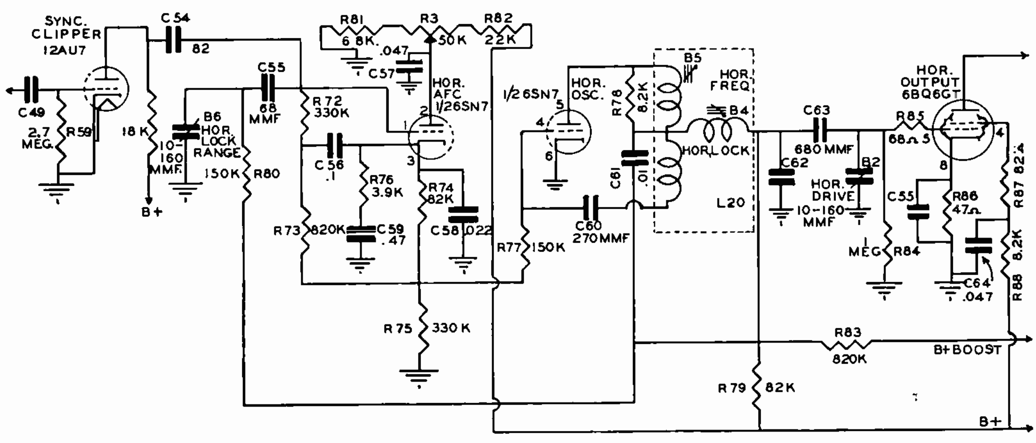

FIG. 3. Horizontal oscillator-afc section of Admiral Model 19F1.

pected component and continually move it back and forth across the body of that component to induce heat. Although this is the most convenient method it does have the disadvantage that a good part may become defective if too much heat is applied.

When using this last method be sure to check the value of the component that is going to be heated beforehand since the heat sometimes causes the markings on the component to be obscured. Also be sure to keep the soldering iron moving across the component from one end to the other. It is not desirable to actually touch the part with the iron since it may too easily cause it to become defective. (In the case of wax-coated condensers, the smoke and odor is very annoying, to say the least.)

After a defective component is located and replaced the controls should be completely readjusted according to the manufacturer's recommended procedure. This usually consists of the previously discussed general method plus adjustment of the oscillator transformer phase slug for proper waveform. For example, coil L1 of Fig. 1 should be adjusted for the waveform shown in section 2 of Fig. 2, with the scope connected between B— and point C of the oscillator transformer. After the first adjustment of the waveform, it should be checked during the adjustments of the other controls since these other adjustments, particularly T1, can alter the waveform.

Incidentally, recently it has been recommended that the "peak" of the waveform be adjusted 10% higher than the "hump" whereas manufacturers previously recommended an equal "peak" and "hump" adjustment. This is said to afford much better noise rejection.

In order to graphically show some of the troubles that can be encountered in this type circuit, a typical commercial receiver was selected and troubles were deliberately introduced into the horizontal oscillator-afc stages. The receiver chosen was an Admiral Model 19F1. Notice the similarity between this diagram shown in Fig. 3 and the basic circuit shown in Fig. 1. The following table lists the components that were deliberately made effective, the actual defect introduced to the component, and the result so far as the picture was concerned. In all cases, after a defect was introduced all controls were readjusted to attempt to obtain normal operation.

Although this table applies only to the Admiral Model 19F1, similar troubles can occur in other receivers using the same pulse width type horizontal sweep system. In some instances you will not obtain the same result from a similar defect. For example, some receivers using a pulse width circuit are inherently more stable than others and such characteristics can be expected to affect a table of this sort. As a specific example, condenser C54 was caused to become leaky. You can see from the result section of the table that almost any leakage causes unstable sync and the degree of leakage regulates the degree of instability. Any leakage below 3 megohms causes the oscillator to become dead entirely. In a receiver that would not be as inherently stable as the Admiral Model 19F1 just a slight amount of leakage may cause the oscillator to become completely unstable or dead. Should you use this table as a guide in servicing the pulse width circuits keep these variables in mind.

