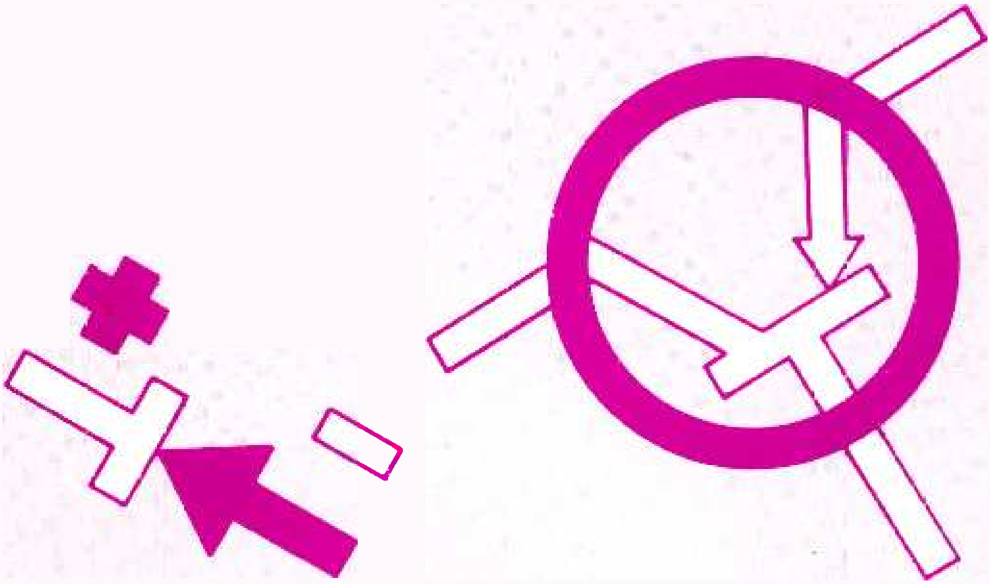
journal



March/April 1970 *35 cents*

CONAR CATHODE CONDUCTANCE TUBE TESTER

CATALOG PRICE

KIT 223UK	$49.95
WIRED 223WT	$75.95

NRI STUDENT & ALUMNI PRICE

KIT 223UK	$44.80
WIRED 223WT	$68.25

Tests all series string and up-to-date tubes as well as the standard base types—4, 5, 6, 7-pin large octal, loctal, 7, 9 and 10-pin miniatures, 5-pin nuvistor, novar and Compactron. Checks 17 individual filament voltages from .75 to 110 volts. Tests multi-section tubes, gas rectifiers and remote control gaseous types. Has open-close "eye" tests for cathode ray indicator tubes, and visible filament continuity check to show up open filaments regardless of pin position.

12 lever element selector-distribution system enables you to select the individual elements of the tube you're checking and simplifies cathode leakage tests and inter-element short tests. Most important this feature provides you with flexibility AND gives you insurance against obsolescence as new tubes reach the market.

Designed around the approved Electronic Industry Association's Emission Circuit, the Model 223 uses a precise, accurate, double-jeweled meter movement. It's balanced and factory calibrated within 2% accuracy. Large, easy to read—with clear plastic case and two 2-color scales.

Test sequence set up to reveal quickly open filaments and shorts. The time-saving feature rejects an "open" or "shorted" tube and lets you proceed with more detailed checks right away. For maximum safety to you and the instrument, the test circuit is transformer isolated from the power line. Triple-window, high-speed, gear-operated roll chart is illuminated, easy to read, even in darkened areas. Lists over 2,000 tube types.

The instruction manual for the Model 223 is written with the same high standard that went into the circuit design—with HUGE picture diagrams to guide you every step of the way.

Building the Model 223 is easy. Using it is even easier. The operating simplicity makes it a pleasure to use. Just 10 lbs.—it's a pleasure to tote along on service calls, too.

SPECIFICATIONS

CASE: Black, leather-fabric; removable, hinged lid with safety catch; PANEL: Satin finish, aluminum; PANEL LETTERING: Red; METER: Double-jeweled D'Arsonval type; accurately balanced and factory calibrated to within 2% accuracy; ROLL CHART MECHANISM: Triple-window, high speed, gear operated; illuminated; SAFETY FEATURE: Test circuits transformer isolated from power line affords utmost safety to operator and instrument; POWER REQUIREMENTS: 50-60 cycle, 110-120 volt, AC only; WARRANTY: Standard EIA warranty on all parts; DIMENSIONS: Width 15¼"; length 10½"; depth 4¾". ACTUAL WEIGHT: 10 lbs.; SHIPPING WEIGHT: 13 lbs., Parcel Post Insured.

FREE

WITH YOUR ORDER

2 TV ADAPTERS

WHICH ALLOW YOU TO TEST EMISSION OF ALL 70°-90° and 110° PICTURE TUBES. A $6.00 VALUE! OFFER ENDS APRIL 30, 1970

USE CONVENIENT ORDER BLANK ON PAGE 25

nri journal

March/April 1970
Vol. 27, No. 2

Published bimonthly by National Radio Institute, 3939 Wisconsin Ave., Washington, D.C. 20016. Subscription $2.00 per year. Litho in U. S. A. Second class postage paid at Washington, D.C.

CONTENTS

A REFRESHER COURSE IN TRANSISTOR FUNDAMENTALS

by Louis E. Frenzel, Jr.

Transistors are really a lot easier to understand than most technicians realize. Despite the fact that transistors have been around for nearly 20 years now, many technicians still seem to have trouble understanding transistor circuits and troubleshooting transistorized equipment. This difficulty arises not because transistors are so complex and difficult to understand, but rather because many people seem to have a mental block about them. In this article you will see how simple transistors really are. There are ten key facts about transistors and transistor circuits presented in question and answer form. When you finish reading, you will have all of the information needed to work with transistorized equipment.

Keep one very important point in mind as you read the information presented here. Transistors have been rapidly replacing vacuum tubes in electronic equipment for many years now. In the future you will see more and more transistors and fewer tubes in new equipment. Perhaps more important, however, is the fact that transistor circuits will be replaced with integrated circuits in the coming years. Integrated circuits are made up of transistors and other components made all at the same time on a silicon chip, and housed in a very small package to form a particular functional circuit. Transistor theory applies to these circuits and, therefore, makes it even more important for you to have an understanding of transistors. Keeping these facts in mind, let's get to our refresher course.

1. What is a semiconductor diode?

A semiconductor diode is a two-element electronic component made of either germanium or silicon, the two most popular types of semiconductor materials used for making diodes and transistors. By adding the correct amount of certain impurities to the semiconductor, germanium or silicon can be made into either P or N-type material. The N-type material has an excess of electrons while the P-type has a deficiency of electrons. By placing the P and N-type materials together we form a diode whose characteristics are such that current will flow through it in only one direction. The P-type material is called the anode while the N-type material is called the cathode. Fig. 1A shows a simple diagram of a semiconductor diode. If we connect a battery and a resistor to

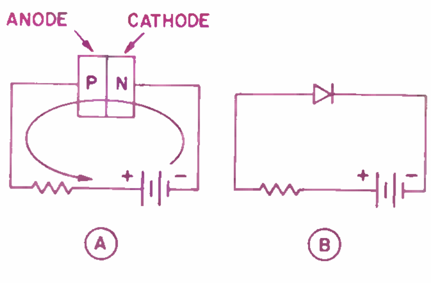


Fig. 1. A forward biased semiconductor diode.

the diode as shown in this figure, current will flow through the diode. Electrons will leave the negative terminal of the battery and move to the cathode of the diode, through the diode to the anode, and back to the positive side of the battery through the resistor. With the diode conducting it acts as a very low resistance. A typical silicon diode will have approximately .6 or .7 volts across it when it conducts. The voltage drop across a germanium diode when it is conducting is approximately .2 or .3 volts. With the negative terminal of the battery on the cathode of the diode and the positive terminal on the anode, the diode conducts and is said to be forward biased. If we reverse the battery polarity, the diode will be reverse biased and no current will flow through it. The resistor in the circuit is used to limit the current flow to prevent damage to the diode. Fig. 1B shows the proper diode schematic symbol.

2. What is a transistor?

A transistor is a three-element semiconductor device made up of either germanium or silicon P and N junctions. Fig. 2A shows an NPN transistor made of alternate sections of N and P-type semiconductor materials. Two P-N junctions similar to the semiconductor diode junction are formed. Either P-N junction of the transistor will perform just as a semiconductor diode. The three elements of the transistor are labeled emitter, base and collector. The symbol shown in Fig. 2B is used to illustrate an NPN transistor. Another version of the transistor can be formed as shown in Fig. 2C. This is a PNP transistor. The symbol for a PNP transistor is shown in Fig. 2D. Notice that the only difference between the NPN and the PNP transistor symbols is the direction of the emitter arrow.

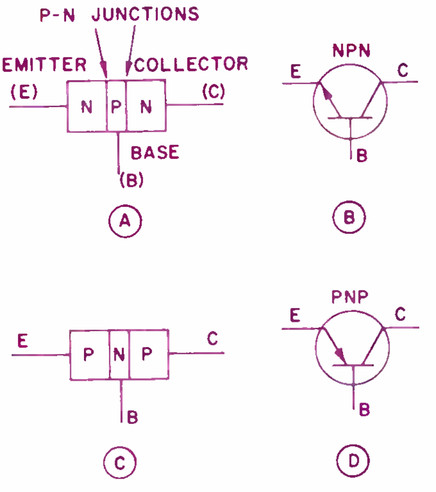
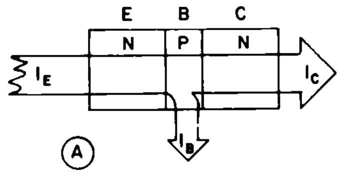


Fig. 2. NPN and PNP transistor symbols.

3. How does a transistor work?

When the proper operating voltages are applied to the three elements of a transistor, current flows through the transistor from emitter to collector. In an NPN transistor electrons enter the emitter and flow across the emitter-base junction and the base-collector junction into the collector. They then flow out of the collector to the positive voltage source. Some of the electrons flowing in the base circuit divide and flow to the positive voltage source connected to the base. The arrows in Fig. 3 show the direction of current flow in an NPN transistor. When the transistor is operating properly it acts as a variable resistance. A small change in the base current can make a large change in the collector and emitter currents. Since only a minute change in base current can control the larger emitter and collector currents, the transistor amplifies.

