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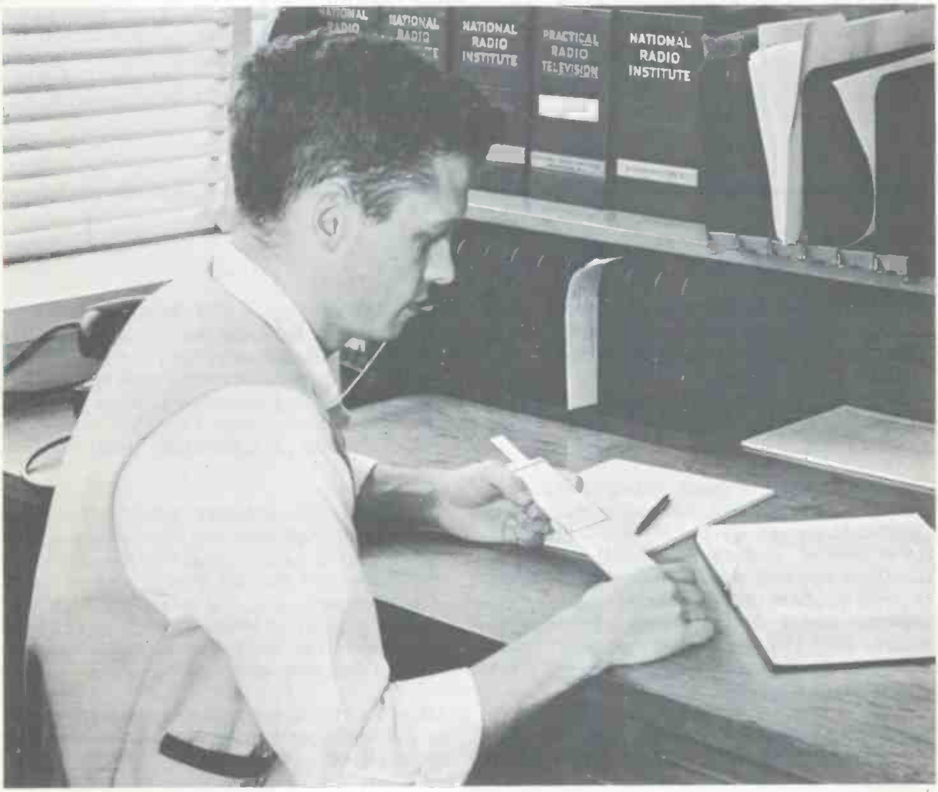

ADVANCED TECHNOLOGY DEMANDS CONTINUOUS STUDY TO PREPARE FOR GREATER OPPORTUNITIES.

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Editorial: FLEXIBILITY

Keeping pace with developments in the electronics industry is an absolute must if the technicians of today are to become the specialists of tomorrow. No other industry or science in our memory has ever undergone such rapid and ever changing advances in so short a time.

The development of the transistor, as but one example, has changed the entire concept of electronic technology and circuit design. The trend toward module construction with its limitless applications in electronic devices is proof positive that TV receivers will surely undergo major design changes in the near future. Flat picture display, plug-in module video, audio and power stages are but a few examples of what's to come.

Along with these new devices, (and there will be many) will come the demand for technical personnel who have studied them and their applications at every opportunity.

There are dozens of "trade journals" published each month for the electronics industry. These won't be found on your newsstand. Most of them will not be known to you unless you are a technician or engineer working for a progressive lab or manufacturer. This is unfortunate, as far as the average technician is concerned, because he is unaware of the many new developments that occur almost daily. He must rely on monthly newsstand publications, his local library, or the financial pages of his favorite newspaper. He might become acquainted, when possible, with other technicians who have access to trade journals in specialized fields of electronics.

The electronics industry is facing a serious shortage of engineers and technicians. I urge all of you to make a real effort to increase your know-how through a continuous program of reading and study and to become "flexible" so that you can fit your own particular talent into one of the many specialized job opportunities that may come your way.

All of us at NRI extend our very best wishes to you and your families as we approach the beginning of another year.

J. M. Smith
President

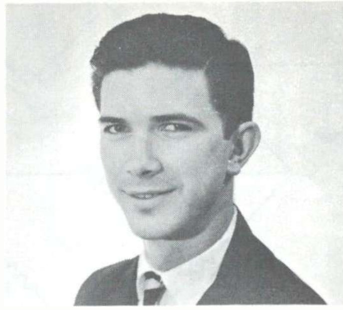
> Good will is the one and only asset that competition cannot undersell nor destroy.
>
> Marshall Field

Servicing The Vacuum Tube Voltmeter

By

Andrew Belski

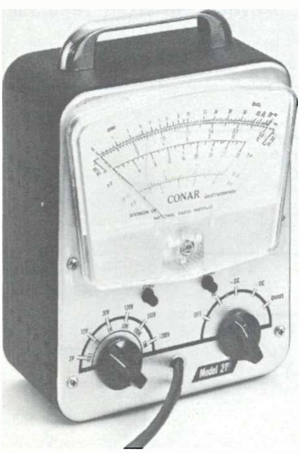
NRI STAFF



The basic test instrument in any servicing lab, workshop, or research lab is the Vacuum Tube Voltmeter. It is commonly referred to as the vtvm.

Whenever a technician has to track down a defective component in a circuit, he must take certain types of measurements. The instrument he chooses depends upon the type of measurements he must make, the speed with which he must make them, and how accurate those measurements must be. The vtvm, with its high impedance input will not "load" the circuit and change those circuit voltages being measured. The use of vacuum tubes increases instrument sensitivity, so extremely low voltages and extremely high resistances can be measured accurately.

The vacuum tube voltmeter, as you can readily see, is an essential part of the service technicians repair shop. It is, in fact, the "backbone" of his test equipment. The vtvm is usually the first piece of test equipment he purchases and the last he wants to be without. Should this instrument be out of order, and sent back to the factory for repairs, many service jobs would have to wait until its return. Therefore the service technician should know as much about his vtvm as he does about the receivers he services. Knowing exactly how it operates, he can troubleshoot it with little time lost from his regular work.



CONAR Model 211 VTVM.

Understanding the vtvm can be approached in much the same way as understanding a commercial receiver. First, you break it down into sections, then, when you understand how each section operates, tracking down the defect is not too difficult. We will use the circuitry of the Conar Model 211 for this discussion.

Let us break down the vtvm into these circuits: The power supply and bridge circuit, dc section, ac section, and ohms section.

How The Bridge Works

The bridge and its power supply are the heart of the vtvm. The circuit is shown in Fig. 1.

The polarity of the steady state operating voltages is marked on the schematic. Bias for V2 is the difference in voltage across R2 and R3 making the grid slightly negative with respect to the cathode. The bias for V1 is the difference in voltage between the drops across R1 and R3. Again the grid is negative.

Since R1 and R2 have the same value, the cathode voltages, everything else being equal, have the same potential. This means there is zero voltage between points A and B and that the meter indicates zero current.

The grid of V2 is grounded so its cathode current remains constant at all times. However, if we apply a positive voltage between the grid

Special **Christmas** *Sale - - see page 14*

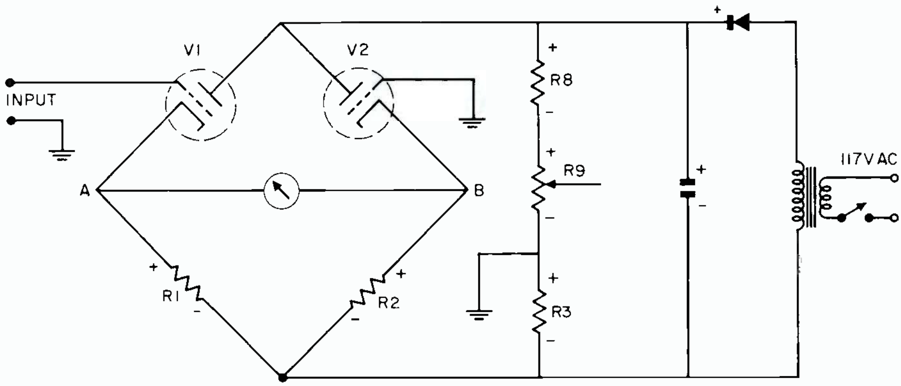


FIG. 1. Power Supply -- bridge circuit.

of V1 and ground, the cathode current of V1 increases, making point A positive with respect to point B. This causes current to flow through the meter. If a negative voltage is applied between the grid of V1 and ground, point A becomes negative with respect to point B and, if its leads are reversed the meter again indicates the difference in voltage.

This vtvm was designed so that slightly less than 1 volt applied between the grid of V1 and ground causes enough voltage difference between points A and B to result in a meter current of at least 1 milliampere. Thus the basic bridge is a low range electronic voltmeter that will read either positive or negative voltages.

The DC Section

A working bridge capable of measuring positive dc voltages from zero to 1200 volts is shown in Fig. 2. Notice that we have added R6, R4, R7, R5, C1 and a voltage divider consisting of R11-R17.

In the basic bridge in Fig. 1 we said that everything being equal, the voltage at A would equal the voltage at B. Actually the cathode currents of V1 and V2 will be slightly different and there will be some variation in the resistance values of R1 and R2. Therefore, we must have some way of adjusting the tube bias so voltage A equals voltage B. This is done by the addition of R4 and R6 to the circuit. R6 may be used to adjust the bias of V1 and V2 so the meter reads zero. Then voltage A is equal to voltage B.

The bridge is designed so its meter will give about full scale deflection when slightly less than 1 volt dc is applied between the grid of V1 and ground. The filter consisting of R5 and C1 prevents ac from reaching the grid of V1.

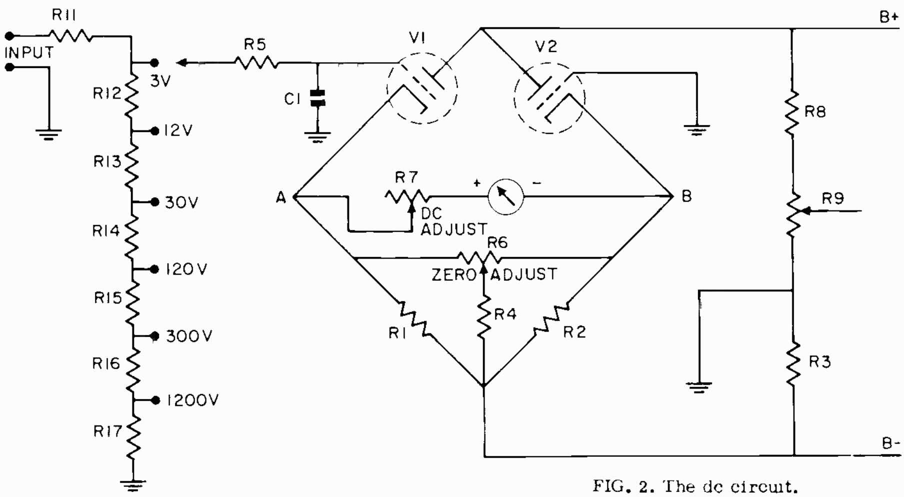


FIG. 2. The dc circuit.

