nri journal

SEPT./OCT. 1971

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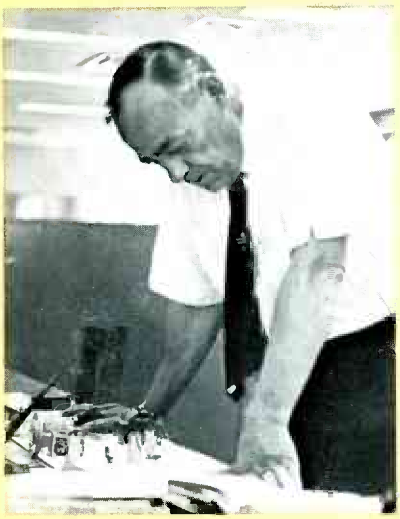

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The NRI Journal is published bimonthly by the National Radio Institute, 3939 Wisconsin Avenue, Washington, D.C. 20016. Subscription price is two dollars yearly or 35 cents per single copy. Second-class postage paid at Washington, D.C. and additional entry.

UNDERSTANDING ZENER DIODES

By Harold J. Turner, Jr.

Even in this time of almost unbelievably complex integrated circuits, there is still a place for the simplest of electronic components. One very useful, yet very simple, device is the Zener diode. As we shall see later, a single unique characteristic of the Zener diode, its controlled reverse breakdown, is responsible for the tremendous usefulness and popularity of this semiconductor device.

In an ordinary P-N junction (rectifier) diode, current is permitted to flow only when forward bias is applied; that is, when the cathode is negative with respect to the anode. When the diode junction is reverse biased, only an extremely small current, known as leakage current, is allowed to pass through the diode in the reverse direction. Again, this leakage current is very small, and for all practical purposes can be disregarded. Fig. 1 shows the relationship between the voltage applied to and the current passed by a Zener diode. Note that the portion of this curve between points B and C is the same as that of an ordinary rectifier diode. Heavy current flows when the junction is forward biased, but only a very small leakage current flows when the diode is reverse biased.

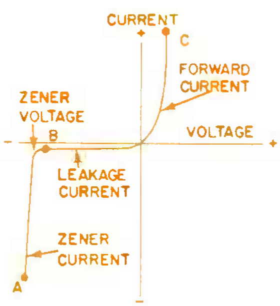

Fig. 1. Relationship between voltage and current in a Zener diode.

The difference between an ordinary diode and a Zener diode is that when a certain critical value of reverse voltage is reached, the Zener diode begins conducting heavily in the reverse direction. The critical voltage, called the Zener voltage, is fixed during the manufacturing process. It can be changed by changing the amount of impurities added to the semiconductor materials. Zener diodes are commercially available with Zener voltages between 3.3 and 200 volts. Because of its ability to begin reverse conduction at a known reverse voltage level, the Zener diode finds use in many different electronic circuits.

THE BASIC CIRCUIT

Fig. 2 shows a Zener diode connected as it is most frequently seen: in a shunt regulator circuit. The purpose of such a circuit is to maintain a constant dc output voltage, regardless of fluctuations in load current and supply voltage. Voltage regulation is not needed in all types of equipment, but it is often a necessity for stable circuit performance. The important thing to notice about the circuit of Fig. 2 is that reverse bias voltage is being applied to the diode. Note that the cathode is connected to a positive voltage source, while the anode is connected to the negative side of the

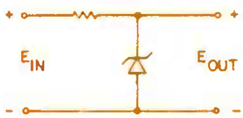

Fig. 2. Basic Zener diode shunt regulator.

supply. As long as the voltage across the Zener is less than the Zener voltage, no reverse current will flow through the diode and the output voltage will be unregulated. As soon as the supply voltage is made high enough, however, the Zener will begin to conduct. It will tend to keep the voltage drop across itself, and therefore across the load, at a constant level. For example, if the load current decreases, the Zener current increases to compensate for it. If the supply voltage rises, the Zener current increases to maintain a constant output voltage. This is basically all a Zener diode does in any circuit: it prevents the reverse voltage applied across itself from exceeding the Zener voltage.

In addition to its exact value of Zener voltage, each Zener diode is also specified in terms of the maximum amount of power that it can handle. This power rating is in watts, and may be from 1/4 watt for a subminiature Zener to 50 watts and even more in the case of large power Zener diodes. The power rating of the Zener is determined by the ability of the diodes to get rid of heat. This depends on the physical size of the diode, so the largest Zeners are those with the highest power ratings. The one-watt size seems to be the most popular. To compute the power being handled by a Zener, you must know the voltage across the diode (the Zener voltage) and the amount of current flowing through the diode. The product of these two quantities is the power dissipation, and it must not exceed the maximum dissipation rating if the diode is to perform reliably.

Although the Zener diode makes a very good shunt regulator, it cannot act alone. The series resistor in Fig. 2 plays a very important role in the action of the basic shunt regulator circuit. If this resistor is not present, when the input voltage rises a very heavy reverse current will flow in the Zener diode. It will soon burn out, and the output voltage will then rise to the same high level as the input voltage. To keep this heavy current from passing through the Zener, the series resistor is needed. Its value is determined by using Ohm's Law. Since the input voltage and output voltage are known, the voltage across the resistor can be calculated by subtracting the output from the input. The current through the Zener is known, so we can calculate the resistance of the series resistor ($R = E/I$). In addition, the formula $P = E^2/R$ can be used to find the power to be handled by the resistor. In practice, a resistor is selected which has at least twice as high a dissipation rating as the actual amount of power to be dissipated. This will result in cool, reliable operation.

Of course, the preceding calculation assumes that the current through the load is zero. As current is drawn by the load, less current will pass through the Zener; therefore, the total current drain will remain more or less constant and the output voltage will be stabilized. Note that the total load current cannot exceed the amount of current that would pass through the Zener when no load is connected; otherwise the total current would increase and the output voltage would drop. Thus we see that the maximum available output current is less than the amount of current drawn through the Zener when no load is connected.

HIGH POWER OUTPUT

Since the amount of current available for the load without lowering the output voltage is limited by the current-handling ability of the Zener diode employed, the output current capability can be increased by using a Zener with a higher power rating. Unfortunately, high-power Zener diodes are rather expensive. Fig. 3 shows a more satisfactory way of providing heavier currents. Here the Zener diode is used to regulate the voltage at the base of the series-pass transistor, and the transistor, in turn, regulates the amount of current passed through the load. In effect, the resistance between the collector and emitter of the transistor is varied to maintain a constant output voltage. If the output voltage falls because of an increase in load current, the forward bias on the transistor's base-emitter junction increases. This is because the base voltage is maintained at a constant level by the Zener, while the emitter voltage has become less positive. This amounts to an increase of positive voltage at the base, so the transistor is turned on harder and the output voltage is restored to normal. The opposite would happen if the output current was suddenly decreased. Of course, all this happens in the twinkling of an eye, so the apparent effect is an output voltage that is constant at all times. A large output current can be delivered to the load, while only a small Zener diode is needed. The combined cost of the transistor and small Zener is considerably less than the cost of the power Zener diode that would otherwise be needed.

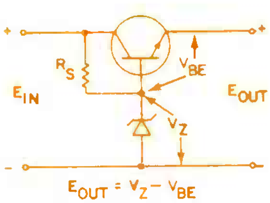

Fig. 3. Emitter-follower transistor used to increase current-handling ability of Zener diode.

In the circuit shown in Fig. 3, the current passed by the Zener is roughly equal to the output current divided by the Beta (current gain) of the transistor. The output voltage is equal to the Zener voltage minus the base-emitter voltage drop of the series pass transistor. If a silicon transistor is used, and this is nearly always the case in modern equipment, the base-emitter voltage drop is about .7 volt, so the output voltage will be about .7 volt less than the Zener voltage.

THE ZENER AS A FILTER CAPACITOR

A Zener is a filter capacitor? Well, why not? After all, isn't the purpose of a filter capacitor to smooth out ripple (residual ac) in the output of a dc power supply? And isn't the purpose of a Zener to maintain constant voltage across itself? There's nothing that will keep the Zener from responding quickly to would-be voltage changes. In fact, under the proper conditions (Fig. 2 or Fig. 3, for example), the Zener makes an excellent filter capacitor. Modern circuits frequently use small, efficient, Zener diodes to replace bulky and expensive electrolytic capacitors.

AC APPLICATIONS

Although the Zener diode is used most often in circuits that require regulated dc voltages, it is sometimes used in ac wave shaping circuits, such as the ones shown in Figs. 4 and 5. In Fig. 4 a single Zener is used to convert a sine wave input to an approximation of a square wave at the output of a circuit. This circuit operates by clipping the sine wave whenever the

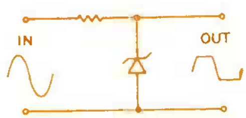

Fig. 4. Simplest square-wave generator. Note that output waveform is *not* symmetrical.

Zener conducts. During the positive half-cycle of the input waveform, the Zener will conduct only after its Zener voltage is reached. At that time, the output voltage is prevented from going any higher, so the top of the waveform is flattened. When the input signal becomes negative, the Zener conducts almost immediately in the forward direction. Zener diodes, as well as other silicon diodes, will conduct in the forward direction when the applied voltage is approximately .7 volt. The peak-to-peak voltage output of this circuit is equal to the Zener voltage plus the forward conduction voltage drop, so if a 6.2 volt Zener were used in this circuit the output signal would be about 6.9 volts peak-to-peak. However, note that the output waveform is not symmetrical; that is, the plus and minus portions of the output waveform are not equal.

