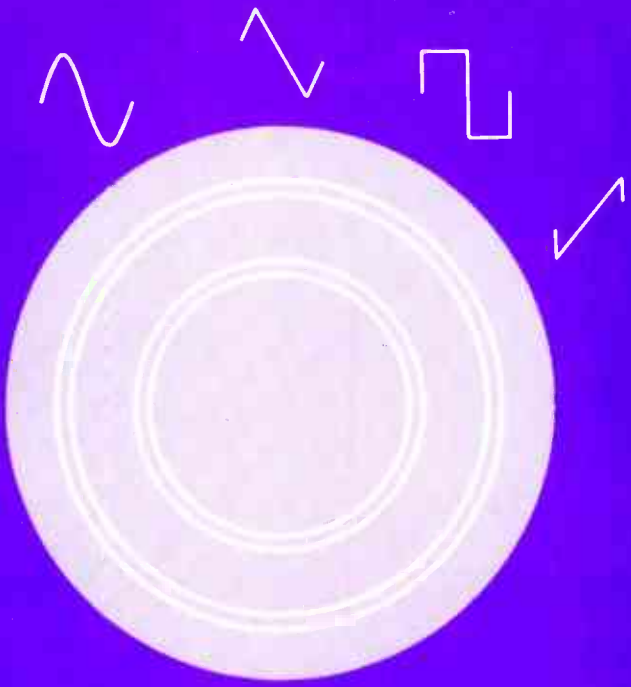

- A Modern-Day Workhorse: The Function Generator
- More Adventures in TV Servicing

nri journal

March/April 1974

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Volume 32, No.2

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In this issue, Joe Turner discusses the many uses of the versatile function generator. Also, long-time Journal writer J. B. Straughn adds another chapter to his interesting and informative series of television repair case histories.

The NRI Journal is published bimonthly by the National Radio Institute, a division of the McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, D.C. 20016. The subscription price is two dollars yearly or 35 cents per single copy. Second-class postage is paid at Washington, D.C.

a modern-day workhorse:

The Function Generator

Harold J. Turner, Jr.

Just what is a function generator? Time was when you could say that it was a "special" type of oscillator. Well, it is certainly true that the function generator is a type of oscillator, but the way it's getting around these days, it can hardly be considered special anymore. Today technicians and engineers regularly use function generators as signal sources for countless tests and measurement applications and, with the availability of low-cost function generator integrated circuits, function generators will begin to be seen as built-in components of larger systems. Read on to learn the basic operation of all function generators and how they differ from the more familiar oscillator circuits.

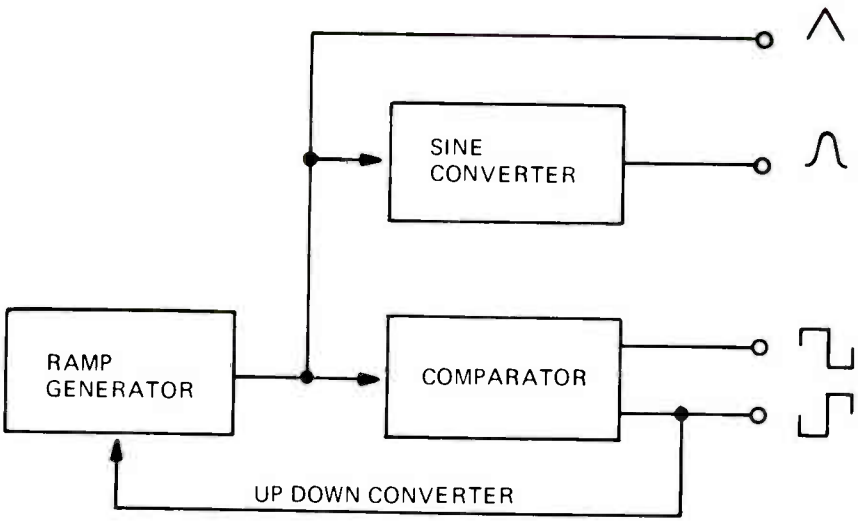


FIGURE 1. BLOCK DIAGRAM OF BASIC FUNCTION GENERATOR.

There is one distinguishing feature that can always be used to determine if a given circuit is really a function generator or just some standard type of oscillator: the function generator always produces a triangular wave output as well as a square wave, while conventional oscillators produce sine waves or sometimes square waves alone.

Figure 1 is a block diagram of the basic function generator. The ramp generator and comparator blocks form a closed-loop system which simultaneously generates triangular and square waveforms. These two blocks form the heart of the function generator; the sine wave is separately synthesized from the triangular wave. In some function generators, in fact, there is no sine wave output at all.

Figure 2 shows the heart of the function generator in greater detail. Here we have a timing capacitor which is linearly charged and discharged by two current sources. When the "charge" current source is turned on, the voltage across the capacitor rises in a linear fashion, thus producing the positive slope of the triangle waveform. While the "discharge" current source is on, the capacitor voltage drops in a linear fashion, thus producing the negative, or falling, slope of the triangle. A dual-threshhold comparator senses the capacitor voltage and determines when it has reached its upper and lower levels, and uses this information to control the two current sources. Thus, while the capacitor is charging through one current source, the comparator watches the charge on the capacitor, and, when it reaches a certain predetermined high level, the comparator changes state, and turns off the charge current source and simultaneously turns on the discharge current source, thus causing the capacitor voltage to begin to drop. When the capacitor voltage drops to some predetermined low value, the comparator senses this and reverses the process again. The charge current source then turns on and the process is thus self-sustaining. The frequency of oscillation is determined by the size of the timing