Part	Defect	Result
C-54	leaky-10 meg	unstable sync
	leaky-3 meg	very unstable sync
	leaky below 3 meg	dead oscillator
	open	lack of sync
86	leaky	decreased width; dim raster; low high volts; poor stability
	open	poor stability on weak and/or noisy signal
R80	short	unstable sync
	open	very unstable
	increase to 1 meg	extremely unstable, tries to squege
C57	short	lack of sync
	open	unstable sync
C56	leaky-10 meg	no adverse effect
	leaky-1 meg	unstable sync, adj. of horiz. hold control reduces brightness
	Open	same as 1 meg leakage
C58	Open	Loss of width: unstable sync tends to block
	short	very unstable sync; horiz. hold—no effect
	leaky-10K	slightly unstable
	leaky-100K to 10 meg	no apparent effect
AFC tube	cathode to heater leakage	
	100K	no effect
	10K	raster bending
	cathode to grid leakage 10 meg	unstable, may block
	(below) 10 meg	dead oscillator
C62	open	dead oscillator
	leaky: 10 meg	no apparent effect
	1 meg-½ meg	loss of width & high voltage
	below- ½ meg	dead oscillator
C61	short	gear tooth effect
	open	dead oscillator
C60	leaky-3 meg	tends to block
	short	dead oscillator
	open	dead oscillator
R-78	open	unstable sync
	short	dead oscillator
	reduced 50%	dead oscillator
R76	open	unstable sync
	short	unstable sync
R74	open or short	dead oscillator
	increase; 150K	dim raster; unstable sync
	increase; 2 meg	very dim raster; no sync
	reduce; 60K	unstable sync
	below 60K	dead oscillator

(*Continued from page* 9)
stock of tubes with them; a serviceman can expect to replace some tubes in the sets that he services, and he must have the replacement tubes with him. Since he, of necessity, has the tubes with him, he can test by substitution rather than bringing along a tube tester.

On the other hand, the tube tester is actually more economical than checking by substitution. This is particularly important to the man who is doing only a small amount of part-time work. To be prepared to test any tube that he runs into, a serviceman must have an extensive stock of tubes. Such a stock of tubes would cost far more than $100. A tube tester that will enable the serviceman to check any tube plus any additional tubes that may be produced in the future will cost less than this.

There are two basic types of tube testers, the emission type and the mutual conductance type. The first is the least expensive of the two and measures the emission of the tube as its name indicates. With this type of tube tester, dc voltages are applied to the plate, screen and grid, and the flow of dc cathode current is measured by the meter on the instrument. There will be a few instances in which a tube will not function properly in a circuit and yet its emission is normal. Perhaps the mutual conductance is far lower than normal as a result of a shift in the position of the control grid within the tube or some other similar situation. In a case such as this, an emission tester will show the tube to be good while the tube is responsible for the failure of the circuit. So you see, the emission type tester is not foolproof.

A mutual conductance type tube tester as its name implies measures the mutual conductance of the tube under test. In other words, it indicates the amount of change that takes place in the plate current when an ac signal is applied to the control grid. The meter on the tube tester indicates the mutual conductance of the tube in micromhos. Knowing the mutual conductance of a tube will tell a great deal more about how it will work in a circuit than merely knowing the dc cathode emission when no signal is present. On the other hand, mutual conductance tube testers are extremely expensive, and as a result they are practical only for service shops that do a reasonably large volume of business. For the small service shop or the part-time repairman, the emission type tube tester is far more practical even with its limitations.

Regardless of which of the two types of tube testers you choose, the characteristics to look for are the same. First and foremost is that the tube tester will not become obsolete. Be sure to find out whether or not the manufacturer is prepared to supply you with tube charts periodically that will contain information on testing new tubes. Ease of operation is another important consideration. A careful examination of the chart which indicates how the instrument is to be set up for each tube and the various controls on the tube tester will enable you to see whether the instrument will be simple or awkward to use. It is also very essential that the tube tester be well built mechanically. A tube tester has numerous switches and potentiometers on it that are constantly being readjusted. If the tube tester is not well built, these parts will wear out requiring costly and time-consuming replacements.

Always check the various tube sockets on a tube tester to be sure that it has sockets that will accommodate the various different types of tubes that you may wish to test. For example, some tube testers produced today do not have sockets for the old 4 and 5-pin tubes that were in use before 1940. You may have occasion to test these tubes, and therefore it is essential that you have a tube tester that is capable of doing this. All tube testers have provisions for testing for shorts but only the mutual conductance type will test for gas.

Unfortunately, there are few detailed specifications given for tube testers. Instead, you must carefully examine the tube tester itself to determine if it has the features that you want. One of the best guides in obtaining a tube tester is purchase it from a highly reputable manufacturer; preferably a manufacturer with whom you have done business before and you are familiar with the quality of his instruments.