4. What are the current relationships in a transistor?



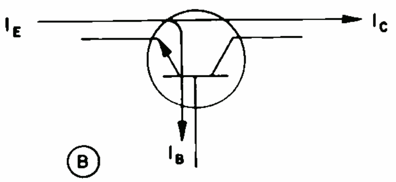


Fig. 3. Direction of electron flow in an NPN transistor.

By referring to Fig. 3 you can see that the emitter current I_E entering the transistor splits up into two parts, the collector current I_C and the base current I_B. The base current of a transistor is usually very small, in most cases only microamperes. Thus only a small part of the emitter current goes to the base. Most of the electrons move on to the collector. For most practical purposes we can say that the emitter and collector currents are nearly equal, with the collector current being only slightly smaller than the emitter current. We can relate the currents to one another in mathematical form as:

$$I_E = I_B + I_C$$

This simply tells us that the emitter current is made up of two components, the base current and the collector current. You can see this current relationship more clearly by looking at Fig. 4 that shows the direction of current (electron) flow in a PNP transistor. The current direction here is exactly opposite to that in an NPN transistor. The electrons enter the base and collector, and flow to the emitter base junction where they form the emitter current.

5. How do you properly bias a transistor?

A transistor is properly biased if the emitter-base junction is forward biased and the collector base junction is reverse biased. Forward bias can be applied by connecting the negative terminal of the battery to the emitter of an NPN transistor and the positive terminal of the battery to the base. This will cause the emitter-base diode to conduct, producing forward bias. To reverse bias a junction, the negative terminal of a battery is connected to the base and the positive terminal to the collector. The proper biasing for an NPN transistor is shown in Fig. 5. Note the directions of the currents in the circuit. Resistors are used to limit the current in the base and collector circuits.

The rule for properly biasing a transistor is easy to remember: negative to N, positive to P for forward bias. To reverse bias a junction simply reverse this rule. The proper biasing of a PNP transistor is similar to that shown in Fig. 5 except that the polarities of both the batteries should be reversed.

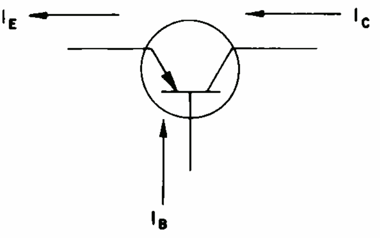


Fig. 4. Direction of electron flow in a PNP transistor.

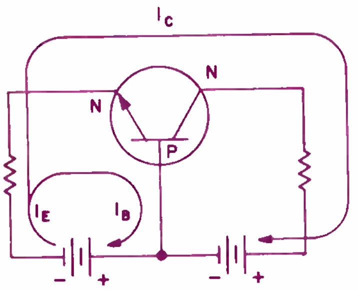


Fig. 5. Proper bias for an NPN transistor.

6. What is the most popular transistor circuit configuration?

The common emitter transistor amplifier is the most popular configuration. The term common emitter means that the emitter is the element common to both the input and output. A simple common emitter circuit is shown in Fig. 6. The proper biases on both junctions are obtained with one battery, unlike the circuit of Fig. 5 which uses two batteries. The supply voltage battery and resistor R_1 supply forward bias to the emitter-base junction. The emitter-base diode conducts and current flows from the negative terminal of the battery to the emitter, across the emitter-base junction to the base, and through R_1 to the positive terminal of the supply voltage. The voltage drop across the emitter-base diode is approximately .6 volt for this NPN transistor. This means that the base is far less positive than the collector or the collector is more positive than the base, meaning that the base-collector junction is reverse biased. The value of resistor R_1 is chosen so that the resulting base current will cause just enough emitter and collector current to make the voltage drop across R_2 equal to 1/2 the supply voltage, V_{CC}. If the supply voltage is 10 volts, then the voltage between the collector and the emitter of the transistor will be approximately 5 volts. If a small ac signal is applied to the input through C_1 it will cause the base current to vary above and below the value fixed by R_1. Changing the base current will cause the emitter and collector currents to change in a similar way. If the input signal goes positive the base current increases. This will cause a corresponding increase in the collector current. The voltage drop across R_2 will increase causing the output voltage between the collector and ground to decrease. If the input signal goes in a negative direction it will subtract from the fixed base current and decrease the collector current. This will cause a smaller voltage drop across R_2 so the output voltage will go up. The output of the circuit will be an amplified version of the input signal.

7. What do the terms Alpha and Beta mean?

The term Alpha is the common base forward current gain of a transistor. It is a figure that indicates the gain of a transistor when it is used in a common base amplifier circuit. Basically it is the ratio of the collector current to the emitter current (Alpha = I_C/I_E). Since these two

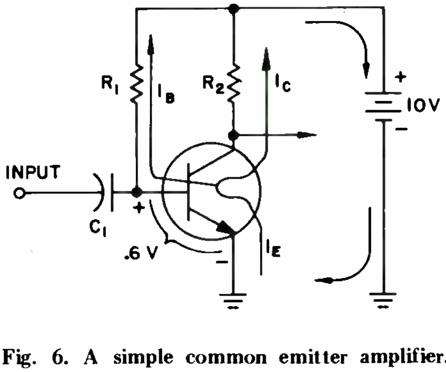


Fig. 6. A simple common emitter amplifier.

currents are very nearly equal in a practical transistor (I_E is always slightly greater than I_C), the Alpha is slightly less than 1. For a good transistor Alpha may be .98 or .99. The Alpha of a transistor varies with frequency. At some high frequency the Alpha begins to drop. The frequency where Alpha drops to 70.7% of its lower frequency value is known as the Alpha cutoff frequency. A transistor cannot be used as a suitable amplifier beyond its Alpha cutoff frequency.

Beta is similar in many respects to Alpha. It is the current gain of a transistor in the common emitter configuration. Basically it is the ratio of the collector current to the base current (Beta = I_C/I_B). Since the base current is substantially smaller than the collector current, Beta values can be very high. Betas of several hundred are obtainable. The Beta value gives a slight indication of the maximum amount of gain that can be obtained from a common emitter transistor amplifier.

8. What other circuits are used to bias a transistor amplifier?

Despite its simplicity and wide use, the amplifier circuit of Fig. 6 is not the best arrangement. The circuit is highly sensitive to transistor characteristics and, if the transistor used in the original circuit becomes defective, a transistor with identical characteristics will have to be used to replace it to obtain proper operation. In most cases this is not possible since even transistors of the same type vary widely in characteristics. A change in the transistor Beta, for example, will cause a shift in the bias point and, therefore, could cause distortion of the signal being amplified. This circuit is sensitive to leakage currents in the reverse biased base-collector junction. Even though a junction in a diode or transistor may be reverse biased and no current is supposed to flow, some leakage current does in reality flow across the junction. In most good silicon transistors this leakage current is very low, so it usually has little or no detrimental effect on the operation of the circuit. However, some transistors do have enough leakage to cause a change in the base bias and, therefore, a shift in the operating point of the amplifier. To make matters worse this leakage current is temperature sensitive. This leakage current increases with temperature. Therefore, when the circuit is operated at high temperatures, a drastic shift in the bias current could cause severe distortion of the signal being amplified. For these reasons other biasing methods have been developed. The circuit in Fig. 7 is an example of an improved bias method. Here the base resistor R_1 is connected between the collector and the base of the transistor rather than between $+V_{CC}$ and the base, as in Fig. 6. This produces some negative feedback which improves the bias stability with temperature. In the circuit of Fig. 6, if the temperature is increased the leakage will increase and cause the transistor to conduct harder. This means more collector current will flow and a larger voltage drop across

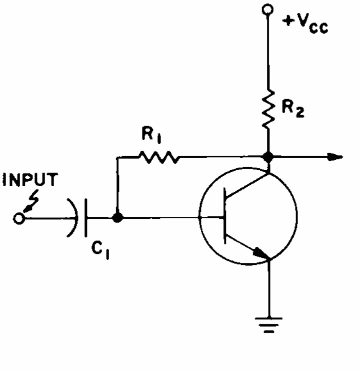


Fig. 7. Negative feedback biasing.

R_2. The dc output voltage will drop substantially. However, the circuit of Fig. 7 offsets this somewhat. If the temperature increases and the leakage current causes greater conduction of the transistor, more voltage will be dropped across R_2. This means that the output voltage between the collector and the emitter of the transistor will drop, thereby decreasing the amount of base current flowing through R_1. Since the base current is decreased, the transistor will not conduct as much and the collector voltage will rise. As you can see this negative feedback effect does compensate for the leakage current effects at high temperature.

Perhaps the best biasing circuit for a transistor amplifier is that shown in Fig. 8. Here a voltage divider made up of R_1 and R_2 is used to set the bias voltage on the base of the transistor. An emitter resistor is also included. This emitter resistor will produce some negative feedback that will help to stabilize the bias for temperature changes and leakage. If the temperature and leakage should increase, causing an increase in the collector current of the transistor, the voltage drop across the emitter resistor R_4 will increase. The polarity of the voltage across R_4 is opposite to that of the forward bias provided by R_2, so the two voltages subtract from one another. An increase in the voltage across R_4 decreases the forward base-emitter bias on the transistor, thereby reducing the amount of collector current, thus compensating for the initial increase. The input signal is coupled to the base of the amplifier through the input capacitor as usual. A bypass capacitor is connected across the emitter resistor to eliminate ac feedback, which would substantially reduce the gain of the amplifier.

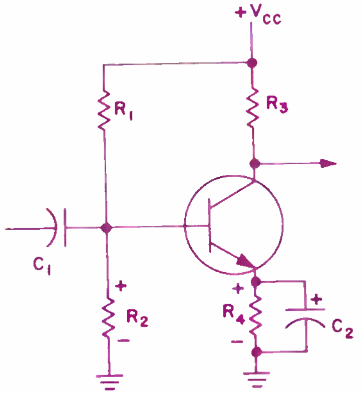


Fig. 8. The preferred transistor bias circuit.