R7 is inserted in series with the meter so that the meter will read exactly full scale when exactly 1 volt is applied between the grid of V1 and ground.

When the applied voltage makes the grid of V1 positive its cathode current increases, making point A positive with respect to point B. The meter polarity is such that an upscale meter reading is obtained. When -dc voltages are to be measured, the function switch (not shown in Fig. 2) reverses the connections to the meter terminals so the meter will still read upscale.

The voltage divider network, between the input terminal and ground, presents approximately 12.2 megohms of resistance of any dc voltage to be measured. The dc voltage to be measured is applied to this voltage divider network. As you know, the sum of the voltage drops in a series circuit equal the source voltage. Thus, using the range switch, we can select a fraction of the input voltage and apply it to the bridge circuit. Remember, the circuit is designed so that when 1 volt is applied to the input of the bridge circuit (grid of V1) the meter will deflect to a full scale reading. For example, if 12 volts is applied to the voltage divider network, with the range switch in the 12 volt position, 1 volt will be applied to the bridge circuit and cause a full scale deflection. When the range switch is in the 12 volt position, we read the 0-12 volt scale. Thus the vtvm will indicate 12 volts being measured. If 1200 volts are applied to the voltage divider, and the range switch is set to 1200, only 1 volt will reach V1 and the meter will again read full scale. The value read on the 0-12 voltmeter scale is multiplied by 100.

If a negative voltage is measured, a meter polarity reversing switch (not shown) is thrown and the meter still reads upscale.

The AC Section

You know that this bridge responds only to + or -dc voltages, so to measure ac the input circuit must be modified. An easy way to do this is to install a shunt type rectifier across the input voltage divider as shown in Fig. 3. C2 has been added to the circuit so dc cannot be applied to the rectifier, R11 has been removed from the voltage divider and replaced by R10. R10 is the same value as R11, so the voltage divider network remains unchanged. R12 and C12 have been added for a reason which will be explained shortly.

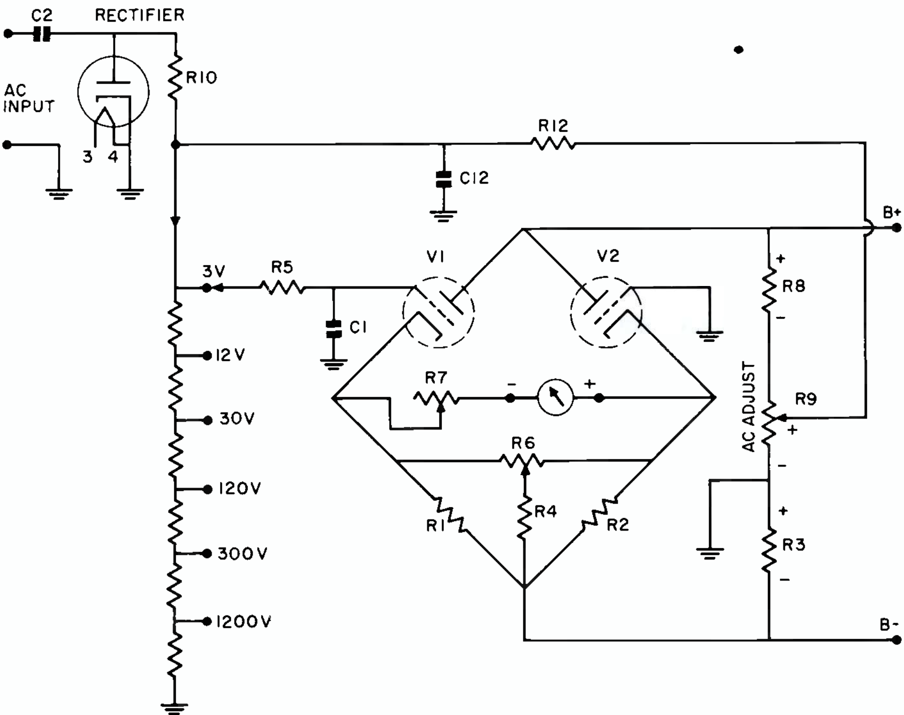
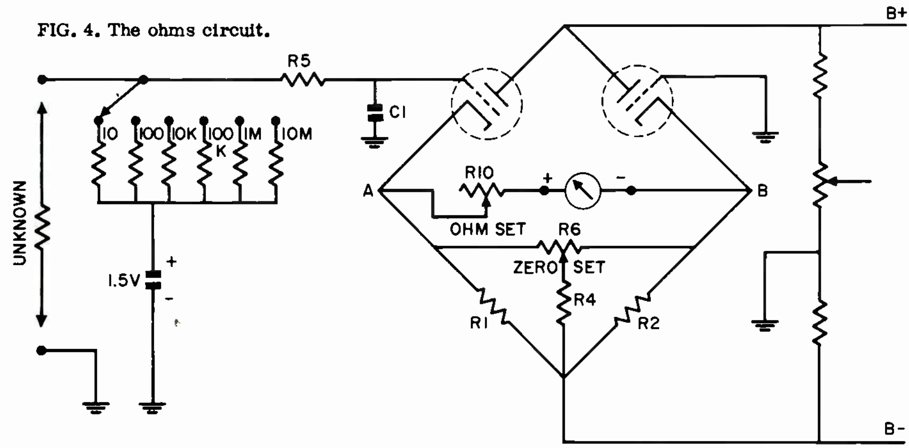


FIG. 3. The ac circuit.

In operation the positive half of an ac voltage will be shorted by the rectifier. The negative half is not affected because the rectifier will not conduct on negative voltage swings. Thus the negative half is applied to the voltage divider and to the bridge. R10 and C12 as well as R5 and C1 act as a filter so only pure negative dc reaches the grid of V1. The connections to the meter are the same as when -dc voltages are being measured so the meter deflects to the right. When no voltage is measured there is still a slight current through the rectifier. This makes the grid of V1 negative by a slight amount and the meter reads upscale, even though a voltage is not being measured. To cancel this voltage, R12 is inserted between the voltage divider and R9.

FIG. 4. The ohms circuit.



By adjusting R9 a positive voltage equal and opposite to the undesired negative voltage is applied to the grid of V1. The net voltage on the grid is thus zero and the meter reads zero.

R9 is called the ac zero adjust. It is not a calibration control and has nothing to do with the adjustment of R7 and R6 which were made in the dc measurement position. Thus, by adjusting the ac adjust potentiometer you adjust for zero voltage applied to the voltage divider network in the input grid circuit. When this adjustment has been made, the vtvm is accurately calibrated for all ac measurements. You can check the accuracy of the ac voltmeter in this vtvm by touching the positive probe to the filament connection of the 6X4 (Pin 3). You should measure approximately 6.3 volts.

The Ohmmeter Section

The ohmmeter section of the vtvm (Fig. 4) compares a voltage drop across a known resistance to the voltage drop across the unknown resistor under test. The scale is calibrated in ohms for direct measurements. When the function switch is turned to the ohms setting, the 1.5 volt dry cell is connected in series with a known resistor to the grid of the input tube. This places +1.5 volts on the grid of the tube. As you know, 1 volt at the grid is enough to cause full scale deflection. However, the ohms set potentiometer (R10) in series with the meter reduces the current through the meter. The meter is adjusted for full scale deflection by this ohms set potentiometer R10.

The resistance to be measured is connected in series with the unknown resistor and the battery. As you know, the voltage is divided between resistances in a series circuit. The voltage of the dry cell will then be divided between the known and unknown resistors.

The voltage drop across the unknown resistor subtracts from the original amount of voltage applied to the input of the vtvm. Thus, the meter deflects back downscale (due to the reduction in voltage) when the unknown resistor is connected into the circuit. The voltage developed across the unknown resistor will be proportional to its resistance. In this way a scale for the meter can be made which translates voltage into ohms. If the 10 ohm resistor in the vtvm results in full scale deflection, another 10 ohm resistor being measured would provide a 1/2 scale deflection. Mid scale on this range of the vtvm is 10 ohms. By switching in other resistors which are a multiple of 10 ohms, higher values up to 1000 megohms can be measured.

AC, +DC and -DC Calibration

The calibration of the instrument is accomplished in the following way. First, the vtvm must be allowed to warm up. During the warm up, the meter pointer may deflect first to one side then the other. This is caused by the irregular warm up time of the two halves of the bridge tube. After the meter pointer settles down, adjust the pointer to zero with the zero adjust potentiometer. Then apply a known voltage to the input. The dry cell in the vtvm is known to be 1.5 volts, so this can be used. Turn the function switch to the +dc position and the range switch to the 3 volt setting. Measure the voltage across this dry cell, by touching the hot probe only to its positive terminal, and adjust the dc calibration potentiometer (R7 in Fig. 2) for 1.5 volts on the scale.

Thus the vtvm is adjusted to read a known dc input voltage and is accurately calibrated. The meter is then switched to ac and with the probes held together to prevent stray ac pickup, the meter is zeroed with the ac zero adjust. The meter will now accurately read ac as well as +dc and -dc voltages. When the probes are separated any upscale reading on ac is ignored as it will disappear when the probes are connected to a circuit.

Troubleshooting

Now that we understand how each circuit operates, and the vtvm is calibrated, let's take a look at the troubles that can occur in each section. If you understand the operation and function of each circuit, you can pinpoint the defect by merely observing the operation of the vtvm.

Power Supply Troubles

The power supply is made up of three components: the transformer, the selenium rectifier and filter capacitor. The transformer is used to isolate the circuitry in the vtvm from the power line. This transformer very seldom becomes defective. However, if a short or low resistance path develops in the secondary circuits, excess current will be drawn from the transformer causing it to overheat. One cause of this is the rectifier and filter condenser becoming defective. If the rectifier shorts, ac will be applied to the filter capacitor, the dielectric in the capacitor will break down and the capacitor will also become a low resistance path. When the rectifier and filter become damaged, the rectifier may emit an odor much like rotten eggs, the electrolytic will probably bubble and leak electrolyte and the transformer will overheat. If this happens, both the selenium rectifier and filter capacitor must be replaced. If a short or low resistance path develops beyond the rectifier and filter, the defect must be isolated by means of elimination. If an ohmmeter is available, resistance checks can be made to detect the low resistance path between B+ and B-.

BRIDGE CIRCUIT TROUBLES

With the vtvm in the -dc position, the circuit is as shown in Fig. 2. Note that the grid of V2 is connected directly to ground and the grid of V1 is connected to ground through the voltage divider network. The zero set control can now be used to adjust the meter to zero. If one of the cathode resistors R1 or R2 or resistors R3 and R8 change value, it may not be possible to zero the meter. However, the most common cause of trouble in this section is an open grid circuit. If this happens, the tube with the ungrounded grid will not have the proper bias applied to it and will draw no current.

This will cause a large difference of potential between points A and B, and the meter will deflect hard to one side. If the grid of V2 is open, it will cause the meter pointer to deflect far to the left, while if the grid of V1 is open it will cause the pointer to deflect to the right. With the vtvm set up for -dc or ac measurements, these effects will be reversed. In either situation, the zero set potentiometer will not be able to compensate for this difference in potential and you will not be able to zero the meter. An open grid circuit can easily be tracked down with the vtvm ground lead and the schematic.