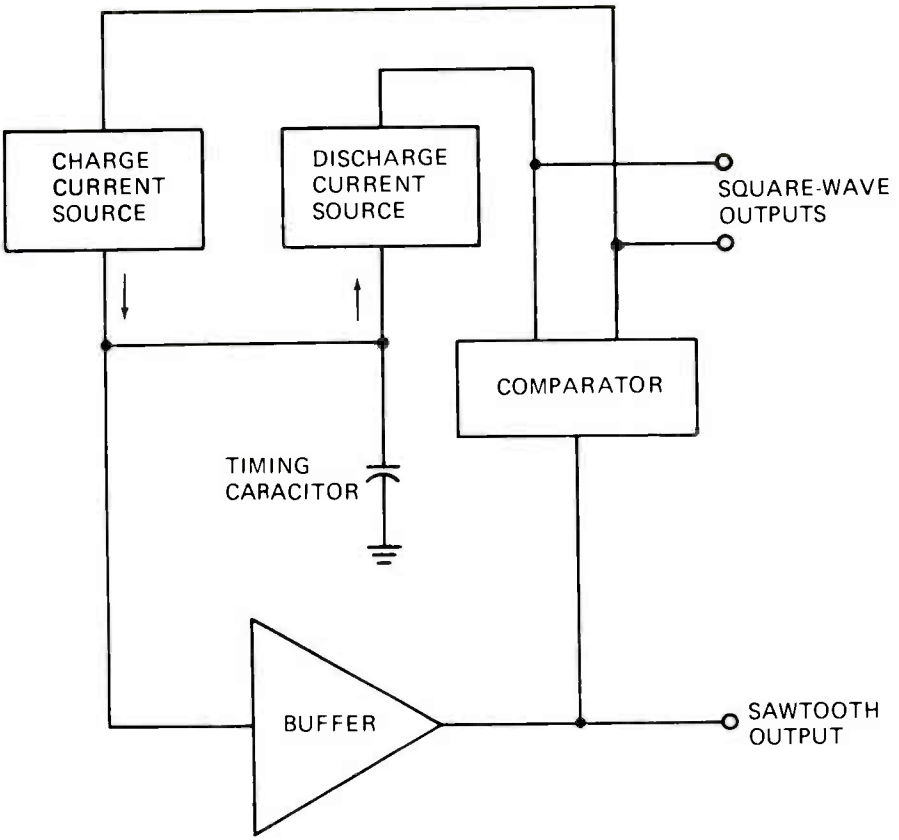


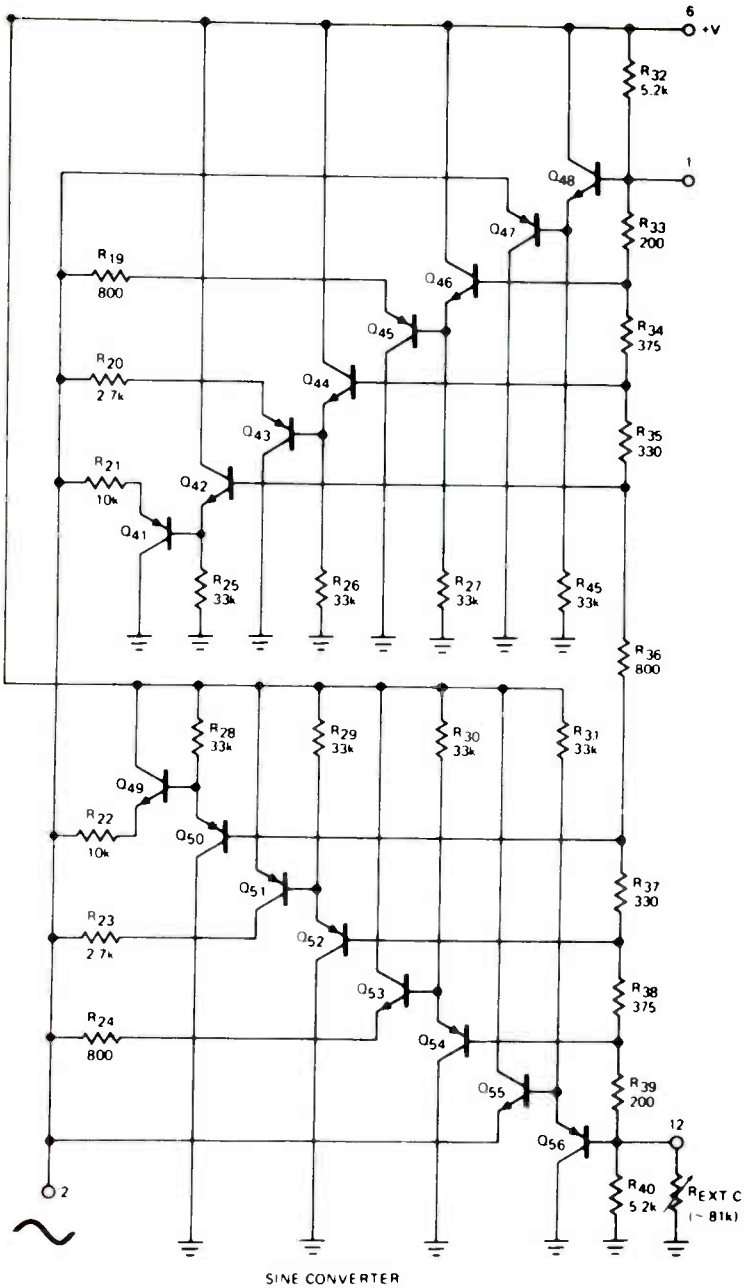
FIGURE 2. THE HEART OF THE FUNCTION GENERATOR.

capacitor (in microfarads) and the magnitude of the charge and discharge currents. The two currents must be equal, although opposite, if the waveform is to have perfect symmetry; that is, equal charge and discharge times.

The useful output of the function generator is a triangle waveform at the input to the comparator, and complementary square wave outputs at the comparator output points.

So far, we have seen a very neat and handy way of generating triangular and square waveshapes. However, in most types of electronic testing, it is a sine wave that is desirable. Let us see how the function generator can provide this essential waveform.

Figure 3 is an actual schematic diagram of a sine converter network, one which receives a triangle wave at its input and produces a sine wave at its output. While such a network may seem unduly complex, consider that it can be easily fabricated on a single silicon chip and made available as a low-cost integrated circuit. In fact,



Courtesy Intersil

FIGURE 3. SINE-CONVERTER CIRCUITRY.

the circuit shown is only a portion of a complete function generator IC (Intersil 8038) which is available in small quantities for five dollars or so.

As you know, the triangle waveform is not far removed in shape from the sine wave. All the converter circuit needs to do is round the peaks a bit. This is accomplished by switching in various resistance values in shunt with the signal path as the signal amplitude reaches various points. The result is shown in Figure 4. Note that the rising portion of the triangle corresponds in time to the "high" portion of the square wave, and that the peaks and valleys of the sine wave correspond to those of the triangle. The difference between the bottom two waveforms is that the corners have been rounded off to form the sine wave. A carefully designed and constructed converter circuit is capable of delivering sine waves with distortion as low as 0.1 percent, although 1 percent is more typical of the distortion levels encountered with integrated circuit function generators. Certainly even 1 percent distortion is tolerable for most general-purpose applications.

One of the nice things about function generators is that the frequency of operation can be changed almost instantly, and over extremely wide ranges. This fact makes

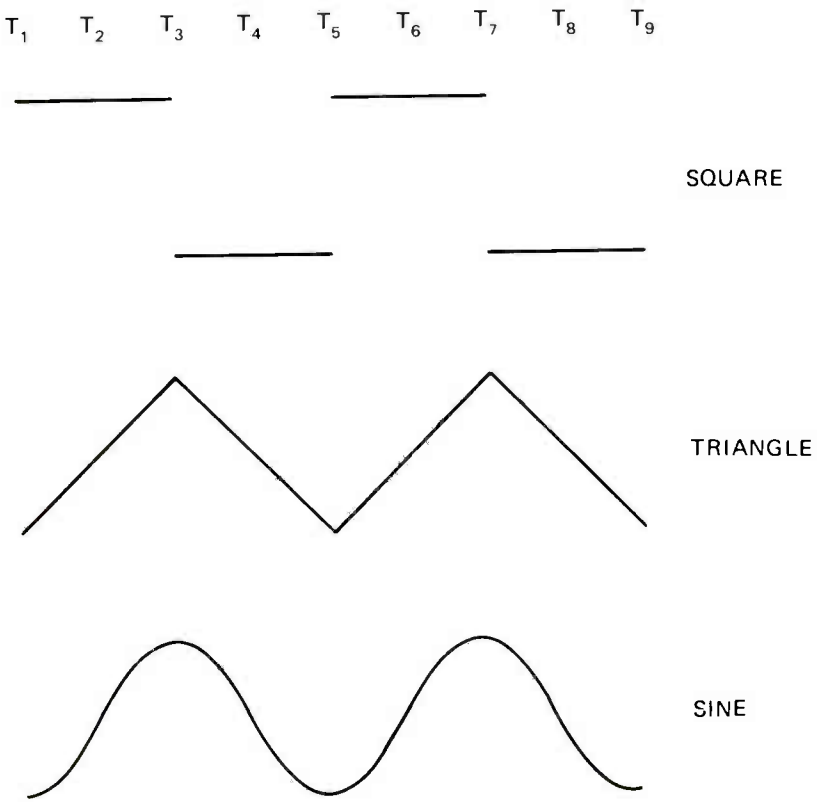


FIGURE 4. PULSE RELATIONSHIPS OF FUNCTION GENERATOR WAVEFORMS.

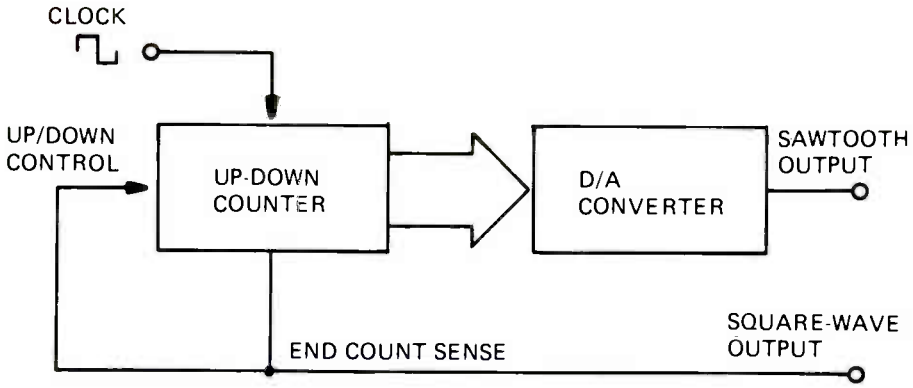


FIGURE 5. BASIC DIGITAL FUNCTION GENERATOR.

possible the modern audio sweep generator, which is capable of sweeping the entire audio range of 20 Hz to 20 kHz in a single sweep and with perfect stability of the waveforms. All that needs to be done to sweep the function generator over a 1000:1 range is to vary the charge/discharge currents applied to the timing capacitor over a similarly wide range. As there are no tuned circuits to cause ringing or other stability problems, the frequency can be changed instantly in the time it takes to change the charge/discharge currents.