This imperfection is of no consequence in many applications, but Fig. 5 shows how two Zeners can be connected to produce a symmetrical output waveform. Note that the diodes are connected in series, back-to-back. Thus, when a positive signal is applied to the cathode of the top diode, it will conduct in the reverse direction when its Zener voltage is reached, and will be conducting in series with the forward conduction path of the second Zener. The total voltage drop will be equal to the Zener voltage of the top diode plus the forward conduction voltage drop of the bottom diode. When the input signal reverses its polarity, conduction in the opposite direction will take place, but only after the bottom diode reaches its Zener voltage. The peak-to-peak voltage of the output signal will be equal to the sum of the two Zener voltages plus the forward voltage drops of the two Zeners. Thus, if 6.2 volt Zeners were used in this circuit the output would be 13.8 volts peak-to-peak. Since conduction will take place only when the Zener voltage is reached in either direction, the output waveform will be symmetrical.

Since the purpose of a Zener diode is to maintain a constant voltage drop across itself, it can be used in any situation where a need for a constant voltage drop

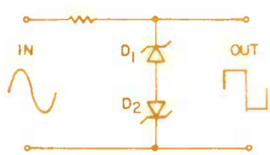

Fig. 5. A symmetrical two-Zener wave shaper.

exists. An unusual example is shown in Fig. 6. Here a Zener is used to couple signals from the collector of one amplifier stage to the base of a second stage, while preserving a fixed voltage drop between the two transistors, so that each transistor receives the proper bias voltage. Since the voltage difference between the collector of Q_1 and the base of Q_2 is 3.3 volts, you know the Zener is rated at 3.3 volts.

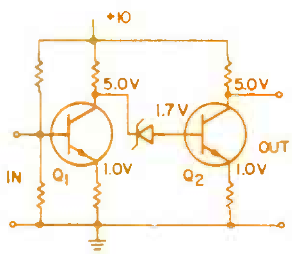

Fig. 6. Zener diode used as dc level shifter in direct-coupled amplifier.

You might think it strange that the Zener is able to pass the signal, but consider how the signal at the output of Q_1 causes the collector voltage to vary. Since the Zener must maintain a constant voltage drop across itself, it must raise and lower the voltage at the base of Q_2 in response to the changes in the voltage at the collector of Q_1. The dc level of the signal is shifted, but the amplitude of the signal itself remains unchanged. Just as in the power supply circuits discussed earlier, the Zener can respond very rapidly to changes in voltage level, so it can pass signals well up into the megahertz range.

PROTECTION CIRCUIT

Fig. 7 shows an interesting combination of a Zener diode and an ordinary fuse. This circuit is sometimes used to protect a piece of equipment from the accidental application of too much voltage by its power supply. A typical application

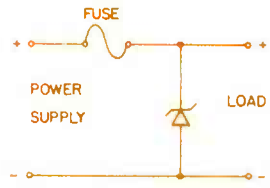

Fig. 7. Zener-fuse combination protects load from excessive supply voltage.

might be in a circuit that is normally operating at a supply voltage of exactly 5 volts. If a 6.2 volt Zener diode were connected as shown in Fig. 7, only a small current would be passed by the diode (leakage current). However, if a defect should develop in the power supply, generating a large voltage surge which exceeds the Zener voltage of the diode, the Zener would suddenly conduct very hard, and pass heavy current through the fuse. This would quickly cause the fuse to open and thereby keep the voltage surge from being applied to the load.

TESTING ZENERS

Since a Zener behaves just as an ordinary rectifier diode when low voltages are applied, an ohmmeter check of a Zener will show low resistance in the forward direction, and infinite resistance in the reverse direction. Of course, this is true only if the ohmmeter battery voltage is less than the Zener voltage. Since the ohmmeter battery voltage in a vtvm or tvom is only 1.5 volts, you can expect a Zener to appear just as an ordinary rectifier diode when tested with the ohmmeter section of a vtvm or tvom. (Remember, Zeners are commercially available in voltages only as low as about 3.3 volts). However, if a Zener is tested with a higher-voltage ohmmeter, such as might be found in a VOM, it would exhibit a low resistance in either direction. Fortunately, most VOM's use a low voltage battery on the low resistance ranges. So, if you use a VOM to test a Zener, use one of the lower resistance ranges. With a tvom or vtvm, the applied voltage will always be very small, so it really makes no difference which range is used. If a Zener is faulty, it will be either completely open (high resistance reading in both directions) or shorted (zero or very low resistance in both directions) even with low applied voltage. As long as the Zener shows high resistance one way and low resistance when the meter connections are reversed, you can assume that it is probably all right. Of course, such measurements should be made with the diode removed from the circuit to avoid any parallel resistance paths.

REPLACING FAULTY ZENERS

Zener diodes, like other semiconductor devices, are very reliable, and you won't often have to replace one. When you must replace a Zener, all you really need to know is the Zener voltage and power rating of the original part. However, just as resistors and other components are made to fall within certain tolerances, the Zener voltage is subject to manufacturing tolerance. A 6.2 volt, 10% diode may have an actual Zener voltage of anywhere between 5.58 and 6.82 volts. In selecting a replacement, be sure to use a Zener with the same voltage rating and at least as close a tolerance specification. For example, if the original diode was a 20% unit, you could select a replacement diode with a tolerance no greater than 20%. A 5% or 10% diode would be perfectly satisfactory. However, it is not wise to replace a 5% Zener with a 10% or 20% diode. But keep in mind that the closer-tolerance units are certain to be more expensive, just as precision resistors are expensive, since they are manufactured to more exacting specifications than wider-tolerance parts.

In any case, the power rating must be at least equal to that of the original diode. If the replacement diode is too small, it will quickly overheat and burn out.

EMERGENCY SUBSTITUTIONS

Fortunately, Zener diodes are made in standard sizes, and replacements are usually quite easy to get, once you know what you need. However, in an emergency, an ordinary silicon transistor can be used as a substitute Zener. In fact, this is becoming quite a common practice among manufacturers of commercial equipment. Zeners usually cost more than 50 cents each, even in large quantities, while silicon transistors can be purchased for less than a dime. This apparent savings is partially offset by the labor it takes to test and grade the transistors as Zeners, but this technique is bound to be seen more and more in the future.

As shown in Fig. 8A, the reverse-biased, base-emitter junction of a silicon transistor will "Zener" at about 6 volts. This varies from one transistor type to another, and even from one transistor to another in the same type, but the base-emitter reverse breakdown voltage is usually somewhere on the order of 6 volts. The wattage rating of the Zener would be approximately equal to the wattage rating of the same transistor used as a transistor. In general, a transistor rated at one watt dissipation is about the same size as a one-watt Zener.

You can use the reverse-biased base-

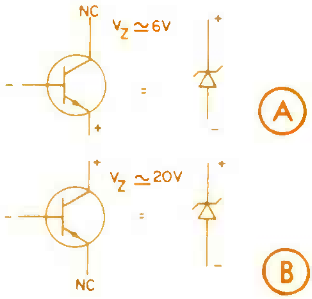

Fig. 8. Substitution of an ordinary transistor for a low-voltage Zener (A), or a high-voltage Zener (B).

collector junction of any silicon transistor as a higher-voltage Zener, as shown in Fig. 8B. Here, however, the reverse breakdown voltage will vary considerably from one transistor type to another. Some transistors might break down at 15 volts, while others would serve as efficient 200 volt Zeners.

To test a transistor for use as a Zener diode, connect the elements as shown in Fig. 8 in series with a high-resistance variable resistor and a source of dc voltage higher than the anticipated Zener voltage. Connect a voltmeter in parallel with the Zener, then slowly reduce the amount of series resistance. As you do, you will note that the voltage reading increases. At some point, determined by the Zener voltage of the transistor junction, the voltage reading will stop increasing and will remain steady. This voltage is then known to be the Zener voltage. If this particular Zener voltage is of no value at the present time, you can mark the transistor and save it for use in a different circuit at some future date.

IN CLOSING

The purpose of this article is to make you aware of a few ways in which the Zener diode is used in modern electronic circuits. For more information on this interesting topic, the author recommends these two very good books:

> *"Motorola Zener Diode Handbook".* This book is available for $2 from your local Motorola dealer, or from Motorola Semiconductor Products Corporation, Box 955, Phoenix, Arizona 85001.

> *"International Rectifier Corporation Zener Diode Handbook".* This book is priced at $3.00, and is available from your local I-R dealer or by mail from International Rectifier Corporation, Semiconductor Division, 233 Kansas Street, El Segundo, California 90245.

SELF-TEST QUESTIONS

Test yourself to see what you have learned. Answer the five TRUE-FALSE questions below. Answers appear on Page 26 of this issue.

1. Zener diodes can conduct in the reverse direction only.
2. The circuit shown in Fig. 3 is used to match the impedance of a large power Zener to a power supply circuit.
3. If D_1 in Fig. 5 were to develop an internal short circuit, no output waveform would be produced by the circuit.
4. The amplifier shown in Fig. 6 would be suitable for use only at very low audio frequencies, since the Zener diode can not respond quickly enough to handle high-frequency signals.
5. When you are selecting a replacement Zener diode, the only thing you need to know is the Zener voltage of the original diode.

How to Restore the Raster

by j. b. straughn

A block diagram of the circuitry developing the raster in a TV receiver is shown in Fig. 1. A typical schematic is shown in Fig. 2. A failure any place in this chain will cause the face of the picture tube to be completely dark. To service a no raster complaint by the instructions in this article, you must know how the circuits work.

The purpose of the circuit in Fig. 2 is to produce high voltage for the second anode of the picture tube and at the same time develop a varying magnetic field in the yoke. This magnetic field will sweep the electron beam from the picture tube gun back and forth across the fluorescent screen of the tube, causing it to light up. This action will produce a thin horizontal line on the face of the tube. The vertical sweep, which will not be considered here, moves the beam up and down to produce the complete raster.

Fig. 2 shows the power supply, horizontal oscillator (8FQ7), horizontal output tube and damper (38HE7), flyback transformer T3, horizontal yoke, and the high voltage rectifier tube V10 (IK3).

