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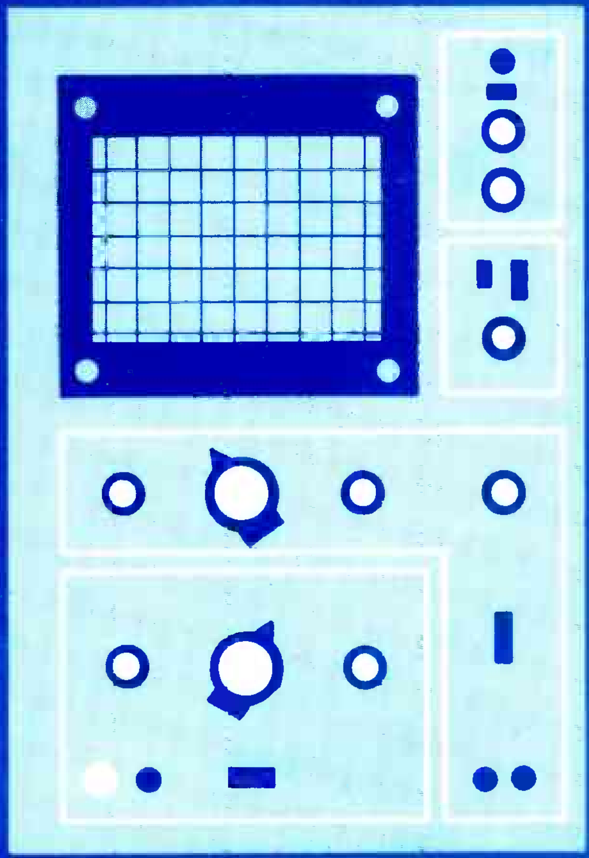

- Introducing the CONAR Model 255 Solid-State Oscilloscope
- Servicing Automobile Stereo FM

nri journal

November/December 1973

CONAR proudly presents its . . .

NEW SOLID-STATE TRIGGERED-SWEEP 5-INCH OSCILLOSCOPE

with more features than any scope at its price.

Why Solid-State?

- High performance
- Space-age reliability
- Low power consumption
- Light weight

Why Triggered Sweep?

- Calibrated time measurements
- Calibrated frequency measurements
- Stable display
- Pulse measurements

Advanced design, newest circuitry, exclusive features — a truly professional oscilloscope for laboratory or service shop. The Model 255 is ideally suited for color and monochrome TV, AM-FM and transistor radios, hi-fi and stereo amplifiers, plus numerous industrial electronic applications.

The Model 255 is 100% solid-state for superior stability, reliability, and ease of maintenance.

Modern solid-state components include 7 integrated circuits (IC's), 6 field-effect transistors (FET's), 14 conventional transistors, and 15 diodes. All the multi-pin integrated circuits are mounted in sockets for easy servicing, and most of the oscilloscope circuitry is on two printed circuit boards.

The direct-coupled deflection amplifiers extend response to dc. The 11-position calibrated vertical attenuator makes voltage measurements a snap, whether the voltages to be measured are ac, dc, or a combination of both.

Other features include: Z-axis input for special frequency measurements, sawtooth output for ringing flyback transformers and yokes, attractive cabinet design, light weight (only 17 lbs.), and low power consumption (only 30 watts).

Kit Stock No.255UK	Only $195.00
Student Price	**Only $180.00**
Wired Stock No.255WT	Only $245.00
Student Price	**Only $230.00**

Weight: 17 pounds. Shipping weight: 20 pounds. Shipped via Parcel Post Insured or United Parcel Service.

SPECIFICATIONS

Vertical Channel — **Sensitivity:** 2 mV maximum, uncalibrated. Calibrated ranges: 10-20-50-100-200-500 mV/cm, 1-2-5-10-20 volts/cm. Input impedance: 1 megohm, 30 pf. Frequency response: DC to 6 MHz ± 3db. **Horizontal Channel** — **Sensitivity:** 50 mV. Frequency response: 3 Hz to 1 MHz ± 3db. **Sweep Type:** Triggered (internal, external, line). Calibrated ranges: 1-2-5-10-20-50-100-200-500 µs, 1-2-5-10-20-50 ms. Source: internal, external, line. **Other Features:** 5-inch flat face CRT — calibrated graticule 8 by 10 cm — mumetal shield on CRT — Z axis input — sweep sawtooth output — focus, intensity, and astigmatism controls — all solid-state (including integrated circuits) — printed circuitry construction. Overall dimensions: 12 inches by 9 inches by 16 inches, including knobs, handle, and feet. Weight: 17 lb.

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The entire staff of NRI wishes you and your family a very happy holiday season and all good fortune for the coming new year.

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introducing

The CONAR Model 255 Solid-State Oscilloscope

Harold J. Turner, Jr.

The Conar Instruments Division of National Radio Institute is proud to announce its new Model 255 solid-state triggered sweep oscilloscope. This fine instrument has been designed from the ground up to provide the student as well as the seasoned technician with a useful and reliable addition to his service bench.

Key features of the new scope's design are: a five-inch flat-face CRT with calibration markings in both vertical and horizontal directions; a triggered sweep for rock-solid displays; direct-coupled amplifiers to permit observation of very low-frequency signals; and all solid-state construction (including six FET's and seven IC's) for dependability.

Figure 1 is an inside view of the Model 255. Note that nearly all components are mounted on two printed circuit boards. The smaller board at the rear of the scope contains the vertical and horizontal output and retrace blanking amplifiers. All other circuitry, including the vertical and horizontal preamplifiers, trigger and sweep circuits, and regulated power supplies are on the large board at the front of the chassis. Note also that the cathode ray tube is fully shielded. The shield is made of a special alloy designed for maximum attenuation of stray ac fields, which results in an extremely sharp trace.

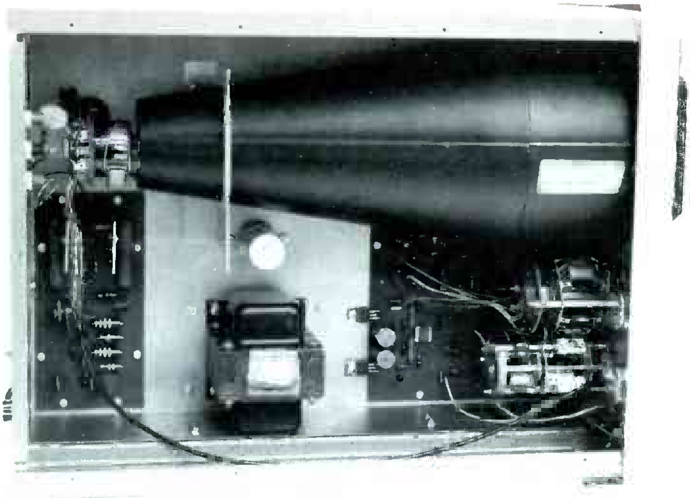


FIGURE 1. INSIDE VIEW OF THE MODEL 255.

CIRCUIT DESCRIPTION

Refer to the block diagram in Figure 2 as we examine the circuitry of the new oscilloscope stage by stage. Let's begin with the signal under observation, which is normally applied to the vertical input jack.

The vertical input jack itself is of the coaxial type, and is designed to accept either a standard coaxial plug or a banana plug. From the input jack, the signal is applied to the input coupling switch, which allows you to select between ac and dc coupling. When dc coupling is selected, the signal is applied directly to the attenuator, and then to the vertical amplifier. This allows you to make dc voltage measurements with the oscilloscope, as well as to observe signals superimposed on dc voltages, and note changes in either the signal level or the dc voltage level at the same time. This position takes full advantage of the direct coupling which is employed throughout the vertical amplifier. Placing the switch in the ac position puts a coupling capacitor in series with the signal path and thus blocks the dc component of the applied signal. This mode is used primarily for looking at small signals superimposed on large dc voltages. Measuring the ripple voltage in a power supply is one example.

The vertical attenuator is calibrated on the front panel in volts per centimeter of vertical deflection. Turning the attenuator switch clockwise increases the sensitivity of the vertical input for measuring smaller signals. Each setting of the switch is calibrated so that you can tell how large the applied signal is simply by noting the number of centimeters vertical deflection and multiplying this number times the attenuator switch setting. For example, if the volts/CM switch is set to the ".05" position, and you observe that the trace is 3 centimeters high, you will know that the signal is 3 X .05, or .15 volt peak-to-peak.