Another nice thing about function generators is that very low frequencies can be produced without the use of excessively large timing capacitors. Frequencies down to one cycle in several hours are not unheard of. And, of course, there are no inductors involved in this type of arrangement, and that means that the circuit can be immune to hum pickup.

Figure 5 shows the basic configuration of a digital function generator; the operation of this type of system is similar to the one described previously, but, in this case, the triangle waveform is developed by applying the digital output of an up/down counter to a digital-to-analog converter (DAC). In a typical digital function generator the up/down counter is composed of from 8 to 12 flip-flops which are arranged to count in a binary sequence from 0 to $2^N - 1$, where N is the number of flip flops in the counter. Thus, an eight-bit counter would count from 0 to 255 ($2^8 = 256$, $256 - 1 = 255$). The up/down counter is arranged so that it senses when it reaches its zero and maximum counts. When the counter reaches zero, it automatically changes direction and begins counting upwards until it reaches maximum count, at which time it senses this, and begins counting down, and so on. The digital output is then applied to the DAC where it is converted into an analog voltage which follows the increases and decreases of the digital word. In other words, a triangle wave is produced. If enough bits are used, the individual steps in the triangle will be so small as to be unnoticeable on an oscilloscope screen. An eight-bit arrangement is satisfactory for most applications.

The operating frequency of the digital function generator is determined by the clock frequency and by the number of bits. In an eight-bit counter which has 2^8 or

256 states, the output frequency is equal to half of 1/256 of the input, since the counter must count to full scale, then return. Since present-day components are limited by the state of the art to about 100 MHz, at least as far as up/down counters are concerned, this means that the maximum output frequency will be in the neighborhood of 200 kHz, and this is even stretching things a bit. A low-cost digital function generator would be limited to perhaps a fourth of this frequency. Of course, there is no limit to the low-frequency end of such an arrangement. If one clock pulse were delivered each day, for example, the circuit would complete one cycle of operation in 256 days.

Here again we are talking about a triangle wave output. If a sine wave is desired, it can be synthesized as we mentioned earlier, or the digital word could be processed by a read only memory (ROM) before application to the DAC. If the ROM were programmed to provide the sine value of whatever digital word were applied to it, this sine value could be applied directly to the DAC, and the output of the DAC would be a very good approximation of a sine wave, the amount of distortion depending upon how many bits (flip-flops) are provided by the counter. Here you have a brief summary of what a function generator is and how it works. Now, what can we do with it? Perhaps the most obvious example of the uses to which a function generator can be put is in the field of audio servicing. Here, sine waves are always needed to test amplifier power output, and to check for the presence of clipping in an amplifier stage. And, of course, square waves are commonly used to check the overall frequency response of an amplifier at a single glance. The triangle wave combines both of these features into one; try troubleshooting an amplifier by using a triangle as a signal source. Since the signal doesn't already have flat tops and bottoms as a square wave does, you can check for the presence of any clipping or other types of amplitude distortion. And, by watching for any undesired rounding of the corners of the triangle, you can check for loss of high-frequency response. Curvature of the sides of the triangle (nonlinearity) point to low-frequency problems.

If you are fortunate enough to have a function generator which is set up for sweeping the audio range, you will probably use its sine wave output and sweep from 20 Hz to 20 kHz, while watching the output with an oscilloscope. Low-frequency sweeps, when applied to a loudspeaker, are often useful in determining the resonant frequencies of a listening room or loudspeaker components.

One thing that is often overlooked, perhaps because it is so obvious, when talking of function generators and sweep generators in general, is that these instruments are not very useful by themselves. An oscilloscope is always needed to check the signals as they pass through the circuits under test. Together, the oscilloscope and function generator form a powerful combination for servicing, experimenting, or design work.

more adventures in tv servicing

J. B. Straughn

MOTOROLA MODEL JTS-594

This set came in with only a dim trace of a picture—the sound was okay. The high voltage to the picture tube was checked with my VTVM and high-voltage probe and was found to be normal. Incidentally, the negative lead of the meter must always be connected to the high-voltage cage instead of some other ground point when making this measurement—this avoids arcing in possible poor ground interconnections.

Thinking that there might be leakage in the capacitor feeding video information to the cathode of the picture tube, I decided to check this possibility by measuring the cathode to chassis voltage. Leakage would increase the bias on the picture tube and give the same effect as turning down the brightness control. Rather than cut the insulation of the crt cathode lead, I traced the lead to the stake on the circuit board to which it was connected. The voltage from this point to the chassis was not excessive, showing that the capacitor was not at fault.

I decided that the picture tube was probably defective. Fortunately, I did not try a picture tube brightener (I did not have one at hand), but instead tested the tube with my picture tube tester and sure enough the tube was shot, even beyond the point where rejuvenation would bring up the cathode emission.

This was a 23-inch tube with a bonded metal mounting bracket, along with the face plate. Twenty-three inch tubes are more expensive to start with than 25-inch tubes (because not as many of them have been used) and this one would cost me $40, not counting the refund on the dud. I told the customer a rebuilt tube with a three-year guarantee would cost him $65 installed, and after a little thought he okayed the job, and I ordered a "new" tube.

The installation was easy, so I turned the set on and waited for a bright new picture. The sound came on but the picture was about as dark as before! I was in a sweat to say the least and had a number of dark thoughts (like taking an axe to the set), but refrained because I had put out for the tube and the customer had paid nothing as yet.

I rechecked the old crt and it was still as bad as before. On the off chance that I had got hold of a bad replacement I checked the new tube and it was perfect.

I was worried about the cathode to grid voltage so I located the green grid #1 lead and stripped off some insulation for a check as the lead termination was not in sight. The dc voltage between this point and the chassis was zero as it should have been. I measured from the cathode stake point to the chassis and again got a normal voltage. I looked the cathode lead over, wondering if there was a break in it. I found a peaking coil in the lead covered with a tough clear plastic, something like the stuff NRI uses to hold parts to their shipping boards in their kits but much tougher. I cut through the plastic between the coil and the pix tube socket and measured the voltage between this point and the chassis. It was on the order of several hundred volts—more than enough to cut off the beam current of the pix tube and account for the lack of brightness.

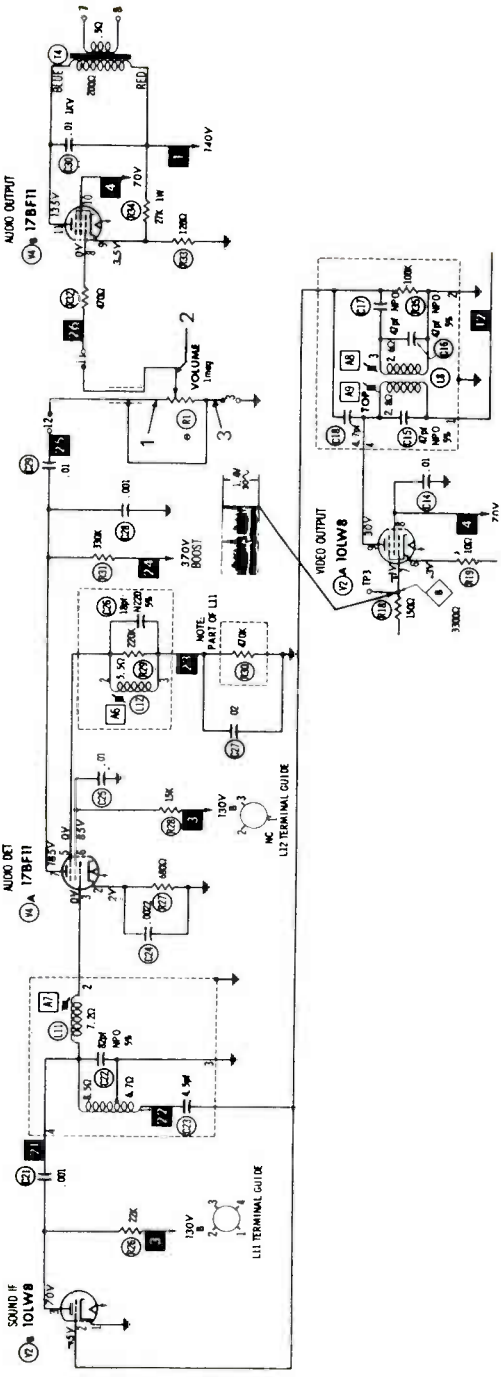
I turned the set off and checked the resistance from the cathode end of the peaking coil to the chassis. It measured over a hundred megohms. The resistance from the other end of the peaking coil (at the circuit board) to the chassis was normal. Either the peaking coil was open or there was a break in the cathode lead itself.