Touch the ground lead to one grid, then the other. If you can zero the needle with the Zero Set Control, that grid circuit is open. To track down an open in the grid circuit of V1, follow the circuit from the grid to ground by touching the ground lead to each connection in the circuit. If you come to a point where the needle does not return to zero, whereas it did at the preceding point, there is an open between these two points. The defect could just as well be a broken wire under

Model 211 VTVM showing the calibration controls.

its insulation, a defective solder connection, or a loose switch contact, as well as an open resistor.

A quick and easy way to check the continuity of R12 through R16 can be made without removing the vtvm from the cabinet. This can be accomplished by turning the range switch through the various positions and observing the operation of the meter pointer. Turn the range switch through the positions from 3V to 1200V. If the meter pointer can be zeroed on one range, whereas it cannot when switched to a lower range, the resistor between those two points is open.

NO METER MOVEMENT WHEN MEASURING VOLTAGE

If the vtvm can be zeroed, but will not measure voltages, there may be an open between the voltage divider network and the probe tip. The probe could also be shorted internally to ground. A wire used in place of the probe could eliminate the possibility of a shorted probe. An open can be traced with the use of the battery in the vtvm. Connect a wire to the positive terminal of the dry cell then touch it to the grid of V1. The dc adjust can be used to avoid excessive meter deflection. Then touch the wire to each connection from the grid to the probe tip. No deflection localizes the open.

INACCURACY ON AC MEASUREMENTS

The most common trouble in the ac section is inaccurate voltage readings. This is usually caused by calibration difficulties. The vtvm must be calibrated correctly on dc for it to operate on the ac function. Then the ac zero adjustment must be made correctly (with the leads shorted in the 3-volt range.) Low readings may be caused by a defective diode or R10 or R12 (see Fig. 3) changing in value. An open C2 or a shorted C12 would result in no readings. In the latter case, the R9 adjustment would be inoperative.

Remember, the ac voltmeter section employs the same circuit as the dc section (with the exception of the input diode, R11, R10, R12, C2, C12, and R9. So, if trouble is encountered in the ac section, check first to be sure the dc section is operating properly before troubleshooting the ac circuit.

OHMMETER TROUBLES

Trouble in the ohmmeter section is usually limited to the battery. A weak battery will result in low resistance readings. These low readings will occur mostly on the low resistance ranges. This is caused by more current being drawn from the battery when measuring low resistances. Current is drawn from the battery only when measuring resistances. If one of the resistors in the vtvm, used for comparison, changes value, the resistance measurements will be incorrect. Note that 1.5 volts is applied to the grid of V1. This could cause more than a full scale deflection. The meter is prevented from pegging by the ohms set potentiometer in series with the meter. If this potentiometer is shorted, the meter will peg on the right of the scale in the ohms setting of the Function switch.

INSTABILITY

Instability in the operation of the vtvm may be caused by a gassy bridge tube. By instability, we mean the need to adjust the "Zero Set" or "Ohms Set" controls when turning to different ranges or functions.

The twin-triode bridge tube used in the vtvm must be relatively free from gas content. If the tube contains more than the prescribed level of gas, the bridge circuit conditions will change causing the bridge to be less accurate. The amount of inaccuracy will vary from range to range. These varying conditions can be explained in this way:

As the tube heats, the gas molecules will ionize. The positive ions will be attracted to the grid and remove electrons from that grid. This will cause a minute flow of current (electrons) from ground, up through the grid resistors producing a voltage drop with the grid end positive. This voltage drop changes the grid bias and a different amount of current flows through one side of the bridge, making an adjustment of the zero set or ohms set necessary. As different values of grid resistance are switched in, the error voltage drop changes. Thus an adjustment must be made once again.

To check for gas content turn to the ohms function and the highest setting of the range switch (R × 1 meg.) Adjust the pointer over the last division on the right side of the scale using the ohms set potentiometer. Now turn the range switch to the R × 100K position. If the pointer moves more than two divisions down scale (left 1/8") the tube contains more than the correct level of gas. This tube can be "cured" with the use of a filament transformer and a tube socket. Connect the tube to the circuit as shown in Fig. 5. Cook the tube for 8 hours. Then allow about 1 hour of cooling before inserting it in the vtvm. Occasionally a few additional hours of cooking is necessary. If the tube still shows gas content, it should be replaced. However this tube will still function properly in most other applications.

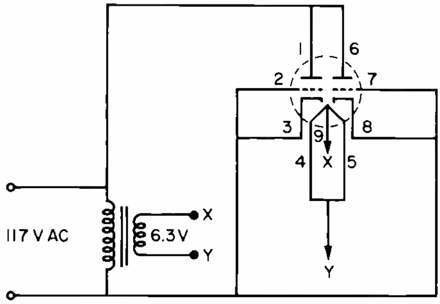


FIG. 5. Circuit for curing bridge tube.

A QUICK CHECK-OUT

The calibration given with each vtvm is usually the "check out" of the instrument. Let's go through the calibration procedure on the Conar Model 211 VTVM and note what circuits it checks out.

Set the vtvm on your work bench in the position in which you will be using it, (usually upright.) Before turning it on, make sure the needle pointer is exactly over zero on the scale. If it is not, adjust it to zero with the plastic set screw located at the base of the needle on the meter face. Turn the instrument on and allow a few minutes of warm-up time. Then adjust the meter pointer to zero with the zero set control.

If the meter pointer can be adjusted to zero, we know that the power supply and the bridge circuit are functioning properly. Turn the function switch to +dc and the range switch to the 3 volt position. Touch the probe to the positive terminal of the battery. (The negative terminal and the ground lead are connected internally.) The meter pointer should deflect to 1.5 on the 0-3 volt scale. If it does not, adjust it to zero, using the dc calibration control. If this can be accomplished, we know that the dc section is functioning properly also.

Turn the function switch to the ac setting and short the leads together with the range switch in the 3-volt position. The meter pointer should rest exactly over zero. Do not touch the setting of the zero set potentiometer on the front panel. If a zero reading is not obtained, adjust it to zero with the ac adjust potentiometer. To check the accuracy of the ac section, turn the range switch to the 12-volt position. Touch the probe to pin 3 of the 6X4 tube socket. The meter should read approximately 6.3 volts.

This leaves only the ohms section to check out. Turn the function switch to ohms and note that the meter pointer deflects to the right side of the scale. This is a result of the dry cell being connected to the grid of V1. Adjust the meter pointer to the last division on the right, using the ohms set control. Short the leads together and the meter pointer will deflect to zero on the left side of the scale. Again the zero set control should not be moved.

On the RX1 setting, you may notice a slight up-scale deflection with the probes shorted. This is the resistance of the leads and internal connections of the circuit and should be ignored. Measure the value of a few known resistances to check the accuracy of the ohms section. Low readings (particularly on the low ranges) indicate a weak dry cell. If you short the leads together in the lower ranges for any length of time the battery will be weakened, so avoid doing this. The life of the dry cell will be dependent on the amount of use the ohmmeter section of the vtvm receives, and of course, on its normal shelf life, which is usually six months to a year.

THE FUNCTION SWITCH

The various controls and circuits that we have discussed are switched in and out of use with the function switch, shown in Fig. 6. This is a six pole switch with 4 positions. When the switch is turned, the slider contacts connect the various circuits together to form the separate sections of the vtvm. Should one of the connections in the switch not be making contact, there would be an open circuit in that stage. These connections can be checked by gently applying pressure to each contact with the rubber end of a pencil. If applying this slight pressure caused normal operation of the vtvm, that contact is loose.

A loose contact can be repaired occasionally by turning the slider contact past the stationery lug and applying a slight pressure to the stationery lug. This may bend it enough to make contact when the slider is turned back.

DEFECTIVE SOLDER CONNECTIONS

One of the most common causes of trouble in an instrument that is assembled by the kit builder is solder connections. In most cases, not enough heat was originally applied. The student thinks that excessive heat could damage the components. Thus, he is very hesitant about applying sufficient heat to the solder connection. The result is either a cold solder joint or a connection that contains rosin. This type of connection may act as an intermittent, or a high resistance in the circuit. It may cause trouble immediately, or act as a good connection for months before developing into a defective solder joint.

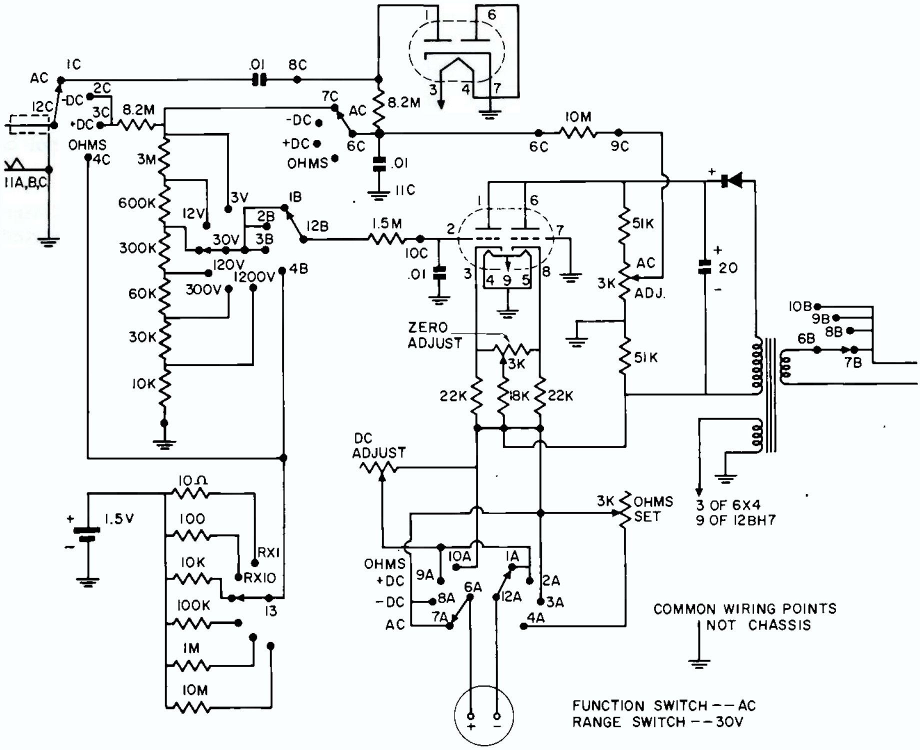


FIG. 6. Complete Diagram of CONAR 211.

However, do not overlook the fact that a defective solder connection could be causing your trouble if it is a factory assembled unit. A defective solder connection may develop even if it was made perfectly at first.

The vtvm is not too delicate a test instrument. It should be handled with a reasonable amount of care, though, if it is to remain an accurate and useful "tool" of the service technician. Become proficient in its use -- not careless.

HELP WANTED

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Thought, not money, is the real business capital, and if you know absolutely that what you are doing is right, then you are bound to accomplish it in due season.

Harvey S. Firestone

"Never mind the theatrics, how much will it cost?"