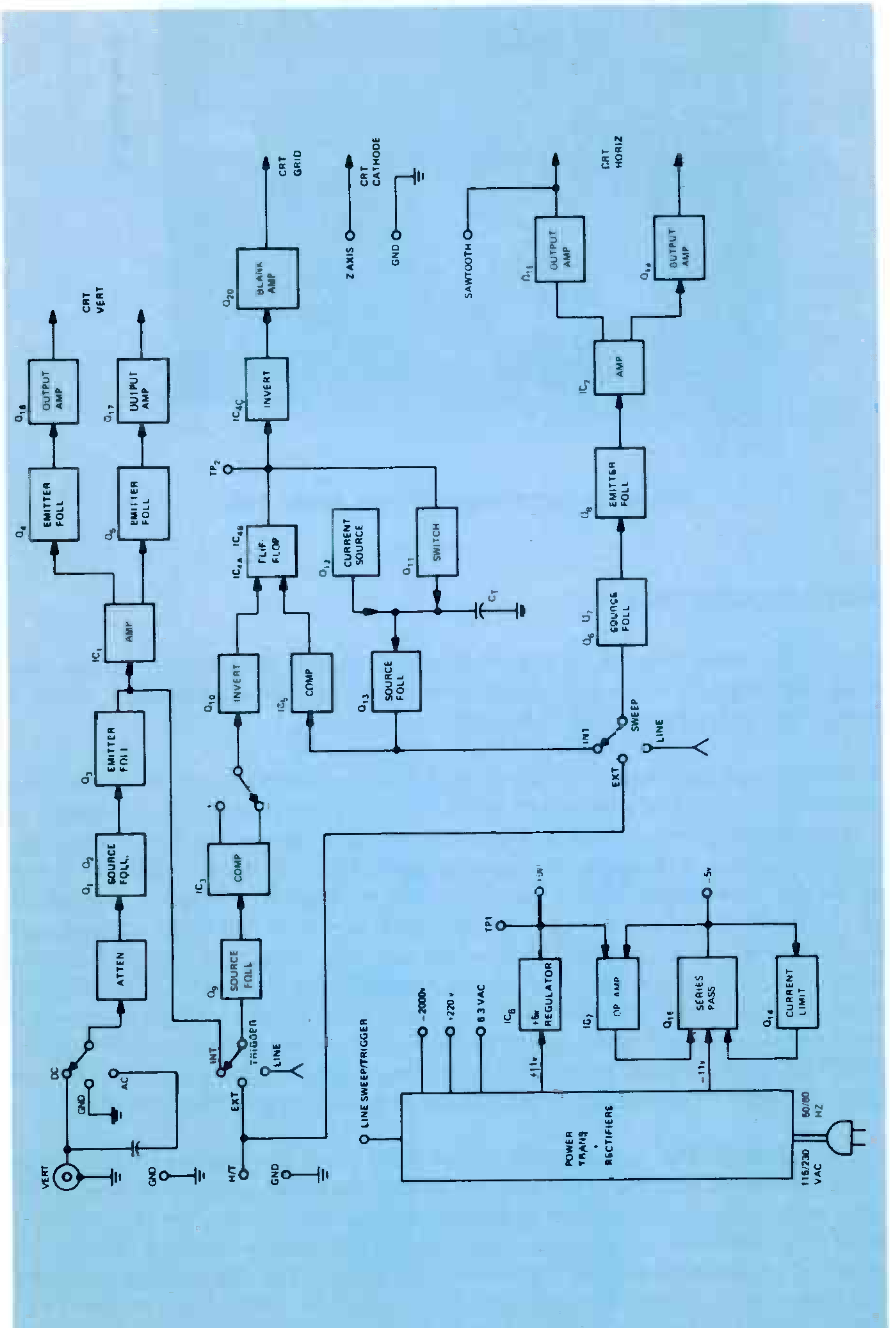


FIGURE 2. BLOCK DIAGRAM OF THE MODEL 255.

From the vertical attenuator the signal is applied to a source follower circuit whose purpose is to give the vertical amplifier a very high input impedance to minimize loading on the circuit under test. The input impedance of the Model 255 is 1 megohm in parallel with 30 picofarads. Two field-effect transistors (FET's) are used in this source follower circuit in a temperature-compensating arrangement. The two FET's are of the same type, and are connected in such a way that changes in their operation due to changes in temperature tend to cancel out, thereby keeping the amplifier balanced over wide variations in operating temperature. The output of the source follower is buffered by an emitter follower, then fed to the vertical amplifier IC, where the signal is amplified and converted into push-pull form. The two output signals are buffered by independent emitter followers and finally amplified by the high-voltage vertical output transistors. The output signals from these transistors, of course, are applied to the CRT vertical deflection plate.

The horizontal amplifier is similar to the vertical amplifier, the main difference being the relaxed gain and bandwidth requirements. This means that the horizontal output stage operates at lower current levels than the vertical output stage, and thus the output of the IC amplifier needn't be buffered before application to the output stage. The outputs of the horizontal amplifier stage are applied to the horizontal deflection plates of the CRT.

So far we have gone through the circuits that control the electron beam in the vertical and horizontal directions. Now let's see how the linear time base is generated. First of all, notice that a signal is taken from the vertical amplifier at the output of emitter follower Q_3. This is a sample of the signal being observed, and this is the signal normally used for triggering the sweep generator. This signal is passed through a source follower and fed to the trigger comparator, IC_3. This comparator is adjustable with a front panel control, called the trigger level control, so that a trigger pulse is generated at some point during each cycle of the applied signal. The trigger level control allows the operator to select at which point the trigger pulse is generated. The trigger comparator has two outputs of equal amplitude but opposite polarity. The front-panel slope selector switch allows you to choose either one so that you can cause the scope to trigger on either the leading or trailing edge of the observed signal. The output of the slope selector switch is shaped and inverted by Q_{10} and applied to one of the two inputs of the set-reset flip-flop, which is made up of two of the four sections of IC_4. The flip-flop is a latch circuit that remains in either of two states until commanded by an appropriate input to switch to the opposite state. It then remains in that state until commanded by switch again. The trigger signal from Q_{10} can set the flip-flop, but cannot reset it. The reset pulse must come from the sweep length comparator, IC_5. Whenever the flip-flop is set, the transistor switch, Q_{11}, is turned off, and the timing capacitor (C_T) is allowed to charge towards +5 volts through constant current source Q_{12}. The constant current charging configuration produces a true linear sweep, as the voltage across the capacitor is directly proportional to time. The capacitor voltage is sampled by source follower Q_{13}, whose output is applied to the horizontal amplifier. This same output is also applied to the sweep length comparator, IC_5. The purpose of this connection is to determine when the sweep voltage has risen high enough. At that point IC_5 generates a pulse which resets the flip-flop, and the circuit ceases operation until the next trigger pulse arrives.

Thus, whenever the flip-flop is in its reset condition, it can be set into operation by a trigger pulse, and will generate one complete sweep, then shut itself off until another trigger pulse is applied. This means that the sweep will always start at the same point on the waveform under observation, and thus the waveform display will be steady and unchanging.

The output of the flip-flop is inverted by a third section of IC_4 (the fourth section is unused) and fed to a high-voltage retrace blanking amplifier stage. The output of the retrace blanking amplifier is a negative-going pulse which occurs each time the sweep is completed; in other words, while the electron beam is moving from the right of the screen back to the left in preparation for beginning a new sweep. This retrace is not a useful part of the waveform and would only confuse things if it were seen, so the negative pulse applied to the CRT grid momentarily turns off the CRT so that the retrace is not seen.

All the low-level circuitry in the Model 255 oscilloscope is operated from the ±5-volt regulated power supply. This means that all the critical amplifying and waveform generating circuits in the oscilloscope are always operated from a fixed voltage, regardless of line voltage fluctuations, which contributes greatly to measurement accuracy. The +5-volt regulator circuit is simplicity itself, as it consists of exactly one component: a three-terminal voltage regulator, which is a self-contained integrated circuit. The input to this IC is unfiltered and unregulated dc of about 11 volts, and the output is well-regulated and well-filtered dc at +5 volts. Current limiting and thermal protection are included on the chip.

The negative voltage regulator is somewhat more complex, at least in outward appearance. This regulator uses an operational amplifier IC to sense the +5 and −5-volt outputs. Since the +5-volt output is accurately known and stable, it is used as a reference for the −5-volt regulator. The operational amplifier senses any difference in the magnitude (ignoring the polarity) of the two voltages, and adjusts the conduction of the series pass transistor, Q_{15}, so that the two voltages are exactly the same. Q_{14} serves as a current limiter to protect the series pass transistor against accidental short circuits on the −5-volt supply line.

In addition to the ±5-volt regulated supplies, the power supply also furnishes 6.3 volts ac for the CRT heater, +220 volts dc for the vertical, horizontal, and retrace blanking output amplifiers, and −2000 volts dc for the CRT electron-gun circuitry. In addition, a small ac voltage is furnished to the trigger and sweep selector switches to allow observation of signals that are near power-line frequencies without external trigger connections. The line sweep mode is often useful for sweep alignment work and in making frequency comparisons. These applications, of course, are described in detail in the oscilloscope manual.

WHAT THE MODEL 255 CAN DO FOR YOU

The important specifications of the new oscilloscope are listed in the CONAR advertisement on the inside front cover. Comparison of these specs with those of other scopes costing twice as much as the Model 255 show that the new CONAR scope is indeed a very good buy. Specifications are very useful in estimating how

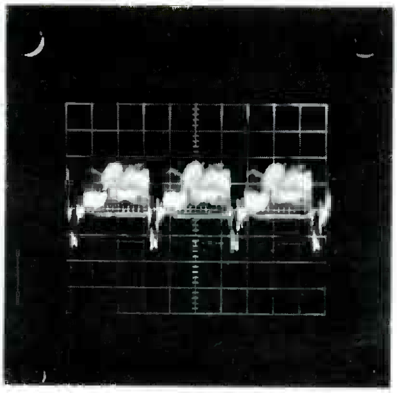


FIGURE 3. VIDEO SIGNAL AT 20 MICROSECONDS/CM.

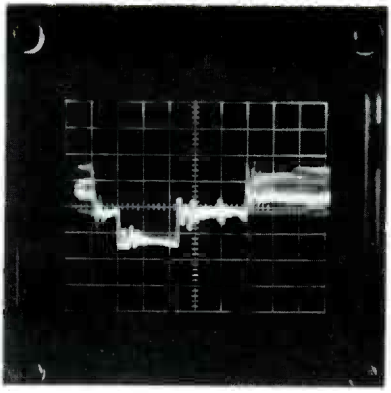


FIGURE 4. SAME SIGNAL EXPANDED TO 1 MICROSECOND/CM.

good a particular piece of equipment may be for a given application, but in everyday work you will be using the scope to view waveforms, and the sharpness and accuracy of these waveform measurements are really what you are ultimately concerned with. If you have ever peeked inside a television receiver with an oscilloscope, you have certainly seen a video waveform such as the one shown in Figure 3. This waveform is as displayed on the Model 255 at 20 μsec/CM. Now, you can get a display like this on just about any scope, regardless of whether it has triggered sweep or not. Different scopes will have different degrees of trace stability and sharpness, but, in general, you will always be able to see this waveform.

Now, imagine that you want to expand the waveform to see the color burst on the back porch of the horizontal sync pulse. If your scope has recurrent sweep, you'll reach for the horizontal gain control to do this. With triggered sweep, you turn the calibrated time base switch to a faster sweep setting. Figure 4 shows the same waveform on the Model 255 at 1 μsec/CM. The waveform is just as sharp and clear as before, but it has been expanded by a factor of 20 without loss of calibration accuracy. Of course, the Model 25 is not the only oscilloscope that can perform such a feat; indeed, it is possible with any scope having a stable triggered sweep circuit. But it is still a good indication of the type of performance that you can expect.