I removed insulation from the other end of the peaking coil and connected a clip lead between the two exposed points. I then turned the set on and got a fine bright picture. The picture quality was good enough to let me permanently short out the peaking coil with a clear conscience, which completed the job. I shorted the coil because a new one was not available and it might have taken weeks to get another from the factory.

This was an odd case as there were two defects causing the same trouble. I was lucky all the way through, because if I had tried a brightener (which increases filament voltage on the crt) before checking the crt there would have been no increase in brightness at all, thus pointing away from the tube, and if I had found the peaking coil open first it would have been some time before it would have occurred to me to suspect the tube. Moral: it helps to be lucky.

ADMIRAL 9G4 CHASSIS

This set came with the complaint that it did not work. An examination showed the horizontal ringing coil had been mechanically abused. The coil was open and the plastic wand for adjusting the slug was broken. The shaft of the uhf tuner was broken off and had been glued into the control knob, which was also worthless. In addition, the high-voltage rectifier tube was weak and it needed a new 6GH8 combination sync separator and agc tube. I didn't really want the job so gave the



Courtesy Howard W. Sams

FIGURE 1. SOUND CIRCUIT OF ADMIRAL 9G4 CHASSIS.

customer a price of $65. I explained what was wrong and that the uhf tuner would have to be sent off for repairs and that I would have to order a new uhf knob and station indicator from the wholesaler in Atlanta. He agreed to the price and as a matter of fact paid me right then and there! This didn't make me happy as there might have been a lot of other things wrong including the picture tube, the yoke, and perhaps the flyback transformer. However, I was stuck with it.

A quick test of the picture tube showed it to be okay and there was nothing wrong with the deflection system according to my CRO test (Conar Model 250 which checks yoke and flybacks). I installed the required tubes and replaced the ringing coil. Then I fired up the set and got a good picture on the vhf, but the sound was very distorted; it sounded like a leaky coupling capacitor or a gassy tube. The circuit is shown in Figure 1.

Gas in the 17BF11 would result in a positive voltage on its control grid, as would leakage in the 0.01 coupling capacitor C_{29} feeding the volume control and the grid of the tube. How to determine which is at fault without unsoldering the circuit? Simple—just connect your dc meter across the volume control. If suspicions are correct there will be a positive voltage from point #1 to point #3 (chassis). Now vary the setting of the volume by turning the volume down. This moves point #2 toward point #3. If the voltage between point #1 and ground remains the same, C_{29} is leaky. If the voltage decreases as the resistance between the control grid and ground decreases, then the tube is gassy. In this particular case the tube was at fault.

After replacing the tube, the set sounded better but distortion was still present. The quadrature coil was adjusted for clearest sound by moving its slug, A6. The sound was now fair but not loud enough. This called for adjustment of A7 for maximum volume and readjustment of A6 as there is some interaction between the two adjustments. Next A8 was adjusted for maximum output. A8, according to the factory manual, is the bottom adjustment. The top adjustment A9 is a hollow slug so the alignment tool can pass through it and get at the A8 slug. Good volume and good audio quality were now obtained. Next A9 was adjusted while I was at it. This was done by turning the fine tuning knob on the vhf tuner so that the picture just started to show a grainy appearance. A9 was then adjusted so the grain was reduced to a minimum. A9 acts as a trap for the 4.5-MHz beat and prevents it from being fed to the picture tube.

Note that all of these adjustments were made without using a signal generator. This is the normal way to make this alignment but you must be sure that you properly identify the sound adjustments. If you make a mistake and get into the video i-f circuits you will be in a real mess and a generator will have to be used. The physical locations of the transformers are a rough guide but are not enough (I know by sad experience). Get a manual which identifies the adjustment location. Even then keep your wits about you. The factory manual for this set under sound alignment says that after adjusting A6 you are to adjust the interstage sound i-f transformer. From the schematic in Figure 1 you can see that A7 is not exactly a double-tuned transformer. They refer to it as T4, which is the audio output transformer. Obviously an error, caused by using the same alignment procedure for another set

that employed a slightly different circuit. However, since there were no adjustments on T4 it was easy to figure out what to do.

After the uhf tuner came back it was installed and the set played okay. It was given back to the customer but he was back with it a few days later saying that it had gone dead. I put it on the bench with the back removed and let it play. After a couple of hours the raster grew smaller and then disappeared entirely. I jarred the set and it came back. Then I found that by lightly tapping the 38HE7 the trouble could be made to come and go. Fine, thought I, that's the trouble—the 38HE7 must be just as unreliable as the 33GY7 which it resembles. A new 38HE7 worked no better. Paying more attention, I noted that the filament went out when the set failed. Turning the set over, it was evident that someone had been there before me. The circuit board was patched in many places, especially around the 38HE7 socket. With the set unplugged I proceeded to make point-to-point resistance measurements of various parts of the printed wiring. I found that continuity existed up to one side of the 38HE7 filament but that through the tube filament the circuit opened when the tube was wiggled in a certain way. I replaced the circuit foil with hook-up wire to no avail. Finally, I came to the conclusion that the open was in the socket itself. I couldn't get a suitable replacement compactron socket locally. Since this is a single-ended tube used as both the horizontal output and damper, there is very high voltage present at some of the socket terminals. I sent to the distributor for a replacement. I paid a pretty penny as the socket was 65 cents, the UPS charge 85 cents and the COD nearly a dollar. I felt in danger on this job of getting two-bitted to death. In removing the old socket I succeeded in breaking a piece out of the circuit board. However, I wired the socket in with hook-up wire and with the tube inserted had no more trouble. This was $65 well earned, but it could have been worse. Next time I don't want to do a job, I will come right out and say so—I hope.

EMERSON MODEL 19EP00

This was one of the Emersons made by Admiral and was subject to the usual problems of breaks in the circuit board caused by rough handling at service benches and rosin joints developing after a number of years of satisfactory service. I didn't feel at all disturbed when the customer said it was intermittent.

I set it up to play and after about four hours with nothing happening I turned it off. For some reason I turned it right back on and the raster was gone. I let the set sit and tried it again. The same thing happened—it would come on and play as long as I liked, but turn it off and it wouldn't come back on till it had a good cool-off period.

With the raster gone, I found that my neon test bulb wouldn't light up when held near the high-voltage rectifier. This pointed to trouble in the horizontal circuit. I tried a new horizontal oscillator—same thing. I looked at the output tube and it was a 33GY7. Betting myself that this tube was the cause of this peculiar trouble, a new one was slipped in. Sure enough, that was it. I keep about six or seven of these tubes in stock at all times as they are real troublemakers—worse than 6GH8s in color sets. I hadn't really spent much time so I charged $7.50 labor and the usual $7.50 for the 33GY7. That's the list price of the tube but I get them for about $2.40 so I got a fair profit from the job.

RCA CHASSIS CTC 38A

There are a fairly large number of these sets in this locality and I don't like to work on them as most have been butchered up by a serviceman in a nearby town. This one belonged to a friend who also works in the County Courthouse. She told me that it had lost color and that another serviceman worked on it for six months and brought it back, still with no color. As a matter of fact, he had called in another man and both had tried their luck with it.

Now the set had developed a frying noise and smoked once. I told her I didn't want the job, but nothing would do but for me to fix it for her. I told her she would have to get a truck and bring it to my place, which is about fifteen miles down the road. So her husband showed up with the set in a borrowed truck, and there in full view was sitting a big hay truck I had been using. He pretended not to see the hay truck and I didn't mention it either. We carried the set into my "shop" and he went his way.