Many men when first embarking on a career of Radio Servicing develop a misconception that a tube tester is an instrument that will tell positively if a tube is good or bad. Even though tube testers frequently have scales on them that say good and bad, this is not true. As you know from the previous discussion, a tube tester only measures the cathode emission or the mutual conductance of a tube. A tube can have satisfactory cathode emission and thereby be indicated as good on an emission type tester, and nevertheless it can still be responsible for circuit failure. Moreover, in many instances a tube can have a cathode emission that is considerably lower than the usually accepted minimum value, and it still will not seriously affect the operation of a piece of equipment. Also, a tube can have satisfactory mutual conductance and still be responsible for circuit failure. A tube tester is not a foolproof device that tells if a tube is good or bad. However, when a tube tester is in the hands of a good technician who takes the information that the tube tester gives him and adds this information to his knowledge of how the particular circuit works and the symptoms of the trouble, the tube tester is an exceedingly useful instrument.

Once you have become familiar with the speci-
(*Continued on page* 26)

Technical Ramblings

By B. VAN SUTPHIN

NRI Consultant

Subject: A HANDY HANDFUL

Every so often, a new piece of equipment comes on the market that makes servicemen wonder, "Why didn't I think of that?" It is usually a simple instrument that does a certain job that has bothered servicemen for years. Let me tell you about one of these.

The instrument shown on the facing page is about the handiest thing since the invention of plug-in tubes.

Every serviceman who has tried to check the filaments of tubes used in series-string equipment appreciates how difficult it is to hold a tube, and at the same time, hold the two ohmmeter prods against the proper pins of the tube. (I wonder if every serviceman has broken as many tubes as I have while trying to do this.)

Also, there is the problem of not knowing which pins are the filament pins. Of course, this isn't too much of a problem on modern tubes, but it does give beginners considerable trouble.

With the "handy handful" shown on the facing page, there need be no more problems with using an ohmmeter to check tube filaments.

Suppose that you have a 5-tube ac-dc receiver and none of the filaments light. This tells you that one of the filaments is defective. The normal system is to remove the tubes one by one and check the individual filament with an ohmmeter. With the NRI Model O Series String Filament Tester, you can simply remove the tubes one at a time and plug them into the corresponding socket on the panel of the instrument. If the tester bulb lights, the tube filament is good; if it doesn't, the tube filament is bad. It is as simple as that.

The filament testing arrangement in this instrument is such that you can check all tubes that are likely to be used in a series-string arrangement. This includes the older tubes such as the 25Z6, and the very latest tubes such as the 600-ma tubes designed for use in modern TV receivers.

To check a particular tube, plug it into the only socket that it will fit—except in the case of 7-pin tubes when there is a special socket marked "battery type tubes only"—and if the bulb lights, the tube filament is good.

Special test terminals are also provided for checking fuses. Of course, it is generally easy to tell when a fuse is blown out simply by looking at it, but there are times when the appearance of a fuse may fool you, and you would normally be forced to check the fuse with an ohmmeter. No more. Simply lay the ends of the fuse across the two terminals at the bottom of the panel, and if the bulb lights, the fuse is good.

The Model O Series String Filament Tester is battery-powered. There are two small 1.5-volt pen-light cells inside the instrument. Since batteries wear out, and that would prevent your obtaining normal tests, a testing circuit is provided. There are two terminals at the lower right of the panel. To check the internal batteries, short those two terminals together. If the bulb lights, the batteries are good. If it doesn't, replace the batteries.

The cable coming out of the left side of the case terminates in a plug especially designed to fit the filament pins of picture tubes. Since pins 1 and 12 of a picture tube are always the filaments, simply slipping this socket-like device up over the filament pins of the tube—pins 1 and 12—will allow you to check the filament. If the tester bulb lights, the picture tube filament is good. (Cable not shown in illustration.)

This handy little tester weighs only 8½ ounces, and is small enough to fit in a man's trousers pocket. Because of its small size and its light weight, it is easy to carry, and will certainly prove to be a handy helper on service calls.

Another point: Two "pin straighteners"—one for 7-pin tubes and one for 9-pin tubes—are also provided on the panel. These are very convenient if you accidentally bend the pins of a tube while trying to get it out of a crowded TV set.

One more point—it also checks pilot lamps.

NRI SERIES STRING FILAMENT TESTER

Only **5.50** postpaid, complete with batteries

THESE IMPORTANT FEATURES

- completely self-contained, uses 2 long-life penlight cells
- can be conveniently carried in jacket. Size: 1" x 3½" x 5⅜"
- easy to use—complete instructions on back
- built in pin straighteners for miniature 7-pin and 9-pin tubes
- handsomely styled. Custom - made case, brushed aluminum panel with black lettering

QUICK CHECKS

√ Receiver tubes for filament continuity
√ TV picture tubes for filament continuity
√ TV and Radio set fuse continuity
√ Pilot lamps, bayonet and screw-base types
√ Most TV filament strings

Low Price Means Worth - While Savings On This Handy Instrument

Made for NRI by a well-known manufacturer, the Model O Series String Filament Tester is a real buy at $5.50 . . . substantially below the selling price of comparable instruments.