The source of the horizontal sweep is the circuit containing tube 8FQ7. This is a cathode coupled multivibrator with a signal fed from plate 1 to grid 7 through coupling capacitor C36. Feedback from V8B to V8A is accomplished by the common cathode resistor R55. Variations in the cathode current of V8B cause a variation in voltage across R55 and between the cathode and grid of V8A. Thus the feedback ring is complete and the circuit oscillates at the frequency determined by the R-C time constant, consisting of the values of R56, R57, R5, and capacitor C36. By adjusting the value of R5, the time constant can be changed, resulting in a change in frequency. R5 is the horizontal hold control. By properly adjusting L19 the circuit becomes more stable.

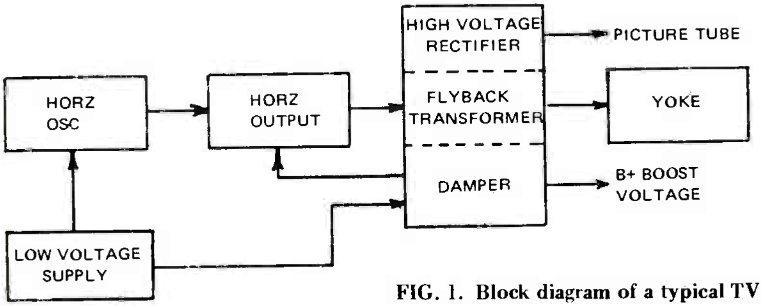

FIG. 1. Block diagram of a typical TV power supply system.

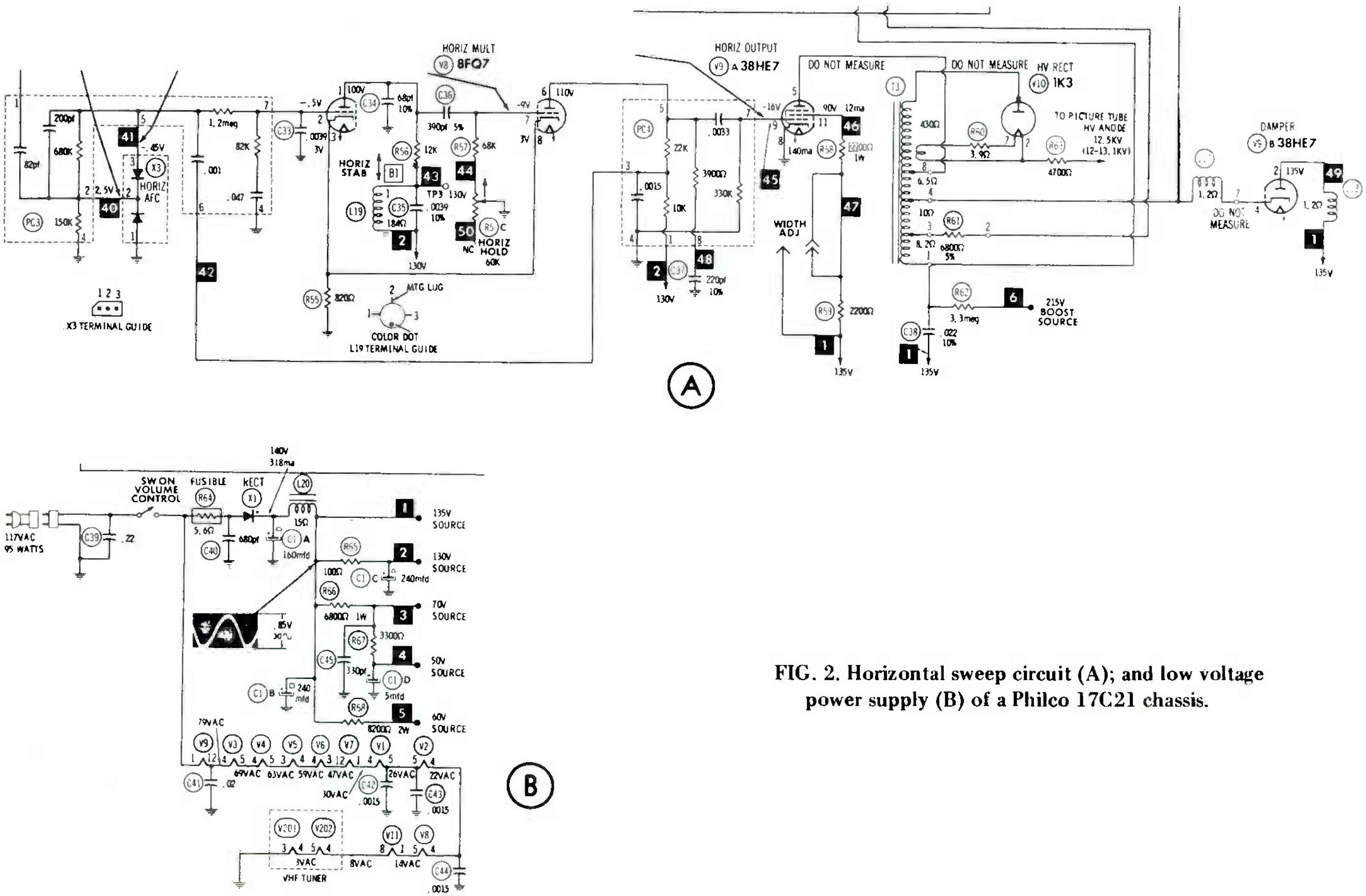

FIG. 2. Horizontal sweep circuit (A); and low voltage power supply (B) of a Philco 17C21 chassis.

All of the resistance in this R-C circuit is not shown in the schematic. We must also consider the resistance between the plate and cathode of V8A. This resistance can be changed by varying the dc grid bias of V8A. By means of the circuit incorporating diode X3, a voltage is produced which will vary in such a way that the R-C time constant of the 8FQ7 is changed to keep the frequency of the signal developed at the output of V8B and the sync frequency equal.

The signal at the output of V8B is fed through the .0033 capacitor in PC4 to the control grid of V9A. Since no self-bias is available (the cathode and grid return are grounded), bias is only present due to the control grid current flowing through the 330k-ohm resistor in PC4. This current flows when the signal from V8B drives the grid of V9A positive. As a result, the .0033 mfd capacitor is charged in such a way that the grid of V9A is held about 16 volts negative when V8 is delivering a signal and the cathode of V9 is emitting electrons. This is important to remember as it is proof that the circuit ahead of the control grid of V9 is operating!

The sharp positive pulses fed to the control grid of V9A cause a rapid rise in the plate current of the tube through section 4-8 of the flyback transformer, T3. As a result, energy is stored in the magnetic field of T3 and the yoke. When this positive pulse is removed, the plate current of V9A cuts off abruptly. The magnetic field around T3 collapses, inducing a voltage of reversed polarity in T3. Now two things happen. The high negative voltage applied to the cathode of V9B results in rectification and charging of C38.

This voltage is in series with the 135 volts of the power supply. The polarity of the two voltages is correct for them to add together to produce the boost voltage, which serves as the plate supply voltage of V9A and, although not shown, for a section of the vertical oscillator tube. There is also a very high voltage developed across the section of T3 between 8 and the top end with a polarity such as to make the plate of V10 positive. V10 rectifies this high voltage, producing about 13,000 volts for the second anode of the picture tube. R63 and the capacity existing in the picture tube act as a filter, so the high voltage is pure dc.

The width adjustment allows R59 to be in or out of the screen circuit of V9A. With R59 in the circuit, the screen voltage is reduced as is the plate current and the width of the horizontal sweep. Thus you can see that excessively low screen voltage will reduce the picture width and result in some decrease in the anode high voltage. Check to see if R58 and R59 increased in value if you notice reduced width.

A defect in the damper will eliminate boost voltage and plate voltage for V9A, thus killing high voltage. A partial short in T3 or the yoke will load the circuit so the high voltage will be low or absent. An open in R60 or R63 will kill high voltage, as will a defective high voltage rectifier tube, V10.

When the circuit is operating you must never try to measure the voltage at the plate of

V9A or the cathode of V9B with a meter. You may damage the meter and you run the chance of a mighty unpleasant shock. If the boost voltage is normal you can assume that the above voltages are also normal. In a receiver using a power transformer and separate horizontal output and damper tubes, you can remove the output tube and safely measure these plate and cathode voltages. They will not be the normal voltages, but their presence will serve to show that continuity exists. The two voltages will be about equal and about the same as the low voltage dc supply of the damper plate.

In Fig. 2B, removing any tube will prevent plate current from flowing in all circuits. Thus there will be no voltage in the control grid and plate of V9A or on the cathode of V9B. However, all dc voltages from the power supply will be measurable although higher than normal since there will be no voltage drops due to plate current flowing through voltage-dropping resistors. Thus the 135-volt line might rise to as much as 150 volts, as would all the other low voltage sources. Such measurements are sometimes useful if you bear in mind what takes place.

Looking at Fig. 1 we can sum up the action as follows: The low voltage supply furnishes dc voltage to the horizontal oscillator, horizontal output and damper tubes. If sound is obtained, you know that the low voltage supply is OK. If not, check for an open fusible resistor (R64 in Fig. 2B.)

The horizontal oscillator produces a signal which is fed to the control grid of the horizontal output tube and which places a negative voltage between the grid and cathode of this tube. The resulting variations in plate current energize the flyback transformer and the damper produces boost voltage.

The damper and horizontal output tubes cause the sweep current to flow through the horizontal yoke, sweeping the picture tube electron beam back and forth across the face of the fluorescent screen. The high-voltage rectifier produces the anode voltage for the picture tube.

While this is only a rough outline of the action taking place in Fig. 2, you can imagine defects other than those mentioned which would prevent formation of the raster. With no raster present, you want to know if the chain in Fig. 2 is working to produce the required high voltage. First you want to see if low dc voltage is available. The presence of the audio portion of the program is proof that low voltage exists. If there is no sound, remove a suitable tube and check from the chassis to one of its electrodes normally receiving low voltage. When locating the tube socket pin holes from the top, remember to count in a counterclockwise direction from the key spacing of the socket – opposite to the direction for locating pins on the base of the tube.