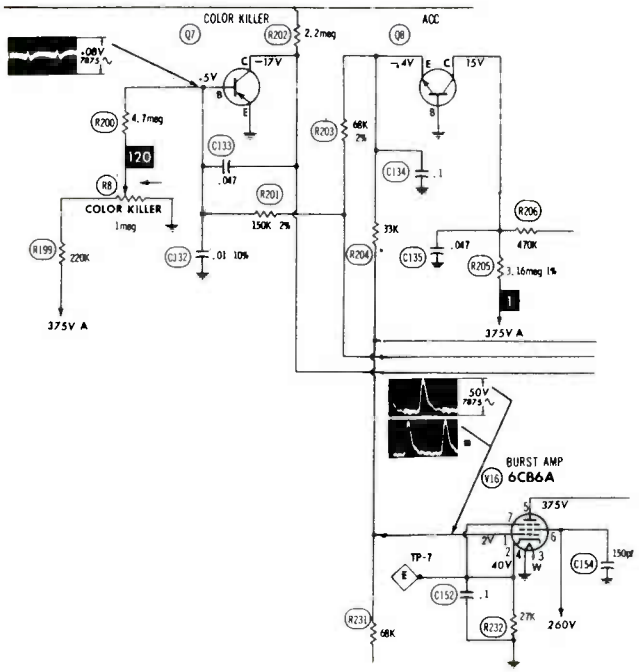
I turned the set on and sure enough she fried. The noise came from the high-voltage cage. I unbuttoned the cage and swung it up. The high-voltage rectifier remains in the top of the cage shield, as only its top cap connects to the horizontal output transformer (it slips into a connector when the shield is lowered). A great deal of wax had melted and run down from the flyback (horizontal output transformer), which led me to believe that the flyback was defective—I have seen this many times. I checked the horizontal output tube, the damper, and the voltage regulator tube. I replaced all these tubes as well as the horizontal oscillator tube on general principles. I figured that the cost of this work could run the customer about $90, leaving a profit around $40. I got the go-ahead and was also asked to bring back the color.

With the new tubes and flyback installed, I got a black-and-white picture which had poor quality. I had the customer call the other serviceman to ask if he had fooled with the alignment of the video i-f or the color section. He claimed not, but as someone else had also worked on the set I didn't believe it.

Before I had time to look at the picture objectively, I heard a series of sharp snapping noises. It sounded like it was in the high-voltage cage. I had an old top cap connector with some lead attached, so I put it on the top cap of the high-voltage rectifier tube and let the free end touch the connector built into the flyback. Thus I was able to operate the set with the high-voltage cage open, allowing me to see inside the cage. When the snapping started I could see an arc at the heavy insulation making up the high-voltage rectifier socket.

I took the top of the cage off, enabling me to get at the rivets holding the socket in place. I drilled out the rivets and removed the socket. The black arc mark was then visible. Then I got and installed another high-voltage socket which cleared up the arcing.

I figured the next thing to do was to find the cause of no color. This is a hybrid receiver using both tubes and transistors. With an adapter, I checked the dc voltage



Courtesy Howard W. Sams

FIGURE 2. COLOR KILLER, ACC AND BURST AMPLIFIER OF RCA CTC38A.

in the color section of the receiver. For those who don't know, the adapter is a tube base with a mounted socket on top, and with lugs coming out the side and connecting to the various leads. The tube is removed and put into the socket of the adapter. The device is then inserted in the receiver socket. The tube is supplied with operating voltages which are available for easy measurement.

The only thing wrong is that the burst amplifier was cut off by negative grid voltage and no amount of adjustment to the color killer would reduce the voltage. The circuit is shown in Figure 2.

I decided that the trouble was in the color killer, in the acc transistor, or both. Voltage measurements on the transistor leads using a voltmeter with the set in operation were so far off that the trouble was pinpointed.

I went to the wholesaler for the transistors and after looking through his manual which showed the equivalent transistors of different companies, I picked two GE transistors he said would do the job. With them installed I could get beautiful colored snow, showing the color killer would let signals through to the burst amplifier. The color killer adjustment would also stop the coloring of the snow, which is the proper adjustment.

However, when the set was tuned to a color picture there was no color unless the set was tuned off the station far enough to almost lose the video signal. This to me

was definite proof that the video i-f amplifier was out of alignment. I borrowed a sweep generator from a friend and looked at the overall response (from antenna to video detector). As expected, with the video marker at the 50 percent point on the curve, the color marker was not on the response curve. With the set tuned to put the color marker at the right point, the picture marker was no longer visible on the response curve. A complete alignment job was necessary. I found that the generator had a defect and that when the signal was fed into the proper point in the tuner, no response curve was developed.

I reported the news to the customer and told her it would be necessary to take the set to our nearby "big" city and get a guy I know to align it. She said okay and I made a tentative price of $55 for alignment. The set had two chassis bolts missing so I took two from a Philco I had in for repair. Then I put the set upside down in the back of my station wagon and set sail for the big city. I turned it over to my friend, who has an excellent sweep generator, scope, etc. He also has a specialist come in about once a week and take care of all his alignment jobs. This man covers all the big service shops and I expect he makes an excellent living. Anyone can learn to use a sweep, but practice makes perfect and most servicemen don't get much since the average set will never need alignment unless the adjustments have been tampered with.

I phoned at the specified time and was told that the set was ready. I got hold of the customer and had him borrow the truck again as I wasn't about to lug it back upside down for fear of damage to the alignment or to the set. We got the set and I had to shell out $56.40. I found that two of the adjustment cores had been replaced as they had been broken by the original serviceman in his attempts to get color. Both the video i-f and color sections had to be aligned and the blue lateral magnet wouldn't work. They had put in a Zenith, which they told me was their standard operating procedure. I had never heard of this but they must have been right because it did the job. I had noticed that the blue lateral was not adjusting before I took the set in, and had planned to tell them but had forgotten all about it.

We took the set to the customer's home and got an excellent picture. I adjusted the agc and color killer, which completed the job, except for my bill of $165.00 for which I took a check, knowing the customer was good for it. Otherwise, I would have had them go to the bank and cash it.

If I had gotten the set when color was first lost, it would have cost $25 to replace the defective transistors. The color killer is the first place to look when color disappears. Of course, the flyback would have gone but the bill wouldn't have been so high at one time, and there would have been no outside alignment charge.

ADMIRAL CHASSIS 3H554-1

This set also belongs to a friend who brought it in along with a small Japanese portable, which showed no picture. They were both left to await their turn. I found that someone had turned the agc adjustment of the portable to the point where the picture was cut off. I readjusted it and made a charge of $10.00, which would have

been less except for the fact that he socked it to me the last time he serviced my tractor in his shop! Moral: do unto others -- etc.

The Admiral gave a dim picture, all out of sync, and with a high hum level. I removed the chassis from the cabinet and found corrosion around the lugs of the electrolytic. I decided this was the cause of the trouble. I cut the lugs of the capacitor on the foil side of the board and then heated what was left one at a time, prying up each time a lug was heated and then removing the soldering iron until the lug had cooled in its new position. In this way the capacitor was removed without damage to the circuit board.

I installed the nearest thing I had on hand but put a separate capacitor in parallel with the section needing it most to bring the capacity up near normal. I reinstalled the chassis and turned the set on—same as before. I could have sworn the capacitor was at fault!

Taking the chassis out again, I looked the bottom side over carefully. I found that one of my connections was at fault. There was solder on the capacitor lug and on the board but there was no connection between the two. I had tried soldering with the board on end. I turned the board so it was parallel to the workbench top and did a proper job of soldering.

Then I put the chassis back in the cabinet and fired the set up. I got a raster with no hum, but also no sound or picture. Prodding around on the chassis, I found that by pushing down in a certain area the picture and sound came in. I decided from this that the trouble was in the video i-f, detector, or possibly in the video amplifier. This is a hybrid set also, being transistorized with the exception of the sound and sweep circuits. I was able to get at the i-f transistor leads with the chassis in the cabinet. I found zero volts on all leads of the last i-f transistor.