The new oscilloscope is available from CONAR in either kit form or factory wired and calibrated. The kit, priced at $195.00, can be assembled in a week's spare time, and the only equipment needed for calibration is a TVOM or equivalent dc voltmeter. Assembly is easy and smooth, thanks to the extensive use of printed circuitry. For those of you who want to put your scope into operation right away, the Model 255 is available in wired and calibrated form for $245.00. Either way, this new instrument is a great buy and is sure to give many years of reliable service on your bench.

The Gernsback Award 1973

NRI is proud to announce the winner of the 1973 Hugo Gernsback Award. The Award has been presented to Hennen J. Blanton of Pittsburgh.

Since 1971, NRI has cooperated with RADIO-ELECTRONICS Magazine in making this annual scholarship award of $125 to a deserving student currently enrolled in NRI. The award is applied toward furthering the selected student's education in electronics. NRI is one of eight home-study electronics schools chosen to perpetuate the scholarship, established by RADIO-ELECTRONICS in memoriam to Hugo Gernsback, its founder and a notable pioneer in electronics.

Hennen J. Blanton was born August 7, 1933 in Pittsburgh, Pennsylvania. Hennen led a rather nomadic existence, being an only child and losing both parents at an early age. His first involvement with the law came at age eleven and has continued through the present offense for which he is now imprisoned.

While incarcerated, Hennon became interested in educational and vocational pursuits and successfully completed the GED tests and received a high school equivalency diploma.

During his periods of freedom he has been variously employed as a vacuum technician, motor rewinder, industrial maintenance electrician, quality control inspector, test equipment construction technician, computer operator on NCR Century Series 100 and 200 with discs, unit record equipment operator, and wireman. His motivation for NRI training came, as he puts it, "because I have had a number of jobs and almost all of them required more knowledge than I had. I want to obtain training in various fields so that I will have more to offer an employer than an untrained or partially trained person. I am going to enroll in an additional NRI course as soon as I complete the present one."

Hennen is single. His hobbies and interests are all directed toward the electrical and/or electronics field: kit building, reading, and listening to classical music.

Hennen worked in Federal Prisons Industries to earn the money to finance his studies. He plans to use his newly acquired skills to rehabilitate himself upon release. The Gernsback Scholarship Award will definitely benefit Hennen in his pursuit of his goals.

He is presently enrolled in the Electronics Technology course from NRI.

Servicing Automobile FM Stereo

Phillip D. Deem

Auto stereo FM has been around for a number of years, now. The early units were composed of a basic AM/FM radio and employed a stereo multiplex unit as an add-on accessory. The multiplex section was undoubtedly designed as an accessory to allow the manufacturer to take advantage of a potentially larger market. People who had purchased their automobiles equipped with only a standard FM radio could purchase the multiplex accessory and enjoy FM stereo in their cars in much the same way as when they added a multiplex section to their home FM receivers.

By 1969 complete stereo FM receivers were available with all the circuitry contained in the regular radio. While the first complete units were available only on General Motors cars, stereo FM is available as an optional accessory on almost all new cars today. This means that there are quite a few of these units in use. Several of them are likely to find their way to your service bench. In order to get these radios back into working condition, you must be familiar with them and understand how they operate.

In this article we will take a look at two stereo FM receivers which are typical of those being installed by automobile manufacturers today. Each of these units contains one or more integrated circuits (ICs). The ICs have enabled the manufacturer to reduce his assembly costs while retaining the same or achieving better performance. From a servicing viewpoint, you will be interested only in how the ICs function, since they cannot be repaired and must be replaced if defective.

One of the receivers we will be discussing is manufactured by United Delco for General Motors. It is listed as the Cadillac Model 36CFMT1. The other receiver we will be discussing is manufactured by Philco-Ford. It is used in several Ford, Lincoln and Mercury models. We will refer to these receivers as the Delco 36C and the Ford, respectively.

An AM section is included in both of these receivers. They are all quite similar in design and very much like most AM automobile receivers. Unlike most home AM/FM receivers, the complete front end (rf amplifier, converter, i-f amplifier and detector) is separate from the FM portion of the receiver. This makes servicing the various sections quite simple since they are completely independent.

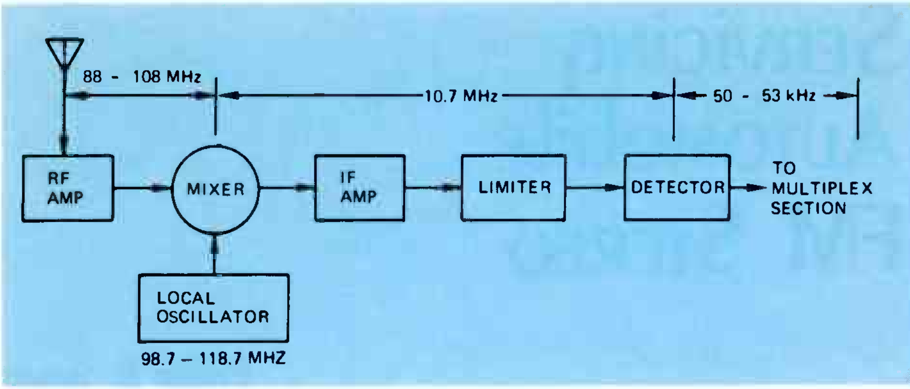


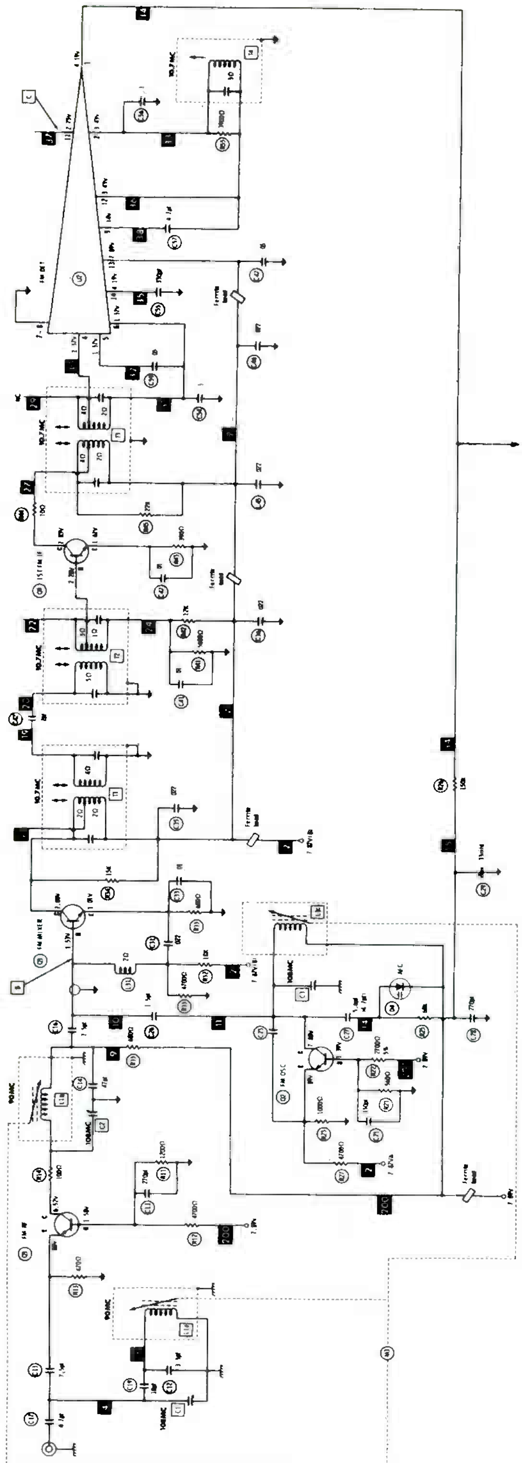
FIGURE 1. BLOCK DIAGRAM OF A TYPICAL FM SECTION.

A block diagram of a typical FM section is shown in Figure 1. Signals from the antenna are fed through an rf amplifier to the mixer. A signal from the local oscillator beats with the incoming rf signal to produce the i-f of 10.7 MHz. The signal amplitude is built up considerably by the i-f amplifier and limiter. In fact, the limiter is merely additional stages of i-f amplification. Eventually the signal is amplified to the point that it becomes nearly a square wave at the output of the limiter. This is done to remove any undesirable amplitude variations on the rf signal. Remember, in FM all of the intelligence is contained in variations of the frequency of the incoming rf signal and not in its amplitude.

The amplified and limited i-f signal is then fed to the detector where the original audio modulating signal plus the 38-kHz subcarrier and its sidebands are recovered. This composite FM signal is then fed to the multiplex section.

A schematic of the FM section in the Delco 36C is shown in Figure 2. The desired incoming rf signal is selected by the parallel-resonant circuit consisting of L1a, C1, C19, and C12. The signal developed across the resonant circuit is fed through C13 to the emitter of the common-base rf amplifier, Q1. The amplified rf signal is fed through the impedance matching pi network tank circuit consisting of L1b, C2, and C14 then through C16 to the base of the mixer, Q3. The pi network tank transforms the relatively high output impedance of Q1 to the low input impedance of Q3.