It is also sensible to check to see if high voltage is available at the picture tube's second anode. You can measure the exact voltage with a high-voltage probe and voltmeter or you can make an arc test to see if any high voltage is present. The latter check can be made with the set on or off. Since the second anode of the picture tube with its glass envelope and outer Aquadag coating acts like a capacitor, it will charge up from the high-voltage source. If an arc is produced on discharge, this is proof that high voltage is present. With the set turned on, use two long screwdrivers with insulated (not wood) handles. Work the blade of one under the rubber cap of the anode on the side of the picture tube so that it is in contact with the anode. Touch the shank of the other screwdriver to the shield of the cage containing the flyback transformer and high voltage rectifier tube. Bring the metal portions of the screwdrivers together. Before contact an arc will jump the gap, proving that high voltage is present.

Always make a ground connection to the shield; use of another ground point could damage the receiver. If necessary, a clip lead can be used to ground the shank to the shield, giving more maneuverability. If you prefer the set to be turned off, any ground point could be used and the screwdriver blades should touch each other. An arc will occur if voltage is stored in the picture tube. If you touch the blades several times at intervals of fifteen seconds or so, the tube will be discharged and safe to handle.

Suppose voltage is indicated. This would point to a worn out picture tube or to a high negative voltage being applied to the control grid of the picture tube, cutting off the beam. The easiest thing to do is to measure the voltages from the chassis to both the control grid and cathode of the picture tube. Excess negative voltage on the control grid or excess positive voltage on the cathode will cut off the beam. If the cathode voltage is too high, look for a shorted or leaky capacitor between the video amplifier output and the picture tube cathode.

Should the voltages be normal, you can check the picture tube with the picture tube tester and, if necessary, try rejuvenation or a booster. A booster just raises the filament voltage of the picture tube. If doing this when testing the tube makes it check OK, a booster should be used.

If everything is OK up to this point, there are a number of other approach methods. You can check all the tubes in the suspected section. You can check for negative voltage on the control grid of the horizontal output tube to clear or implicate the horizontal oscillator. You can measure the screen voltage of the output tube.

I prefer a check which is easy and which will localize the trouble. The equipment is most simple. It consists of a small neon bulb pushed into the end of plastic or Teflon tubing. The bulb could just as well be cemented on the end of a wooden dowel. The bulb leads can be either twisted together or cut off. An NE23 neon bulb will be fine. The tube or dowel should be long enough to keep your fingers out of contact with possible shock sources. Six inches or so of tubing will be fine.

These tests are made with the set turned on and with all tubes in place. Bring the bulb against the top cap of the horizontal output tube or, if there is no top cap, around the base of the tube envelope. Neon bulbs have the property of glowing if placed in a strong alternating magnetic field such as the one used to sweep the picture tube beam horizontally. Glowing of the bulb shows the presence of horizontal signals and at once proves that the oscillator, output tube, and damper are working. The flyback can also be considered to be OK. You should pick up a glow by bringing the tube against the horizontal yoke if sweep signals are passing through it.

Next unbutton the shield hiding the high-voltage rectifier. A strong glow should exist around the tube envelope because of the high voltage being applied for rectification. If this is present, try a new rectifier tube and check for anode picture tube voltage. If the voltage to be rectified is present and the tube is OK but there is no high voltage, look at the schematic in Fig. 2 to see what might be wrong. R60, if open, would prevent voltage from being applied to the rectifier filament. R63, if open, would prevent high voltage from appearing at the picture tube second anode. With the set turned off and V10 removed, locate the filament socket holes and check between pins 2 and 7 with an ohmmeter. Lack of continuity shows an open R60. Next measure the resistance from the anode lead of the picture tube to pin 2 of V10. There should be about 4.7k ohms present. Both resistors are under the base of the socket and can be replaced without too much trouble.

Fig. 2 is a Philco chassis 17C21. It is used in this article because it was pulled for a set I was working on. You may be interested in the case although it has nothing to do with the purpose of this article. The customer said the set developed a mess of horizontal lines. Sure enough, it lost sync in a short time. This was fixed by adjusting the ringing coil, L19, and I left the set to cook before releasing it as fixed. Much to my dismay it developed a real mess of horizontal lines without losing horizontal sync. I then noticed that by adjusting the fine tuning I could make a ghost appear. I tried new tubes in the tuner and the video i-f amplifier. No soap! The trouble seemed to be i-f oscillation; the fine lines looked just like an interfering signal near the i-f frequency. A change in value of an i-f cathode resistor or an open in a bypass somewhere in the i-f amplifier would do this. Rather than fool around, I decided the i-f tuning was off and forming the wrong i-f wave shape.

Without a sweep generator, which I do not have, you shouldn't mess much with the i-f tuning. However, I very carefully turned the second i-f adjustment, watching the picture and noting how much adjustment was made. This fixed the trouble; adjustment of the front end fine tuning no longer produced ghosts. If this adjustment had not worked I would have tried the others just as gingerly, and finally I would have gone into the circuitry to locate the defect or to make a change which would have reduced the i-f gain.

Now to an actual case of no raster to see how it was handled. The circuit in question was an RCA chassis KCS97 shown in Fig. 3. If you are familiar with TV, you can tell that this is an old set by the type of horizontal oscillator and the magnetic focusing and ion trap on the picture tube. Before doing anything else, I checked the picture tube because of the age of the set. The base of the tube was cracked to pieces and held together with tape. The tube tested weak, but one touch of rejuvenation with the old CRT tester fixed that. However, still no raster.

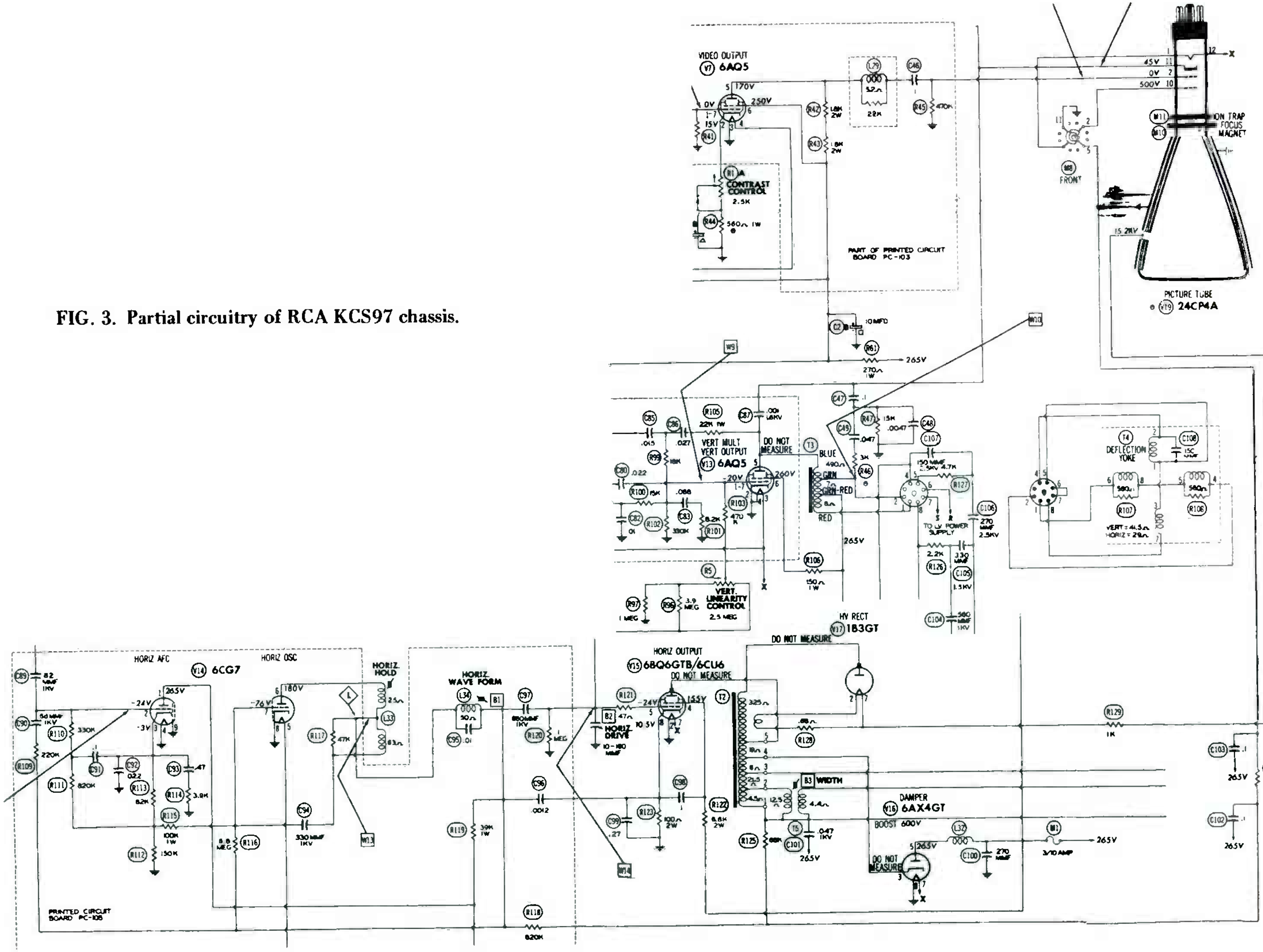

FIG. 3. Partial circuitry of RCA KCS97 chassis.

I did not want the job because I thought a new picture tube might be required. Also, the horizontal output tube was cold to the touch with the set just turned off. I gave an estimate of $55.00 (a rebuilt tube is $15.00), which I thought would scare the customer off. No soap. So there I was, committed to fix the set.