9. What are some representative voltages and component values in a typical transistor amplifier circuit?

Fig. 9 shows a typical transistor amplifier. A silicon NPN transistor is used. Bias is obtained with the voltage divider made up of R_1, R_2 and the emitter resistor R_4. The collector supply voltage is +10 volts. Some typical voltages on the emitter, base and collector elements with respect to ground are shown in Fig. 9. The voltage divider, made up of R_1 and R_2, divides the +10 volt supply voltage down to 1.7 volts. Current flows from the negative terminal of the power supply to ground through the 20K resistor R_2 and the 100K resistor R_1 to +10 volts. The voltage produced across the 20K resistor is applied to the base of the transistor. This is about 1.7 volts. Since the voltage on the base is more positive than the emitter, the emitter-base junction is forward biased so current flows. This produces a .7 volt drop between the emitter and base as shown in Fig. 9. For that reason the voltage at the emitter of the transistor is .7 volt less than the voltage at the base, or about 1 volt. This means that we have a 1 volt drop across the emitter resistor, R_4. Using Ohm's Law we can

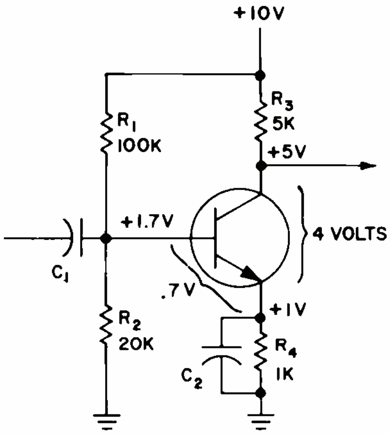


Fig. 9. A typical amplifier circuit with representative voltage and component values.

calculate the amount of emitter current flowing in the circuit. Simply divide the voltage by the resistance. One volt divided by 1000 Ohms = 1 milliampere.

One milliampere of emitter current will flow into the transistor and most of it will pass on through to the collector. A very small amount of it will, of course, divide off and flow in the base circuit up through resistor R_1 to the supply voltage. However, if the transistor gain is high, this base current will be relatively small compared to the other currents in the circuit. For that reason we can say that the collector current is very nearly equal to the emitter current. This means that 1 milliampere flows in the collector resistor R_3. Using Ohm's Law again we can calculate the voltage drop across the 5K collector resistor. One milliampere = .001 amperes. Multiplying this by 5000 ohms gives us the voltage of 5 volts. Since the sum of the voltages in a series circuit is equal to the supply voltage, then the voltage between the collector and ground must also be 5 volts. With 1 volt across the emitter resistor the voltage between emitter and collector will be 4 volts. This is designated as shown in Fig. 9. Generally the transistor bias is selected so that the fixed dc output voltage at the collector is approximately 1/2 of the supply voltage as you can see here. This amplifier circuit is quite typical of those that you will encounter in your work and if you become familiar with it you should have little or no trouble in learning to test or troubleshoot such a circuit. To be sure you understand it thoroughly, consider the voltages on the transistor elements. With 1.7 volts positive on the base and 1 volt positive on the emitter, you can see that the emitter base is forward biased as it should be for proper transistor operation. Notice also that the collector is at +5 volts while the base is at 1.7 volts. This means that the collector is more positive than the base, or rather the base is more negative (less positive) than the collector. This is reverse bias for the base-collector junction as required.

10. How is a transistor used as a switch?

In the amplifier circuits we have just discussed the transistor really acts as a variable resistance. By varying the base current on the transistor the amount of current flowing between the emitter and the collector varies, and this is equivalent to saying that the transistor is a variable resistance. However, it is also possible to use a transistor as a simple on-off switch. When a transistor is cut off so that no current flows through it, it acts as an open switch. When the transistor is made to conduct very hard it acts as a very low resistance and, therefore, resembles a closed switch. Such a transistor circuit finds wide application in pulse and digital circuits. A simple transistor switch circuit

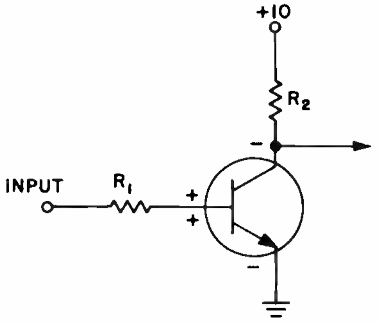


Fig. 10. A transistor switch.

is shown in Fig. 10. If we apply 0 volts or ground to the input of the circuit no current will flow in the emitter-base circuit. This junction will not be forward biased so the transistor will not conduct. The transistor switch is off and if we look at the output we will see +10 volts through resistor R_2. If we apply a +10 volt signal to the input, the emitter-base junction will be forward biased. This will cause the transistor to conduct. If we make the value of R_1 small enough so that a large amount of base current flows, the transistor will conduct quite hard and will go into a state known as saturation. When the transistor saturates, both the emitter-base and base-collector junctions become forward biased. When the transistor is in this state it acts as an extremely low resistance and resembles a closed switch. At this time the output voltage is very nearly equal to 0 volts. Such circuits operate at very high switching speeds with square wave signals similar to that shown in Fig. 10. If the input signal switches repeatedly between 0 and +10 volts, then the output will also switch between 0 and +10 volts but will be switching in the opposite polarity. For that reason, the simple transistor switch is also an inverter circuit.

Now let's see what you learned. Answer the five True-False questions below. The answers are on page 11.

1. To forward bias the emitter-base junction of a PNP transistor, the base must be negative with respect to the emitter.
2. Varying the base current in a transistor causes the collector current to change.
3. Sophisticated bias circuits are used mainly to minimize the sensitivity of the circuit to temperature changes.
4. You measure the collector output voltage of a transistor amplifier like that in Fig. 6 with a supply voltage of +10 volts and find it to be +10 volts. You can conclude that the circuit is operating properly.
5. Both junctions of a transistor are never forward biased.

GET THE MOST OUT OF YOUR SERVICE DIAGRAMS --

READ THEM!

I encountered a servicing problem the other day that made me very much aware of a very simple, but still very important, point to remember: when you read a schematic diagram or other servicing information, ***read it thoroughly.***

Now my friend Woody is pretty handy with a soldering iron. He also has an excellent reputation as a color TV benchman. But a certain aged Magnavox B&W portable really had him going for a while.

At first, things went smoothly. The trouble was easily localized to the vhf tuner. There was no signal coming out of the tuner at all. The local oscillator was running, as indicated by a normal negative voltage at the mixer control grid. Other voltages in this stage appeared normal, so Woody went over to take a look at the rf amplifier pin voltages. A simplified version of the circuit is shown in the figure. As you can see, the rf amplifier was the old standby cascode circuit.

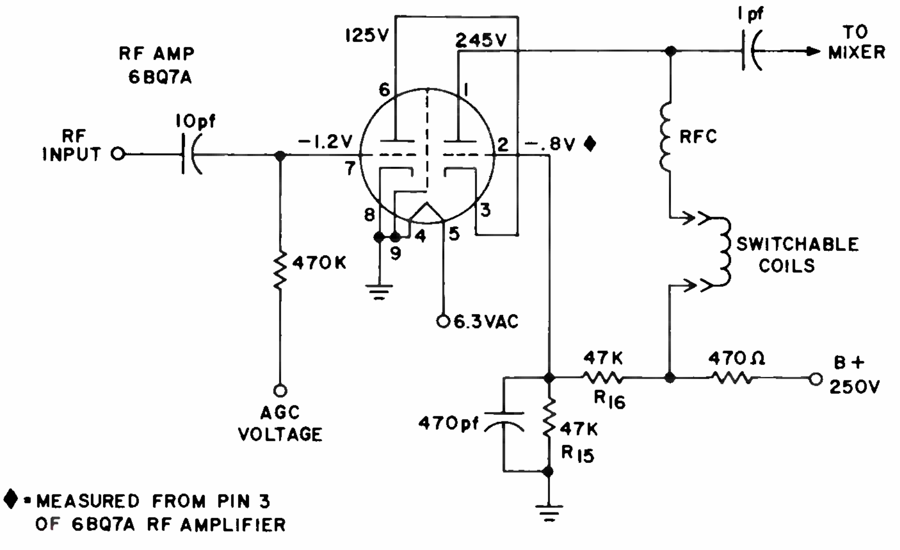
Remember that in this circuit the two triodes are in series as far as dc is concerned. The signal is coupled from the plate circuit of the first triode to the cathode circuit of the second. In its day, this was the best way to get low-noise rf amplification.

The first thing Woody noticed was that the voltage at the plate, pin 6, was only about 25 volts, instead of the expected 125. Pin 3 measured the same. The expected amount of agc bias was found at the grid, pin 7. Since the tube had already been changed, Woody assumed that this triode must be working all right. The plate voltage applied to the other triode was about normal, so B+ voltage problems were not suspected. The diagram called for –.8 volts at the control grid of this triode, and it was measured to be very close to zero. So why didn't that triode conduct as it should?

What Woody had overlooked was the little diamond right next to the voltage reading for pin 2. If he had looked at the bottom of the diagram for the meaning of this symbol, he would have saved himself a lot of time. The diamond was used to indicate that the specified voltage at this pin should be measured with the vtvm ground lead connected to pin 3 of the same tube - not to chassis ground! So there really should be about 124 volts positive at pin 2, as measured from chassis ground, because of the connection to B+ through the voltage divider consisting of R_{15} *and* R_{16}.

As soon as my friend realized this, he had no trouble finding the source of the problem. R_{16} was burned open, probably as a result of the shorted 6BQ7A that Woody had replaced hours before. Of course, the low control grid voltage caused the tube to cut off almost completely. Replacing the resistor brought the Magnavox back to life.

Symbols such as this diamond are used frequently by Sams Photofacts and by many set manufacturers to refer to special test conditions and other pertinent information. Look for them especially in cascode rf amplifiers, stacked B+ power supplies, agc circuits, and sync separators, or wherever bias voltages between two points may be more meaningful than voltage from either point to ground. Someone went to a lot of trouble to put those little symbols there...use them to save yourself time and trouble. ....**Joe Dexter.**



Answers to True-False questions on p. 9.