The most frequent cause of tube failure is an open filament. With the NRI Model O, you can check the filaments of tubes in series string Radio-TV receivers FAST. Just plug tube into the socket it fits. If test lamp lights, filament is good. (7-pin battery tubes use a plainly marked socket.) To check fuses, place ends on contact points. If pilot lamp lights, fuse is good.

Convenient to use in customer's home. Carry in pocket or tool box. Speed up your service work. Order today.

ORDER BLANK

USE THIS BLANK TO ORDER YOUR SERIES STRING FILAMENT TESTER

National Radio Institute
Washington, D. C.

I enclose $5.50 for which send me, postpaid, one NRI Model O Series String Filament Tester.

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(If you live in Washington, D. C., add 2% for D. C. Sales Tax)

(*Continued from page 23*)
fications of basic servicing instruments and what they mean, you will have no difficulty in analyzing the specifications of all servicing instruments. In addition to the more common servicing instruments that we have discussed thus far, there are numerous other instruments that are used to speed up the servicing procedures in shops where the large volume of business makes speed an important factor. Such instruments as the signal tracer, the RC Tester, and other instruments fall into this category.

In recent years kit type instruments have come into prominence. These instruments have the advantage of being less expensive than factory-built instruments. They have the disadvantage that you must take the time to assemble them yourself, and they are not factory checked after assembly to be sure that they do come up to their rated specifications. The same specifications that are given for factory-built instruments are also given for kit type instruments. They should be evaluated in the same way.

Test instruments are both important and expensive. Going into servicing work on a scale that will yield a good profit requires an investment in equipment and parts. Choosing your test instruments wisely will enable you to turn your starting capital into equipment that will best enable you to get maximum profit from your work. The first item to consider in purchasing equipment is exactly what piece of equipment do you need at the time. Your own experience is the best guide to this. When you frequently find in your servicing work that a particular piece of equipment is needed in trouble-shooting a set, clearly this piece of equipment should be at the head of the list of the equipment that you are going to obtain.

After you determine that you do need a specific piece of test equipment, carefully check the advertisements of different manufacturers who make this equipment. Compare the specifications of the equipment made by different manufacturers to see which is the best, taking into account also the price of the instruments. As an example, consider Fig. 2 in which is shown the specifications of two prominent oscilloscopes which sell at essentially the same price. Another important consideration in obtaining test instruments is that you do not want to use up your capital buying very expensive equipment with many features, when less expensive equipment with fewer features will be completely adequate for the job. A careful consideration of the specifications of test instruments will enable you to select the best equipment for the job at hand.

Should the occasion arise where you are uncertain about the merits of a piece of test equipment, ask the man who owns one. If he immediately tries to sell you his at a big savings you don't want it any more than he does.

	NRI Model 56	Oscilloscope made by prominent manufacturer
Frequency Response (vertical) ±3 db	10-4.5 meg.	0-500 kc
Sensitivity (direct probe & cable)	.014 v. per inch	.025 v. per inch
Calibration signal available	Yes	Yes
Input resistance	2 meg	1 meg
Input Capacity	28 mmf	80 mmf
Sweep circuit frequency	10cps to 100kc	15cps to 35kc
Regulated Power Supply	Yes	No
Number of tubes	12	8
Direct reading calibrated vertical gain control	Yes	No
Sync polarity reversing	Yes	Yes
Matched probe kit available	Yes	Yes

Fig. 2.

——— *n r i* ———

——— *n r i* ———

Mystery Payment

Is it Yours?

A United States Postal Money Order, No. 2-8,687,898 for $5 dated February 4, 1957.

The Purchaser neglected to write his name in the space provided on the money order. It came to us in a plain envelope without any name or return address and there wasn't any identification with it.

We'd like very much to credit this money to the account of the student who sent it. He'll probably be very annoyed when his next statement fails to show that credit. But until we get some word from the student to identify himself, it will remain a *mystery payment.*

——— *n r i* ———

Cover Photo

FIRST lady "Ham of the Year" is Mrs. Mary ("Mae") Burke who has won General Electric's 1956 Edison Radio Amateur Award for public service. She is known throughout the world for voluntarily handling an average of 3000 messages a month in Morse code, many from far-flung military outposts. Mrs. Burke, 45, has been a licensed radio amateur since 1932. Eight hours a day she operates station W3CUL at her home at 265 Waverly Road, Morton, Pa., on the outskirts of Philadelphia. She received the Edison cup and a $500 check on Feb. 28 in Washington, D. C., at a banquet. Rear Adm. H. C. Bruton, chief of naval communications, was the principal speaker. She is the first woman to win this annual Award which started in 1952.