First I had to do something about the lack of heat in V15. I turned the chassis upside down and found that the manufacturer had thoughtfully put a removable screen on the bottom of the chassis and had cut out a hole in the bottom of the cabinet. This made it possible to get at much of the wiring without removing the chassis. An examination showed cathode resistor R123 burned in half. This was due, no doubt, to excess heat caused by too much cathode current. The resistor was replaced with a 120-ohm unit, which was the closest I had to 100 ohms.

With the set fired up, I found about 20 volts across the cathode resistor and a dim compressed vertical raster. The control grid voltage of V15 showed −6 volts instead of the −24 volts called for, showing that there was not enough drive to V15. I tried a new tube for V14. This brought up the drive to about normal but the raster was still compressed and quite dim. Then I measured the anode voltage of the CRT and found it to be about 8kv instead of 15kv. A check of all the tubes in the circuit showed them to be OK, as were the flyback and damper. The boost voltage, as measured at the junction of R125 and R118, was a little below normal, but the 500 volts called for on the picture tube first anode was about 275 volts.

An examination of the circuit led me to believe that leakage might exist in C103. I had to turn the set right side up and pull the chassis, turning it on its side to get at this capacitor. Sure enough it was leaky. With C103 replaced, the voltage came up to normal and the raster filled up. Then the raster shrank back as before and the first anode voltage dropped back to 275 volts. I forgot about it for the time being, having thought about the matter enough to become befuddled.

I tried adjusting the vertical controls to see if I could get the raster to cover the whole screen. No luck. As a matter of fact, the vertical linearity control had no effect. Furthermore, the vertical output tube was too hot and would sizzle when touched with a moist finger. A check around the control showed a resistance to ground from any terminal of better than 10 megs. Sure enough, the 1 meg resistor, R97, from one end of this control to ground proved to be open when removed for a check. Replacing it brought the first anode voltage up to normal and the picture tube raster was plenty bright — a little too bright I thought. Nevertheless, I tuned in a station and got good sound and vertical hold.

The horizontal hold was way off and no adjustment would bring it into sync. The circuit shows that the horizontal frequency is controlled by L33 and L34. If they were shot I was in a mess; replacements would probably not be available. I had visions of rebuilding the whole horizontal oscillator and AFC system along modern lines. Possible, but not a job I wanted to undertake considering the estimate I had given. I had seen that some

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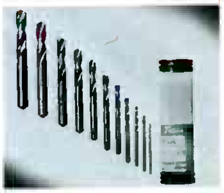

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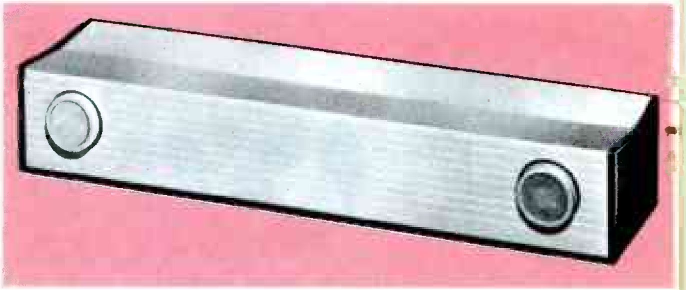

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50.01- 60.00	4.15	5.50		
60.01- 70.00	5.50	6.00	6.40	4.50
70.01- 80.00	7.00	6.50	8.00	5.00
80.01- 90.00	8.00	7.75	10.10	5.00
90.01-100.00	9.00	8.75	12.60	5.25
100.01-110.00	10.00	9.75	14.80	5.50
110.01-120.00	11.00	10.75	16.20	6.00
120.01-130.00	12.00	11.75	17.60	6.50
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other serviceman had replaced the .01 capacitor (C95) across the waveform coil and, hoping it had broken down again, I removed it for a check. Glory be, it had a marked value of .05 mfd instead of the .01 mfd called for on the schematic. I replaced it with the right value and, after adjusting the waveform coil, the picture synced perfectly but it was still too bright.

This time when I looked at the schematic I noticed that the video signal was applied to the control grid of the picture tube rather than to the cathode. The video is capacitively coupled from the plate of the video output tube to the CRT control grid. If the coupling capacitor (C46) was leaky, it would put a positive bias on the picture tube and the brightness could not be turned down. Sure enough the capacitor was leaky. A new one fixed up the trouble, giving as good a picture as on a new set.

This was on UHF. The VHF was intermittent. I won't bore you with how I located the trouble in a screwball switch on the back of the tuner and got it working. This is $55.00 I really earned, but also had a certain amount of fun doing it. Next time I come across a set I don't want to fix, however, I will either say so or quote $100.00. I would rather give a high estimate than say I don't want to, as people always think "He couldn't fix it."

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Ham News

BY TED BEACH, K4MKX

Just the other day I got a real nice note from Jerry, WBØBEK, in response to my comments in the last column about my proposed QRP ideas. Jerry is very enthusiastic about low power operation, and informs me that using the Ten Tec rig qualifies to say that I'm using QRPP. The second P indicates that less than 5 watts is being used. OK, so I'm now QRPP instead of just QRP.

Jerry gave me some suggestions on how to load up the little rig on a random length wire antenna, and surprisingly enough his ideas were almost exactly what I had tried. I managed to string up about 75 feet of aluminum clothesline wire with one end coming into the "shack." The other end is about 35 feet high and fastened to a tree with a piece of nylon rope. Since the rig is still on a real breadboard, I built up an antenna tuner on another breadboard. This was simply a length of B & W miniductor with some shorting clip leads and a 400 pf variable capacitor, very much like the "windowsill antenna tuner" described in the ARRL Handbook. A water faucet outside the window serves as the system "ground".

As I suspected, when I hooked the whole mess together, the Ten Tec wouldn't even budge the needle on my SWR meter. Digging through some back issues of *QST* turned up a circuit for a QRP SWR meter, but since I didn't have most of the parts, that didn't really help. Then Jerry's letter arrived, and he had a suggestion for a low power indicator – simply a number 47 pilot lamp in series with the antenna connection to the tuner. While this is not really an SWR indicator, it does show when power is getting into the antenna. This arrangement seems to work all right, but to date I haven't raised anyone on 80 meters cw. Not even a local. Oh, well.

Jerry also reminded me that there is a publication strictly for QRP called *The Milliwatt* published by Wes Mattox, K6EIL/2. Subscription rates are $3.40 per year and can be had by dropping a line to Wes at:

115 Park Ave.
Binghampton NY, 13903

I think this is perhaps the second time that I have had this info in the column, but we are always getting new readers, so all of you guys who are interested in QRP rush out and subscribe to *The Milliwatt.* Jerry tells me that he has written some articles for the magazine and expects to write some more in the future.

We had a very interesting "eyeball QSO" with Br. Bernard Frey, WA1FKE, the other day. Br. Frey was in Washington for a conference, and dropped by NRI to see just what goes on around here. He wanted to see Tom Nolan, the Executive Secretary of the Alumni Association, but Tom was under the weather with a bug, so I showed Br. Frey around. We had a most interesting chat, and if any of you guys ever get to the nation's capital, be sure to stop by and see us.

We didn't have too much correspondence from NRI hams this time, but please note that in the list that follows *every* call area is represented. I think this a "first" for the column.

Although not in the list this time, Jim, WA3MIE, wrote to tell me that he has a brand new TR4 waiting to be hooked up but that he needs a new antenna and the doctor has grounded him temporarily. That sounds like a real shame, Jim, and I certainly hope that whatever is keeping you grounded won't last long and you'll be able to get the new rig on the air real soon.

WN4SYJ writes that he is active on 80 and 40 using the Conar transmitter and makes consistant contacts even in New York state on 80. Bryan uses a dipole and has crystals for 3735 on 80, and 7173 on 40, and expects to get his General this summer. Best of luck, Bryan.

An air mail letter from WN6JSY proudly let us know that Erne got a fine 66th birthday present – his Novice ticket! Congratulations Erne, and we'll look forward to hearing WN6JSY on the air.

WN8KES got his ticket in June, and is probably one of the big signals from Mt. Clements by now. Ray gives a lot of

Hans	WN1ONX	N	Georgetown CT
Ken	WN1OTY	N	East Norwalk CT
Charles	K1UAM	G	Coventry RI
Oliver	WN2ANY	N	Pine Plains NY
Melvin	WN2NHM	N	Wyandanch NY
Bruce	WN3PJH	N	Rockville MD
Erne	WN3QPL	N	Pottstown PA
Bryan	WN4SYJ	N	Orangeburg SC
Bill	WN4SYK	N	Columbia TN
Gene	WN4VKN	N	Newton NC
George	WB5EEM	T	Durant OK
Wilburn	WN5EET	N	Jonesboro AR
Nelson	WB6BFX	-	Fullerton CA
Mario	WN6HJX	N	North Hollywood CA
Ernest	WN6JSY	N	Vista CA
Paul	WN7PFD	N	Reno NV
Ray	WN8KES	N	Mt. Clemens MI
Mike	WN9FXN	N	Racine WI
Tommy	WN9GQB	N	Indianapolis IN
Al	WN9GZX	N	Shelbyville IN
Glenn	WNØDSN	N	Bismarck ND
Carl	WAØYOX	A	Arkansas City KS

credit to NRI for his new license, and says that his volunteer examiner, Vince Sukur WA8BIJ, was also a lot of help. Ray also wanted to know if we had any ideas on making QSL cards. Well, Ray, I have never made any myself, but there are two or three possibilities you might look into. First, there is the rubber stamp approach which quite a few hams use for inexpensive QSLs. For a little more "professional" looking cards you might consider trying silk screen or linoleum block printing. Most libraries have good books in their crafts section on these techniques. It doesn't take a lot of equipment and the results can be quite pleasing with just a little work. (I have made a silk screen outfit for making printed circuit boards, and I don't see why it couldn't be used to make QSLs. Maybe I'll try it out and let you guys know more about it.)