DC Amplifiers

By

Ted Beach

NRI STAFF

First of all, just what exactly does the term "dc amplifier" mean? Some people say that it means "direct coupled" amplifier, others say that it means "direct current" amplifier. Both definitions to a large extent are correct, since an amplifier which is direct coupled must be capable of amplifying direct current. On the other hand, a direct current amplifier is not necessarily direct coupled, as we shall soon see. To be on safe ground let us define a "dc amplifier" as an amplifier whose low frequency response extends down to direct current. We can't go wrong this way and we will satisfy advocates of both camps.

Next, why should we concern ourselves with this strange breed of amplifier at all? You may say, they are not used in TV, radio, or hi-fi, so of what concern are they to me? Well, now, don't be too sure that they are not used in TV, radio, and hi-fi! Actually, a great number of TV receivers have one or more dc amplifiers in their circuitry; some very desirable hi-fi circuits use dc amplifiers; and even the lowly radio has been known to sport a dc amplifier on occasion.

One piece of test equipment with which all are familiar and which is used daily by most technicians has as its heart a dc amplifier... Anyone ever hear of a vtvm? This very definitely comes under the heading of dc amplifier, even if it is really an attenuator. In the truest sense of the word the vtvm is a direct CURRENT amplifier, producing a large output current in proportion to a small input current.

Another piece of test gear using a dc amplifier is an electronically regulated power supply. This gadget has a very high gain dc amplifier hung onto the output terminals that control the output power and voltage.

DC amplifiers are used extensively in the field of industrial electronics in analog computers, controllers and power supply regulators. In fact, it is the field of computers that has caused such rapid advances in the art of dc amplifier design.

This article will discuss some of the basic dc amplifiers as well as a few of the many applications of dc amplifiers.

BASIC CIRCUITRY

Fig. 1A shows a two stage dc amplifier. Notice that the first stage, V1, is simply a conventional vacuum tube amplifier stage. Stage V2, the second stage, is quite different from the usual vacuum tube amplifier circuit. The plate of V1 is directly connected to the grid of V2. Even if the plate voltage of V1 is very low, it will still be positive, so in order for V2 to have the proper grid-cathode bias the cathode of V2 must be returned to a positive voltage greater than the plate voltage of V1.

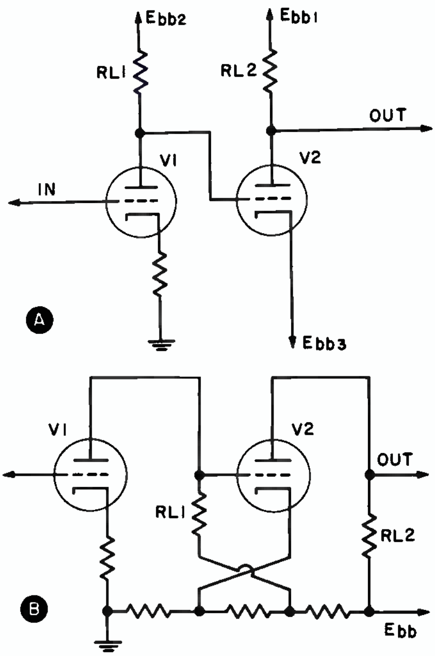

FIG. 1. Simple two stage dc amplifiers.

With both the grid and cathode of V2 going to positive supplies, the plate supply voltage must be larger than either the grid or cathode supplies. Fig. 1A shows three separate supplies used for the two stages. Actually, a single supply with a voltage divider could be used, and usually this is what is done. Imagine, however, what would be required of the power supply if several stages were used. It is entirely possible that if five or six simple stages were connected in cascade as the two stages are in Fig. 1B, the power supply would have to put out over 1000 volts! Furthermore the resting output of the last stage would be somewhere in the neighborhood of 1000 volts also.

This leads us to one of the first axioms of dc amplifier designers:

1) use as few stages as possible to do the required job.

The reasons for this axiom are twofold. First, as mentioned above, to make the circuit practical, and second, to ensure long and short term stability and accuracy. Five stages critically adjusted with a tapped power supply and a gain of 10,000 for example, is much less desirable than a two stage amplifier with the same gain. Variations in characteristics of any of the five stages would upset operation, and power supply drift would be less tolerable than with the two stage amplifier.

In order to get the maximum possible gain per stage high gain pentodes are normally used in dc amplifiers. Triodes and tetrodes are also used, but the pentode usually is the workhorse that supplies the majority of the gain. The other tube types are used to provide the desired input and output configurations for any given requirement.

INPUT CIRCUITS

In order to avoid the requirement of an extremely large positive power supply, dc amplifiers sometimes use two power supplies, a positive supply and a negative supply. In this way, a number of stages can be cascaded, if necessary, merely by suitable selection of parts values for the individual stages.

A basic amplifier circuit using this idea of two power supplies is shown in Fig. 2. This particular circuit, or a variation of it, is used as the input stage of practically all dc amplifiers used in computer work. In addition, this same circuit is the basis of most vtvm's. Some of you may also recognize the basic circuit as a cathode coupled phase inverter quite popular in hi-fi amplifiers and oscilloscopes. In the latter two occupations the negative supply is usually not used since no further direct coupling would be used in such cases. This circuit may also be called a "differential amplifier" if the grid circuit of V2 is altered slightly. By omitting Rb and by making Rk adjustable for balance, signals may be fed into the grids of both V1 and V2. If RL1 is also left out and the output taken from the plate of V2 only, the amplifier becomes single ended. There will be an output only when the two signals fed to the two grids are different one from another. In fact, the output will always be the difference of the two signals, hence the name "differential amplifier". Any signal which tends to make both grids go either positive or negative together will not appear in the output. This circuit is shown in Fig. 3. V1 is essentially a cathode follower stage, and contributes no gain at all while V2 combines the two input signals as a combined grounded-grid and grounded-cathode amplifier. If input 2 is grounded, the amplifier becomes a single-ended input stage, frequently used in high gain amplifiers of analog computers. Neither V1, which acts as

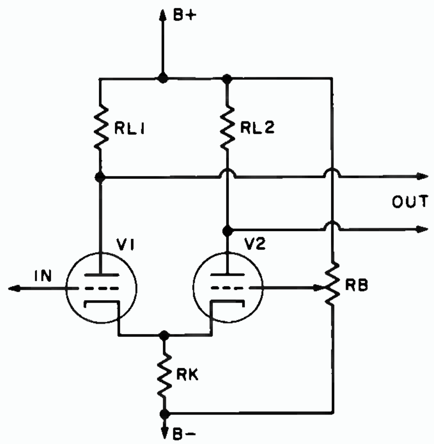

FIG. 2. Basic cathode coupled input stage.

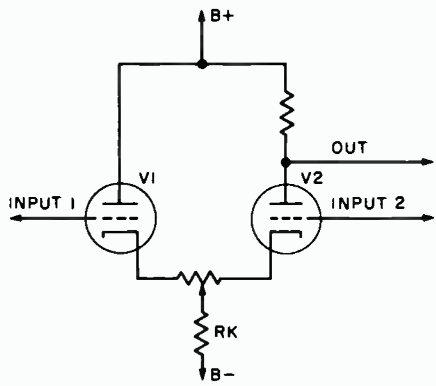

FIG. 3. Basic differential amplifier.

a cathode follower, nor V2, which is a grounded grid amplifier, will change the phase of the signal as it is passed from input 1 to the output. Thus this configuration is frequently used where amplification with no phase inversion is desired.

As previously mentioned, most high gain dc amplifiers use pentodes because of their high gain characteristics. The circuits discussed above are all circuits which are commonly used as input circuits for dc amplifiers and which contribute little or no overall gain. The input stage feeds either directly or by way of a resistive voltage divider to the grid of the next stage. This is the stage that normally provides the largest portion of the amplifier's gain. The circuit used is nearly always a grounded cathode stage which will produce a phase inversion of 180°. This 180 degree phase reversal is necessary in many applications of the dc amplifier but undesired in other applications. Thus, by using the differential amplifier ahead of the high gain pentode amplifier a choice of zero or 180 degree phase inversion is possible, merely by selecting one of the two inputs to the differential amplifier.

OUTPUT CIRCUITS

In order to eliminate the large dc component which would be present at the output of the dc amplifier, a cathode follower stage is frequently used as the output stage. In addition, the use of a cathode follower provides a very low output impedance allowing a dc amplifier to supply a certain amount of power if need be. Figs. 4A and 4B show two common output stages. The circuit of Fig. 4B is somewhat better than that of 4A because the glow tubes used in the cathode for bias provide a constant drop. Thus, any change that takes place at the cathode is reflected without loss at the output terminal.

COMMON DC AMPLIFIER CIRCUITS

Fig. 5 shows a simple degenerative type power supply regulator using a pentode dc amplifier tube. The triode, V1, is usually referred to as the "series tube", and V2 as the control or amplifier tube. VR is a glow tube used as a constant cathode bias for V2. For a given load the bias of V2 is set by R4 so that the drop produced across RL, the plate load resistor of V2, biases V1 correctly to produce the desired output voltage. Variations in output voltage due to changes in input voltage or output current are amplified by V2 and applied to the grid of V1. Capacitor C1 couples any rapid fluctuations of the output directly to the grid of the amplifier, while Ck reduces the gas-tube noise voltage across VR. R1 and R2 are chosen to supply the nominally correct screen voltage to the amplifier tube from the unregulated input supply voltage. This very simple regulator circuit is a good example of the use of a dc amplifier in a familiar application.

CASCODE AMPLIFIER

Another common dc amplifier circuit is shown in Fig. 6. This "cascode" amplifier is quite popular as an rf amplifier in VHF and UHF applications since it provides the gain of a pentode with the tube noise of the triode. V1 acts as a grounded cathode amplifier stage with V2 as its plate load resistor. V2 in turn operates as a grounded grid stage. The fact

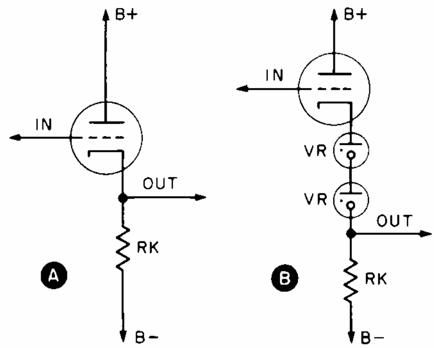

FIG. 4. Typical single ended output circuits.

that this combination can amplify dc as well as ac signal voltages is usually of no consequence in rf amplifier applications. However, this same basic circuit is frequently used as the input stage of operational amplifiers in analog computers. The bias on V2 is adjusted by selection of R2 and R3 for a particular value of E_{bb} to split the voltage equally between V1 and V2. With the introduction of a slight amount of positive (regenerative) feedback to the cathode of V1 the cascode dc amplifier using medium mu triodes can have a gain on the order of 1000 to 7500; much greater than can be realized from a single pentode stage, and considerably more than the same two stages connected in cascade.