Out again with the chassis and upside down with it on the workbench. I located the collector of the last video i-f amplifier and checked continuity between it and its voltage source. No continuity! I traced the circuit visually and with the ohmmeter and found an open at the point where a jumper wire was used. I resoldered same and put the chassis back in the cabinet. I got good sound but no picture. I started moving parts and found a resistor which when moved brought in the picture. By this time I was heartily sick of taking out the chassis, but I did so and resoldered the bad connection on the resistor. The set worked fine except that the picture was dim. I measured the picture tube anode voltage and found it to be only 10,500 volts. I looked at the schematic to see what the voltage should have been and saw listed 10,800 volts, so my voltage was quite normal. I tested the picture tube and found its emission to be far below normal. Then I tried boosting the filament voltage in the tester but this didn't bring up the emission. Then I tried rejuvenation. This helped a little so I did it a number of times. This gave a bright picture so I decided to let well enough alone. I billed the customer $25 labor and $10 for parts, making a total of $35 for the job, which was reasonable considering my time and all the chassis removals.

When you neglect...

. . . to include your student number in your correspondence with NRI, it causes an unavoidable delay in fulfilling your requests. Please—to enable us to serve you as quickly as possible—always include your student number!

Reader Exchange

FOR SALE: Make me an offer: Riders Manuals, Volume I-V abridged, VI, VII, VIII, and X. Also, Index. Matthew M. Zack, Sr., 202 Male Avenue, Syracuse, NY 13219. Telephone (315) 468-0458.

FOR SALE: CONAR five-inch oscilloscope, wideband. CONAR Model 311 resistor-capacitor tester. CONAR Model 230 tuned signal tracer. CONAR Model 280 signal generator. Must sell due to illness; all in excellent condition. Will accept any fair offer, all or in part. Will sacrifice. Contact Robert Hood, Monroe, Maine 04951.

Job Ops

FOR SALE: TV and Appliance shop in Salem, Illinois. Established for 24 years in a growing town of 6000. For sale by NRI graduate who now wishes to retire. Contact Avery Leuty, Leuty's TV and Appliance, 110 S. Broadway, Salem, Illinois 62881. Telephone (618) 548-1111.

HELP WANTED: Station KCBG-TV of Columbia, Missouri needs an employee with a First Class FCC Phone license. Qualified persons should contact Tom Koenig, KCBG-TV, Columbia, Missouri 65201.

HAM NEWS

By Ted Beach K4MKX

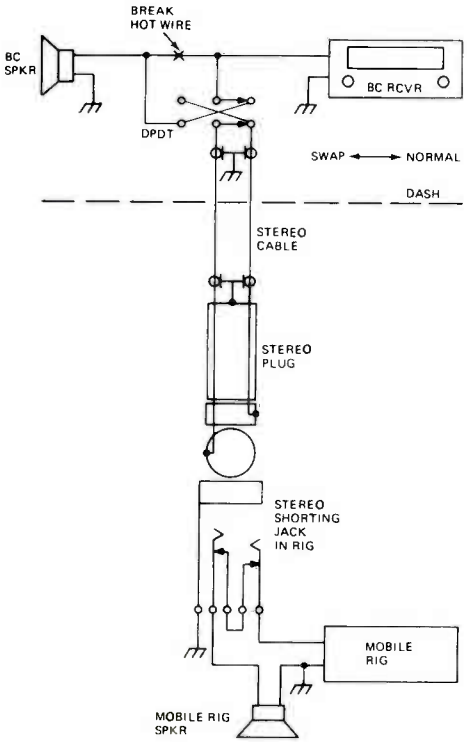
It looks as if all my ills are coming to haunt me at once—after having made the error in the diagram of the QRPP keyer regarding the assignment of the two ICs in the first article, I've had two or three letters asking what the characteristics of the diode in the circuit are. That one I also overlooked, fellows, and once again my apologies. The fact of the matter is that after working with the little circuit for so long I just sort of took for granted that everyone would understand it immediately! Actually, this was my first adventure with the COS/MOS ICs and I was very taken up with their characteristics. So much so that when it came time to put the keyer together I really didn't notice what kind of diode I was using. I just picked up the nearest one to hand and stuck it in! In the first prototype this turned out to be a garden-variety rectifier (silicon). Subsequent experiments showed that with the 22-kilohm resistors used in the circuit, ANY diode would work just so long as its forward resistance was less than 22 kilohms and its reverse resistance greater than 22 kilohms. This takes into account just about any diode you can get your hands on. Anyway, you will be safe to use any old diode you can find as long as it is not open or shorted.

I may have prematurely announced that I was getting on the low bands. I am still planning to get the antenna mentioned last time, but being as Scotch as I am, I'm trying to get the very best deal that I can on it, and so far I haven't conned anyone into my terms. This isn't as bad as it sounds since this is being written in January, and perhaps NEXT time we'll have everything in order and ready to go. I do have to renew my license soon, and I've got to get some on-the-air time on cw so I can go for that Extra. I have been copying W1AW on their code practice sessions but I still seem to be a long way from 20 wpm so I still have a lot of work to do. Keep your fingers crossed.

Back when I first got started on mobile FM operation, I decided that there must be a better way to go than having the under-dash rig directing its sound toward my feet. You wouldn't believe how hard I had to strain to hear what was going on

on the repeater. The only real problem was that there was absolutely nowhere to mount another speaker conveniently in the VW. The AM broadcast radio speaker already had the only available dash space well in hand. Hmmm!

You guessed it. Why not swap speakers (electrically, of course)? No sooner said than done. The diagram shows the way I did it.



My GTX-2 did not have a separate phones or external speaker jack, but there was plenty of room on the rear apron to add one. Rather than put in the usual shorting type two-conductor jack, I installed the shorting stereo jack shown. If your rig already has a jack you can do the same thing quite simply since both types are the same size.

The DPDT reversing switch mounts under the dash in some unobtrusive out-of-the-way spot which I'm sure you can find. Locate the "hot" wire from the automobile radio to the speaker and connect it to the switch as shown. The other side of the speaker line is the auto chassis (in almost all cars, that is; be sure to check this first).I used a piece of shielded stereo cable about the size of regular lamp cord to connect the switch to the stereo plug. It is not necessary to use shielded leads here in this low impedance circuit; however, the wires are color coded and I happened to have a length of the stuff lying around at the time.

And that's it. Now I can listen to the repeater and not miss a word while having soothing background music directed toward my feet through the rig speaker. When a news bulletin comes in I can flip the switch and swap the two speakers.

Now let's see who we have heard from.

As you can see, we have not had very many new respondants this time. As usual, the names listed first are those belonging to students and/or graduates of the NRI Course for Amateur Licenses. The last seven people are other NRI students and graduates.

Randy, WN3VUP, got his license back in December and is anxiously looking forward to getting the General.

The third name in the list came via the lesson grading section on a report for Training kit 3R. Sudie is a YML who got the Novice call in September of 1972. I do hope she gets the next grade before this September or she's going to have to QRT. Good luck.

There is absolutely no irreverence intended by the "Rev" beside WN9NPI's

Charles	WA1NVO	-	Cumberland RI
Randy	WN3VUP	N	Duncansville PA
Sudie	WN4BUB	N	Whitesburg KY
Phil	WB4CYG	T	Macon GA
"Rev"	WN9NPI	N	Racine WI
Harold	WNØEOL	N	Pittsburg KS
Leland	KL7IAC	A	Anchorage AK
George	K2EV/4	E	Pensacola FL
Tom	WA4BZP/7	A*	Bremerton WA
Dick	WA6HFI	-	Oildale CA
Ray	W7YKN	A	Reno NV
Gary	WB8ICU	A	Sanford MI
Dick	WB8JIR	-	Jackson MI
Vince	WØGP	E	Bloomington MN

* Hopefully!

call. We received a note from our Student Service department that Rev. L. Gleissner had received his Novice license WN9NPI and that was it. We couldn't list this as "L" and we do know a minister locally who is an active radio amateur and likes to be called "Rev" on the air so we hope that this listing is all right.

KL7IAC really had a rough time of it. Leland held a Novice ticket twice, WN7THG being the latest one, and then started the NRI course. He says he studied and practiced but just could not get the code up past 12 wpm. He had reached the "Novice Plateau" which so many of us stumble upon. Then almost overnight he could copy 17 wpm solid, so real quick-like, down to take the test. The General exam was so easy he decided to take the Advanced at the same sitting. Now he's looking at the Extra but it still takes two years in harness and 20 wpm for that one.

Did you notice that we have two two-letter calls listed this time? Fantastic! Let's see, I got my Novice ticket in 1957 (same call I have now with the "N" but from Florida then), so I have eight more years before I qualify as an oldtimer and can apply for a two-by call. That will be 1982. Unreal. I don't think I want to discuss this matter any more.