WAØYOX had written before that he had gone from Novice to Advanced class, but didn't know the new call at the time. Now he has the license and we know the call. Thanks, Carl.

Now let's see who else we have heard from.

The picture is of WA3GJF at his operating position in Baltimore. Bob didn't say which one he was, however.

Steve, WA3PIR, says that he gives credit to his NRI FCC course material for letting him trade in the "N" in his call for an "A". Steve is 15 years old and operates mostly on 75 phone, although he still spends a good deal of time in the Novice bands on cw.

WN3QHU writes that after joining the NRI gang via the color TV servicing course he happened across this column in the Journal. This, says Stephen, was either good or bad, since the interest

Bob	WA2IHJ	-	Clifton NJ
Bob	WA3GJF	-	Baltimore MD
Steve	WA3PIR	G	Fairview Village PA
Stephen	WN3QHU	N	Suitland MD
George	WA3RFJ	T	Cairnbrook PA
Wes	WB4TNY	A*	Memphis TN
Mark	WN4TOU	N	Birmingham AL
Douglas	WA4UNS	A	Virginia Beach VA
Charles	WB5AEY	G*	Norfolk AR
Carl	WN5DDP	N	Sweetwater TX
Glenn	WA5NHI	-	Denton TX
Pete	WA5RKN	A	Duson LA
Bill	WN6HBM	N	Hamilton AFB, CA
Louis	WA8UFK	-	Sault Ste. Marie MI
Howard	W9LHM/MM	-	Ft. Wayne IN
Larry	KØBLW	A	Minneapolis MN
Charles	WNØENV	N	Keytesville MO
Luc	VE2AFB	-	Arvida, PQ Canada

*Just upgraded – congratulations!

generated by the column urged him to get his Novice ticket, but now he is worried about getting ulcers. Stephen says he wants to make WAS as a novice but is constantly plagued by: will the lady downstairs crank up her QRM generating vacuum in the middle of a desperately needed QSO? Will the resident manager tear down his dipole and throw him out? What equipment to build or buy when the General ticket comes? And similar frustrating questions every time he thinks Ham Radio. Hang in there, OM, it can't be all that bad. You *know* you love it!

WA3RFJ just got his Technician license and would like to know if there is any six meter activity in the Johnstown PA area. George runs a Lafayette HE-45B and HE-61A VFO and because of the low power has not been able to raise anyone so far. If any of you guys know of any six meter activity up his way, let George know, would you? His address is:

George Dooley, Jr. WA3RFJ
Box 252
Cairnbrook PA, 15924

In the May/June Journal we listed WN7TNY as awaiting his General ticket, and now he has it – WB4TNY. At present he also has his Advanced Class license. Now Wes says he will have to slow down in going for the Extra unless the FCC does something to relieve the two year wait for Extra. Wes says "NRI was a great help, if not the main reason for all three licenses". Thanks, Wes, it sure does make it all seem worthwhile to have commendations like that.

WA4UNS was first licensed as a Technician while on duty in Alaska with the Navy. His call was KL7HDF. In 1970 he upgraded to General and in 1971 (June) got his Advanced Class license. Doug is presently stationed in Virginia Beach, Virginia and likes to work RTTY on 20 (14.090). He says all the terminal equipment is homebrew and that he would homebrew some 15 meter SSB gear except for time and money problems.

Glen, WA5NHI, has a listing in our Ham Ads this month (all free, remember – two items or less per ad) and I'm not *really* sure what he wants to swap. Specifically he said "...anyone who would like to swap a clean HW22A and HP23A power supply for a nice Hammarlund HQ170". Now, does he *have* an HQ170 and *wants* the HW22A/HP23A, or does he *have* the HW22A/HP23A and *wants* an HQ170? It would sure help if we could get the wording a little clearer.

WA5RKN is a 1947 graduate of our Radio and TV course and is presently taking our FCC license course. Pete does all of his own maintenance on his Ham gear which includes an HW17 with FM adapter, Galaxy GT550 and Ten Tec transceiver. Mobile, Pete runs a Galaxy V. Antennas include an inverted Vee and a TA33 beam.

WN6HBM says that he will be QRT for some time as he is in the Air Force and is being sent to Turkey (no reciprocal licensing). Bill says he will be there for 18 months maintaining telephone equipment, and even though he won't be able to operate, he will still be listening and practicing. Good for you, Bill.

KØBLW writes that "the more you learn about electronics, the more you know how much you *don't* know!" How true, Larry! I find this out every day. Larry also credits NRI with helping get his latest license (started with Novice, went to General and now has Advanced), saying that the basic electronics part of his course really served as a good refresher – along with the experiments –

for the theory part of the Advanced test. Larry populates 20 with CW and SSB using an EICO 753 and a 2 element beam, which, he says, seem to do OK for their size when conditions are right.

WNØENV is working for his General and at present is using a DX20, HQ170 and S40A with a long wire antenna. Charles also asked us if we knew of any Novices who worked with a "severe weather warning net". Quite frankly, Charles, I've never heard of such a net, but if anyone has any info on this, drop me a line and I'll pass it along.

Well, gang, that is about it for this time. Frankly, we are getting so many cards that it is almost impossible for my secretary to keep track of who is new and who isn't. For this reason, you may find that whenever you write you will get yourself listed in the columns, just as if we hadn't heard from you before. But that isn't so bad, is it?

VY 73, and we'll BCNU.
Ted – K4MKX

SALE: Drake TR4 w/AC power supply, speaker and Viking phone patch, $250.00. Gene Manning – W5FZQ, 147 Mouton Switch Rd., Lafayette LA, 70501.

SALE: Heath SB401 and SB301 $475.00. Bob Patti – WA2IHJ, 90 Alfred St., Clifton NJ, 07013.

SALE: Globe Scout AM/CW Xmtr. $55.00. Hammarlund HQ110, fair condition, working $100.00. Steve Klincewicz – WA3PIR, 1020 Ethel Ave., Fairview Village PA, 19409.

WANTED: Tube chart and service manual for B&K Model 500 tube tester. John Walter – W3CZL, 2008 Grace Church Rd., Silver Spring MD, 20901

WANTED: SSB rig in good condition; with or without cw. Mark Harger – WN4TOU, 517 Grant St., Birmingham AL, 35228.

WANTED: Used bug for use with homebrew keyer, need not be in working condition. Will pay up to $10.00. Carl Finke – WN5DDP, Box 1133, Sweetwater TX, 79556

SWAP: Clean HW22A and HP23A for Hammarlund HQ170. Glenn Brazzel – WA5NHI, Rt. Box 426, Denton TX, 76201.

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NRI honors program awards

For outstanding grades throughout their NRI courses of study, the following March and April graduates were given Certificates of Distinction with their NRI Electronics Diplomas.

HIGHEST HONORS

Rufus B. Abbott, Halifax NS Canada
Paul E. Bartles, Jr., Cocoa FL
Allen R. Belzel, Ft. Meade MD
David R. Boger, Washington IN
Robert W. Davis, Varnville SC
Candelario Del Pino, Judibana Falcon Venezuela
Franklin D. Eidson, Memphis TN
Gary L. Feeler, Wichita KS
David N. Freeman, Falls Church VA
Fred E. Haller, Williamsville NY
C. Peter Hannus, Cambridge MA
Robert M. Holmes, Wooster OH
Leslie I. Hursky, Minneapolis MN
Donald G. Kaehler, Arlington VA
Jacquin Kahn, Camp Springs MD
Suzanne P. Lack, East Lansing MI
James E. Munsey, Waldorf MD
Robert H. Paine, Jacksonville FL
Jean Robinson, Elkhart IN
R. G. Shirriff, Appleton WI
Bernard A. Stolp, Brigham City UT
G. Royden Streib, MD., Boise ID
Oris E. Valentine, Ferndale MD

HIGH HONORS

James A. Ainsworth, St. Louis MO
James W. Bailey, Hampton VA
John D. Bartlett, Nashua NH
David S. Beach, Trenton ON Canada
Ivan C. Beck, San Jose CA
Stanley Beckham, New Brighton MN
Robert Biske, Manchester CT
Roman A. Bohatiuk, Newark NJ
Richard H. Brann, Ft. Meade MD
Ronald G. Brantner, Bell Gardens CA
Russell F. Brown, Jr., Anchorage AK
Archie C. Byrd, Big Spring TX
James R. Byrd, Jr., Upland CA
Ronald W. Castle, Frederick MD
Garland W. Christian, Cleveland OH
Harvey J. Collins, Saint Paul MN
Glenn W. Crocker, Jr., Magee MS
James F. Crook, Warner Robins GA
George T. Davis, Jacksonville FL
Roland R. Davis, Dallas TX
Wolfgang J. Doerr, Fremont NE
C. M. Featherston, Waukesha, WI
Donald N. Finken, Madison WI
Leslie T. Foster, Westover AFB MA
Damian Garcia, El Paso TX
Richard Gelsinger, Robesonia PA
Dan A. Gilbert, Fort Wayne IN
William S. Glatt, Jr., Metairie LA
Gerard P. Goudreau, APO San Francisco
James P. Graham, Jacksonville FL
Luverne D. Grant, McGuire AFB NJ
Robert C. Green, Houston TX
Robert L. Hamilton, Westbury NY
Vernon W. Hill, N. Platte NB
Merlin R. Hintz, New London WI
Clark J. Holmes, Ogden UT
Leon Johnston, Stuart FL
Ralph Kimbrel, Westby MT
Marvin L. Kirkland, Millington TN
Charles J. Knotek, Racine WI
Robert Kreider, Danville PA
Frank Larry, Riverdale NJ
Milford R. Lawhun, Jr., Dayton OH
Paul B. Layne, Hyattsville MD
Robert R. Lindsay, Ann Arbor MI
Frank Lucas, Mingo Junction OH
William P. Majosky, Staten Island NY
Marvin E. Matthiesen, Patrick AFB FL
R. J. McLennan, Vancouver BC Canada
Denzel E. Murphy, Orlando FL
Luc Nobert, Arvida PQ Canada
Edwin M. Noonan, Spring City UT
James D. North, Los Angeles CA
William O. Northern, Brandon FL
Glenn C. Norton, APO San Francisco
James W. Patterson, Rochester NY
Bradford A. Perlstrom, Cranbrook BC Canada
Willie L. Ramey, Suffolk VA
S. E. Richardson, III, Tappahannock VA
John E. Rickens, Victorville CA
Paul A. Riggle, Lima OH
Donald E. Risher, Brunswick OH
Ronald Robinson, Niles MI
Martin Safe, Blackduck MN