1. True. Remember the simple rule for forward bias. Positive to P and negative to N. In a PNP transistor the emitter is P material; the base is N material.
2. True. Increasing base current increases collector current and vice versa.
3. True. Most of the bias circuits use some form of negative feedback to achieve stability with temperature.
4. False. If both the output voltage and the supply voltage are +10 volts, then there is no voltage dropped across the collector resistor. This indicates that the transistor is not conducting. The output voltage should be one-half the supply voltage. The problem may be a defective (open) transistor or base resistor or a broken circuit connection.
5. False. When a transistor is used as a switch it is driven into a high conduction state (on switch) known as saturation where both junctions are forward biased.

SELECTING AND OBTAINING REPLACEMENT SEMICONDUCTORS

By Harold J. Turner, Jr.

Each year, more and more of the equipment serviced by electronics technicians is transistorized. The forward-looking serviceman is always on the alert for new troubleshooting methods and servicing techniques. However, keeping his technical knowledge up-to-date is not enough to stay abreast of the latest developments. There are thousands of different types of transistors and other solid-state devices now being used in commercial equipment. Must the serviceman keep exact replacements for all of these types on hand?

Now, if you service only a few different models or pieces of equipment, this may be the best approach to use. You would not have to stock very many different types, and you would have the assurance that the replacement units would work as well in a circuit as the originals did before they failed. Unfortunately, most technicians must service a wide variety of radio, television, audio and other equipment. To keep his stock of replacement semiconductors down to manageable size, he would do well to consider using some type of substitution system.

The most obvious way of finding a suitable substitute for a transistor is to look up the type number in a substitution guide, such as the one published by Howard Sams & Company (Transistor Substitution Handbook, 9th Edition). This book is not available from NRI. Ask for it at your distributor, or order directly from Sams at 4300 West 62nd St., Indianapolis, Indiana 46268. This reasonably-priced book ($1.95 in the U.S., $2.50 in Canada) lists all transistors in current use, along with suitable replacement types for each. Also given are polarity (NPN or PNP) and material (silicon or germanium). Base connections for each type are shown in a condensed section at the end of the book.

Transistor manufacturers are well aware of the service technician's problem, and most have separate lines of semiconductors especially designed for replacement applications. These devices are made readily available to the serviceman through his regular parts dealer. Most original equipment transistors and diodes can be obtained only from industrial electronics distributors who are rarely anxious for the serviceman's small volume of business.

Now, that sounds mighty nice of the manufacturers to go to all that trouble for the service industry. How can they afford it? That's easy...replacement line semiconductors are priced about twice as high as similar industrial types. Is this fair to the serviceman? Consider first that each manufacturer makes available at low cost (ranging from free in most cases to $1.00 in one case) a comprehensive cross-reference guide that lists industry and original equipment manufacturers' part numbers and recommended replacements. Then consider that these devices are immediately available through your regular parts dealer...you needn't make a special trip across town or wait days for a mail-order part to arrive. Most important-

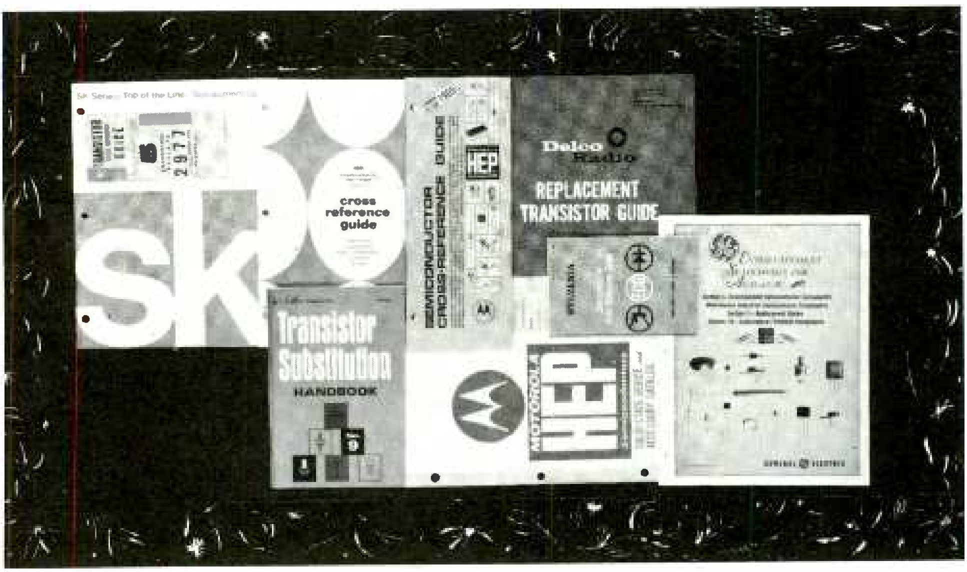


Figure 1

ly, consider that the manufacturer has done a lot of research in determining the best possible replacement for your specific need. If you keep all these things in mind, you will probably decide that the manufacturer really is doing you a great service.

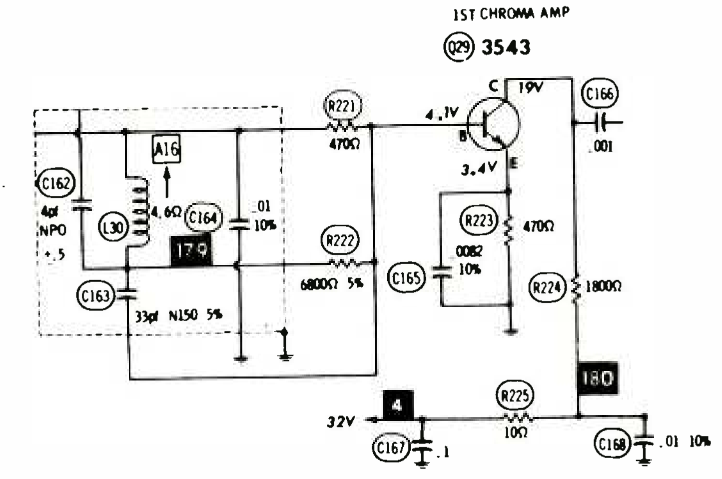
The largest replacement lines are made by RCA (SK series), International Rectifier (TR series), Motorola (HEP series), General Electric (GE series), and Delco (DS series). Ask for information on them from your dealer. Other lines are available, but these are limited to replacing only the most popular types in use. Fig. 1 shows several of the replacement/ substitution guides we have mentioned.

If you must replace an unmarked transistor, you can usually get a fairly good idea of what type replacement is required by considering the type of circuit used, maximum operating voltages, currents, and frequencies, and by the polarity of supply voltages. If a schematic diagram of the equipment is available, you will have most of this information at your fingertips. You can tell if the transistor is germanium or silicon by noting the voltage difference between base and emitter. If the difference is between .1 and .3 volts, the transistor is a germanium unit. If the voltage difference is between .5 and .7 volts, then the transistor is a silicon type. Of course, you cannot use the defective transistor to make these measurements. You must use the specified voltage from the diagram. If the equipment uses several identical stages, such as would be found in a stereo amplifier, you can use the measured voltages from a working circuit. If you must guess which material is used, remember that about 90% of all NPN transistors are silicon, while about 90% of all PNP transistors are germanium.

You can tell from the type of circuit used what frequencies the transistor must handle. Some work well only in the audio range; others are suited for use as 455 kHz intermediate-frequency amplifiers; still others are used at 4.5 MHz, 10.7 MHz, and even up into the vhf and uhf spectrum. Of course, any transistor capable of handling rf signals will work at audio frequencies, but transistors designed for high-frequency operation are generally more expensive than their lower-frequency counterparts, and usually are restricted in power-handling ability.

Of course, the maximum voltage, current, or power ratings of the replacement transistor must not be exceeded. Industrial types have complete specifications given in transistor manuals and in manufacturers' catalogues, while only the most essential information is listed for the replacement lines.

As an example of how to select a replacement transistor, suppose we must replace Q_{29} in the circuit of Fig. 2. The transistor type used in the chroma bandpass amplifier stage is not listed in any of the cross-references, so, if you can not obtain one from the manufacturer, you will have to get the necessary replacement information from the schematic diagram itself. The first thing you would notice is that the transistor is NPN. The specified voltages indicate a base-emitter voltage of 0.7 volts, so the device must be silicon. You could tell from the small physical size of the unit that it doesn't handle much power, so the replacement transistor wouldn't have to either. The power supply is 32 volts, so the new transistor



Courtesy Howard W. Sams

Figure 2

should be rated at least that high. Since the circuit is a chroma bandpass amplifier, the maximum frequency that must be handled is about 4 MHz. This information narrows the choice of a replacement transistor down to only one or two devices in each replacement semiconductor line, so the choice should not be too difficult. RCA SK-3024, International Rectifier TR-25, GE17 or HEP728 would likely be suitable substitutes.

Solid-state diodes are much easier to replace than transistors, largely because there are fewer variables in diode manufacture. In general, you need be concerned only with maximum voltage and current ratings, whether a diode is silicon or germanium, and whether it is a signal diode or a power rectifier.

If the diode to be replaced is a power rectifier, and an exact replacement is not available, use a silicon diode to replace it. If the original rectifier was a germanium or selenium unit, there may be no current-limiting resistor in series with it. Some resistance is needed in the circuit to protect the diode and input filter capacitor; without this resistance, when power is first applied, the filter capacitor will draw a large current through the rectifier. Older rectifier types have a fairly high forward resistance, so this resistor is not always used. If a power transformer is used, this resistor is usually omitted, since the dc resistance of the transformer secondary winding is great enough to limit the charging current to a safe value. If you must add a resistor in series with the new rectifier, you can generally use a 10-ohm unit. The power rating of the resistor depends on the amount of current handled by the rectifier. In radios, a 1-watt unit is usually adequate. In television receivers, you may need as high as 20 watts. If the resistor runs cool, or only slightly warm, then it is operating safely within its ratings.