The local oscillator signal is developed by Q2 across the parallel-resonant circuit, L1c, C3 and the AFC diode, D4. The signal is coupled from the collector of the oscillator through C26 to the base of the mixer. Now, we have both the selected rf signal and the oscillator signal at the base of the mixer. These two signals will beat together in the mixer forming both a sum and a difference frequency. The first i-f transformer, T1, is tuned to select the difference frequency or i-f of 10.7 MHz. The i-f is coupled from the secondary of T1 to the primary of the second i-f transformer, T2. Two i-f transformers are used here to achieve the necessary bandwidth to accomodate the FM signal. The i-f is coupled from the secondary to T2 to the base of Q4, the first i-f amplifier. The amplified i-f signal is fed to the primary of the third i-f transformer, T3 and coupled from the secondary to the



Courtesy Howard W. Sams

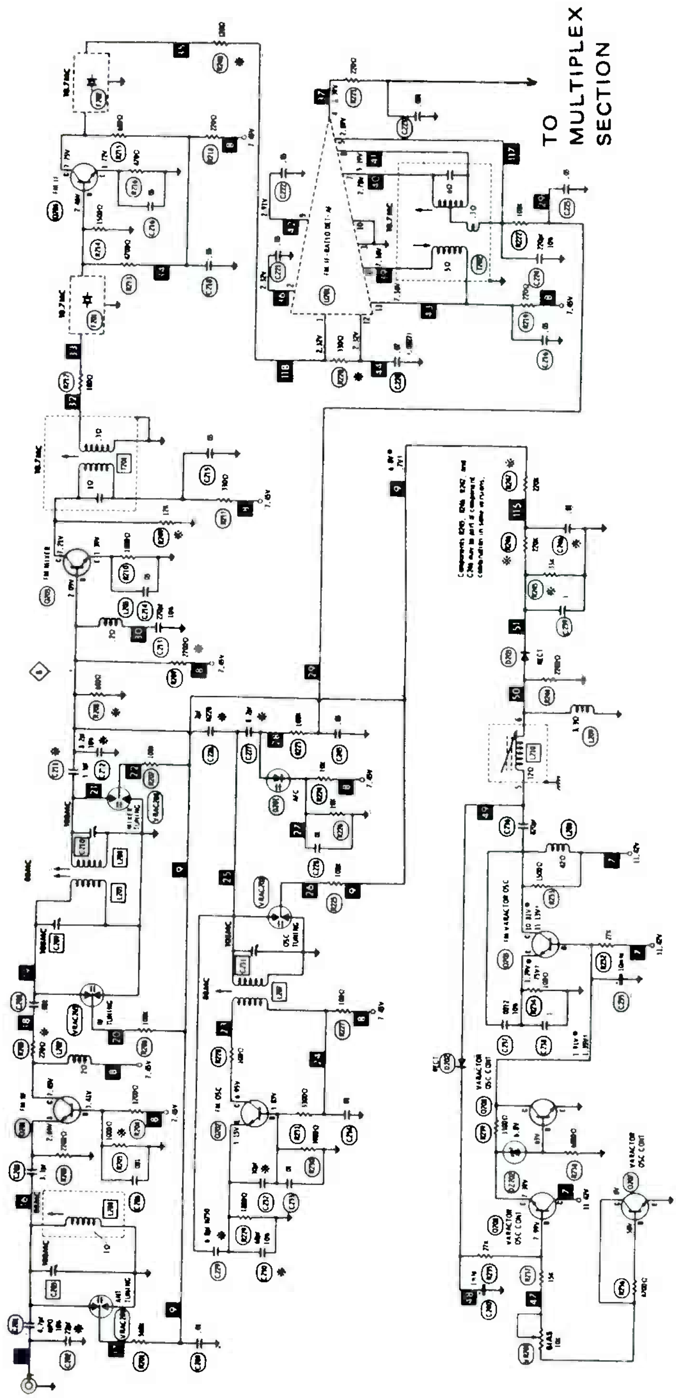
FIGURE 2. SCHEMATIC OF THE FM SECTION OF THE DELCO 36CFMT1.

input of U2, an integrated circuit containing the limiter/quadrature detector. This IC contains several additional stages of amplification to perform the limiter function. T4 is the quadrature detector coil. It is adjusted to the center or resting frequency of 10.7 MHz. As the incoming i-f carrier deviates above and below 10.7 MHz, a positive or negative voltage will be developed at pin 1 of U2. This varying voltage exactly corresponds to the original modulating signals. The recovered composite FM signal is then fed to the multiplex section, which we will examine later. The detector output is also fed back through an RC filter composed of R26 and C29. The resulting dc voltage is fed through R25 to the anode of D4, the AFC diode. The voltage will cause the capacitance of the diode to change, thus changing the frequency of the local oscillator and keeping the selected rf signal centered in the i-f passband.

The FM section of the Ford radio is quite a bit different from the Delco receiver. The schematic of the Ford FM section is shown in Figure 3. The major difference between this radio and the Delco is the manner in which the receiver is tuned to a particular frequency. All of the "front-end" stages are tuned by varactor diodes. This has allowed the manufacturer to eliminate the three slug-tuned coils usually found in the FM section. They have been replaced by one slug-tuned coil and four varactor diodes. These tune the antenna input circuit, the rf amplifier output circuit, the mixer input circuit, and the local oscillator. You will recall that there was only one tuning adjustment (L1b) between the rf amplifier and the mixer in the Delco receiver.

Since we have already followed the FM signal through the Delco receiver, we will examine only the difference between it and the Ford radio. Let's look at the system of tuning the receiver first. The varactor diodes, VRA201, VRA202, VRA203, and VRA204 are different from the usual single junction AFC diodes. These diodes have two junctions so they appear electrically as two variable capacitors in series. This arrangement allows a much larger variation in total capacitance so the tuned circuits can be varied over a wide range (88 MHz to 108 MHz for the rf amplifier and mixer). These four diodes must receive a variable dc voltage in order to change their capacitance and thus tune the resonant circuits to the required frequency. Normally, this would be accomplished with a potentiometer. However, a potentiometer would not lend itself to the pushbutton tuning format always used in auto radios. Therefore, it was necessary for them to develop this variable dc voltage using a slug-tuned coil as its controlling element. This is accomplished by the circuit consisting of Q205, Q206, Q207, Q208, and their associated components.

Q205 acts as a constant frequency/constant amplitude oscillator. A portion of the oscillator output is rectified by D202 and fed back to the base of Q206. Should the output from the oscillator attempt to increase or decrease, the dc voltage produced by D202 will cause the conduction of Q206 to change. This will result in a change of voltage at the base of the oscillator and ultimately result in a "leveled" signal at the oscillator output. This technique is frequently used in signal generators where a constant-amplitude, calibrated output is necessary. Q207 and Q208 are used to regulate the voltages in the oscillator control circuit. The output from the oscillator is fed through L210, to a second rectifier, D203. The inductance of L210 can be



Courtesy Howard W. Sams

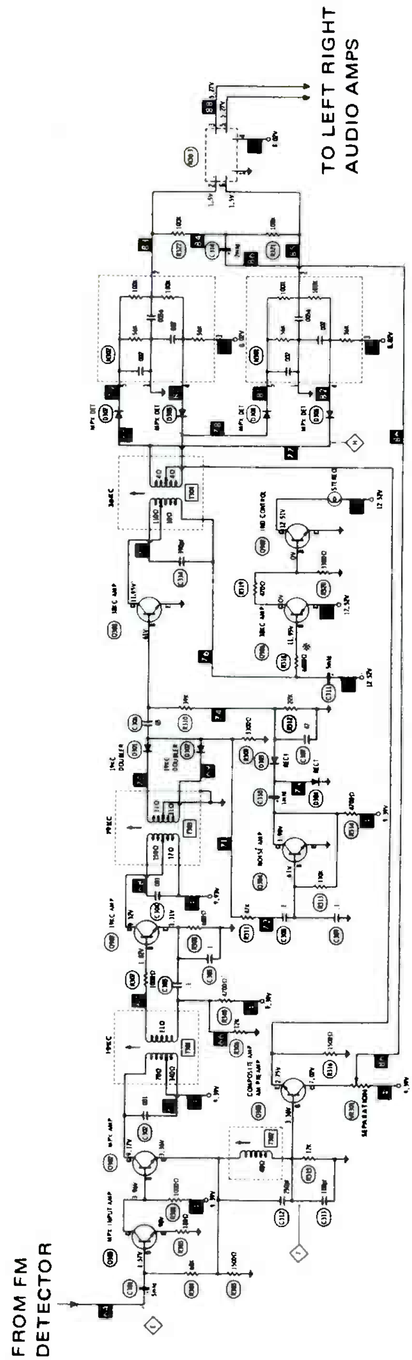
FIGURE 3. SCHEMATIC OF THE FM SECTION IN THE FORD RECEIVER.

varied from the front panel of the receiver. Since the amplitude and frequency from the oscillator remain constant, the inductance of L210 will determine the amount of signal that passes through it to rectifier D203. The rectified voltage is filtered by an RC network and applied through series resistors to the various varactor diodes in the resonant circuits. Thus, by varing the inductance of L210, we are able to vary the resonant frequency of the tuned circuits and ultimately the frequency which the radio will receive.

Another feature different from the Delco receiver is the use of monolithic crystal filters, F201 and F202. They are connected between the input and output circuits of the first i-f amplifier, Q204 and replace two i-f transformers, thus eliminating two adjustments that would otherwise be required. The output of the second filter is fed to the input of U201, an integrated circuit containing a high-gain i-f amplifier, limiter, ratio-detector and audio preamplifier/driver. This IC is manufactured by RCA and listed as CA3043. It is not quite as simple to adjust as the limiter/detector we examined in the Delco unit since two adjustments must be performed to set the ratio detector to the correct frequency; however, it performs the same function. The detected audio signals appear at the junction of R222 and C224, near the ratio-detector coil, T202. A portion of the recovered signal is fed to the AFC circuit to ensure that the received signal remains centered in the i-f passband. The remaining detected audio signal is fed back into U201 at pin 5, the input to the audio preamplifier/driver. The amplified audio signal appears at pin 4 and is fed to the multiplex circuits.