Scott Saunders, South Ogden UT
Kazuo N. Shimono, Riverside CA
Edward J. Slick, Oceanside CA
Michael A. Sloan, APO San Francisco
Vernus L. Smith, Alexandria VA
George C. Snyder, Wildwood Crest NJ
John R. Stanley, Bastrop LA
Wilfred S. Steingold, Sepulveda CA
Ralph H. Thompson, Sr., New Castle DE
Roshan Lal Verma Ro, New York NY
William S. Vickers, Chatsworth CA
Robert Watt, Cobourg ON Canada
Harrell K. Whitehead, Gadsden AL
Robert K. Whitten, Chadds Ford PA
John F. Wilkinson, Jr., Winchester TN
Harvey Wong, Toronto ON Canada

HONORS

Clifton J. Anderson, Amarillo TX
Kenneth C. Anderson, Parker PA
Michael L. Avery, Cumberland WI
Lloyd Kirk Babcock, Henderson NV
Robert L. Beck, Fair Bluff NC
Mike Bedenbaugh, Lexington SC
Louis F. Berlepsch, Norwich CT
Clarence A. Besio, Dover Plains NY
Albert L. Beutler, Alsip IL
Edwin K. Black, Livingston NJ
Thomas R. Bosse, Covington KY
Richard W. Brown, Aliquippa PA
William L. Brown, Auburndale FL
Bruce Barton Bush, North Bay ON Canada
Ernest Cameron, Jr., Schenectady NY
Lewis W. Campbell, Tillamook OR
William B. Cash, Chamblee GA
Jack R. Claypool, Worthington PA
Joel A. Collamore, Nellis AFB NV
Albert C. Costanzo, Oxon Hill MD
Chester V. Cox, Spring Valley CA
Charles H. Duttweiler, Homestead FL
Ralph Eaton, Harrisville PA
Julius P. Echols, Chicago IL
Charles J. Elvecrog, Minneapolis MN
Mark G. Fehlig, Rolla MO
Richard Floryance, West Allis WI
Francis R. Friedrichs, Bowie MD
Willard B. Garrison, Cornelia GA
Frederick R. Goerne, San Angelo TX
Wayne G. Greene, Shawnee Mission KS

NRI JOURNAL CHANGE OF ADDRESS LABEL

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Student No. ______________ Date ______________

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R.F.D., or
P.O. Box No. ______________________________

City or Town: ______________ State ______________

NEW ADDRESS – after ______________ 19 ______________

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R.F.D., or
P.O. Box No. ______________________________

City or Town: ______________ State ______________

Zip Code ______________

Telford G. Grenke, New Florence PA
Charles T. Guion, Washington DC
Wilson G. Hall, Fayetteville NC
Hollis J. Hanback, Waynesboro VA
James R. Hanna, Hornsby TN
Junior T. Hanson, Wahoo NE
Howard E. Harrell, Camden NC
Arnold Haymes, Welland ON Canada
George W. Heine, MD., Cedar Falls IA
Harmon W. Henderson, New Market VA
Prince G. Henry, San Antonio TX
Ernest W. Henton, Bradford PA
Sam K. Hickman, Valley Falls NY
Lenard F. Hines, APO San Francisco
Robert L. Jackson, Le Sage WV
Eugene F. Juliano, Chester PA
Kazuyuki Kajioka Emi, FPO San Francisco
Joseph P. Kelley, Eastham MA
Fred W. Keylor, Auburn ME
Gary G. Knutson, Vincent IA
James A. Lawson, Greenville SC
Charles Lee, Oakland CA
Roy MacDonald, APO San Francisco
Ronald R. Macovitz, Hubbard OH
George H. Martens, Muskegon MI
George L. Martin, St. Louis MO
Maurice Martinat, Alta Loma CA
William J. McDermott, Belpre OH
Arthur J. McDonald, Auburn WA
Robert McEntire, Mount Vernon NY
Robert A. Mears, Longview TX
James B. Menendez, Silver Spring MD
Paul M. Mersincavage, Spanaway WA
Pedro Diaz Miro, Brooklyn NY
Carl W. Nelson, Biddeford ME
Keith D. Noe, Superior WI
Benjamin G. North, Jr., Biloxi MS
Donald W. Nyberg, Las Vegas NV
Carl Olsen, Arkansas City KS
David C. O'Sada, Albany GA
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Johnnie C. Shaffer, Iowa City IA
John E. Shirey, Bedford Heights OH
Robert D. Shupe, Glen Burnie MD
Howard E. Smith, FPO New York
James Smith, Dyersburg TN
Gerald W. Spaur, Flatwoods WV
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John R. Walker, Nevada MO
William L. Wallace, Kirtland OH
Richard D. Warfield, Escondido CA
Wesley C. Whitely, Jr., Lynchburg VA
William W. Wilson, Rochester NY
Mansel A. Young, Cape Yakataga AK
William S. Young, Portland OR
Jose Zaragoza, Jr., Fort Worth TX
Edmund W. Zenker, Westbrook MN

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ANSWERS TO SELF-TEST QUESTIONS
(questions on page 8)

All five statements are FALSE. If you marked any of them TRUE, you should review the article to clear up any possible misunderstanding.

Alumni News

James Wheeler	President
Robert Bonge	Vice-Pres.
Graham Boyd	Vice-Pres.
Br. Bernard Frey	Vice-Pres.
Thomas Schnader	Vice-Pres.
T.F. Nolan, Jr.	Exec. Sec.

DETROIT Chapter Enjoys Talk on Early Days of Radio

Mr. John Nagy, who collects antique radios as a hobby, brought in literature which dated back to the beginning of radio. He also brought in early lessons from NRI. Most of us could remember when we were able to buy our parts from the dime store. We also listened to a recording from station WJR made during its very first years of operation.

The June meeting was the last meeting before summer vacation. The Chapter had coffee and sandwiches. Earl Oliver and Leo Blevins brought the sandwiches and Charles Cope brought the coffee. The meeting closed on a nice note for the summer months.

FLINT SAGINAW Chapter Demonstrates Newly Purchased Color TV Set

At the May meeting members worked on their recently purchased color TV set. Mr. Steve Avetta put his color bar generator

A new color TV delights Steve Avetta, Frederick Malek, Cash Laferty and Andrew Jobbagy — all members of the Flint-Saginaw Chapter.

to work and explained various faults in the convergence, what to look for, and how to correct them by adjusting the various controls.

Andrew Jobbagy demonstrated how to straighten the plates on a variable capacitor in AM radios, and how to use a power

An oscilloscope provides some practical learning for the Flint-Saginaw Chapter. Doing the demonstrating are Andrew Jobbagy and Steve Avetta.

pack voltage supply to check for shorted plates in the variable capacitor.

A new member joined the Chapter this month. He is Mr. George Martin.

Most of the time at the June meeting was devoted to checking a black and white TV using an oscilloscope. Andrew Jobbagy adjusted the scope and read the diagram while Steve Avetta used the probe through the TV receiver. All those present benefited from the lecture.

Students and graduates in the Flint area are invited to attend these meetings to get the full benefit of the members' experience.

All meetings are suspended during July and August. However, arrangements have already been discussed for the grand opening in September.

LOS ANGELES Chapter Has Good Turnout

The Executive Secretary visited the Los Angeles Chapter in June and gave his yearly talk on the latest technical information. This year the talk concerned solid-state testing and the use of solid-state devices in the latest color television receivers.

The new meeting place at the Columbia Federal Building on Wilshire Blvd. was most pleasant. There was a very good turnout and an enlightening question and answer period followed Tom's talk.

The Secretary appreciates the fact that many people come a great distance to attend the meetings. It is always gratifying to know that NRI creates such an interest among people.

PITTSBURGH Chapter Continues TV Studies

At the June meeting one of the newer members was selected to install a flyback transformer in the Chapter's black and white TV set. Some of the more experienced members joined in to help him. In this way, information was brought up to date for everyone.

The Admiral Corporation is scheduled to

Pittsburgh Chapter members George McElwain, left, Tom Schnader, center, and Joe Burnelis.

A meeting of the Pittsburgh Chapter.

talk to the Chapter in August, and General Electric is to come in September. The Chapter hopes to have a visit from Zenith shortly after.

Three New Members for NORTH JERSEY Chapter

At the May 28 meeting three new members were admitted to the Chapter, Mr. Alexander Boweebank, Lindsay Grant, and John D. Luciano. Welcome to the Chapter, fellows.

Chapter member Howard Ross gave a lecture on diodes and transistors and their chemical properties and operation. This was a very interesting lecture and the Chapter enjoyed it.

The June 25 meeting was the last one before vacation. The Chapter held an especially interesting and educational meeting. Chairman George Stoll conducted the Howard Sam's Co. television review lecture series in four parts: fundamentals of the color TV system, receiver circuit fundamentals, color receiver circuit analysis, and installation and maintenance. The slides and tapes were obtained by Franklin Lucas from Sam's, and George Stoll brought the tape recorder and projector for the lecture.

The meetings will resume in September after the warm weather has passed.

NEW YORK Chapter Continues Work on Color Receivers

Reverend George Hilton attended the May meeting as a guest of Mr. J. Robertson.

Mr. Robertson brought in a GE television set that was arcing around the picture tube. The Chapter had quite a discussion about what might be done to correct it.