Most small-signal (detector, AVC, etc.) diodes are germanium, but there are exceptions. When in doubt, use an exact replacement. Signal diodes are usually marked with a series of colored bands which serves a dual purpose: polarity identification (the marked end of a diode is always the cathode end) and type identification. The color code used is similar to that used for resistors. The colors are used to signify the same figures as in the resistor color-coding system. The difference is that there is no "multiplier" band. Each colored band represents a significant figure in the diode's type number. These digits are prefixed with "1N", so that, for example, a diode marked, "blue, black" is a 1N60 germanium diode. This same type might also be marked, "black, blue, black". The first zero is simply dropped, since it has no meaning. Using this system, identify a diode coded "blue, red, blue". Of course, red signifies a "2", and blue is a "6", so the diode is a type 1N626 silicon unit. Incidentally, if you should have to replace an unmarked signal diode, chances are excellent that a 1N60 will work well in its place.

Power supply rectifier diodes are rated in terms of peak inverse voltage and maximum forward current. Peak inverse voltage is simply the greatest voltage applied to the diode in the reverse-bias direction. This voltage is substantially higher than the rms value of the ac input voltage. This is because the charge on the input filter capacitor is in series-aiding with the ac supply across the diode when it is not conducting. In most rectifier circuits, the peak inverse voltage is about 2.83 times the rms value of the input voltage. For example, in a power supply operated directly from the 117 volt power line, the peak inverse voltage rating of the rectifier must be at least 331 volts. In this case, you should select a replacement having a peak inverse voltage (p.i.v.) rating of at least 400 volts. The best buy in replacement power rectifier diodes nowadays is the bullet-shaped epoxy type. These are quite low in cost and are available in maximum current ratings of one and two amperes at p.i.v.'s from 50 to 1000 volts. The tapered end of this type is always the cathode. Always select a replacement whose maximum current and voltage ratings are at least as high as those of the original unit.

The cathode end of a diode is usually marked with a band, a series of bands, or a "+" mark. Now, the use of this "+" mark is very confusing to us who must work with these devices. As you know, the cathode of a diode is always negative with respect to the anode when the diode is conducting. However, in most circuits, the cathode is connected to the positive voltage output of a power supply, and the positive lead of an electrolytic filter capacitor is usually connected to the same point. This is why this confusing symbol is sometimes used.

Special high-voltage diodes are used as focus rectifiers and boosted-boost rectifiers in many color television receivers. These units are made of hundreds of selenium discs; the longer the diode, the more discs, and the higher the p.i.v. rating. Because of the special construction of these diodes, it is not possible to test them with an ohmmeter as discussed in the last issue of the NRI Journal. Replacement with a known good unit is the only way to check a suspected diode in these circuits. Fortunately, there are only two popular types: one for focus circuits, the other for boosted-boost circuits. International Rectifier makes replacements for both.

Zener diodes are almost always used in voltage regulator circuits. In general, when you select a replacement for a zener, you need be concerned with only the zener voltage and maximum power dissipation ratings. The zener diode is designed to maintain a constant voltage across itself, regardless of variations in the applied voltage or load current. The voltage that appears across the zener during normal operation is equal to the zener voltage. Whenever you replace a zener, be sure to obtain a substitute having exactly the same zener voltage rating as the original. The power rating is determined by the physical size of the diode. The replacement must have a power rating at least as high as that of the original unit. Notice that voltage is normally applied to the zener diode in reverse-bias direction. This means that the cathode will be connected to the positive side of the circuit, and the anode will be connected to the negative side. However, remember that the marked end of a zener diode is the cathode, just as on other diode types.

Other solid-state devices you may encounter are field-effect transistors, unijunction transistors, silicon-controlled rectifiers, and integrated circuits. At the present time, exact replacement is the only practical approach to these devices, since their characteristics and specifications are much more complex than those of the transistors and diodes discussed in this article.

"For the tenth time, it's not a No. 401H thingamijig – it's a transistor."

...HELP WANTED... ...HELP WANTED... ...HELP WANTED...

Do you have your FCC license and a desire to work in the vehicular radio field?

If so, contact:

William J. Cling, Jr.
International Mobile Telephone Systems
10442 Burbank Boulevard
North Hollywood, CA 91601

POSITIONS AVAILABLE DEALING WITH HEAVY DUTY INDUSTRIAL EQUIPMENT, 2-WAY RADIOS, CLOSED CIRCUIT TV AND PAGING SYSTEMS. REQUIRES AT LEAST 2ND CLASS FCC LICENSE.

CONTACT: MR. GLENN WHITE
DISTRICT SERVICE MANAGER
19-A BRADSTON STREET
BOSTON, MA 02118
617-445-4545

MANAGEMENT OPPORTUNITIES

Career opportunities leading to management positions in TV-Stereo service and sales. Profit sharing, retirement, continuous training, individual recognition, good compensation and other benefits. A good place to work in a community you will like.

CONTACT: Jim Renier
RENIER'S
Dubuque, IA

WANTED
RADIO-TV TECHNICIAN

Top Wages for experienced man. Or if you prefer to "Start on your Own," we are ready to assist in capital needed. Our aim is to have SERVICE TO BACK SALES. It's our 37th year.

TOMALINO'S RADIO-TV
A. Tomalino
Box 1126
Glendive, MT 59330
Phone: 406-365-3645

Montgomery Ward has opportunities for TV technicians or grads of electronics schools. Openings available in Wash., Md., and Va. areas.

CALL OR WRITE:

Pat F. Consentini
7100 Old Landover Rd.
Landover, Md. 20785
301-322-3344

FULL AND PART TIME OPPORTUNITIES AVAILABLE IN AM RADIO BROADCAST ENGINEERING FOR HOLDER OF FIRST CLASS RADIO-TELEPHONE LICENSE. LICENSE AND TRAINING NEEDED.

CONTACT: Robert F. Burns, Chief Engineer
Radio Station WOKW
P.O.Box 6
Whitman, Mass. 02382

WANT TO MAKE UP FOR LOST TIME?

RCA HAS TRAINING PROGRAMS FOR THE INEXPERIENCED BEGINNER IN BASIC TV SERVICE AS WELL AS FOR THE EXPERIENCED TECH IN THE LATEST SOLID STATE CIRCUITRY.

If you've got some catching up to do, write to:

T. G. MacNamara
Employment Manager
RCA Service Company
Cherry Hill, NJ 08034

Immediate opening for an experienced technician or trainee for in-home color TV servicing. Good company benefits.

Richard Miller
Balie Griffith Firestone
400 N. Texas Ave.
Odessa, TX 79760
915-322-8282

TECHNICIAN

To service stereo and radio with opportunity to break into black/white and color TV.

SLATTERY'S RADIO & TV
4309 Wisconsin Ave., N.W.
Washington, D.C. 20016

SEARS has many career opportunities for experienced TV technicians or recent grads of electronics schools. Top benefits - locations throughout the U.S.

CONTACT: William J. Lynott
Department 731A-E
Sears, Roebuck and Co.
P.O. Box 6742
Phila., PA 19132

WANTED . . . .

Experienced or well-trained two-way radio technicians. Ideal positions open for responsible men. FCC second class license required.

CONTACT . . . .

Manager, Communications Department
Lafayette Radio Electronics
2025 Arden Way
Sacramento, Calif. 95825

Position open for a technician in the radio-TV field. Located in British Colombia for 25 years.

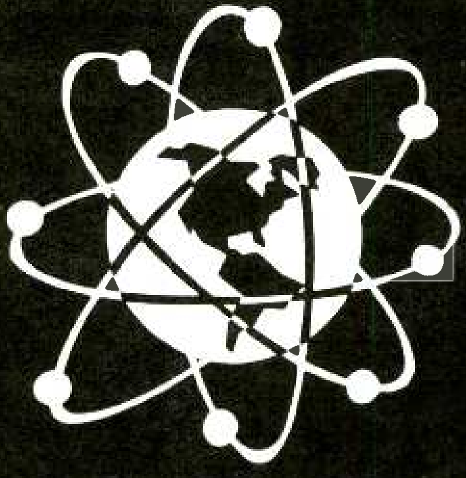
Contact:

George Schoenenberger
George's Electric
Box 832
Fort St. John, BC
Canada
ST-5-2701

!!!!!!!!!WANTED!!!!!!!!!!Field Service Technicians!!!!!!!!!!

Positions now available in the Graphic Communications Field. Technicians needed to install and maintain such equipment as Electronic handwriters and Facsimile units. Top starting salary and excellent benefits.

Contact: Telautograph Corp., 1921 North Harlem Ave., Suite 108, Chicago, IL 60636
(312-622-7111)



HAM NEWS

By Ted Beach —K4MKX

As we indicated in the "Flash" in the last issue, Paul Morey, K1PNB, has graciously volunteered to attempt to get an NRI cw net going on 40 meters. This is real good news, and if you haven't done so already, write Paul and let him know that you are interested. His address is:

304 Main Street
Townsend, MA 01469

Paul is a real avid cw man and has had lots of experience in various ARRL nets. His suggestion for a congregating frequency is around 7100 kHz. 40 meters seems to be generally the best band for an all around cw net year round, and 7100 is easy to locate with a 100 kHz calibrator. For those of you who are interested, Paul will haunt 7100 kHz (± a few kHz) every Saturday night at 8 p.m. EST listening for any CQ NRI calls. He runs 200 watts with a Netco transmitter to an all band antenna and says he has had good reports from all over the country with this combination. His receiver is a Bell.

After Paul has heard from enough of you, he will try to arrange some sort of sectional groups according to location in the country. The ARRL uses similar organization. This will give us a contact man in every section of the country.

We receive numerous inquiries about the 20 meter sideband net. Again, since we have heard absolutely nothing on this, we can only assume that there is no active interest hence no activity. We are really very sorry to have to report this, as this band is, perhaps, the very best to get together with the members of our DX fraternity.

At any rate, please let's all give Paul our support on the 40 meter net, and perhaps we can go on to other bands after getting thoroughly established on 40!

We have nine more students of the NRI Course for Amateur Licenses to report for this issue. Seven of them are brand new Novices and the other two are looking for bigger and better things. In fact, Harold, WA8YRI, just got his Advanced Class. Congratulations, all of you.