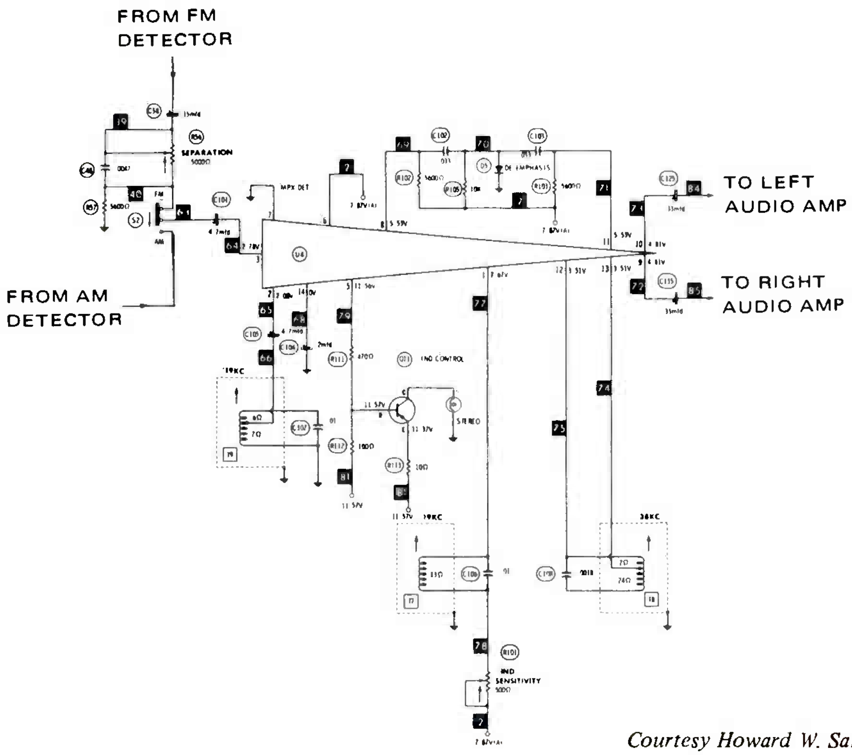
Next, we will examine the stereo multiplex section of these receivers. Since the multiplex section used in the Ford radio is composed of discrete components rather than integrated circuits, we will study it first, since it is somewhat easier to see how it works. The schematic of the Ford multiplex section is shown in Figure 4. The signal at the input of the multiplex section will consist of the composite FM signal or the signal from the AM detector, depending upon which function has been selected at the front panel of the radio. If the selector is in the AM position, the audio signal will be amplified by Q301 and coupled through Q302, as an emitter-follower to the base of Q305, the AM preamplifier. The output of the preamplifier is fed to the center tap of the secondary of T304. Since equal amplitude and opposite polarity signals will appear at the opposite ends of the secondary, equal audio signals will be fed to both the right and left channel stereo amplifiers.

The composite FM signal follows a similar path, but is acted upon differently by the multiplex detector after it reaches the center tap of T304. The signal is amplified by Q301 and Q302. A circuit tuned to the pilot frequency, 19-kHz, is placed in the collector circuit of Q302. The selected 19-kHz signal is further amplified by Q303 and applied to the primary of the pilot doubler coil, T303. The secondary of T303 is fed to the doubler diodes D301 and D302. This circuit produces 38-kHz at its output in much the same way as the 60-Hz signal in a power supply is doubled by a full-wave rectifier circuit. A portion of this signal is fed to the noise amplifier, Q304. This transistor and its associated components determine the minimum acceptable signal level by biasing the 38-kHz amplifier, Q308, beyond cutoff until the minimum threshold is achieved. When the signal is sufficiently strong, the amplifier is allowed to conduct and feeds the 38-kHz signal to the



Courtesy Howard W. Sams

FIGURE 4. SCHEMATIC OF THE FORD MULTIPLEX SECTION.



Courtesy Howard W. Sams

FIGURE 5. SCHEMATIC OF THE MULTIPLEX SECTION IN THE DELCO 36CFMT1.

primary of T304. The amplified 38-kHz signal appears at the secondary of T304 along with the composite FM signal. The 38-kHz signal so developed is equivalent to the subcarrier that was used at the FM broadcast station and allows recovery of the individual left and right stereo signals.

This type of multiplex detector is referred to as a switching or envelope detector. The polarity of the 38-kHz signal determines whether the upper or lower pair of diodes conduct. The upper pair of diodes and associated filter network recover the left audio signal. The lower pair of diodes and filter recover the right audio signal.

A portion of the 38-kHz signal is also applied to the base of Q306. This transistor amplifies the signal and feeds it to the base of the indicator control transistor, Q307. The presence of a sufficiently strong 38-kHz signal will cause Q307 to conduct, providing a ground return for the stereo indicator lamp. In other words, when a stereo signal of sufficient strength is received, the stereo indicator lamp will be lighted.

Now let's examine the multiplex section used in the Delco radio. The schematic diagram of the multiplex section used in the Delco 36C is shown in Figure 5. Notice how few components are used in this multiplex section in comparison with the sizable number used in the Ford receiver. It is no wonder that the manufacturers are designing integrated circuits into their receivers as quickly as possible. The obvious saving in reduced parts count and less assembly time is very desirable.

The composite FM signal is coupled through C58 and the separation control network to the selector switch. When the selector switch as in the FM position, the composite signal will be coupled through C101 to the input of the multiplex IC, U4. When the selector is in the AM position, the detected audio information is fed through C101 and the IC and appears as equal signals at pins 9 and 10, the right and left channel outputs from the multiplex decoder.

The multiplex IC performs the same functions as the discrete circuit used in the Ford radio. T9 is adjusted to select the 19-kHz pilot signal from the incoming composite FM signal. The pilot is amplified and applied to the pilot doubler. The output of the doubler is selected by T8 and is used to recover the individual left and right stero signals. A portion of the amplified 19-kHz signal is applied to the stereo switching and indicator circuitry. The threshold is adjusted by R101. The setting of this control determines the weakest usable stereo signal and also when the stereo indicator lamp will be lighted.

The left and right stereo outputs from the multiplex section are fed to a switch in this particular unit, since a cartridge tape player has also been included. The switch determines whether the stereo multiplex signals or the signals from the tape deck preamps are fed to the left and right audio amplifiers.

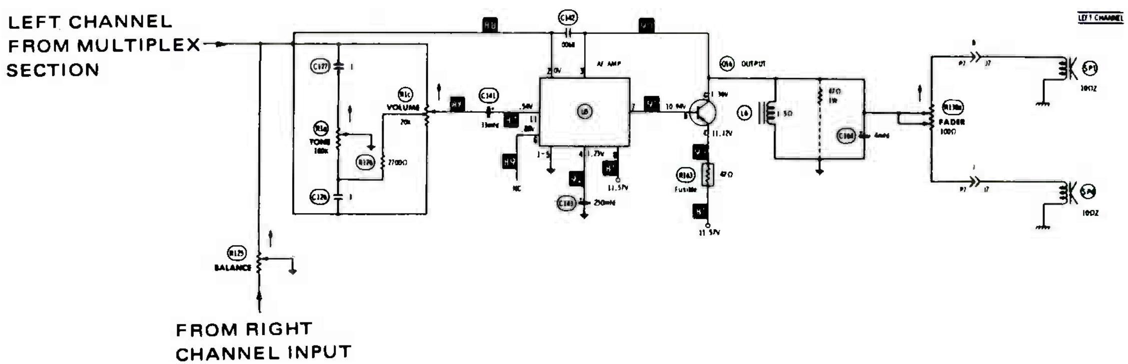
A schematic of one of the audio channels used in the Delco 36C is shown in Figure 6. The audio signal is fed through the tone and volume control circuitry to the input of an integrated audio preamplifier/driver, U6. The amplified audio signal is direct-coupled from the IC to the base of Q17, a high-power audio output stage. The amplified audio signal is fed through the fader control to the front and rear speakers. The amplifier for the remaining channel is identical to the one shown.

The audio section used in the Ford radio is made up of discrete components. Three single-ended amplifiers are used to drive a complementary-symmetry power output stage. However, the design is straightforward and will not be discussed further here.

Now that we have taken a close look at some of the circuits contained in these receivers, let's think about possible problems that could arise in them.

Suppose the complaint is that the radio works on AM but not on FM. Since the radio works on AM, you know that the antenna, AM front end, and audio circuits are in good condition. In the circuits that we have studied, you will also know that the multiplex section is at least partially functioning, since the audio from the AM section is fed through it. The trouble is likely to be located in the FM rf amplifier, the mixer, the local oscillator, or the i-f amplifier stages.

Though you are testing the FM section of the receiver, you will be able to use the signal from your AM generator in troubleshooting certain parts of this section. Adjust your signal generator to the FM i-f, 10.7 MHz. Inject the signal at the collector of the mixer. Use a high-impedance meter with a demodulator probe or



Courtesy Howard W. Sams

FIGURE 6. SCHEMATIC OF LEFT CHANNEL AUDIO AMP IN THE DELCO 36CFMT1.

make up a demodulator to detect the presence of a signal at the output of the i-f. As you vary the generator frequency to either side of the i-f, you should observe a voltage peak when the generator is on 10.7 MHz if the i-f stages are working.

Another likely cause of this problem would be a defective local oscillator. If you suspect that this is the trouble, inject a signal at the base of the mixer between 99 and 119 MHz. If you are able to hear stations, the local oscillator is bad. Measure the voltages at the oscillator transistor and compare them with the typical readings given in the schematic diagram. If your readings vary by more than ±20% from the typical readings, a replacement transistor should be tried. Since this transistor must operate at a very high frequency, it is unlikely that a conventional testing method would be satisfactory.

If injecting a signal at the local oscillator frequency did not enable you to hear stations from the receiver, the trouble is located in the rf amplifier section. Again, measure the voltages at the rf amplifier transistor. If they are not correct, try a substitution.

A frequent complaint regarding stereo units is that one channel does not operate. This is probably one of the easiest troubles to repair. It is always possible to compare measurements between the operating channel and the defective one in order to locate the cause of the trouble. By injecting an audio signal, working from the speakers toward the preamp, you should be able to discover which stage is defective. Don't forget to reduce the amplitude of the signal you are injecting as you progress toward the more sensitive stages. Otherwise, you may force a signal through a defective stage.

Nearly all of these units contain a fusible resistor in the collector-emitter circuit of the audio output stage. A temporary short in the wire connecting the output of the amplifier to the speaker could cause enough current to be drawn through the transistor to open this fusible resistor. Since the speakers are likely to have remained in the customer's car when he brought the unit to you, be sure to check his speaker system if you find this resistor open.

Another complaint may be that there is no audio from either channel. In this case, always take a check at one of the B+ points in the audio amplifier section. Since both channels are dead, the trouble is probably caused by some component which is common to both channels. In most cases, this is limited strictly to the power supply. By consulting the schematic, you will be able to determine which section of the power supply operates the audio section. Compare your measurements with the typical readings given on the diagram. This should lead you to the cause of the trouble. Look for shorted filter capacitors, a defective on/off switch or open B+ dropping resistors.

Sometimes a customer will tell you that the FM section seems to work, but it does not put out a stereo signal. This should tell you that the trouble is located in the multiplex section of the receiver. If an integrated circuit is used in this section, about the only tests you will be able to perform are measuring the voltages at the IC pins. If you find a voltage in error, check the components connected to this pin to be sure they are good.