Important considerations in the cascode amplifier are heater-cathode voltage rating of V2 and the undesirable effects produced by variations of heater supply voltage and plate supply voltage. The latter effects are a plague with most types of single ended amplifiers, however, and are not peculiar to the cascode circuit alone. Using positive and negative stabilized (regulated) power supplies would reduce greatly the effects due to plate supply variations, as it would in any dc amplifier configuration. The cascode circuit has

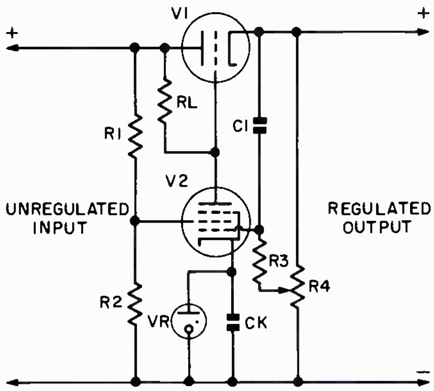

FIG. 5. Degenerative series voltage regulator.

been successfully used to replace the usual pentode dc amplifier in regulated power supplies as discussed earlier.

PHASE INVERTER DRIVER

Another frequently encountered dc amplifier circuit is shown in Fig. 7. This circuit, again, is not usually looked on as being a dc amplifier, nevertheless it is exactly that. The popular cathode follower phase inverter circuit used in many hi-fi amplifiers depends upon equal load resistances in both the plate and cathode. In order to offset the rather large dc voltage that appears across the resistor in the cathode, various methods are used to reduce the grid-to-cathode voltage to that required for linear operation of the stage. Fig. 7 shows a very good method of accomplishing just this; direct coupling from the plate of the driving stage to the grid of the phase inverter. This is easily done by using a fairly large value of plate load resistance for V1. The quiescent plate voltage may then be on the order of 40v to 50v. If Rk2 and

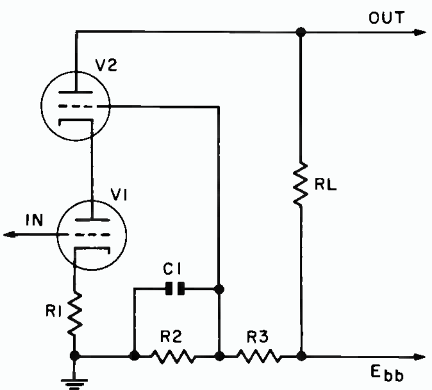

FIG. 6. Cascode dc amplifier.

RL2 are properly chosen for V2, the cathode voltage will be on the order of 45v to 55v, giving V2 a bias of about -5v. This dc amplifier circuit as used in hi-fi amplifiers thus eliminates one resistor (grid return for V2) and the coupling capacitor between V1 and V2 at the same time the bias problem of V2 is solved. The low frequency response of this circuit is flat down to, and including, dc even though the rest of the amplifier necessarily uses RC coupling between stages. As with other simple dc amplifiers, there is no inherent stabilization in this circuit against changes in filament and plate supply voltages. However since it is usefully only an ac amplifier, these considerations are not very important or critical to any extent.

GAIN-BANDWIDTH-STABILITY

In dc amplifiers as well as in most ac amplifiers there is a continual conflict between the requirements of high gain, wide bandwidth and stable operation. The dc amplifier is worse off in many respects than its ac-type brother since many more factors can influence proper operation.

Taking the three requirements listed above in reverse order we will look briefly at some of the problems and their solutions with respect to dc amplifier design.

STABILITY

In a high gain dc amplifier, a very small change in the input stage can result in a significant error in the output voltage. Drift in the input stage can ordinarily be traced to one or more of the following:

(1) variations in grid current.
(2) variations in heater voltage.
(3) variations in dc supply voltage.
(4) variations in the input tube and other circuit components.

Consider a high gain dc amplifier with a gain of 10,000. Suppose the input tube of the amplifier had a grid current of .05 μa with normal supply voltages. This is a fairly realistic and representative value of grid current for negatively biased tubes. Suppose further the grid resistor of the input stage is 10k ohms. This means an input voltage of $10k \times .05 \times 10^{-6}$ volts or .0005 volts would always be present at the grid of the input. This would appear in the output as: $.0005 \times 10{,}000$ volts or 5 volts. This is not too bad since this small amount of voltage can be balanced out by adjusting the operating point of the input stage. However, if for any reason the grid current were to change, this change would show up in the output as an undesirable drift of the output voltage. As long as the grid current remains constant there is no problem. However, a change in grid circuit resistance, heater voltage, plate voltage or aging of the tube can cause a significant change in grid current to produce drift. Special tube types have been developed that have very low values of grid current that are virtually unaffected by the above mentioned factors. Aging of tubes also helps to eliminate the problem of drift due to grid current variations.

If the filament voltage of an input stage amplifier tube is changed 10%, an equivalent change in grid bias of 100mv will result due to the combined changes in grid current and plate-cathode potential. This holds true for relatively small values of plate current, and the effect becomes worse at higher values of plate current. As you can see, this is really quite a pronounced problem; less than one volt change in filament voltage producing a 100mv or larger change in grid voltage! A very practical method used to reduce the effects of filament voltage changes is shown in Fig. 8. Plate current variations in V2 due to heater voltage change causes the voltage across common cathode resistor Rk to vary. This change in cathode voltage causes a change in the grid-cathode potential of the input tube V1 of the correct polarity so as to tend to hold the plate current of the input tube constant. Notice the similarity of the circuit of Fig. 8 with the circuit of the differential amplifier of Fig. 2. Not too surprisingly the differential amplifier also proves to be exceptionally stable with regards to changes in heater supply voltage.

The best way to combat the problem of changes in power supply voltages is to provide well regulated, stiff power supplies. Some types of bridge amplifiers can be used that will be insensitive to variations in plate supply

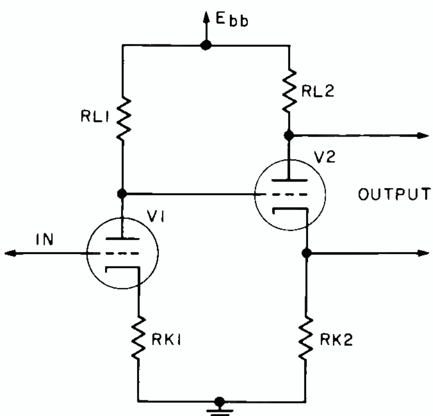

FIG. 7. Direct coupled phase inverter.

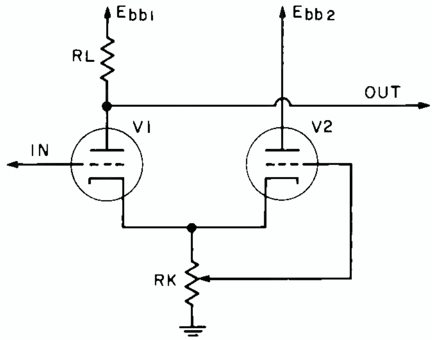

FIG. 8. Using a second tube for heater compensation.

voltage, however the complexity seldom warrants their use. Push-pull amplifiers tend to be more tolerant towards plate supply changes than single ended amplifiers, so when really stable operation is needed they are usually used.

Input tube variations and variations in other circuit components are best avoided by careful selection of components. Special aged premium tube types should always be used in the input stages of dc amplifiers if stable performance is to be counted on. Low temperature coefficient precision resistors should be used. In addition, resistors should be overrated powerwise by a factor of from 10 to 25 to avoid changes in value from dissipated heat. Ambient temperature within the amplifier housing should be controlled to eliminate thermal drift. Adequate forced ventilation by a small blower or fan usually is sufficient.

GAIN BANDWIDTH

Amplifiers with a low frequency response extending down to dc are always plagued with the problem of obtaining large gain along with wide bandwidth. For reasons of stability and simplicity as few stages as possible should be used. Yet in order to get high gain, large values of plate load must be used. This means restricted high frequency response due to shunt capacity (tubes, wiring, stray). Many high gain operational amplifiers have an upper frequency limit of approximately 100 kc, and for dc amplifiers this is wideband! Using video techniques and many stages of amplification the bandwidth of a dc amplifier can be extended to 10mc or 20mc, but the resulting circuitry is very complex and extremely expensive.

One answer to the question of gain-bandwidth-stability is to use a special amplifier known

(continued on page twenty-four)

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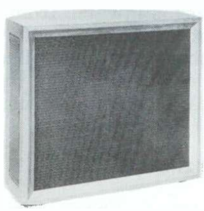

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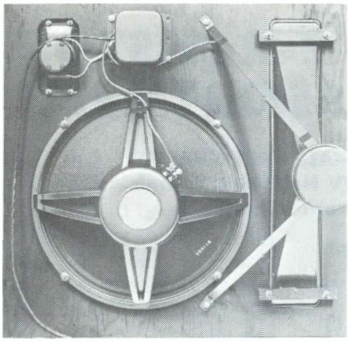

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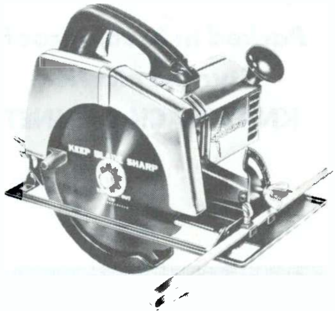

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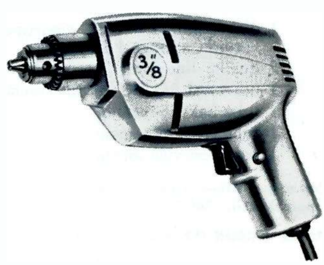

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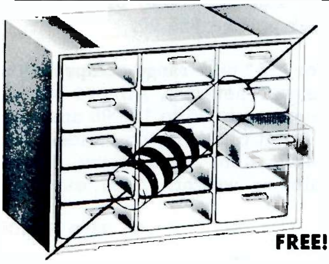

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60.01-70	7	7	210.01-220	22	21
70.01-80	8	8	220.01-230	23	22
80.01-90	9	9	230.01-240	24	22
90.01-100	10	10	240.01-250	25	23
100.01-110	11	11	250.01-260	26	24
110.01-120	12	11	260.01-270	27	25
120.01-130	13	12	270.01-280	28	26
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6	.32	.53	.59	.70	.85	1.03	1.22	1.40
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8	.36	.63	.71	.84	1.05	1.29	1.54	1.78
9	.38	.68	.77	.91	1.15	1.42	1.70	1.97
10	.40	.73	.83	.98	1.25	1.55	1.86	2.16
11	.42	.77	.89	1.05	1.35	1.67	2.02	2.34
12	.44	.81	.95	1.12	1.45	1.79	2.18	2.52
13	.46	.85	1.01	1.19	1.55	1.91	2.34	2.70
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The Collins Radio Company of Cedar Rapids, Iowa has announced the appointment of Ray C. Evans, Jackson, Miss., as broadcast sales engineer for Collins' southern regional sales area.

Evans, 45, a long-time radio engineer in the south, will cover Arkansas, Louisiana, Mississippi and Alabama in his new post.

He is a graduate of the National Radio Institute, Washington, D. C.; the U.S. Army Signal Corps school; and of a special course in radio and TV management at the University of Tennessee.