WA4BZP was leaving Washington for his home QTH in Georgia in early December after six years in the Navy. Tom likes to build things and one of his latest projects was the QRPP key which he reduced in size to 1/3 original. He included a computer printout of some OSCAR VI orbital data which I must admit snowed me. Tom says that as soon as he is settled in GA he will write again and let me know if he has found a computer to get some more updated printouts which he will be glad to share with anyone who cares to write.

W7YKN got his Advanced license on Christmas eve, after waiting only twelve weeks and three days after he passed the test. It was a welcome present on December 24th anyway. Ray says he was tempted to go for Extra but wasn't too sure about the code so he played it safe and took the Advanced test instead. Nevada being as scarce as it is, Ray says he would be more than willing to schedule a contact with anyone who writes, or better yet look for him on 14.247 every Friday

evening at 11 p.m. Pacific time. His address is:

Raymond B. Bass - W7YKN
570 Darwin Circle
Reno NV, 89503

Gary, WB8ICU, is another two-time Novice who never operated as a General. Gary had his first Novice back in 1959 but it died. In 1966 he got another Novice ticket, jumping to Advanced in 1967. Gary operates cw only, having sold his SB102 "after 6 months of gabbing, and vox keying—UGH!" A man after my own heart. Currently he is using a Viking II and is awaiting a Heath SB303 receiver to go along with it.

WB8JIR is an electrical engineer working in the power field. Dick enrolled with NRI to learn more about communications so that he could get an FCC license and have a "backup" job as a radio operator. He expects to finish the course late in January and sit for the exam then. We're sure you won't (or didn't) have any problems, Dick.

The last one on our list this time wrote a very newsy letter telling all about his 40 years as an amateur. Unfortunately we do not have the room to relate it all to you, but here is some of it. Vince is and has been mostly a cw man and a home-brewer to boot. He has had his fling with am (loop modulation of a pair of self-excited 45's) and sideband (home-brew version of HT-37) but has extensively modified his latest rig, an SB-34, for better cw keying. To go along with this rig, he has a 40/20/15 meter log-periodic antenna pointed west.

In addition to the WØGP call, Vince has a First Phone and a Second Telegraph to paper the walls of his shack and has made very good use of them in his many active years.

That's about it for this time, gang. We'll be looking forward to next time. Very 73 and CUL. Ted – K4MKX

Ham Ads

FOR SALE: Hammarlund HQ110, $75; Heath HR10, $40; Heath DX60B, $60; Heath vfo, $15; Turner D104+2 mobile microphone, $15; Central Electronics cw transmitter, $15; surplus 2-8 MHz receiver with power supply, $20. Crystals available for Heath and CE transmitters. No shipping except collect. $200 for all of the above. Send SASE for list of other goodies. Dick Mettler, WA6HFI, 119 Lincoln Avenue, Oildale, CA 93308.

FOR SALE: Delta Mark 10 SCR ignition system for negative ground. Kit in original carton, $20. Gerald A. Cline, RR 1, Elgin, IA 52141.

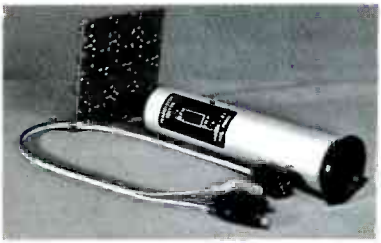
FOR SALE: Floor model RTTY, Model 28 KSR, $200; Kliendschmidt TT-122A 100 wpm TD, $25; Motorola 25-watt transceiver with 34/94, 94/94, 28/88 and OSCAR in excellent condition, $125. Tom French, WA4BZP, Route 2, Glenwood, GA 30428.

FOR SALE: Clegg 99er with Lafayette HE61A vfo. Complete six-meter station. Charles Horstman, WA1NVO, 16 Countryside Drive, Cumberland, RI 02864.

SELECTED TEST EQUIPMENT FROM FAMOUS MANUFACTURERS

Order Now from CONAR

In-Circuit Transistor Tester



This recently introduced transistor tester can be a real help in locating defective transistors. It places the transistor under test into actual operation without removing it from the circuit. It operates upon contact and emits a clear tone if the transistor is good. No visual observation to make. The absence of a tone indicates a shorted or open transistor. Save time and effort with this low-cost service aid.

Stock No.85WT
Weight 2 pounds
P.P. Insured

$17.45

NEW! Model HV-32 Probe

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For fast, accurate, safe high-voltage measurements up to 30,000 volts. Extremely lightweight for ease in handling, yet very rugged. Built-in overload capability. Tracking accuracy, ±2% of full scale. Reading accuracy, 2% at 25 KV. Meter movement includes self-shielded bar magnet. Housing is anti-static treated. Knife-edge pointer and large numbers for ease of reading. 1.75" probe tip for reaching under corona cap. Shpg. wt., 1½ lbs.

Stock No.32PB
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IF YOU OWN A CONAR 224 TUBE TESTER* .. YOU CAN NOW TEST COLOR PICTURE TUBES USING CONAR'S NEW

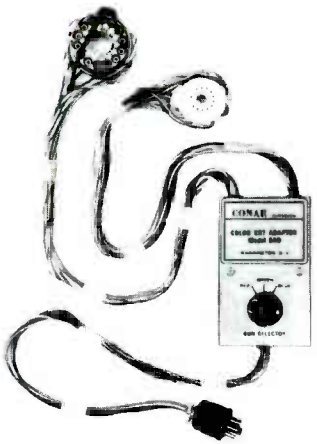
9AD ADAPTER

For some time, we've had requests for an adapter to use with Conar tube testers to test color picture tubes. When we couldn't locate one, we decided to design our own.

Conar's new 9AD adapter lets you test color picture tubes in the receiver or in the carton. Tests include checks for cathode emission and for shorts between elements.

will not test special tube types such as Sony Trinitron or GE's Portacolor. To use the 9AD, you must have both the 3AD and 5AD.

9AD	for 70°-90° color tubes	$12.00
3AD	for 70°-90° B/W tubes	3.00
5AD	for 110° B/W tubes	3.00



*Each of the above adapters is compatible with previous models including Models 70, 71, 220, 221, and 223.

NRI HONORS PROGRAM AWARDS

In the tradition of NRI's pursuit of excellence in training, the following graduates who earned NRI electronics diplomas in November and December also earned unusual recognition under the NRI Honors Program. On the basis of their grades, these graduates distinguished themselves by earning the right to honors listed below and to the appropriate Certificate of Distinction in addition to their regular NRI Diploma. This distinction is made part of their permanent NRI records.

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PHILADELPHIA-CAMDEN CHAPTER meets 8 p.m., 4th Monday of each month in RCA Building, 204-I, Route 38 in Haddonfield Rd., Cherry Hill, New Jersey 08034. Chairman: Joe Szumowski.

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. and 2nd St. Chairman: George McElwain.

SAN ANTONIO (ALAMO) CHAPTER meets 7 p.m., 4th Thursday 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: Robert E. Bonge, 222 Amador Lane, Antonio, Tex. 78218, 655-3299. San Antonio area NRI students always welcome. Free annual membership to all NRI graduates attending within 3 months of graduation.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8 p.m., last Wednesday of each month at the home of Chairman Daniel DeJesus, 12 Brookview St., Fairhaven, Mass. 02719.

SPRINGFIELD (MASS.) CHAPTER meets 7 p.m., 2nd Saturday of each month at the shop of Chairman Norman Charest, 74 Redfern Dr., Springfield, Mass. 734-2609.

TORONTO CHAPTER meets at McGraw-Hill Bldg., 330 Progress Ave., Scarborough, Ontario, Canada. Chairman Branko Lebar. For information contact Stewart J. Kenmuir (416) 293-1911.

PHILADELPHIA CHAPTER ENTERTAINS EXECUTIVE SECRETARY

On November 19, Tom Nolan, Executive Secretary of the NRI Alumni Association, gave a talk on troubleshooting the color section of a color television receiver. Tom gave an interesting talk and demonstration.

On December 10, the Chapter met at the RCA Building in Cherry Hill, New Jersey. Mr. Joe Szumowski was elected Chairman at that meeting. The Chapter also decided to give up the old meeting place at the K of C Hall and hold all meetings at Sylvania Technical Systems located in the RCA building, 204-I, Route #38 Haddonfield Road, Cherry Hill, New Jersey 08034.