R. W. Haustein, WN6KSJ, is already thinking of phonetics for his call. He likes WN6-Kindly-Smile-Judiciously. He uses the Conar 400 transmitter and triband dipole along with a Swan 350C. R. W. says he hopes that the course can help him get his General as easily as he got the Novice -- a dream of 40 years. So do we R. W.! Keep at it.

Bob Stilwell, WN5AJT, is perhaps our latest Novice. He got his ticket on December 1, 1969, a nice Christmas present, I think.

Garland, WN6MRI (note call - close, wot?), is so proud of his license that he sent us a photocopy of it. Unfortunately he hadn't signed it and had written "copy" on it. We do hope you sign it, Garland, and erase the "copy" from your real license. He tells us that he is real eager to treat himself to a real birthday present the week of April 20th, 1970 - his General Class license. Well we're rooting for you, Garland.

Herewith are the names, calls and QTH's of our newest amateurs:

Joe	**WN4ONE**	**N**	**Nashville, TN**
Bob	**WN5AJT**	**N**	**Ozona, TX**
Buster	**WA5UFT**	**G**	**Bastrop, LA**
R. W.	**WN6KSJ**	**N**	**LaMesa, CA**
Garland	**WN6MRI**	**N**	**Ventura, CA**
Joe	**WN8EHN**	**N**	**Detroit, MI**
Harold	**WA8YRI**	**A**	**Akron, OH**
Terry	**WNØADH**	**N**	**Tryon, NB**
Bob	**WNØZZQ**	**N**	**Waunetka, NB**

Well, the wheels turn slowly, but two things have happened recently that put us on the road toward getting our NRI Club Station. First, as noted earlier, it is quite unlikely that we will get the W3NRI call; however, one of our students who happens to work with the FCC gave us the name of a couple of officials in the FCC who might possibly help us along in our quest. Unfortunately, we have been very busy with routine office work here at NRI (we do have to service our students, you know) and have not been able to pursue the license. However, rest assured that we will continue in our efforts to get a club station.

The second recent "happening" is that we acquired a used National NC200 transceiver (all bands, sideband and cw, 200 watts input). The receiver works real fine, but so far we haven't put it on the air for lack of an antenna. As you might imagine, an office building presents certain problems relating to antenna erection. At present we do have a 15 meter dipole (age, 6 years) atop the building with about 150 feet of even more ancient coax going to the rig. So far we haven't screwed up enough courage to hit the transmit switch with this combination (no SWR indicator either). We are also lacking an operating manual, but this has never stopped us before! At any rate, the NC200 let me take my

SX100 home, so now there is no excuse for my not getting an antenna up and getting on the air. Maybe I can join the 40 meter cw net although I'm not an NRI student or graduate. 40 meters used to be my favorite band.

We have only 17 new calls for the Rogue's Gallery this time. They are:

Bob	**W1IAU**	**E**	**Whitman, MA**
Henry	**K2ZIN**	**A**	**Kingston, NY**
Steve	**WA2ZYP**	**T**	**Bergenfield, NJ**
Boyd	**WA3NIK**	**G**	**Silver Spring, MD**
James	**K4DNV**	**C**	**Woodruff, SC**
James	**WN4LRN**	**N**	**Miami, FL**
Frank	**WN4OPF**	**N**	**Satellite Beach,FL**
John	**WN5YFW**	**N**	**Little Rock, AK**
Bob	**WB6YHD**	**A**	**La Puente, CA**
Ray	**W6ZQI**	**A**	**Poway, CA**
Francis	**WA7CBN**	**A**	**Richland, WA**
Van	**WA7JCQ**	**G**	**Mount Vernon, WA**
Kent	**WA7JLU**	**G**	**Libby, MT**
Charles	**WN9CZO**	**N**	**Evansville, IN**
Harold	**WA9KHG**	**A**	**Decatur, IL**
Loren	**WAØJCE**	**A**	**Agency, IA**
David	**KR6NH**	**C**	**Okinawa**

Starting at the top of the list, W1IAU tells us he now has all the FCC licenses he can use; Extra, First Radiotelephone and Second Radiotelegraph - both the latter with radar endorsement. Bob is chief engineer at WOKW in Brockton, MA (you may have noticed his "help wanted" ad at the tail of our column in the last Journal) and attributes all his commercial licenses and his Advanced Amateur license to his NRI course. Thanks, Bob.

WA2ZYP is an avid and active Technician, working on 6, 2, 220, 440 and 1296 using commercial, surplus and home brew gear. Steve likes AM, FM, RTTY and cw.

WA3NIK works here in DC at Walter Reed Hospital and finds time to operate the MARS station there. Boyd says Russ' experiences with his HW100 convinced him maybe he should wait a bit and get an SB101 instead. Says he will keep us informed. Boyd is also enthusiastic about our club station and the nets, and only hopes we have them going by the time he retires from the Air Force next year and settles down in San Antonio. So do we.

WB6YHD is another one who intends to give himself a present of an SB101 kit - but only after he upgrades to Advanced Class. We'll keep our fingers crossed, Bob.

Ray, W6ZQI, works 40 and 15 and is a traffic monger. He is another who would like to see an NRI net get going.

The names you see in the lists this time appear as the result of a suggestion by Van, WA7JCQ. He thinks, and we agree, that putting names with all the calls makes everything a lot more "friendly" and may prove helpful for intra-NRI QSOs when back issues of the

Journal are used to refer to calls. Van is also quite a chart follower and loves to predict band conditions - blackouts, ionosphere storms, etc. Says he finds it fascinating for some reason. You know, that's what makes ham radio so interesting - there is something to interest everyone. Van also claims to be our youngest General Class - 16 years young. No contest?

WA7JLU was surprised that we had already heard from Montana (would you believe he is our fourth from that state?). Kent says everybody needs Montana for WAS.

WN9CZO is the first second-time Novice we have heard of. Charles was licensed as WN4NLP in 1962 and didn't get to General. Then, when the new rules came in, he got his present Novice call. Keep at it this time, Charles, and we know you'll make it.

WA9KHG wonders why he hasn't seen his call in the Journal before. Well, Harold, if you sent it in to us, it got lost somewhere. If you didn't send it in - well we are not psychic!

Loren, WAØJCE, works all bands 80 through 2 and virtually all modes. RTTY is his favorite, however.

David, KR6NH, on Okinawa probably qualifies as our "best DX" so far. David has a real problem as he receives his Journal 3 to 4 months late and by that time our "timely" news is way out of date and so he can't get in on our nets. From what I can tell, you really haven't missed anything so far, David.

We received a chiding note from Richard, now WA2LEP, saying that we had incorrectly listed him (then WA3LAG/2) as a General Class. Well, seems as though you didn't tell us, Richard, and our Callbook showed W<u>N</u>3LAG so we just guessed General Class. Correctly, WA2LEP is Advanced Class.

We have four more upgrades to bring to you this time. Tommy Walker is now WA5ZJJ (General Class) and ex WN5ZJJ. He got his Second Class Phone license at the same time. Nice going, Tommy. James Stone went from Novice to Advanced Class and is now WB4JJG. Joe Torres joins the Advanced ranks also as K3YCA, and Stanley Krause went from WN5WRM to WA5WRM/3, General Class. The /3 moved Stanley to Laurel, Maryland (a DC suburb) where he has gotten a very active 2 meter group going. They are trying to stimulate interest in vhf and invite anyone who is interested to join them on 145.080 MHz.

From time to time we get "QSL" cards from CBers, and, while much CB activity is carried on as if the stations were Hams, we don't feel they should properly be listed in Ham News. (Some people feel even stronger than this about CBers!) Anyway, thanks for the cards, fellows, and why not get a Ham license and make those CQs legal?

That's it for this time - we'll BCNU soon.

vy 73

Ted
K4MKX

NRI HONORS PROGRAM AWARDS

For outstanding grades throughout their NRI course of study, the following November and December graduates received Certificates of Distinction along with their NRI Electronics Diplomas.

WITH HIGHEST HONORS

Raymond H. Broomfield, APO San Francisco
Harold E. Cain, Rockville, Md.
Terry A. Hall, FPO New York
John L. Harden, Ravenswood, W. Va.
Ben Hillis, Scott AFB, Ill.
Robert D. Martin, Parkersburg, W. Va.
Jerry D. McKnight, Newark, Ohio
Ronald Miller, Big Falls, Minnesota
Roland Porcher, Baie Comeau, P.Q., Canada
Ralph Rohrbacher, Greensburg, Pa.
George R. Shields, Council Bluffs, Iowa
Boyd A. Wright, Salt Lake City, Utah

WITH HIGH HONORS

Donald A. Andersen, Rockville, Md.
Jerry T. Arnold, Greensboro, N. C.
James G. Black, San Diego, Calif.
Omer W. Blodgett, Cleveland, Ohio
Edward L. Boeger, Olathe, Kansas
John E. Caret, East Hartford, Connecticut
Richard Christensen, Kearney, Arizona
Patrick J. Chuinard, Minneapolis, Minn.
Robert C. Cozad, Fairmont, W. Va.
Charles L. Davis, Glendale, Arizona
Donald L. DeCoursey, Cleveland, Ohio
Campo E. Delgado, APO San Francisco
John F. Delli Pizzi, Lansdowne, Pa.
David C. Douglas, Birmingham, Alabama
Paul F. Dzwileski, Trenton, N. J.
Charles F. Edison, Akron, Ohio
Jerry H. Ezzelle, Wilmington, N. C.
Robert H. Fahrney, Garden City, N. Y.
Lester W. Fisher, Smyrna, Tenn.
Alfred B. Frederick, Anchorage, Kentucky
John W. Gaff, Jr., Washington, D. C.
Philip Gedaly, Long Island City, N. Y.
George Goldstein, Brisbane, Calif.
Orlando Gonzalez, New York, N. Y.
William E. Graham, Everett, Mass.
Jose M. Hernandez, Silver Spring, Md.
Arden H. Hetzel, Milwaukee, Wisconsin
Talmo Holbrook, APO New York
William H. Hughes, South Gate, Calif.
Lawrence M. Jarratt, Nashville, Tenn.
Robert J. M. Kasper, Long Valley, N. J.
Anthony Kudlay, Easthampton, Mass.
Carl R. Lee, Hattiesburg, Mississippi
Roland Lindberg, Milaca, Minnesota
Julius Liska, New York, N. Y.
E. David Mahmoud, Mount Vernon, Va.
George R. Maier, Lincolndale, N. Y.
Cecil Wayne Mansfield, San Francisco, Calif.
Vito F. Panaro, Bloomingdale, N. J.
Nikitas Papanikitas, New York, N. Y.
Joseph Perrone, Hicksville, N. Y.
Arthur J. Ruberg, Bowie, Md.
John R. Shaw, Santa Clara, Calif.
Gilfred A. Swartz, Silver Spring, Md.
Thomas M. Sweany, LaMarque, Texas
Rolla L. Wallace, Knob Noster, Missouri
Terrence Lee Webb, Louisville, Kentucky
Bryan L. Wilburn, Florissant, Missouri