Since the composite FM signal apparently is getting through the multiplex circuit satisfactorily, you will want to determine whether the 38-kHz signal is being developed. Refer to the alignment instructions and go through the alignment for the multiplex section. If a particular adjustment does not produce the correct result, it would be a good idea to substitute a new component to see whether it will correct the trouble. As a last resort, a new IC will have to be tried.

If you were working on a unit similar to the Ford radio which we discussed previously, you would be able to make certain additional tests in the multiplex section since discrete components are used. If the stereo indicator lamp goes on and off as you tune across stations known to be broadcasting in stereo, you know that the multiplex section is working up to the input of the multiplex detector network. The trouble may be caused by a defective detector transformer or a bad diode.

If the stereo indicator lamp does not go on and off as you tune across the stations, the trouble could be located in several other places. Use your scope to check for the presence of the 19-kHz pilot signal at the collector of the pilot amplifier. Check for the presence of the 38-kHz signal at the output of the pilot doubler. The trouble could be caused by a weak pilot amplifier, an open pilot transformer, an open or shorted doubler diode or a defect in the noise amplifier. Remember, in this particular receiver, the noise amplifier holds the 38-kHz amplifier at cutoff until it receives a suitably strong signal from the pilot doubler.

Repairing these stereo units is really no more difficult than repairing a regular AM radio. All you need is a thorough background in basic electronics and an understanding of how the stages in a typical receiver operate. By consulting the schematic diagram for the particular unit you are working on, you will be able to determine how those specific stages should function. Though each manufacturer uses slightly different circuitry, they must all produce the same result.

Job Ops

OPPORTUNITY: Macke Company is interested in hiring students and graduates of SEA courses. Constant demand for trainees. If interested, contact: Macke Company, 5006 Herzel Place, Beltsville, Md. 20705 or phone 937-5404.

WANTED: TV transmitter engineer for station WITV. Requires 1st class license. $6752 per year starting salary. Higher starting pay with commensurate experience. Other benefits: Pension plan, three weeks vacation, 12 state holidays, medical insurance.

WITV is one of five educational stations operated by the state of South Carolina. These stations provide educational programs for various school levels, starting with grade school. A closed circuit TV system is used in conjunction with the telephone company.

If interested, contact: Mr. Frank Simpson, WITV Chief Engineer, Rifle Range Road, Mt. Pleasant, S.C. 29464, Tel: 803-884-9290, or Gerald Warr, Transmitter Engineer, Drawer "L," Columbia, S.C. 29205, South Carolina Educational TV.

HAM NEWS

By Ted Beach K4MKX

Just in case you guys find yourselves with an hour or two with nothing to do one of these fine Fall evenings, we thought we'd give you an interesting and unique construction project to play with. The circuit involved is what I call the "QRPP Key." It's an all-IC self-completing digital keyer that will operate on any supply voltage from +9 V to +14 V with a standby (key up) power consumption of from 900 μw to 2.8 mw (that's right, microwatts and milliwatts) depending on the supply voltage. At 40 WPM and +9 volts the power consumption goes up to a whopping 2.2 mw. If that isn't QRPP, I don't know what is.

The major part of the power consumption is by the external resistors shown in Figure 1. The two ICs use only about 30 μw together! Both IC's are low-cost RCA COS/MOS chips available from many distributors. U1 is a quad two input NOR gate which is used as the clock oscillator and as two combinational logic gates. U2 is a dual D flip-flop which generates the dits and dahs. U2A divides the clock output by two and produces a 50% square wave—the dots and spaces. U2B divides the output of U2A by two and fills in the space between two dits to make the dah. The outputs of the two flip-flops are combined in U1C which controls the clock and the keying transistor driver, U1D. Q1 will handle cathode (or emitter) currents of 100 ma and a key up voltage of 40 volts.

R2, R3, and C1 determine the speed range of the clock and thus the key. With the values shown in Figure 1 the WPM range is approximately 10 to 60 (goodness knows I can't send that fast!). You can easily change these to suit your own needs. Increasing R3 will raise the lowest speed, decreasing C1 will raise the entire range, etc.

Now, to the "unique" part of this project. While you could build this simple circuit on a piece of perf board, the easiest way is to make an etched circuit board. For the first time anywhere (at least to my knowledge) we give you all you need so that you can make the circuit without having to make a negative or use a resist pen or any of that unwelcome stuff. All you need is a

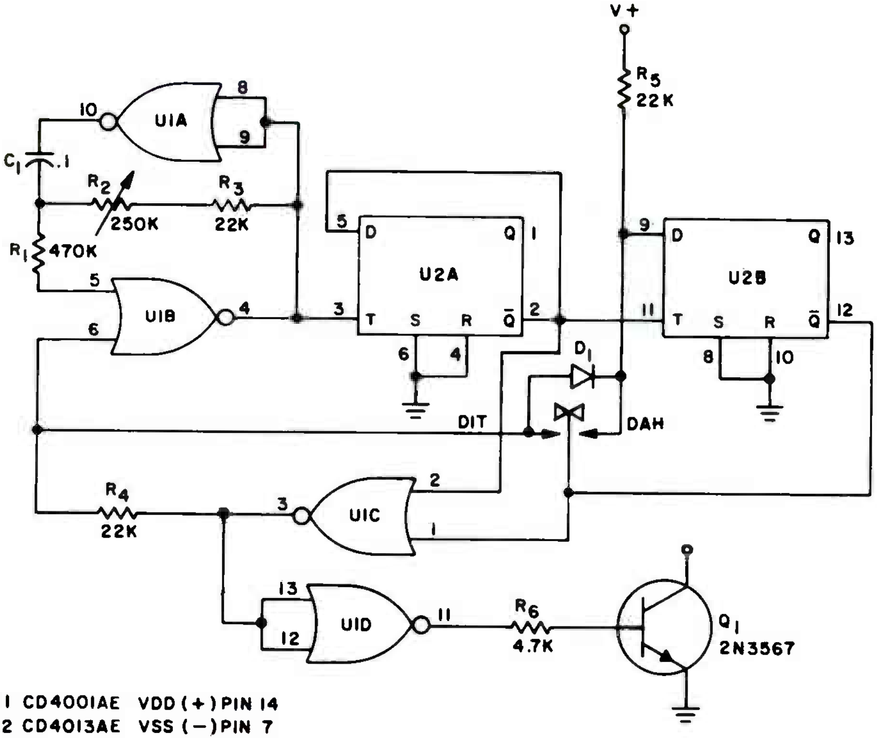


FIGURE 1. SCHEMATIC OF QRPP KEY.

pre-sensitized circuit board and the chemicals and such to process the board.

Figure 2 is an actual mechanical negative that you can cut out and use to expose the pre-sensitized board. You will notice that the printing in Figure 2 is backwards and the space on the page behind Figure 2 is blank. If you hold the page up to the light and look at the figure from the other side you will see what the foil will actually look like. The printing will read correctly from this side. Every place you see black (lines, dots and lettering) will be *without* copper on the finished board. The white areas will be copper. As you can see, this is a minimum copper removal layout so you won't waste your etchant (Hi!). At the same time, if the parts you use differ from those I used originally, you can easily drill other mounting holes in the large copper areas to accommodate different lead spacing. How about that?

You can use the pre-sensitized circuit boards mentioned earlier (Kepro and Vector make them and they are available almost everywhere) or you can sensitize your own board (Kodak KPR or GC spray sensitizer). In any case you will need a board 2" by 4" which is photosensitized. Cut out Figure 2 (outside the border which marks the board edges) which is your negative. Lay it *print side up* on a piece of glass and (in subdued light) place the pre-sensitized side of the board in contact with the negative. Use whatever means you have to secure the three (glass, negative and board) together. Clips or large rubber bands work nicely.

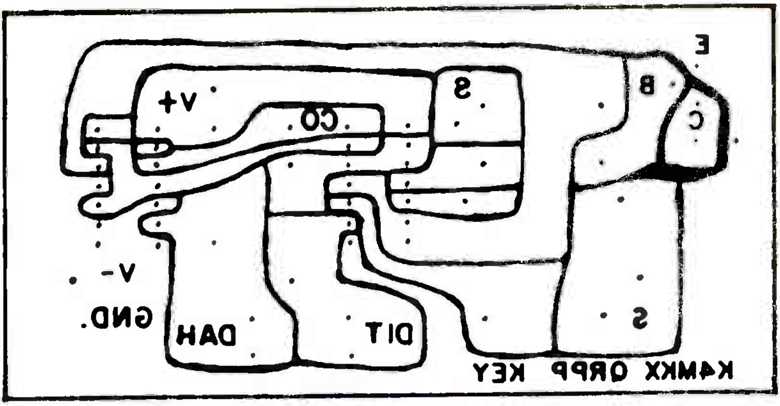


FIGURE 2.

The next step is to expose the board. All boards are most sensitive to ultraviolet light so you should use a light source which is high in UV content. My personal preference is to use skylight. Not direct sunlight, but skylight. This means you'll have to expose the board during the day (moonlight won't work!), but what the heck, it's free and quite reliable. You can even do it on an overcast or cloudy day. You may have to experiment to get the proper exposure, but I have found that one to two minutes of skylight does the trick very nicely under most conditions. I put the assembly in a light-tight box, take it outside and, with my back to the sun (if it's out), open the box and point the glass toward the sky. After about two minutes pop the lid back on the box and take it inside to develop the board.

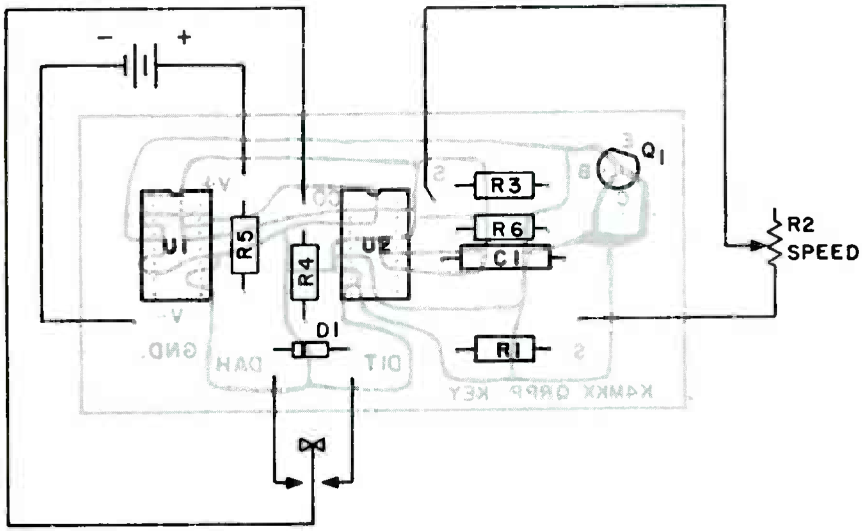


FIGURE 3. COMPONENT LAYOUT FROM TOP OF CIRCUIT BOARD.