Joe's home address is 1316 Morgan Avenue, Cinnaminson, New Jersey, 08077. His home phone is 1-609-829-8957. The business phone is 1-609-665-0480.

The Chapter hopes that this will be a good move into a new location and will increase the membership in the Chapter.

Alumni News

NRI AA OFFICERS

James Kelley.....President
William W. David.....Vice President
Albert H. Sharp.....Vice President
W. L. Simmons.....Vice President
Arnold E. Verdow...Vice President
Tom Nolan.....Exec. Secretary

A meeting of the Philadelphia-Camden Chapter in November.

PITTSBURGH CHAPTER HOLDS ELECTION OF OFFICERS

At the December 6 meeting, new officers were elected and they are as follows: Chairman George McElwain, Vice Chairman Thomas D. Schnader, Treasurer Charles Kelly, Secretary James M. Burnelis, Directors John L. Benoit, William J. Lundy and Gerald F. Genellie.

After the election the membership celebrated with an annual party and refreshments. A photograph of the new officers is included in this Journal.

The new officers of the Pittsburgh Chapter.

NATIONAL SECRETARY GUEST OF NEW YORK CHAPTER

The December 6 meeting was held at the home of Chairman Steven Kross. There were 17 members present. Steve discussed the money problems that would now arise to pay for the new meeting room. This meant an increase in dues, which the membership promptly approved.

After this discussion, Mr. Tom Nolan, Executive Secretary of NRI AA, took the floor and brought with him an RCA CTC40 color chassis, a trigger scope, and a color bar generator which he used to demonstrate what scope signals looked like when trouble is present in the color section of a color receiver. He also used a blackboard for demonstrations of waveforms in the color section.

The meeting ended at 11:15 p.m. after which refreshments were served. Mr. Kross wished all a Merry Christmas and Happy New Year and the meeting was adjourned.

FLINT MICHIGAN CHAPTER HAS ACTIVE SEASON

At the December 5 meeting, the chapter members continued the Color TV Clinic with a problem brought in by Larry McMaster. It was a Ward Airline color set and the members had a busy day with it because it had several problems. One was an open filter condenser. There was the loss of color, a tuner problem, and a sync problem. Each member had a chance to take on any of the problems and solve them.

October meeting of the Flint-Saginaw Valley Chapter.

Also, Andrew Jobbagy brought in a Motorola color set to demonstrate the Christmas tree effect, which is a horizontal frequency problem. By the time the meeting was over, all of the sets were repaired.

At the January 16 meeting, Mr. Herald from Michigan State University gave a talk on the CET Program. All of the members have been interested in taking the Certified Electronic Technician Test and therefore they were interested in hearing some background on what it was all about.

Also at this meeting, new officers for the Chapter were elected. They are as follows:

Larry McMaster, Chairman; Donald L. Stewart, Vice Chairman; Stephen J. Avetta, Secretary; Andrew Jobbagy, Treasurer and Corresponding Secretary; Clyde Morrisette, Retired Honorary Member; Dennis Besser, Goodwill Ambassador; Cash Laferty, Sergeant at Arms; George Maker, Entertainment Committee; Robert Newell, Gilbert Harris, and William Salerno, Membership Committee; and Richard S. Jobbagy, Photographer.

NORTH JERSEY CHAPTER HAS TRANSISTOR PROGRAM

On December 14, the Chapter was treated to a lecture by the Howard W. Sams Company called "Transistor Program."

The Chapter mourns the loss of their Secretary and very good friend Harry Weitz and he will be missed by all of the members.

SAN ANTONIO CHAPTER HAS LECTURE AND CHRISTMAS DINNER

At the November 30, 1973 meeting of the San Antonio Chapter, Mr. Howard Smith, an instructor with Parish Draughn's School of Electronics, gave a talk on selling the services and the business aspects of Electronic repair. This program was arranged by Mr. Guy Elder and was enjoyed by all the membership.

On December 20, the Chapter enjoyed their annual Christmas dinner meeting at the Little Red Barn. There was no speaker, just an evening of eating and visiting. Everyone stayed some two hours after they finished the steak. It was a very enjoyable evening.

Again the Chapter owes a vote of thanks to Guy Elder for making arrangements for this years' Christmas party and also to Mrs. Madeline Rodgers for assistance to Guy in contacting all the membership.

Harry Weitz

Mr. Harry Weitz, Secretary of the North Jersey Chapter, died suddenly of a massive coronary occlusion on December 26.

Harry originally came from the Brooklyn, New York area but moved to New Jersey and lived in Dumont, New Jersey. About seven years ago, he retired from the Wright Aeronautical Corporation of Woodbridge, New Jersey. Harry was a veteran of the Air Force where he served during World War II.

Harry will be missed by all the members of the North Jersey Chapter and also by the Executive Secretary, who always received his communication once a month giving all the details of the chapter meetings.

SPRINGFIELD CHAPTER HAS ANNUAL VISIT

At the December 5 meeting of the Springfield Chapter, National Secretary Tom Nolan demonstrated by blackboard drawings and with an oscilloscope and color bar generator, waveforms present at different points in the color section of a normally operating TV receiver. He went on from this point to show how to troubleshoot and how to recognize waveforms which were incorrect.

The meeting was enjoyed by all the membership and guests and refreshments were served by Norman Charest, at whose home the meeting was held.

A meeting of the Springfield Massachusetts Chapter during National Secretary Tom Nolan's visit in December.

A meeting of the Chambersburg Chapter in November of last year, at which the National Secretary was guest.

Members of the Southeastern Massachusetts Chapter during the National Secretary's visit in September.

Members of the Detroit Chapter of NRI AA during Tom Nolan's annual visit in October of last year.

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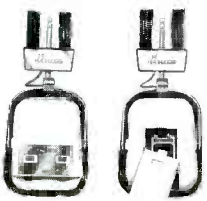

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25.01- 30.00	1.50	4.00		
30.01- 35.00	2.05	4.50		
35.01- 40.00	2.65	4.75		
40.01- 50.00	3.00	5.00		
50.01- 60.00	4.15	5.50		
60.01- 70.00	5.50	6.00	6.40	4.50
70.01- 80.00	7.00	6.50	8.00	5.00
80.01- 90.00	8.00	7.75	10.10	5.00
90.01-100.00	9.00	8.75	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
130.01-140.00	13.00	12.75	19.40	7.00
140.01-150.00	14.00	13.75	21.60	7.50
150.01-160.00	15.00	14.75	23.20	8.00
160.01-170.00	16.00	15.75	24.80	8.50
170.01-180.00	17.00	16.75	26.20	9.00
180.01-200.00	18.00	17.00	27.90	10.00
200.01-220.00	20.00	18.50	29.80	11.00
220.01-240.00	22.00	20.00	32.40	12.00
240.01-260.00	24.00	22.00	35.20	13.00
260.01-280.00	26.00	24.00	38.20	14.50
280.01-300.00	30.00	24.50	41.20	15.50
300.01-320.00	32.00	25.50	44.20	17.00
320.01-340.00	35.00	27.00	47.80	18.00
340.01-370.00	38.00	28.00	52.40	18.50
370.01-400.00	42.00	29.50	57.20	20.00
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A ➔

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HOME ADDRESS ..... CITY ..... STATE ..... ZIP CODE .....

HOME PHONE ..... HOW LONG AT THIS ADDRESS .....

( ) OWN HOME ( ) RENT ..... RENT OR MORTGAGE PAYMENTS $ ..... PER. MO.

WIFE'S NAME ..... MARITAL STATUS ( ) MARRIED ( ) SINGLE

..... NUMBER OF DEPENDENT CHILDREN .....

PREVIOUS ADDRESS ..... HOW LONG? .....

WHERE DO YOU WORK?

B ➔

YOUR EMPLOYER ..... POSITION ..... MONTHLY INCOME $ .....

EMPLOYER'S ADDRESS ..... HOW MANY YEARS ON PRESENT JOB?

Street ..... City ..... State .....

PREVIOUS EMPLOYER ..... HOW LONG?

Name ..... Address .....

WIFE'S EMPLOYER ..... MONTHLY INCOME $ .....

Name ..... Address .....

WHERE DO YOU TRADE?

C ➔

BANK ACCOUNT WITH ..... ( ) CHECKING

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