Evans joined Radio Station WNOX at Knoxville, Tenn., following service during World War II and became chief engineer of that station in July 1947. In addition, Evans has been consulting radio engineer for a number of stations in the East Tennessee area.

Another graduate, Donald A. Smith, a member of IRE and long a contributor to many electronics magazines, is the author of a new book. Titled "Medical Electronics Devices Handbook", it is being published by Horace W. Sams Co., of Indianapolis, Indiana.

The book is the first to be published on the subject and is written for technicians, not engineers. It contains 265 pages and will sell for $6.95.

> Contrary to the commonly accepted belief, it is the risk element in our capitalistic system which produces an economy of security. Risk brings out the ingenuity and resourcefulness which insure the success of enough ventures to keep the economy growing and secure.
> Robert Rawls

NEW from NRI - Conar research and development

"300" stereo system

The shock of common sense in STEREO — you *must* hear it to believe it!

Conar proudly presents an outstanding, quality, yet amazingly economical stereo system — guaranteed to satisfy.

The "300" Stereo System is designed for those who consider their *ears* as the best judge of true stereo reproduction. It is not for people who insist on spending $400 or more for stereo — or people who thrive on long lists of specifications, technically accurate or not.

Here is quality stereo to compliment your tastes for good listening and fit any budget. A precision engineered system with carefully matched components; yet ruggedly built as a home entertainment center for the entire family. With the "300" in your home, you can *afford* to let the wife, children or friends use it (at least on rare occasions).

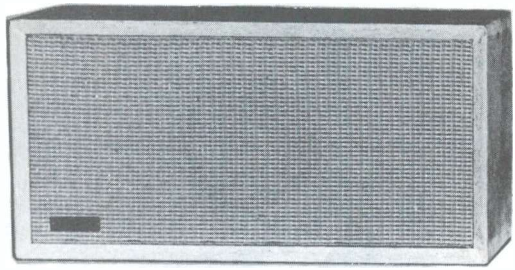
Whether it's violin, piano solo or bass drum — Beethoven, Belafonte or Brubeck — the "300" urges and invites your comparison with stereo systems costing considerably more. We repeat, let your EARS judge the living sound, superb channel separation, the startling realism that only good component stereo can bring.

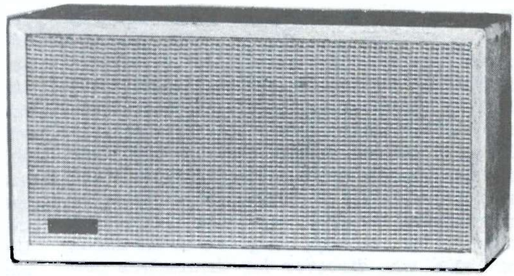
The "300" Stereo System includes:

- Conar power amplifier kit, beautifully styled in circuitry and outside appearance. Build it one evening with time left over for a trial run. Reserve output for "concert hall" volume in 30 x 30 living area. Frequency response 50 cps to beyond audible limits. 50 db or better channel separation. (Hum, noise and distortion *not distinguishable* at full output.) Amplifier price if bought separately — $31.50.
- Two, fully assembled bookshelf enclosures with pre-mounted, 8" extended range speakers. Not the usual midget enclosures you'd expect in a low priced system — each is a full 24" x 12" x 10". Sturdily constructed of 3/4" wood ready for finishing to match any decor. (Enclosure and speaker price if bought separately — $19.95 each)
- Electro-Voice Model 0126A diamond-sapphire cartridge; reg. manufacturer's price — $16.50.
- Well-known LESA Model CD2/21 4-speed changer. Fully automatic, heavy-duty 4-pole motor, balanced tone arm, high inertia turntable, automatic intermix and shut-off, constant speed change cycle. Pre-finished walnut base included. (Sells nationally at $49.25.)
- All hook-up wire, coaxial cable, plugs, jacks, etc.

The "300" Stereo System was recently demonstrated at meetings of hi-fi enthusiasts, dealers and service technicians (dates and places upon request). Audience response was *overwhelming*.

Your own 30-day "listener's" test will show you WHY — you *must* hear the "300" to believe it!





MODEL 300 STEREO AMPLIFIER

- **CONTROLS:** Phone-Tuner switch, Balance, Loudness, Bass, Treble, on-off switch
- **TUBES:** 2-7025, 2-6BQ5
- **CABINET:** Steel, baked-on deep gray finish
- **PANEL:** Steel, off-white finish
- **DIMENSIONS:** 4½" x 13" x 9"
- **POWER SOURCE:** 110-120 volts, 60 cycle AC
- **ACTUAL WEIGHT:** 7 lbs.
- **SHIPPING WEIGHT:** 8 lbs. (other specifications—see opposite page)

MODEL 300 SPEAKER ENCLOSURES

- **DIMENSIONS:** 24" x 12" x 10"
- **SPEAKERS:** 8" extended range (19-21,000 cps.)
- **GRILLE CLOTH:** Gold texture
- **CONSTRUCTION:** 3/4" wood (ready for finishing)
- **ACTUAL WEIGHT:** 21 lbs. each
- **SHIPPING WEIGHT:** 24 lbs. each

LESA CD2/21 RECORD CHANGER

- **MOTOR:** Heavy-duty 4-pole motor (balanced within 100 micro-inches), rubber idle wheel, automatic disengage
- **SPEEDS:** 78, 45, 33⅓ & 16⅔ rpm; constant speed change cycle; automatic intermix 7", 10" & 12" records
- **TONE ARM:** Balanced, no resonance
- **DIMENSIONS:** (overall) 8½" x 16" x 13"
- **ACTUAL WEIGHT:** 14 lbs.
- **SHIPPING WEIGHT:** 16 lbs.

STEREO CARTRIDGE

- **ELECTRO-VOICE MODEL 0126A:** 0.7 mil diamond (lp), 3 mil sapphire (78); tracking force 3-6 grams; response 20-20,000 cps; matched channel output for monaural records

Complete System Stock #300UK. Low as $10.90 down, $10.00 monthly.
Shipped via Express for safest handling. Total shipping weight: 72 lbs.

$109.00

Notes From J. B. Straughn

CHIEF, CONSULTATION SERVICE

Getting The Most From Your Course

There is a common feeling that a textbook is the final word on the subject it covers and that by "knowing the book" one has stored away all necessary knowledge of the subject. This, of course, is not true. No text is or can be complete or final; nor if it were, would an understanding of the subject be gained by memorizing the whole book. Knowledge is not obtained in this way, but grows in the minds of those who discover for themselves new facts and relationships.

It is natural for you as a student to take the facts presented in a textbook and form an opinion in your own mind of resulting circuit action. This growing knowledge must be examined carefully from time to time to make certain that misconceptions have not crept in which could bring you up against an impossible situation.

For example, you may have read that an audio voltage can be stepped up with a transformer. So -- why use tubes or transistors to amplify an audio signal? Just use a number of step-up transformers, each being fed from the preceding transformer so the output of the last one will have the desired value.

Your common sense tells you that it would be highly unusual to get something for nothing, but why won't this idea work?

If you were in a classroom you probably would not expose your ignorance before the class. If you are really curious, and you should be, you would try to corner the instructor after class to get a private discussion of your problem. If you are lucky enough to be taking the NRI Home Study course you just include your letter with your next set of answers and get your private consultation.

Remember that the principles of electronic circuitry have developed out of the hard study of scores of original investigators, and an understanding of the principles can best be gained by a guided process somewhat similar to that employed in their original discovery. This process begins with, and is continually pushed along by, curiosity as to the methods and the electronic mechanism of circuit action; it goes forward by the collection and study of facts and by deciding which of these facts are true and apply, and which are untrue and do not apply. Finally, this process involves practice of the reasoning faculty by which deductions are made and applied or tested in many similar cases. It is only in this way that electronic processes can be UNDERSTOOD. The learning of facts alone cannot accomplish this.

Because textbooks by themselves are not sufficient, you get demonstrations conducted in the privacy of your own home. If you were attending a resident school the instructor would lecture on the important aspects of the demonstration and you would be expected to take notes and ponder on the facts brought forth. In this type of schooling you must be right on your toes and present at all times, as lectures are not repeated.

The important "lecture part" which describes the significance of the experiments you have conducted is covered in the DISCUSSION which is a part of each experiment. Don't make the mistake of reading these Discussions as you would a newspaper article. Let your mind be stimulated and think about the meaning of the truths and facts which have been set forth.

In your first and second kits you will repeat George Ohm's experiments which led to Ohm's law. A thorough understanding of the principles involved is your first long step up the electronic ladder of success. Other famous discoveries are treated in like manner so your knowledge grows rapidly and is channeled along the right paths.

Always review frequently, as new ideas will often "come home to roost" through review. You will receive a real feeling of satisfaction and sense of mastery as your knowledge grows. Of course, thinking can lead to confusion, but this is not a bad thing. It is when you have to stop and take stock of the facts that you are doing your best work.

Should you come up against a stone wall, such as "how many amperes there are in a volt," write to me for help. Tell me what you think and, if possible, why -- then I'll be able to straighten out your facts and get you back on the right track.

I might add that we, too, feel a real sense of satisfaction as we watch the growing knowledge of a student who has been asking for help. So when you are stuck and can't figure things out to your own satisfaction, let us hear from you.

Answers To Common Problems

Flyback-Yoke Defects

The Conar Model 250 cathode ray oscilloscope has a built-in circuit which permits easy, accurate tests of all horizontal sweep components between the horizontal output tube and the deflection yoke.

There is, however, a quick check which can be made with a vtvm. Measure the negative voltage on the control grid of the horizontal output tube. Repeat with the plate top cap removed from the tube. If there is a definite increase in grid voltage with the top cap removed, the impedance seen at the tube output is incorrect and you should suspect a defective yoke or flyback transformer. Caution: Do not leave the receiver on any longer than necessary to measure the grid voltage. With the top cap off screen current becomes excessive.

Checking Local Oscillators

In the early days of radio, one of the favorite methods of proving oscillator operation was to pick up the radiated oscillator signal with a test receiver. The receiver under test should be tuned below the frequency setting of the pickup receiver by a frequency difference equal to the i-f of the receiver being tested. Suppose you tune your operating receiver to pick up a broadcast station at 1450 kc. If the set you are testing has an i-f of 450 kc its local oscillator should be working at 1450 kc when its dial is set to approximately 1000 kc. As you tune back and forth across 1000 kc a squeal will be heard in the test receiver, showing the local oscillator in the set being tested is working. No coupling or connections are necessary between the two receivers. This test has come back into use in transistor receiver servicing although we will see there are other methods which can be used.

In a tube receiver the standard practice today is to measure the dc voltage between the grid of the local oscillator and its cathode. If the oscillator is working, the grid will be negative by 5 to 15 volts. No voltage or a very low voltage indicates a defective oscillator. To make certain the voltage is due to oscillator operation, short the oscillator tuning capacitor with your finger. If the bias voltage drops, the voltage was a result of oscillator operation. If it remains constant with the oscillator tuning capacitor shorted, the oscillator was working.