——— *n r i* ———

N.R.I. ALUMNI NEWS

Elmer E. Shue .... President
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William Fox .... Vice Pres.
Joseph Stocker .... Vice Pres.
Theodore E. Rose .... Executive Secretary

Chapter Chatter

Springfield, Mass. Chapter is moving right ahead with its TV Demonstration Panel. As expected, the project has met with enthusiastic reception, not only by the regular members of the Chapter but also by others who have heard about it. Attendance at the meetings is steadily rising and new members have joined the Chapter as a direct result of the program.

Chairman Howard Smith has informed National Headquarters that the plan of instruction using the TV Demonstration Panel was copyrighted in 1950 by Lyman Brown, the Chapter's Technical Director, and that the Springfield Chapter is employing it with his sanction as a fellow-member.

Lyman Brown has very generously offered to furnish details of the TV Demonstration Panel to any other Chapters who wish to make use of it. The Detroit Chapter has already indicated its interest by taking advantage of Mr. Brown's willingness to make the construction plans available to other Chapters. Other Chapters wishing to undertake the construction of a TV Demonstration Panel should write to Mr. Lyman Brown, 69 Pasadena St., Springfield, Mass.

NRI students and graduates in the area who have not been attending meetings of the Springfield Chapter—regardless of whether they are members of the Chapter—should avail themselves of this opportunity to get a thorough grasp of the construction and servicing of a TV receiver.

Meetings are held at 7:00 P.M. on the first and third Friday of each month at the U. S. Army Headquarters Building, 50 East St., Springfield. The Chairman is Howard Smith, 53 Bangor St., Springfield; the Secretary, Marcellus Reed, 41

Westland St., Hartford, Conn.

New York City Chapter has been temporarily deprived of the services of its hard-working Secretary, Emil Paul. A week before Christmas Emil was injured in an auto accident, suffered a severe concussion—so severe that he lost his sight and hearing for a time—and has been at home slowly recuperating. All of Emil's friends and fellow members earnestly hope for his complete recovery as speedily as possible.

In spite of his condition, Emil—ever mindful of his duties and responsibilities—telephoned National Headquarters on the recent activities of his Chapter. Under the circumstances the following report is necessarily skimpy, being confined to the customarily excellent talks made by various members of the Chapter: Tom Hull on his TV series; James Eady on TV alignment, TV troubles, and record players; Phil Spampinato on his audio series and customer relations; Willie Fox on TV troubles, with demonstrations.

Frank Zimmer delivered a rather unusual talk on the dangers of carbon tetrachloride. This is a subject with which every serviceman should acquaint himself; under some circumstances and to some people carbon tetrachloride can be poisonous. Chapter Chairman Ed McAdams made a talk consisting of timely tips on Radio and TV troubles; Dave Spitzer on power supplies and TV trouble; Marc Antony on substitutions for foreign tubes; Frank Catalano on TV Dogs.

A mere report of these talks gives no indication of how valuable they can be in acquiring helpful advice and information in Radio and TV Servicing from practical, experienced men. NRI students and graduates, even though they may not be members, are urged to attend meetings of the Chapter and profit by the practical knowledge and experience of these speakers.

The Chapter meets at St. Marks Community Center, 12 St. Marks Place, New York City. The Chairman is Edward McAdams, 135 West 90th Street, New York. The Secretary is Emil Paul, 6 Gateway, Bethpage, L. I., N. Y.

New Orleans Chapter extended its customary warm Southern hospitality to Ted Rose, Executive Secretary of the NRI Alumni Association, who was a guest at the Chapter's annual shrimp feast.

Although no longer Secretary, due to his having to travel so much in his job, Anthony Buckley was very much in evidence at this affair since he was in charge of the refreshments. "Buck" did his usual excellent job with the victuals. You have to go to New Orleans—and to this annual get-together of the New Orleans Chapter—for this kind of shrimp and hospitality.

Since this was a social, only two items of business were transacted. Following a short talk by Ted Rose, the retiring Chairman, Alfred Francis, expressed his appreciation to the members for the cooperation given him during his term of office. The new officers for 1957 were then elected. They are: Pat Boudreaux, Chairman; B. Collins, Vice-Chairman; Oscar Hilding, Secretary; O. Jumonville, Treasurer.