WITH HONORS

Ronald M. Abad, Rochester, New Hampshire
Augustus R. Allegretti, Trenton, N. J.
Louis J. Andris, Belpre, Ohio
Frank Aquino, Cochrane, Ont., Canada
Terry W. Ballou, Westminster, Colorado
Winston Robert Barnes, London, England
Kenneth A. Bergeron, Radcliff, Kentucky

Henry L. Birkenfeld, Providence, R. I.
Floyd Blue, Tacoma, Wash.
Hans J. Bode, Ottawa, Ont., Canada
Robert E. Bond, Winooski, Vermont
Earl Bridges, Rockford, Ill.
Richard O. Bryant, Fresno, Calif.
Andy O. Campbell, Chickasha, Oklahoma
R. A. Clarke, Edmonton, Alta., Canada
David F. Conrad, Placerville, Calif.
Franklin Lee Cook, Silver Spring, Md.
Roger L. Counts, Las Vegas, Nevada
Harold D. Crouse, Lincoln, Nebraska
Melvin J. Doyle, Collinsville, Ill.
Edward F. Dunithan, Bayard, W. Va.
Richard G. Ellers, Warren, Ohio
James L. Ellisor, St. Charles, Missouri
Jerry Wayne Fallin, Madisonville, Kentucky
Larry R. Geis, Toledo, Ohio
Donald Graves, Marble Falls, Texas
Howard M. Harden, Elkhard, Indiana
Jeri Healey, Marshfield, Vermont
Franklin J. Henderson, Tullahoma, Tenn.
Robert H. Higham, Jr., Alexandria, Va.
Arthur J. Holle, Marshfield, Wisconsin
Charles E. Holzer, Forbes AFB, Kansas
Carl A. Huneycutt, Jr., Albermarle, N. C.
James R. Johnson, Walnut Creek, Calif.
Richard W. Johnston, John Day, Oregon
Daniel F. Keegan, Union City, N. J.
Walter E. Kennymore, Rye, Colorado
Roy F. King, Jr., Pensacola, Florida
Gary M. Kite, Poplarville, Miss.
Harold S. Lindstrom, McGregor, Minnesota
Dennis H. Loar, Pease AFB, N. H.
Ardell McClellan, Glasgow, Pa.
John L. Montgomery, Jr., Chantilly, Va.
A. H. Moore, Lincoln, Nebraska
Percy E. Morgan, Van Nuys, Calif.
Arthur C. Neumann, Daly City, Calif.
Earl H. Nixon, Orange, Va.

CONAR ORDER BLANK

J11

DIVISION OF NATIONAL RADIO INSTITUTE, 3939 WISCONSIN AVE., WASHINGTON, D.C. 20016

PLEASE PRINT

NRI STUDENT NUMBER

NAME

ADDRESS

CITY STATE ZIP

- ☐ CASH
- ☐ C.O.D. (20% Deposit required)
- ☐ ADD TO MY CONAR ACCOUNT
- ☐ NEW EASY PAYMENT PLAN (10% Deposit)

Quantity	Model	Name of Item	Price Each	Total

If you live in Washington, D.C., add sales tax.
All prices are net, F.O.B. Washington, D.C.

TOTAL ________

ON NEW TIME PAYMENT ORDERS please be sure to complete the Easy Payment Plan credit information form on the reverse side of this page and include 10% deposit with your order. ▶

Javier Ocasio, New York, N. Y.
Nils O. Ohman, Bolling AFB, Wash. D. C.
Barry L. Oldham, Lockbourne AFB, Ohio
Maurice T. Overn, Belle Fourche, S. D.
George R. Paley, APO New York
Charles T. Parker, Columbus, Ohio
Paul E. Phipps, Muncie, Indiana
Robert W. Reinhard, Middletown, Pa.
Francis W. Robinson, Richland Center, Wisc.
George E. Sabine, Albuquerque, N. M.
Joseph M. Scerri, Detroit, Michigan
John W. Schuble, Evansville, Indiana
Michael K. Scism, Houston, Texas
I. David Shank, Hagerstown, Md.
Peter W. Sinnema, Cleveland, Ohio
O. G. Smeltzer, Los Angeles, Calif.
Jay C. Smith, Pocateelo, Idaho
Walker M. Smith, Covington, Tenn.
Thomas G. Socci, Auburn, N. Y.
Boodram Sooklall, Guyanna, S.A.
Harlan L. Spangler, Omaha, Nebraska
Elmer D. Stith, Lodi, Calif.
Elmer H. Storts, Phoenix, Arizona
George E. Sweatt, Norfolk, Va.
Albert H. Tomlinson, Kokomo, Indiana
F. J. Trotter, Corpus Christi, Texas
Jerold C. Waedekin, Milwaukee, Wisconsin
David A. Walsh, Paterson, N. J.
Ralph L. Walters, Marietta, Ga.
Clyde B. Walterscheid, Muenster, Texas
Holger R. Warva, Napanee, Ont., Canada
Leo H. Westley, Angola, N. Y.
Ronald P. Williams, Kingsport, Tennessee
Gerald E. Wright, Norton, Kansas

CONAR EASY PAYMENT PLAN

J11

CREDIT APPLICATION

Note: Easy payment plan credit applications cannot be accepted from persons under 21 years of age. If you are under 21, have this form filled in by a person of legal age and regularly employed.

Enclosed is a deposit of $.................................. on the merchandise I have listed on the reverse side. I hereby apply for credit under the Conar Easy Payment Plan. The statements below are true and are made for the purpose of receiving credit.

Date .... Written Signature ....

CREDIT APPLICATION

Print Full Name .... Age ....

Home Address ....

City & State .... How long at this address? ....

Previous Address ....

City & State .... How long at this address? ....

Present Employer .... Position .... Monthly Income ....

Business Address .... How Long Employed? ....

If in business for self, what business? .... How Long? ....

Bank Account with .... Savings ☐ Checking ☐

CREDIT REFERENCE (Give 2 Merchants, Firms or Finance Companies with whom you have or have had accounts.

Credit Acct. with .... Highest Credit ....
(Name) (Address)

Credit Acct. with .... Highest Credit ....
(Name) (Address)

Alumni News

EXECUTIVE SECRETARY ANNOUNCES

NEW PUBLICATION

NRIAA is about to publish a bimonthly newsletter of Electronic Service tips.

This will consist of our own information as well as that furnished by well known manufacturers of entertainment-type Electronic equipment.

Once you have seen a copy of this publication, I believe you will be looking forward to the next edition.

Detroit Chapter upon annual visit by Executive Secretary.

DETROIT CHAPTER ENROLLS NEW MEMBERS

At the November meeting of the DETROIT CHAPTER two new members were installed. Mr. David Hardy of Grosse Pointe Woods, and Mr. Nefus Butler of Detroit were welcomed to the membership. Charlie Cope brought in two radios for the members to troubleshoot and Mr. Kelly used the blackboard to demonstrate circuits used in some of the older sets.

At the December meeting Prince Bray brought down his oscilloscope that he had just repaired by replacing a defective transformer.

Mr. Nagey, our audio expert, gave us some do's and don'ts when wiring PA systems. Also, we had a visit from Mr. Robert Walsh from Windsor, Canada.

Mr. David Harding is going to bring his Color TV to the meeting. He built this set from a kit.

The meetings have been well attended and the year ended on a high note.

FLINT, SAGINAW VALLEY CHAPTER HAS GOODWILL AMBASSADOR

The December meeting had a wealth of speakers. There were six in all. They were Andrew Jobbagy, Steve Avetta, Gilbert Harris, Art Clapp and Robert Poli. Each one talked on a different electronics subject.

The January meeting was devoted to the election of officers, and the new officers are: Chairman, Andrew Jobbagy; Vice Chairman, Steve Avetta; Secretary, Jim Wintom; Treasurer, Arthur Clapp; Photographer, Richard Jobbagy; Sergeant-at-Arms, Robert Poli; Goodwill Ambassador, Jim Burke; Entertainment Comittee, Gilbert Harris; Educational Director, George Maker. The membership committee is Leslie Carley, George Martin and John Allen.

The Chapter welcomed Richard Jobbagy back home. Richard has just finished a hitch in the Air Force.

Andrew Jobbagy will be in San Francisco soon, and as a Goodwill Ambassador will visit the San Francisco Chapter of the NRIAA.

There is real action in the FLINT, SAGINAW VALLEY CHAPTER.

Andrew Jobbagy (left) and Robert Poli demonstrate Conar Audio/Color.

NEW YORK CHAPTER HAS YEARLY "GALA"

At the first meeting in December, the Chapter entertained Tom Nolan, the Executive Secretary of the Alumni Association at his yearly visit.

There was a good turnout, and the talk on alignment was well received by the members and guests. Slides and a blackboard were used to illustrate the various waveforms, and the equipment needed in the alignment of color TV receivers. The discussions of electronics difficulties of members, and their questions on various alignment instruments, was especially appreciated.

Steven LoPiccolo, a guest, won the door prize.

At the same meeting, new officers were sworn in by the National Secretary. They are: Chairman, Samuel Antman; Executive Chairman, Albert Bimstein; First Vice Chairman, Sylvester N. Carter (Pete), Second Vice Chairman, Willie Foggie; Treasurer, Roy DaSilva; Secretary, Theodore Freije.

The second meeting in December was a special "Gala" which is held each year by the Chapter.