Etching and drilling complete the process. The whole deal should take less than twenty minutes.

Figure 3 shows the parts mounted on the board as well as the external connections to the board. It would be a good idea to use IC sockets for U1 and U2. When you install the ICs, put the notch of each IC *up* as shown in Figure 3. The power goes from "+V" to "−V" and the speed control (R2) connects to the two pads marked "S". The key connects to "DIT," "DAH," and "CO." The common (paddle) connects to "CO." The output is from the collector "C" of Q1. The parts designations in Figure 3 are the same as in Figure 1. You can drill mounting holes around the outside of the board if you wish since there is plenty of room and this is ground (−V).

And there you have it—a QRPP key you can make with a minimum amount of effort without using a camera or having a negative made. I am presently working on a second version of this key which uses three ICs and has a built in sidetone generator as well as a grounded key paddle. I plan to write this key up for one of the national Ham magazines using the same techniques described here so you might keep your eye peeled for it. I would be very interested in any and all comments from you guys regarding both the construction technique and the key itself, so let me hear from you.

Now, let's see who's who out there among the NRI Ham fraternity. The last three listed at the top of the next page are students or graduates of courses other than the Amateur courses, while the rest are involved with our amateur program.

The question mark following WNØKSV is because I could not read the call as written and what is printed is my own interpretation.

WB4SYF took a long time to write us, but when he first enrolled he studied hard and fast, getting his General ticket in December of 1971. Bryan says he was in such a hurry to get his ticket that he "went ahead to lesson R105 and studied that." Now he operates 75 sideband as well as two meters using a HW12A and a Motorola rig respectively. On two he uses an 11-element beam as well as a home brew parabolic dish built from an article in QST. Nice going, Bryan, keep up the good work.

Richard	WN4DGF	N	Shelbyville, TN
Bryan	WB4SYF	G	Orangeburg, SC
Wayne	WN5HMB	N	Garland, TX
Joel	WN5JCA	N	Plainview, TX
Walter	WA6FAQ	–	Vallejo, CA
Keller	WN6ILK	N	San Diego, CA
Gerald	WA6QOG	G	Blythe, CA
Fred	WN6VMX	N	Huntington Park, CA
Mike	WN7WIM	N	Reno, NV
Edwin	WN8OVM	N	Northfield, OH
Tom	WB9GQB	E	Indianapolis, IN
Lynn	WB9KTR	–	Ft. Wayne, IN
Phil	WNØKSV(?)	N	Springville, IA
Norman	WB2LAO	–	Audubon, NJ
Charles	W4DEQ	–	Jamestown, NC
Albert	WA7SHF	C	No Las Vegas, NV

WA6QOG has had his General since 1944 when he was W7JMO. Right now Gerald is working for his Extra and we're sure he'll make it real soon.

Mike, WN7WIM, wrote on his report for Training Kit 3R that he got his Novice in August and really likes the CONAR 400 transmitter. He has worked lots of states, two of them over two thousand miles distant. Mike says that since he has gotten on the air that his studies have suffered and he will have to get back into the study habit so he can go for his General.

WB9GQB deserves all of our congratulations for acquiring his Extra. In addition, Tom says he also got his First Phone license at the same time and thinks NRI really helped him get both licenses. Thanks, Tom, and again our heartiest congratulations to you also.

Just about the only thing WB9KTR didn't tell us in his nice long letter was the class of his license. Lynn started off as an SWLer and has an SB310 which he uses for DXing. He says that he built the antenna tuner described here in the March/April issue to match the SB310 to his 80/40 meter antenna in the SW bands. Lynn used insulated hookup wire wound very tightly, stripping off the insulation to make the taps as he wound the coil. Thanks a lot, Lynn, it sure is nice to know that something we say here has helped someone.

One of the many aspects of Ham radio that I have not yet gotten involved in is TV–ATV or slow scan. The latter, however, appears to be the major interest of WB2LAO. Norm converted an old scope by putting in a P7 tube and installing a dc vertical amplifier. He built an adapter which was written up in the 1973 ARRL Handbook. His first pictures received were from Venezuela. How about that?

W4DEQ is enrolled with NRI for the second time at present. Charles first enrolled in 1945 when he was a Naval radio operator. At that stage of the game he says he was long on operating but real short on theory, hence the interest in the

NRI Communications Course. His first rig was the old double-decker AM rig which was part of the course in those days. From that rig Charles went to an 807 home brew and finally to his present Swan 270B which he uses mostly on 75 and 40, both mobile and at home. Charles' second NRI course is Radio TV Servicing which takes a bit of time away from his operating these days, but that's the way it goes.

And that about winds it up this time fellows. Have a nice Thanksgiving and Christmas and we'll see you next year. Be sure to read the Ham Ads, and do write!

Very 73

Ted – K4MKX

Ham Ads

WANTED: Schematic or manual for RT-19/ARC-4 Aircraft Transceiver.

J. W. Heater
2704 S. Highland
Amarillo, TX 79103

SELL or TRADE: Heath HW101, HP23B and SB200. Brand new. $350.00 or trade for Drake T4X with ac power supply.

Bill Gleason
24-09 28th Street
Astoria, NY 11102
Phone: (212) YE 2-1075

SELL: Hallicrafters SR160 with dc supply and Hustler foldover mast and 75 meter resonator. $200.00.

Charles S. Coy – WBØENV
RR2
Keytesville, MO 65261

FOR SALE: Complete station. Galaxy V MK-2 transceiver with matching speaker console and 125 V supply SB-44 mike. $300.

Ronald Muha--WA3AOL
Rd. #4, Box 239 G
Johnstown, Pa. 15905

Reader Exchange

FOR SALE: Sencore Model CG141 color bar, dot, and crosshatch generator in good condition for $100. Originally cost $170. Amphenol b&w and color crt checker in good condition for $50. Original Price $79. Wahl cordless soldering iron. NEVER BEEN USED. Asking $15.

Timothy Schnapp–B121-G926-G
2905 Rockwood
Toledo, Ohio 43610

NRI HONORS PROGRAM AWARDS

In the tradition of NRI's pursuit of excellence in training, the following graduates who earned NRI electronics diplomas in July and August 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.

With Highest Honors

Kim Adelman, Minneapolis, MN
Randall K. Bahr, Albuquerque, NM
Yip Chow, Toronto, ON, Canada
John X. Cota, Prairie Du Chien, WI
Morris H. Crabb, Elsinore, UT
Richard L. Craig, Jr., Chicora, PA
James R. Hanna, Hornsby, TN
Patrick Hwang, North Garden City, NY
John L. Isom, Indianapolis, IN
Clifford H. Jording, Sterling, IL
Edwin J. Kandler, Victoria, TX
Barry H. Nicholson, Richland WA
Norman M. Peterson, Virginia Beach, VA
Harry J. Reichert, Jr., Philadelphia, PA
Floyd E. Riggle, Van Meter, IA
Michael F. Smith, Beverly, MA
Claude K. Stambaugh, Bellingham, WA
Robert J. Sullivan, Binghamton, NY
Wilbur C. Thompson, Hanahan, SC
Lee W. Troupe, Zephyrhills, FL

With High Honors

Orval J. Anderson, Scaramento, CA
Neal E. Baker, Geneva, OH
Wilbur E. Baskin, Drums, PA
Richard A. Beckenbaugh, Issaquah, WA
Arthur G. Bernier, Jacksonville, NC
Kenneth L. Booth, Clarksburg, WV
Ronald Bouley, Whitinsville, MA
Michael Breskiewicz, Kulpmont, PA
Guy W. Campbell, Jacksonville, FL
Narciso Carrillo, North River British Honduras Central America
Thomas Carrion, Jr. Havelock, NC
G. C. Caswell, Arlington, VA
Harry W. Conrad, Via Sept Isles, PQ, Canada
John A. Conti, New York, NY
Anthony W. Cukar, Brooklyn, NY
Brian R. Cushing, Decatur, IL
Nicholas L. De Church, Big Run, PA
Capt. Jerry A. De Lozier, Martinez, GA
James R. Edmunds, Huntsville, AL
Michael L. Falwell, Lynchurg, VA
P. M. Fischer, Barberton, OH
Niels P. Frandsen, Potomac, MD
Edgar E. Forry, Bowie, MD
Travis L. Frizzell, Unalakleet, AK
Dr. Thomas C. Graham, Newnan, GA
Charles K. Grote, St. Paul Park, MN
Clarence Halfmann, Clute, TX
Robert D. Harrison, Jackson, MS
Richard T. Hemsley, Annandale, VA
Robert L. Hilty, Columbus Grove, OH
John E. Hogg, Rockville, MD
Howard N. Holley, Fitzgerald, GA
Charles R. Hutchins, London, OH
Richard A. Johnston, Falls Church, VA
Richard Jolley, Oakland, CA
Charles F. Kellner, Racine, WI
Harold Kinley, Kingstree, SC
Barry Kreel, Toronto, ON, Canada
John Korlick, Manassas, VA
Trammell C. Lacey, Arlington, VA
Frank Ladra, Bridgeport, CT
Ernest W. Lang, Beverly, MA
Arthur F. Lewis, Englewood, NJ
Richard K. Madison, Eglin AFB, FL
George M. Marechek, Jr., Cheverly, MD
John E. Matheny, Metairie, LA
Ronald J. Mayer, West Allis, WI
Jack E. Mergele, Crystal Lake, IL
Steven K. Molnar, FPO New York
Stephen J. Momot, Jr. Wilmington, DE
Larry A. Moore, Houston, TX
Gilbert H. Moorhead, Hastings, NE
Jury Muchin, Glendale, NY
Northe K. Osbrink, Santa Cruz, CA
Don Patterson, Ottawa, ON, Canada
Philip R. Phelps, White Haven, PA
Radames C. Pineiro, Caparra Heights, PR
Jack R. Reid, Denham Springs, LA
Edward V. Riley, Hamilton, OH
Gustave P. Robicheaux, Fort Worth, TX
Charles E. Rothganger, Kansas City, MO
Patrick Ryan, Maspeth, NY
Michael H. Siegel, Flushing, NY
Webb Simmons, San Diego, CA
J. B. Singleton, Odessa, TX
William J. Stevens, Farmingdale, NY