Upon being installed the new officers thanked the members for the confidence placed in them and expressed the hope that they would fulfill their duties as well as the officers for the previous year.

Considerable discussion then took place as to whether the Chapter should continue to meet as in the past, on the first and third Tuesday of each month. The consensus of opinion was that members were too busy with radio and TV servicing to attend meetings this often and that attendance would be improved if meetings were held only once a month. The members present finally agreed to meet only on the second Tuesday of each month.

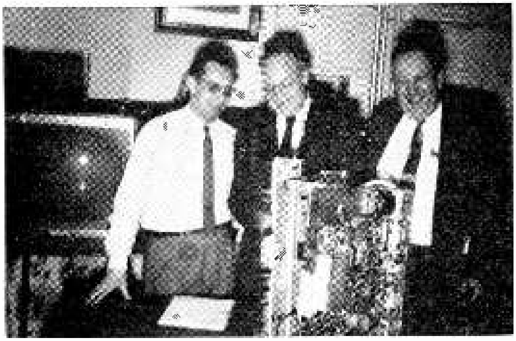
The Chapter particularly wants NRI students in the New Orleans area to know that they are cordially invited to attend the meetings and become associate members of the Chapter if they wish. The only difference between regular and associate members is that the latter may not vote or hold office. NRI Graduates are of course entitled to full membership. Except for this difference students enjoy the meetings and get the same benefits from them as graduate members.

A drawing was made for a door prize, a video probe donated by Chapter Member C. E. Davidson, proprietor of the Columbia Radio & Supply Company, New Orleans. The prize was won by John Moore.

The Chapter is planning soon to have representatives of Bell Telephone as guest speakers on transistors and sun-powered batteries.

Meetings are held at the home of Chapter Member Louis Grossman, 2229 Napoleon Ave., New Orleans. NRI students and graduates interested in attending the meetings should get in touch with Chairman Pat Boudreaux, 1015 Race St., or Secretary Oscar Hilding, 6225 St. Anthony St., New Orleans.

Philadelphia - Camden Chapter reports eight more new members: Graduate James Ring, Graduate Anthony DeVincent, Student Alfred R. Lund, Student William McLelland, Graduate Frank Kennedy, Student Frank Donnelly, all of Philadelphia, and Graduate Victor H. Frey and Associate Norman Funk, both of Conestoga, Pa. Our warmest welcome to these new members.



Charles Unrath, Sylvania Philadelphia TV Service Manager, Russ Mauger, Sylvania Distributor Service Manager, and Hank Fillman, Sylvania District Service Manager, discussing the proper servicing of a Sylvania TV receiver at a meeting of the Philadelphia-Camden Chapter.

Secretary Jules Cohen says that TV service work in the Philadelphia-Camden area has struck a new high, that he has been going at it with hammer and tongs without a stop day and night, seven days a week. He declares that long as he has been doing service work, he has never been so busy and that it is the same with all the other Radio-TV servicemen he talks to

Nevertheless, the Chapter is managing to maintain its usual heavy program of guest speakers, exhibitions, and various other activities. The Chapter welcomed as guest speakers Mr. Hank Fillman, District Service Manager of the Sylvania Electric Products Company, Mr. Russ Mauger, Philadelphia Distributor Service Manager for Sylvania, and Mr. Charles Unrath, Sylvania TV Service Manager for Philadelphia. They brought two Sylvania TV Receivers for demonstration purposes. Mr. Fillman gave an excellent talk on how to remove the chassis from the cabinet, also some very good hints on servicing the receivers. The Chapter members present then inspected the chassis out of the cabinet and saw how to replace it in the cabinet. Members agreed that due to the way these new sets operate, servicemen need a demonstration of this kind in order to make the servicing of them easier. Members also learned all about the Halo light. Sylvania not only provided service bulletins and schematics but also donated four door prizes, which four lucky members took home with them.

Ted Rose administering the oath of office to President-Elect Elmer Shue.

Chapter members were so well pleased with Mr. Fillman's talk and demonstration that they asked him to return at some future time to speak on picture tubes and receiving tubes. Mr. Fillman promised to do so.