Mr. S. Kross donated a Capacitor and Resistor Bridge tester to be raffled off. Mr. Da Silva won it, adding $11 to the treasury.

Pete Carter and Onti Crowe continued their demonstration of the color convergence of the Chapter's TV receiver. The membership joined in seeing who could converge the color set in the best possible way.

At the June meeting Mr. Bimstien discussed how to reduce the feathering in the picture when performing a dynamic convergence adjustment on a color set. This was accomplished by reducing the color control and by proper fine tuning.

Pete Carter described a couple of very interesting problems. One problem was a Zenith with a bad printed circuit board. A new board had to be obtained from the company. The same trouble was experienced by Mr. James Eaddy in a different Zenith of the same model.

The June 17 meeting was the last Chapter meeting before vacation. Refreshments were served by the committee, Mr. Al Bimstien and Mr. Sam Antman. Everyone was wished a happy vacation.

SAN ANTONIO Chapter Continues Interesting Programs

At the may meeting Mr. Charles Boylan, an electronic engineer previously with Packard Bell and now with Video Visual Aids Company, gave a talk on practical servicing shortcuts. He also gave the Chapter members a rundown on the 1972 Packard Bell TV receiver line.

Two new members were brought into the Chapter. They are Mr. C. R. Webb and Mr. Morris Hutchings.

At the June meeting Mr. Charles J. Boylan, who spoke at the May meeting, was admitted to the Chapter as a member. Welcome, Charles. We are certainly glad to have you.

Mr. Jack Reagor, technical advisor of Motorola Company's regional office in Dallas, talked on the Motorola Quasar TV. The new switch mode, all-electronic control power supply was also discussed. Thank you, Jack, for a very good talk.

Our next speaker at the July meeting will be Mr. Tom Meir, who was obtained by member Jim Rivet. Tom is an electrical design engineer.

For the past six months the Chapter has had a professional outside speaker at each meeting. This is a pretty good record for the Chapter.

Editor's Note: Keep up the good work, fellows!

The San Francisco Chapter listens to a "how to test transistors" talk.

Executive Secretary Visits SAN FRANCISCO Chapter

The San Francisco Chapter was visited in June by Tom Nolan, Executive Secretary.

Everyone enjoyed Tom's lecture on solid-state devices including methods of testing transistors and their use in color TV receivers. A good many questions were asked by those present. The Secretary appreciated the good turnout.

The membership of NRIAA has selected two good candidates for the office of President for the year 1972. They are Mr. Andrew Jobaggy of the Flint, Michigan Chapter, and Mr. Tom Schnader of the Pittsburgh Chapter.

These are both outstanding men who have served their Chapter and NRIAA well. Either one of these gentlemen would make an excellent President of the National Radio Institute Alumni Association.

We have an all-new slate of nominees for the office of Vice President. A list follows of those names nominated by the membership. Out of this list you must select four members of the Alumni who fill the office of Vice President of the NRIAA for the year 1972. Nominees for Vice President:

Frank Berdar – White Stone, New York
Charles L. Graham – Norfolk, Virginia
Donald L. Wier – Lititz, Pennsylvania
John Rote – Fairmont, West Virginia
William A. Simms – Tucson Arizona
Ernest A. Forbes – Aberdine, West Virginia
Andrew W. Perry – Brooklyn, New York
Weyland E. Duncan – Altus AFB, Oklahoma

Please indicate your choice of the candidates on the ballot below. Then mail the ballot well before October 8, when the polls close. The list of winners will appear in the November/December issue of the Journal.

Alumni Election Ballot

FOR PRESIDENT (VOTE FOR ONE)

☐ ANDREW JOBBAGY, Flint, Michigan
☐ TOM SCHNADER, Pittsburgh, Pennsylvania

FOR VICE PRESIDENT (VOTE FOR FOUR)

☐ FRANK BERDAR, Whitestone, New York
☐ CHARLES L. GRAHAM, Norfolk, Viigina
☐ DONALD L. WIER, Lititz, Pennsylvania
☐ JOHN ROTE, Fairmont, West Virginia
☐ WILLIAM A. SIMMS, Tucson, Arizona
☐ ERNEST A. FORBES, Aberdine, West Virginia
☐ ANDREW W. PERRY, Brooklyn, New York
☐ WEYLAND E. DUNCAN, Altus AFB, Oklahoma

YOUR NAME ____________________

ADDRESS ____________________

CITY ____________________

STATE ____________ ZIP ____________

MAIL YOUR COMPLETE BALLOT TO:

T. F. Nolan, Jr., Exec. Sec.
NRI Alumni Association
3939 Wisconsin Ave. N.W.
Washington, D.C. 20016

POLLS CLOSE ON OCTOBER 8, 1971

DIRECTORY OF CHAPTERS

CHAMBERSBURG (CUMBERLAND VALLEY) CHAPTER meets 8 p.m. 2nd Tuesday of each month at Bob Erford's Radio-TV Service Shop, Chambersburg, Pa. Chairman: Gerald Strite, RR1, Chambersburg, Pa.

DETROIT CHAPTER meets 8 p.m., 2nd Friday of each month at St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich. 841-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m., 2nd Wednesday of each month at Chairman Andrew Jobbagy's shop, G-5507 S. Saginaw Rd., Flint, Mich.

LOS ANGELES CHAPTER meets 8 p.m., third Friday of each month at Graham D. Boyd's TV Shop, 1223 N. Vermont Ave., Los Angeles, Calif., 662-3759.

NEW ORLEANS CHAPTER meets 8 p.m., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad 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 Tuesday of each month at 218 E. 5th St., New York City. Chairman: Samuel Antman, 1669 45th St., Brooklyn, N.Y.

NORTH JERSEY CHAPTER meets 8 p.m., last Friday of each month at The Players Club, Washington Square. Chairman: George Stoll, 10 Jefferson Avenue, Kearney, N.J.

PHILADELPHIA-CAMDEN CHAPTER meets 8 p.m., 4th Monday of each month at K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore, Philadelphia, Pa.

PITTSBURGH CHAPTER meets 8 p.m., 1st Thursday of each month in the basement of the U.P. Church of Verona, Pa., corner of South Ave. & 2nd St. Chairman: Tom Schnader, RFD 3, Irwin, Pa.

SAN ANTONIO (ALAMO) CHAPTER meets 7 p.m., 4th Friday of each month at Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (3 blocks north of Austin Hwy.), San Antonio. Chairman: Joe R. Garcia, 8026 Cinch, San Antonio, Tex., 694-3461.

SAN FRANCISCO CHAPTER meets 8 p.m., 2nd Wednesday of each month at the home of J. Arthur Ragsdale, 1526 27th Ave., San Francisco. Chairman: Isaiah Randolph, 60 Santa Fe Ave., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8 p.m., last Wednesday of each month at the home of Chairman John Alves, 57 Allen Boulevard, Swansea, Massachusetts.

SPRINGFIELD (MASS.) CHAPTER meets 7 p.m., 2nd Saturday of each month at the shop of Norman Charest, 74 Redfern Dr., Springfield; and 4th Saturday at the shop of Chairman Al Dorman, 6 Forest Lane, Simsbury, Conn.

NEW—From LEADER

For Those Who Want the Best! 5" Solid State Triggered Oscilloscope / Vectorscope

WHAT IS A TRIGGERED SCOPE?

The triggered scope is an improved type of cathode ray oscilloscope with a one shot sweep circuit. The electron beam remains in a stationary position and does not deflect until "triggered on" by an input waveform or transient. When turned on the beam sweeps across the CRT displaying the incoming wave shape and then returns to rest. Each succeeding pulse will cause the beam to deflect again giving the effect of a repetitive waveform. The triggered sweep feature makes it possible to observe non re-occurring transients and to synchronize on either the high frequency or low frequency components of complex wave forms. The horizontal deflection is calibrated in time making it possible to measure the frequency or duration of waveforms and pulses. The vertical is calibrated in volts per centimeter making precise amplitude measurements possible. It is also possible to operate the sweep in an automatic or conventional free running state.

SPECIFICATIONS

Vertical Amplifier	
Sensitivity	20MVp-p/cm to 10Vp-p/cm, 9 steps in 2-5-10 sequence and uncalibrated continuous adjuster.
Bandwidth	DC or 2Hz to 10MHz
Rise Time	35nsec
Input Impedance	1 megohm, shunted by 33 pfd
Calibration	
Square Wave Voltage	0.05, 0.5 and 5Vpp; 1KHz approx.
Horizontal Amplifier	
Sensitivity	200MVp-p/cm or better
Bandwidth	2Hz to 200KHz
Input Impedance	1 megohm, shunted by 40 pfd
Time Base	
Sweep Speeds	1μs/cm to 0.2s/cm, 17 steps in 1-2-5 sequence and uncalibrated continuous adjuster; TV: V (for 30Hz) and H (for 15.75KHz/2)
Magnification	X5 (max. speed 0.2μs/cm)
Sweep Mode	Triggered and automatic (Slope + and −)
Sychronization	Internal and external: + and −.
Power Supply	115/230V; 50/60Hz; 50VA, approx.
Size and Weight	10½"H x 8"W x 16½"D; 30 lbs.

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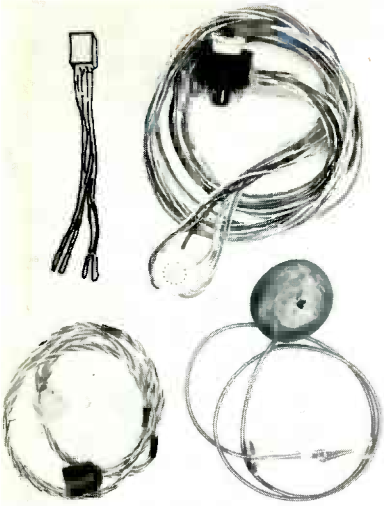

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