In a transistor receiver, measure the emitter to ground voltage of the mixer transistor. If the voltage changes when the oscillator tuning capacitor is shorted, the oscillator is working. No change in emitter voltage shows oscillator failure. If you have a vtvm which measures rf (the NRI Model W, Y or the 211), you can measure the ac oscillator voltage across the oscillator tuning capacitor. This is a very definite test - no voltage means no oscillation. The ac voltmeter of the NRI vtvm in question is flat up to 6000 kc, which permits checking all broadcast receiver oscillators. The test works on either tube or transistor receivers with equal success.

A Quick Test For Leaky Coupling Capacitors

If you suspect leakage or a short in a capacitor used to couple the plate of one tube to the grid of the next tube, connect your dc voltmeter across the grid resistor of the tube. There should be no voltage reading. A positive reading indicates either gas in the tube or a leaky coupling capacitor or both. Clip one of the capacitor leads. If the voltage drops to zero, the capacitor was leaky or shorted. If the voltage is reduced but does not disappear, the capacitor was leaky and the tube was gassy. Replace both.

If there is no change in voltage, the capacitor was OK, but the tube was gassy.

If you get a negative voltage reading, the grid resistor was open. This is deduced by the fact that a very high value of grid resistance will produce a slight negative voltage at the grid due to electrons trapped on the grid flowing back to the cathode through the grid resistor ($V = I \times R$).

The grid resistance is normally too low to produce an appreciable voltage drop. The input resistance of the vtvm is more than 10 megohms and becomes the grid return resistance in the stage if the grid resistor opens - hence the negative voltage measured on the grid.

IMPORTANT ANNOUNCEMENT

Students !

The NRI Alumni Association has local chapters in a number of the larger cities. NRIAA Executive Secretary Ted Rose visits most of these chapters about once a year.

On his visits this year he is accompanied by Mr. J. B. Straughn, NRI Chief of Consultation Service. Mr. Straughn conducts a service forum during which he discusses and demonstrates the test equipment used in Radio-TV service work and answers questions about test equipment and service problems. He also answers questions on the latest developments in color television.

All NRI students and graduates in each chapter's area, whether or not they are members, are cordially invited to attend these meetings as guests of the chapters. Here is a rare opportunity to meet Mr. Straughn and to see him demonstrate Radio-TV test equipment and techniques,

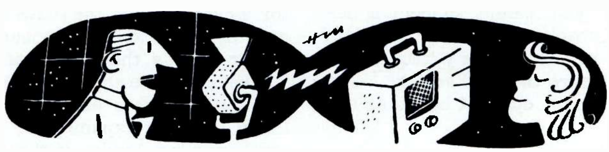
Graduates !

-- hear his answers to questions on current service problems. An attractive door prize is raffled off among those who attend.

By the time this issue of the News is published most of the visits will have been made. Only those listed below are still scheduled (see "Directory of Local Chapters" on Page 28 for information on time and place):

Chapter	Date
Pittsburgh	December 6
New Orleans	January 8
San Antonio	January 10
Minneapolis-St Paul	April 11

IMPORTANT: Students and graduates who expect to attend these meetings should notify the Chairman of the chapter in their area, as much in advance as possible.



DC Amplifiers

(continued from page thirteen)

as a chopper amplifier. This is simply a high gain ac amplifier with a mechanical switch at the input and output that periodically shorts the signal to ground as shown in Fig. 9. Thus, even with a dc input, the input to the amplifier will be an amplitude modulated square wave, that is amplified in the amplifier and then rectified by the same mechanical switch that provided the original modulation. The beauty of this arrangement is that an ordinary non-critical amplifier can be used rather than the usual "dc" amplifier. This type of amplifier is severly limited in the high frequency department, however, since the highest input frequency cannot be greater than the frequency of the switch or chopper. Unfortunately mechanical switches are limited to a rate of about 400 cps maximum, with 60 cps being the usual switching rate.

CONCLUSIONS

DC amplifiers represent a new field to many service technicians. However, in order to stay abreast of the rapidly growing electronics field these technicians must become acquainted with subjects, terminology, tech-

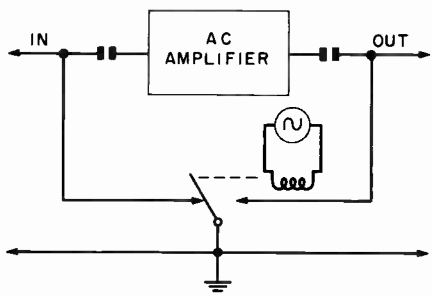


FIG. 9. Chopper amplifier.

niques, and practices that before were out of their field.

In this brief article the subject of dc amplifiers has been presented in an introductory manner, relating the already familiar circuits to the not-so-familiar ones. Keep abreast of current subjects and trends in electronics by reading, studying and doing!

It's Teamwork That Counts

by Harvey W. Englebrecht
(Reprinted from ITI NEWS)

Our astronauts have become national heroes, and rightly so. Behind their exploits, however, are many engineers and scientists working on the Mercury project who, while nameless nevertheless have important assignments that must be carried out in errorless fashion.

To give you something of a behind-the-scenes picture of these men you hear nothing about, let us start with communication. The astronaut must be in contact with the control station at all times, and his equipment must be absolutely foolproof. Transmitters and receivers in the capsule and at the control station must be capable of sending and receiving signals from any distance, under the most extreme operating conditions.

Every valve, and movable component part in the rocket must be controlled from the ground through the use of telemetry. The transmitter codes the control signal into bits of information. The receiver at the rocket decodes this information and fits it to the appropriate circuit. The results, including any corrections that might be necessary, are radioed back to the control station. The computer that is designed specifically for this purpose then makes further computations that are coded and sent back to the rocket.

Just think of all the initial jobs that are created in the sub-assembles that go into the construction of this space vehicle. The instruments on the ground manned by the engineers and technicians keep track of the Mercury, once it takes off and is in orbit. Consider, too, that important as these various projects are right now, they are only the beginning of a program that will continue to expand until that day is reached when we actually put a man on the noon. Then, our problem will be of a different nature, and new projects will have been initiated to get him back. This is an age of great discoveries, and electronics can be given most of the credit for the advancements made thus far.

It is well to keep in mind, then, that these men you hear nothing about, who back up the astronauts, are doing vital work for their country. Their numbers will not diminish, but on the contrary, will increase and multiply, as we continue our progress into space.

> Business is never so healthy as when, like a chicken, it must do a certain amount of scratching for what it gets.
> Henry Ford

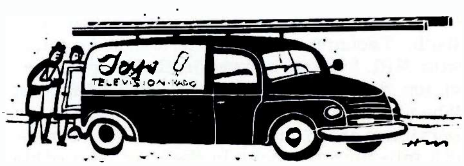
Home Study School Enrollments Now Almost Three Million

(Reprinted from ITI NEWS)

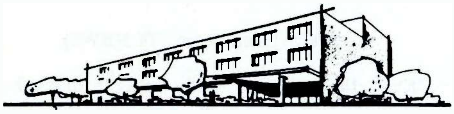
"Even though home study schools throughout the country have almost three million students presently enrolled in all forms of correspondence courses, the need for this type of training is steadily increasing." This statement was made in a speech given by ITI Director of Education, J. F. Schindlbeck, recently, at the Rural Electrical Inspectors Conference held at Arcadia, Wisconsin. He further pointed out that as colleges find it necessary to keep turning away large numbers of applicants, and also as standards are set higher all the time, and costs rising, there is no doubt that education through home study methods will have to take over, more and more.

Interesting statistics cited by Mr. Schindlbeck were that there are now 450 schools in the United States which teach by correspondence, but of this number, only 55 are accredited by the only officially recognized home study accrediting agency -- The National Home Study Council. Altogether, more than 400 courses are being offered, and the tuition fees are at a very low figure, compared to the expenses of a college education. Furthermore, the man who decides to study at home does have certain advantages over other educational methods. He knows that there will be no loss of income from his job, nor will he be separated from his family. His training program will be on an individual basis, he will do his studying at home in his spare time, and yet his work will be properly supervised by competent instructors. Of great importance, too, is the fact that he selects exactly the type of study he wants, without being required to take other subjects which are of no interest to him.

In concluding his remarks, Mr. Schindlbeck emphasized that today home study courses provide only carefully prepared texts written by the most skillful technical writers available, and that the exams, kits, and spare time lessons, also furnished, represent an integrated program that provides an excellent training as a result of the high standards to which each member school must conform.



NRI ALUMNI NEWS



BERKA WINS NRIAA PRESIDENCY BY NARROW MARGIN

Two New Vice-Presidents Elected

John Berka of the Minneapolis-St. Paul Chapter is President-Elect of the NRIAA for 1963.

But he barely made it. J. Arthur Ragsdale of San Francisco gave him stiff opposition right down to the finish line.

Two of the incumbent Vice-Presidents were re-elected: Dave Spitzer of the New York City Chapter and James Kelley of the Detroit Chapter. We have two new Vice-Presidents: Eugene De Caussin of the Los Angeles Chapter and Howard Tate of the Pittsburgh Chapter.

Warmest congratulations from National Headquarters to all these officers for 1963!

President-Elect Berka often answers to the name of "Shorty" because he was born in Superior, Wis., on the shortest day of the year, December 21, 1915. He doubts that being 5-foot, 4-inches tall has anything to do with the nickname. He graduated from high school in 1934 and went to work as a bus boy, porter, and elevator operator at a hotel in Duluth, where he decided he would try to get more schooling. After working three years he attended Dunwoody Institute Day School in Minneapolis where he took the two-year electrical course. Upon graduating he went into the electrical contracting business with two buddies with whom he wired farms in Wisconsin under the REA program. Government restrictions on copper and copper wire put them out of business.

Berka returned to Minneapolis in 1940, obtained employment with the Smith Welding Equipment Company making, and later repairing, gas welding equipment for thirteen years. During the war he was drafted into the Navy and spent a year in a Navy school as a Radio Technician. After the war he enrolled with NRI for the course in Radio and Television Servicing under the GI Bill of Rights. When he completed the course he started TV servicing part time but after two years made it a full-time business in the basement of his home. Wanting to keep it as a one-man operation, with the growth of his TV servicing he finally had to drop auto radios, transistor radios, phonograph repairing, etc., and concentrate on TV servicing only. His wife, Kathryn, and daughters Barbara and Kathy handle his phone calls and reports from customers. He is particularly proud of the work done by his two girls aged 15 and 19 respectively.

John Berka of Minneapolis-St. Paul, President-Elect of NRIAA for 1963.

Berka is a charter member of the Minneapolis-St. Paul (Twin City) Chapter and has served it in many officer capacities. The members like best to have him serve as technical advisor and instructor in order to get the benefit of his many years of experience in TV service. Berka likes it that way too, because he feels that in this way he can best serve his fellow members.

Berka's hobbies are fishing, camping, rock collecting, and playing bridge. He will take over as President on January 1 when that office is relinquished to him by Frank Skolnik of the Pittsburgh Chapter.