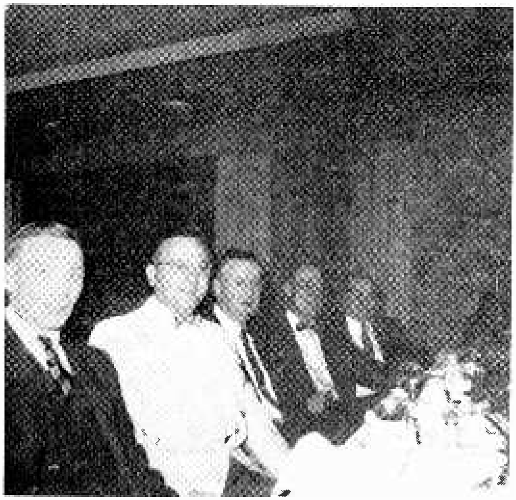
At another meeting Mr. Floyd Myers, Service Manager of the Stuart Lochheim Corporation, spoke on Zenith's "Space Command" automatic tuning. Mr. Myers brought the mechanism with him and during his talk passed among the members the parts composing the device. He also brought service bulletins which were distributed among the members. The Philadelphia-Camden Chapter is proud to have Mr. Myers as an honorary member.

Representatives from other manufacturers are scheduled to appear as guest speakers at future meetings.

All NRI students and graduates in the Philadelphia-Camden area are extended a warm welcome to attend meetings and get the benefit of these talks and demonstrations. Contact Secretary Jules Cohen, 7124 Souder St., Philadelphia. The meetings are held at the Knights of Columbus Hall, Tulip and Tyson St., Philadelphia.

Baltimore Chapter announces a change in its Secretary. Joseph Nardi, who was elected as Secretary for 1957, had to resign the office. Having been assigned to night work, he cannot attend meetings with the regularity necessary to fulfill the duties of Secretary. Mr. John C. Woolschleger, 1106 S. Lakewood Ave., Baltimore 24, Md. has taken over the office of Secretary. Our best wishes to you, John.

The Chapter meets on the second Tuesday of each month at 100 North Paca St. Students and graduates in or near Baltimore are urged to attend the meetings, either as guests or prospective members. Write or telephone Secretary



A few of the Baltimore Chapter members who attended a banquet honoring Elmer Shue's election as President of the NRIAA for 1957. Left to right: Claude Keller; Joseph Dolivka, Chairman of the Baltimore Chapter; Ted Rose, Executive Secretary of the NRIAA; J. Blan Straughn, Assistant Director of the NRI Instruction Department; and Ernie Gosnell, Vice-Chairman of the Baltimore Chapter.

John C. Woolschleger, 1106 S. Lakewood Ave., or Chairman Joseph Dolivka, 717 N. Montford Ave., Baltimore.

Milwaukee Chapter Vice-Chairman Slavko Petrich has announced that he would welcome telephone calls from members of the Chapter on problems they encounter in Radio-TV Servicing. This is a fine gesture on the part of Mr. Petrich and shows how far members of local Chapters are willing to go in helping out fellow-members.

For the benefit of NRI men in the Milwaukee area who may not know about it, the Milwaukee Chapter publishes a monthly bulletin known as the NRIAA Milwaukee Chapter News. In addition to reports of the activities of the Chapter, this publication contains practical information and timely tips on Radio and TV servicing, test equipment, tools, and other topics of interest to Radio-TV servicemen. Those interested in receiving this very worthwhile publication should write and request that their names be put on the mailing list. Write to: The NRIAA Milwaukee Chapter News, 3407-A North 1st St., Milwaukee 12.

Always eager to improve the publication, Editor Ernest Bettencourt accepted a suggestion by Mr. Lasky to inaugurate a Service Corner in the periodical. This will make the publication that much more interesting and informative.

A searching analysis of and chalk talk on an old TV receiver, an aged Air King, was conducted by Mr. Petrich. The set showed only a thin horizontal line and the trouble was traced to the vertical blocking oscillator transformer, with Mr. Petrich's video generator isolating the stage and his oscilloscope visually showing the defect.

Ernest Bettencourt has obtained a plentiful supply of catalogs from electronic houses for distribution to those members who would like to have them.

The Chapter invites all NRI students and graduates in or near Milwaukee who care to do so, to come to its meetings. They will be welcome as guests. Get in touch with Chairman Erwin Kaphein, 3525 N. Fourth St., or Secretary Robert Kraus, 2467 N. 29th St., Milwaukee. Meetings are held on the third Monday of each month at the Radio-TV Store & Shop of S. J. Petrich, 5901 W. Vliet St., Milwaukee.

Hagerstown (Cumberland Valley) Chapter has informed National Headquarters of its slate of officers for 1957, as follows: John H. Pearl, Chairman; Harry W. Straub, Vice-Chairman; Edwin M. Kemp, Secretary; Robert J. Saum, Treasurer.