This year, the Chapter was lucky to have Mr. Craighead of the New York Telephone Company who gave an illustrated talk titled "Beyond the Moon".

He brought up a good many points about the moon flight that the television coverage slid over. The talk was excellently presented and received a good ovation.

Samuel Antman was then sworn in as a National Vice President of the National Radio Institute Alumni Association by the local outgoing Secretary, Joseph Bradley.

Then came the serious business of getting down to eating those refreshments, which were provided by Messrs Antman, Bimstein and Carter. It was a real nice party.

NORTH JERSEY CHAPTER VISITED BY INDUSTRY SPOKESMAN

Mr. Ralph Sassano, Supervisor with Emerson TV Company gave an interesting and informative lecture and demonstration of the methods used in testing assembled TV receivers.

He showed the various check points throughout the set and indicated the proper values of voltage and the waveforms that should be present. Each waveform was demonstrated in fine detail and trouble spots were pointed out where the waveform was of improper shape. Adjustments of chokes and transformers were thoroughly explained.

All in all, this was a very informative lecture.

At the December meeting the Chapter elected new officers and they are: Chairman, William E. Coke; Treasurer, Leroy Frienschner; Programming, Franklin Lucas; Secretary, Harry Weitz; and Vice Chairman, Franklin Lucas who took on two jobs.

Chairman William E. Coke gave a lecture and demonstration concerning transistors, diodes and selenium rectifiers. He used his scope and a simple diode checking setup, which he builf from spare parts.

Don Clark brought in a malfunctioning TV set that the membership worked on and located the problem.

The NORTH JERSEY CHAPTER is all set for a brand new year.

PHILADELPHIA-CAMDEN CHAPTER HAS YEARLY PARTY

The Executive Secretary was entertained by the PHILADELPHIA CHAPTER on his yearly visit. The talk on alignment procedures was well received by the membership.

After the meeting, hot dogs, sauerkraut and other good foods were served by the members. This is a yearly event looked forward to by the membership.

There is one sad note to communicate. The wife of Jules Cohen, Secretary of the PHILADELPHIA CHAPTER, was involved in a very serious automobile accident and she lost the sight of one eye. All of us at NRI and the Alumni Association express our deepest sympathy.

PITTSBURGH CHAPTER LOSES MEETING PLACE

The building on Forbes Avenue, which has been the meeting place for the PITTSBURGH CHAPTER for a number of years, is being demolished. The November meeting was the last one held in that hall. The meetings from now on will be held at Jim Wheeler's home at 1436 Riverview Dr., Verona, PA.

The December meeting was held at Jim's, and new officers were elected. The officers for 1970 are: Chairman, Tom Schnader; Vice Chairman, James Wheeler; Recording Secretary, George McElwain; Treasurer, William Sames. The board members are Jack Benoit, George Turner and William Lundy. The new officers were sworn in by Dave Benes.

The meeting was followed by the annual Christmas party where everyone had a good time.

Until a new meeting location is found, Jim Wheeler will host the Chapter.

SAN ANTONIO CHAPTER SWEARS IN NEW NATIONAL PRESIDENT

At the November meeting of the SAN ANTONIO CHAPTER, the little game of "What's My Line" was played, and the subject was horizontal afc circuits. Bob Bonge and Sam Stinebaugh led the discussion.

New Officers were elected for 1970 and they are: Chairman, Bob Bonge; Vice Chairman, Lt. Col. E. B. Geisendorff; Treasurer, Sam Dentler; Secretary, Sam Stinebaugh.

The big meeting of the year was the Christmas Dinner where Sam Stinebaugh was sworn in as the National President of the NRI Alumni Association. Along with this issue we have a picture of the swearing-in ceremony. Best of luck for a good year, Sam, and the best of luck to the San Antonio Chapter.

SAN FRANCISCO CHAPTER TAKES IN NEW MEMBER

Arthur Byron was welcomed as a member in the SAN FRANCISCO CHAPTER.

R. E. Bonge (left) swears in Sam Stinebaugh as Nat'l NRIAA President.

Ross Alexander gave a talk on transistor application at the November meeting.

At the December meeting Mr. Arthur Byron, who is in the Merchant Marine Radio Service, presented a discussion on oscilloscopes and frequency generators. The Chapter welcomed his talk.

The January meeting will have Ross Alexander demonstrating, with instruments, various phases of transistor amplification. Best of luck, San Francisco.

SPRINGFIELD CHAPTER VISITED BY NATIONAL SECRETARY

The November meeting consisted of discussions of various pieces of electronic equipment. The Chapter decided to adopt the panel game used by the SAN ANTONIO CHAPTER and this will be done at the January meeting.

At the December meeting the Chapter played host to Tom Nolan, the Executive Secretary of NRIAA.

Tom's topic was TV alignment of color sets. Tom endeavored to remove the fear that most serviceman have for this phase of servicing. Tom covered the whole color set from the tuner through to the detector, chroma and bandpass circuits. He explained the equipment needed and its application. Cautions were injected here and there, expecially in tuning broad band circuits in the color section.

The members wish to extend their thanks to Tom and NRI for an evening of enlightenment. Also, thanks to Norm Charest for the use of his home.

At the following meeting, Brother Bernard Frey was sworn in as a National Vice-President of the National Radio Institute Alumni Association for the year 1970.

NEW CHAPTER FOR SACRAMENTO CALIF.?

Mr. Richard E. Russell of North Highlands, Calif. is anxious to start a new Chapter of the NRIAA in the Sacramento, Calif. area.

All those Alumni members and graduates in that area who are interested may contact Mr. Russell by phone: 916-332-5419.

His home address is:

Richard E. Russell
6609 Stoneman Dr.
North Highlands, Calif. 95660

If and when a new Chapter could be started, the Executive Secretary, Tom Nolan, would be glad to make a trip to Calif. and present the Charter.

DIRECTORY OF CHAPTERS

CHAMBERSBURG (CUMBERLAND VALLEY) CHAPTER meets 8:00 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. VI 1-4972.

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

LOS ANGELES CHAPTER meets 8 p.m., 2nd and last Saturday of each month at Graham D. Boyd's TV Shop, 1223 N. Vermont Ave., Los Angeles, Calif., NO-2-3759.

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 Thursday of each month at 264 E. 10th 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 Midland Hardware, 155 Midland Ave., Kearney, N.J. Chairman: William Colton, 191 Prospect Ave., North Arlington, 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: Herbert Emrich, 2826 Garden Lane, Cornwell Heights, 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: R. E. Bonge, 222 Amador Lane, San Antonio, Texas.

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 John Alves, 57 Allen Blvd., Swansea, Mass. Chairman: Oliva J. Laprise, 55 Tecumseh St., Fall River, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7 p.m., last Saturday of each month at the shop of Norman Charest, 74 Redfern Dr., Springfield. Chairman: Al Dorman, 6 Forest Lane, Simsburg, Conn.

SPECIAL OFFER FOR THE COLOR TV SERVICEMAN

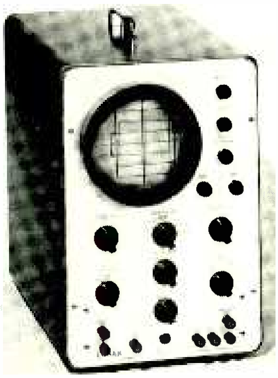
GET OUR $22.35

ISOLATION TRANSFORMER FREE

WHEN YOU ORDER BOTH:

CONAR 5" WIDE BAND OSCILLOSCOPE *AND* **CONAR COLOR BAR GENERATOR**

(*OR* BUY ONE OF THESE TWO INSTRUMENTS AND GET THE ISOLATION TRANSFORMER FOR ONLY $7.00)



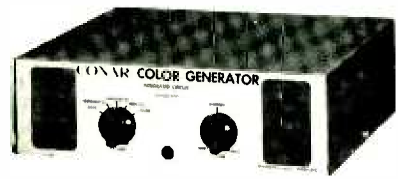
CATALOG PRICE

KIT 250UK	$99.90
WIRED 250WT	$139.50

STUDENT AND ALUMNI PRICE

KIT 250UK	$82.90
WIRED 250WT	129.75

Shipped Express collect



CATALOG PRICE

KIT 680UK	$89.50	WIRED 680WT	$121.50

STUDENT & ALUMNI PRICE

KIT 680UK	$79.50	WIRED 680WT	$109.00

The Conar model 250 features:

- Uses 2400 volts on the cathode ray tube—50% more than most scopes.
- Vertical gain control is calibrated for direct reading of peak-to-peak voltages.
- Two stage retrace blanking amplifier gives 100% retrace blanking at all frequencies produced by the scope sweep generator.
- Accurately measures ripple output of power supplies; checks auto radio vibrators dynamically.
- Intensity and focus controls use special insulated high voltage potentiometers to eliminate leakage and shock hazards.
- Has push-pull outputs balanced by separate phase splitter tubes in both horizontal and vertical amplifiers.
- Built-in flyback checker gives rapid, in-circuit testing of flybacks, transformers, yokes, coils, loopsticks.
- Sweep range—10cps to 500kc—five times the range of most other scopes, using special linearity circuit.

The Conar model 680 integrated circuit color bar generator features:

- Exclusive digital integrated circuits.
- Exclusive 4 crystal controlled oscillators.
- Exclusive AC or battery operation.
- Completely solid state.
- Color amplitude control.
- Color phase adjustment.
- Regulated power supply.
- Stability control.
- TV station sync and blanking pulses.
- Nine patterns.
- Red, blue and green gun killers.
- Compact, lightweight, portable.

ORDER NOW AT YOUR SPECIAL STUDENT & ALUMNI PRICE.

BOTH FOR ONLY: KIT $162.40 OR WIRED $238.75

(THIS SPECIAL OFFER EXPIRES APRIL 30, 1970)

USE CONVENIENT ORDER BLANK ON PAGE 25

SEE INSIDE BACK COVER FOR DETAILS

NRI JOURNAL
3939 Wisconsin Avenue
Washington, D. C. 20016

MR WALTER MEISNER
5251 S E OSTKIN WAY
MILWAUKIE OREG 97222

C54-A327-C

Second-class
postage paid
at Washington, D. C.