Chapter Chatter

DETROIT CHAPTER members were pleased with the visit of Executive Secretary Ted Rose and NRI Chief of Consultation Service J. B. Straughn. They were particularly pleased with the lecture and demonstrations given by Mr.

Straughn and his answers to the many questions asked concerning problems in Radio-TV Servicing, test equipment, the outlook for color TV, etc.

At a previous meeting, Chairman James Kelley conducted a demonstration in the principles of power supply circuits in Television and similar equipment. This demonstration was in line with the general program adopted by the chapter for the current season, namely, taking the various sections or stages of a Television receiver and devoting an evening to each.

The latest member to join the chapter is George B Adair. Congratulations George!

FLINT (SAGINAW VALLEY) CHAPTER members were delighted hosts to Ted Rose and J. B. Straughn on their visit to the chapter. The members were equally enthusiastic about the program conducted by Mr. Straughn. On behalf of the chapter, Chairman Jobbagy presented Ted Rose with a very attractive combination desk clock and pen set.

Chapter members were guests of TESA Television Electronic Service Association at which the Zenith Corporation put on a demonstration of their latest developments in stereo FM models and floating cartridges, new tuners, and gave instructions on servicing Zenith color TV receivers. At still another meeting, a special feature was using the chapter's Handy Andy tracing by Oscilloscope and how to check flybacks with a B and K Tester. A demonstration was also given of a separate high voltage supply which was assembled from parts out of the junk box.

LOS ANGELES CHAPTER has been busily engaged in assembling the Conar Custom 70 Television Kit they purchased from the Conar Division of NRI. The kit comes in four packages or sections. At last report the chapter members had completed the third section and were about to begin on the fourth. The receiver will be used for chapter purposes and will undoubtedly make the meetings much more interesting and instructive.

Floyd Cox, NRI graduate and a highly successful full-time Radio-TV serviceman, informed the chapter members that he is a distributor for Sony and Zenith Television sets and offered any members of the chapter who were in business a chance to buy them at his price. This is a generous offer on the part of Mr. Cox.

MINNEAPOLIS-ST. PAUL (TWIN CITY) CHAPTER is continuing to feature talks and demonstrations by John Berka on Radio-TV problems and their solution. At recent meetings John has devoted his lectures to servicing transistor radio receivers and also on space command TV tuner control.

As we go to press with this issue of the NRI News, the chapter had completed plans to hold its annual banquet in St. Paul.

NEW ORLEANS CHAPTER, at the conclusion of business matters at each meeting, devotes all available time to what it has named a "TV Clinic". The Clinic is conducted by Gaston Galjour, a thoroughly experienced Radio-TV Technician. As part of this program, members bring in TV sets to the meetings and methods of troubleshooting and repairing them are discussed and demonstrated.

The latest member to join the Chapter is Mr. Willie Patin. Welcome to the chapter, Willie!

NEW YORK CITY CHAPTER started the new 1962-1963 season with high hopes and the members have maintained this enthusiasm. Chairman Dave Spitzer, at the first and subsequent meetings, introduced seven new members. Then are Messrs. Webster, DaSilva, Nieves, DeFillipi, Stevens, Laux, and Sanabria. A cordial welcome to all these new members!

Vice-Chairman James Eaddy conducted an interesting talk and demonstration on low voltage in TV. Chairman Dave Spitzer and Executive Chairman Thomas Hull have developed some interesting programs on Electronics for future meetings.

Tom Hull, on his return from his vacation in Wyoming, Utah, Washington and Canada, brought in some excellent slides of different points of interest in each state, which all members enjoyed viewing.

PHILADELPHIA-CAMDEN CHAPTER was pleased to welcome Mr. Bernie Bycer, design engineer for RCA, as a guest speaker. He is one of the chapter's old standbys. His talk this time was on AGC and AFC. It was well done and very educational. Mr. Bycer knows how to put a subject over so that everyone understands what he is talking about.

At a subsequent meeting the feature was a lecture on tuner troubles delivered by another old standby of the chapter, Harvey Morris. At the end of the lecture Harvey held a question-and-answer forum and the members really threw the questions at him. But he had an answer for everyone.

As reported in previous issues of the NRI News, Chris Urbach is conducting a class in code for members interested in learning it. He has informed members to bring a tape recorder if they can and make a recording of his sessions and in that way learn much faster. He guarantees participating members that they can qualify for a second class operators license in less than ten lessons. The members attending these classes are extremely well pleased with the results they are getting.

Hardly a single report comes from Secretary Jules Cohen that does not include a mention of new members. The latest are Messrs. Herbert Bleam, Clarence Guthrie, Thomas Pell, and Andrew Harris. A warm welcome to these new members!

PITTSBURGH CHAPTER had reversed a meeting for the Radio Parts Company people to bring in and demonstrate Channel Master Antenna Systems, but Pittsburgh Station Channel 11 stepped in and took up two nights for a show on how antennas affect pictures and other things, so the Chapter had three nights of meetings. The two nights at Channel 11 Studio were the biggest. One night was devoted to tape programs and the other to studio wrestling, much enjoyed by the members.

The Chapter reports five new members. They are Messrs. George White, Gordon Van Natta, George Telesko, George Fisher, and William Bricker. A warm welcome to you, gentlemen!

SAN FRANCISCO CHAPTER Chairman Ed Persau undertook a discussion and demonstration of TV signal tracing with a scope. He also demonstrated a TV response curve, using a sweep generator and an oscilloscope.

John L. Jones was recently accepted as a member. Our congratulations, John!

As we go to press a lecture on the uses of the oscilloscope was scheduled to be given at a chapter meeting by Mr. Eric Levin of Associated Radio Distributors.

SOUTHEASTERN MASSACHUSETTS CHAPTER extended a cordial welcome to Ted Rose and J. B. Straughn on the occasion of their recent visit to the chapter. The members expressed their appreciation of the program conducted by Mr. Straughn.

The chapter recently admitted Michael Campbell of South Weymouth. Welcome, Mike!

Plans for programs in the current season are mostly of the variety type, whatever the membership requests will be the topics. Color TV and transistor circuitry are the favorite topics at the present time.

SPRINGFIELD CHAPTER usually holds its elections in the spring. The officers are elected to serve for the season beginning the following fall.

This year the chapter did not hold its elections until fall, hence this belated report of the successful candidates. They are: Steven Chomyn, Chairman; Albert E. Dorman, Secretary; Augusto Lorenzatti, Treasurer; John Parks, Norman Charest and Sam Infantino, Executive Committee. Our congratulations to these officers!

Directory of Local Chapters

Local chapters of the NRI Alumni Association cordially welcome visits from all NRI students and graduates as guests or prospective members. For more information contact the Chairman of the chapter you would like to visit or consider joining.

CHICAGO CHAPTER meets 8:00 P. M., 2nd and 4th Wednesday of each month, 666 Lake Shore Dr., West Entrance, 33rd Floor, Chicago. Chairman: Frank Dominski, 2646 W. Potomac, Chicago, Ill.

DETROIT CHAPTER meets 8:00 P. M., 2nd and 4th Friday of each month, St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich., VI-1-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 8:00 P. M., 2nd Wednesday of each month at Chairman Andrew Jobbagy's Shop, G-5507 S. Saginaw Rd., Flint Mich., OW 46773.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month, at homes or shops of its members. Chairman: George Fulks, Boonsboro, Md., GE2-8349.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, 5938 Sunset Blvd., L. A. Chairman: Eugene DeCaussin, 5870 Franklin Ave., Apt. 203, Hollywood, Calif., HO 5-2356.

MILWAUKEE CHAPTER meets 8:00 P. M., 3rd Tuesday of each month, at home of Treasurer Louis Sponer, 617 N. 60th St., Wauwatosa, SP 4-3289. Chairman: Philip Rinke, RFD 3, Box 356, Pewaukee, Wis.

MINNEAPOLIS-ST. PAUL (TWIN CITIES) CHAPTER meets 8:00 P. M., 2nd Thursday of each month, Walt Berbee's Radio-TV Shop, 915 St. Clair St., St. Paul. Chairman: Paul Donatell, 1645 Sherwood Ave., St. Paul, Minn., PR 4-6495.

NEW ORLEANS CHAPTER meets 8:00 P. M., 2nd Tuesday of each month at Secretary Nathan Prince's Radio and TV Shop, 8520 Oak St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P.M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: David Spitzer, 2052 81st

St., Brooklyn, N. Y., CL 6-6564.

PHILADELPHIA-CAMDEN CHAPTER meets 8:00 P. M., 2nd and 4th Monday of each month, K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore Ave., Philadelphia, Pa.

PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: Howard Tate, 615 Caryl Dr., Pittsburgh, Pa., PE-1-8327.

SAN ANTONIO ALAMO CHAPTER meets 7:30 P. M., 2nd Thursday of each month, National Cash Register Co., 436 S. Main Ave., San Antonio. Chairman: Thomas DuBose, 127 Harcourt, San Antonio.

SAN FRANCISCO CHAPTER meets 8:00 P.M., 1st Wednesday of each month, 147 Albion St., San Francisco. Chairman: E. J. Persau, 1224 Wayland St., San Francisco, Calif., JU 4-6861.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month, home of John Alves, 57 Allen Blvd., Swansea, Mass. Chairman: James Donnelly, 30 Lyon St., Fall River, Mass. OS 2-5371.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., 1st Friday of each month, U. S. Army Hdqts. Building, 50 East St., Springfield, and on Saturday following 3rd Friday of each month at a member's shop. Chairman: Steven Chomyn, Powder Mill Rd., Southwick, Mass.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT AND CIRCULATION OF

NRI News, published bimonthly at Washington, D. C., for October 1, 1962.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, National Radio Institute, 3939 Wisconsin Ave., N. W. Washington 16, D. C.

Editor, Theodore E. Rose, 3939 Wisconsin Ave., N. W., Washington 16, D. C.

Managing editor, None.

Business manager, None.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

Elsie Smith Davis, RFD 1, Rochester, N. H.

The National Radio Institute Charitable Trust c/o J. E. Smith, 4521 Crest Lane, McLean, Va.

Carol Smith Galbraith, 430 E. Ledbetter Drive, Dallas 16, Texas. Gail Galbraith Peek, 305 N. Virginia Ave., Falls Church, Va.

James E. Smith, Sarah Morrison Smith, 4521 Crest Lane, McLean, Va.

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James Morrison Smith, Lee Morrison Smith, James Morrison Smith, Jr., Terry Morrison Smith, 4523 Crest Lane, McLean, Va.

Marjory M. S. Sarich, Charles B. Sarich, James R. Sarich, 4525 Crest Lane, McLean, Va.

David H. Smith, RFD 1, Rochester, New Hampshire.

Michael Morrison Galbraith, 3550 Lake Shore Dr., Apt 2508, Chicago 13, Ill.

Susan Smith Bartlett, Rt. 1, Box 17A, Wyoming, Del.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. Paragraphs 2 and 3 include in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 42,830.

NATIONAL RADIO INSTITUTE
H. E. Luber, Ex. Vice-Pres.

Sworn to and subscribed before me this 12th day of September, 1962.

Charles Alexander, Notary Public
(My commission expires January 14, 1964.)

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