Secretary Ed Kemp recently delivered a talk to the Chapter on colorimetry. This is a lecture course on color TV based on Howard W. Sams Color TV Training Manual and it is a subject that Radio-TV servicemen would do well to acquaint themselves with.

The Chapter invites all NRI students and graduates in the Cumberland Valley to come to its meetings, which are held at the YMCA in Hagerstown at 8:00 P.M. on the second Thursday of each month. The Chairman is John H. Pearl, 702 Potomac Ave.; the Secretary, Edwin M. Kemp, 618 Sunset Ave., Hagerstown.

Flint (Saginaw Valley) Chapter has been handicapped lately because most of its members are employed in automobile or other factories in the Flint area and have been putting in a great deal of over-time. On top of that, most of the older members report that they have more Radio-TV service work than they can do. But the factory over-time is expected to taper off soon, so the members will have more time to attend the Chapter meetings.

The Chapter invites NRI students and graduates in the area to attend its meetings. Get in touch with Chairman Warren Williamson, 1201 Allen St., or Secretary George Rashead, 338 E. Marengo, Flint. Meetings are held at the Buick Local Union Hall, Flint, on the second Saturday of each month.

Chicago Chapter devoted a meeting to a discussion and study of Hi-Fi, the term used to denote high-class reproduction of recorded musical performance that we hear so much talk about. There is a field of technique in the selection, setting up and servicing of Hi-Fi units. Much space is devoted to this subject in electronic publications but the members feel they need to learn all they can about Hi-Fi and nothing will benefit them more than an exchange of ideas and experiences.

A cordial invitation is extended to NRI men in the vicinity of Chicago to attend meetings of the Chapter. Write or telephone Secretary Charles C. Mead, 666 Lakeshore Drive, Room 228, Chicago. The Chapter meets at the same address, 666 Lakeshore Drive, West Entrance, 33rd Floor, on the second and fourth Wednesday of each month.

Detroit Chapter has undertaken the construction of a TV Demonstration Panel. Oddly enough, the Chapter reported this to National Headquarters just before the February-March issue of National Radio-TV News was mailed, and that issue included a report that the Springfield Chapter had already undertaken a similar project. The Detroit Chapter was advised to get in touch with the Springfield Chapter for help and advice on the construction and use of this panel.

Due to the great interest created by these TV Demonstration Panels, it is expected that other Chapters will follow suit and want to build their own panels. This is a project that is well worth all the effort that can be put into it because of the help it can be to Chapter members in learning more about the construction and servicing of TV receivers.

The Chapter reports its officers for 1957 as follows: John Nagy, Chairman; John Stanish, Vice-Chairman; Earl Oliver, Treasurer; James J. Kelley, Recording Secretary; Leo H. Blevins, Assistant Secretary; Prince Bray, Librarian; Asa Belton, Financial Committee; Stanley J. Szafran, Financial Committee; Charles Mills, Sergeant-at-Arms.

At one meeting Earl Oliver held the interest of both new members and old alike with a discussion and demonstration of an RCA Radio Demonstration Panel. That is something Earl would do—hold the interest of his listeners—for he does so whenever he makes a talk.

Any NRI students and graduates in the Detroit area who are not attending meetings of the Detroit Chapter are missing a valuable opportunity not only to meet a grand bunch of fellows but also to improve their store of practical Radio-TV knowledge through association with experienced old-timers. They will be heartily welcomed at the meetings, which are held at 8:00 P.M. on the second and fourth Friday of each month at St. Andrews Hall, 431 E. Congress St., Detroit. Write or telephone Chairman John Nagy, 1406 Euclid, Lincoln Park, or Secretary James Kelley, 1140 Livernois Ave., Detroit.

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Here and There Among Alumni Members

Congratulations to Graduate Victor Castens, recently promoted to Chief Engineer at KGHM, Brookfield, Mo.

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Graduate Hayden L. Howard reports that he originally planned a career in music education. He has combined his NRI training with this and is now a recording technician with Fidelity Sound of Jacksonville, Fla. A clever combining of talents!

———*n r i*———

Walter F. Turnage of Richmond, Va., services Accu-Ray; an electronic device that automatically adjusts the weight of cigarettes. A leading manufacturer stresses this in cigarette ads.

———*n r i*———

From Hawaii, Graduate Charles Pilares writes he has a "going" Radio-TV shop. Says earnings have doubled since he started his NRI course. We wish you continued success, Charles.

Graduate Morton Brotman of Baltimore, Md., says the only advertising he needs is the "chain" action of satisfied customers. Lots of business with low overhead is a good set-up.

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