H. K. Stinnett, Gary, IN
James Sylvester, Rockville, MD
Walter E. Timpson, Jr., North Kingstown, RI
Michael Titchenell, Culpeper, VA
Craig L. Townsend, Kittery Point, ME
Wendell P. Turner, Jr., Falls Church, VA
Pink Underwood, Jr., APO San Francisco
Jerry E. Ward, Nashville, TN
Alan Watson, North Little Rock, AR
Harold L. Wesson, Lafayette, LA
Richard A. Williams, APO, San Francisco
James S. Wilson, Glendale, CA
James E. Womble, Siler City, NC
Clyde Woods, Rumford Center, ME
Christopher York, Rockledge, PA
Miroslav M. Zich, Rockville, MD

With Honors

Juan Abiega, New York, NY
James J. Anderson, APO, New York
David K. Barber, Rotterdam, NY
James R. Batesole, North Highlands, CA
Gordon L. Baxter, Seattle, WA
Raymond E. Birch, Cincinnati, OH
Lyle E. Blaede, Waverly, IA
Lyall A. Blaker, Sr., Elmira, NY
Frank Bombino, Elmhurst, IL
Tom C. Bonsett, Indianapolis, IN
Victor J. Boutin, Winnipeg, MB, Canada
Donald L. Brown, Jerseyville, IL
Austin J. Burns, Jamaica Plains, MA
Michael G. Butler, Kankakee, IL
Orville A. Carlson, Spring Hill, FL
Ronald J. Carlson, Marysville, WA
Chester L. Cheatham, Mineral Springs, AR
George B. Clark, Jacksonville, FL
Kenneth N. Codrington, Brooklyn, NY
Glenn M. Connor, Bryan, TX
Keith H. Coultrap, Phoenix, AZ
Eugene Crusan, Commerce City, CO
Donald L. Dixon, Brunswick, MD
Konstantin Egedus, Chicago, IL
John C. Ellis, Jr., Rockville, VA
Fred J. Fellows, Port Jefferson Station, NY
Thomas E. Finderson, Carrollton, VA
E. David Foord, North Bend, OR
Frank H. Ford, Pittsburgh, PA
Pedro L. Garza, Chualar, CA
Louis Gonzales, FPO, San Francisco
George G. Gregg, Pittsburgh, PA
Richard M. Grieve, Texarkana, AR
Allen W. Guest, Jr. College Park, GA
John Haith, St. Albans, NY
Brian A. Hall, Locust Grove, VA
Eugene R. Harkness, Honolulu, HI
Roy C. Harris, Ewing, VA
Elmer J. Hauer, Collinsville, IL
James W. Heil, Pittsburgh, PA
James M. Hicks, Ilano, TX
Arthur R. Hren, Hesperia, MI
Edward Huhn, Irvington, NJ
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Robert E. Magyar, Tionesta, PA
Gerald Martin, Federal Way, WA
Casimer C. Marzec, Chicago, IL
Eddy I. Mattison, Codette, SK, Canada
John B. McCormick, East Hampton, CT
Miguel A. Medina, Carolina, PR
Donald R. Mock, Placentia, CA
Arthur S. Montz, Broomfield, CO
Thomas J. Moyer, East Northport, NY
Frederick R. Mumma, Mechanicsburg, PA
Edward H. Nenno, Deming, NM
Thomas J. Nilon, Newtown, CT
Charles E. Olds, APO, New York
Charles Oliver, Saint Louis, MO
Stanley L. Owens, Albuquerque, NM
Donald G. Page, Tribes Hill, NY
Larry J. Paxman, Patrick AFB, FL
Norman F. Peterson, Marion, IA
William A. Peterson, Jenison, MI
Russell C. Phelps, Grand Island, NE
G. F. Rhodes, Tulsa, OK
Ray Richardson, Linden, TN
Gaston Rodrigue, San Josef, BC, Canada
L. J. Rogers, Waxahachie, TX
George E. Rotan, Anton, TX
George B. Savely, Leon, IA
Slavko Savic, Phoenix, AZ
Allen J. Sawyer, Dixon, CA
George A. Schopperth, Haledon, NJ
Nicholas C. Schroeder, Boulder, CO
Thomas A. Skvarek, Middletown, NY
Frank E. C. Smith, Qualicum Beach, BC, Canada
Daniel B. Stedman, Tacoma, WA
Kenneth W. Stevens, Kinder, MO
Walter D. Stoddard, Fremont, CA
William Taylor, Boston, MA
Richard Teruya, Huntsville, AL
Felix Tossan, Toronto, ON, Canada
Harold O. Tripp, Shelbyville, IL
Philip J. Veverka, Cicero, IL
Robert W. Wagner, Campbell River, BC, Canada
William V. Walters, Martinsburg, PA
Glenn D. Walton, Yoder, IN
Chester F. Washabaugh, Claymont, DE
Billy Joe Welker, Olmsted Falls, OH
Theodore L. Williamson, Macomb, IL
William C. Wilson, FPO, San Francisco
Max G. Zimmerman, Fairborn, OH

James Ernest Smith

. . . the legend continues . . .

James Ernest Smith, 92, died Sunday, September 30, 1973, at his home. Mr. Smith founded the National Radio Institute in 1914, and served as President until 1956 when he became Chairman of the Board.

"J.E." has long been a friend, an inspiration, and a legend to the people at NRI. Only a few years ago, almost any day, you could expect to see a familiar figure walking the halls of the National Radio Institute, visitors in tow, explaining to them the intricacies of NRI's research and development labs, the latest NRI Training Kit, or some new operation to make NRI more efficient, more personal in teaching each individual student.

Watching, you'd be hard put to say which he enjoyed most: what he was showing, or the people he was showing to. And why not? He was "matchmaking" in the most natural way, two of his lifelong great mainsprings: people and the NRI concept of individual, practical career training.

That was J.E. Smith for you, and age was never a deterrent to doing what he had always done so well. Indeed, today's extraordinary organizational vigor of NRI can be attributed largely to the character of its founder.

It follows naturally then that that kind of unchanging spirit has motivated numberless others and will continue undiminished into the future. For no matter how NRI training evolves to meet the technological explosion of the eighties, J.E.'s legacy will continue.

Over the years many an NRI instructor was startled to find J.E. at his shoulder absorbed in the student's work. The precedent of individual concern for the student as a person still holds. J.E. Smith's love of people and his personal concern for their welfare made NRI a natural outlet for his immense energy. From the day NRI enrolled its first student, J.E. was intensely motivated by his belief that one man could make a difference. He inspired this same conviction in each and every NRI employee.

During his lifetime, James Ernest Smith received many honors. In June, 1965, he received the Robert H. Goddard Award for outstanding professional achievement. In 1969, he received an Honorary Degree of Doctor of Engineering from Worcester Polytechnic Institute from which he had graduated with a B.S. degree in 1906. Additional honorary degrees included an L.L.D. from Southeastern University, Washington, D.C., and Doctor of Space Education from the Florida Institute of Technology, Melbourne, Florida. The National Home Study Council in admiration and respect for one of the "giants" of home study named James E. Smith to the Home Study Hall of Fame.

Of all the honors and accolades heaped upon him in his long and fruitful life, the one of educator pleased him the most. Because to him, the NRI Idea and "education" were inseparable, for this man had guided the growth of NRI in every detail. Nothing had been too insignificant for his constant and loving attention.

At a simple, but moving ceremony, the following plaque was presented:

OCTOBER 16, 1964
ON THIS FIFTIETH ANNIVERSARY OF THE
NATIONAL RADIO INSTITUTE
WE HONOR OUR FOUNDER
JAMES E. SMITH
OUR SCHOOL WAS BORN OF HIS VISION
SIX YEARS BEFORE THE WORLD'S
FIRST RADIO BROADCAST.
IN THE TRADITION
OF HIS INSPIRED LEADERSHIP
WE REDEDICATE OURSELVES TO PROVIDING
THE VERY BEST TRAINING
FOR TODAY'S NEEDS AND TOMORROW'S
OPPORTUNITIES.
1914 NRI EMPLOYEES 1964

DIRECTORY OF ALUMNI CHAPTERS

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

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

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m., 2nd Wednesday of each month at Andy Jobaggy's shop, G-5507 S. Saginaw Rd., Flint, Mich. Chairman: Stephen Avetta, 239-0461.

LOS ANGELES CHAPTER Chairman: Graham D. Boyd, 3177 Virginia Ave., Santa Monica, Calif. 90404. (213) 828-8129.

NEW YORK CITY CHAPTER meets 8:30 p.m., 1st and 3rd Thursday of each month at 199 Lefferts Ave., Brooklyn, N.Y. Chairman: Steve Kross, 381 Prospect Ave., Brooklyn, N.Y.

NORTH JERSEY CHAPTER meets 8 p.m., 2nd Friday of each month at The Players Club, Washington Square, Chairman: George Stoll, 10 Jefferson Ave., Kearney, N.J.

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

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

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

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

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

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

EXECUTIVE SECRETARY PLANS FALL AND SPRING VISITS TO LOCAL CHAPTERS OF NRI AA

With the fall season now here, and the chapters having been in recess all summer, we are a little short on chapter chatter. However, we are looking forward to a tremendous year with new programs planned by most of the chapters and new members coming in from recent NRI graduates.

Your Executive Secretary, Tom Nolan, is planning visits to all of the chapters during our fall and spring season. The following is a tentative list of the dates of these visits.

Southeastern Massachusetts (Thursday, September 27); Flint Saginaw Valley (Wednesday, October 10); Detroit (Thursday, October 11); Chambersburg (Thursday, November 15); Philadelphia-Camden (Monday, November 19); Springfield, Massachusetts (Wednesday, December 5); New York (Thursday, December 6); North Jersey (Friday, April 12); San Antonio (Wednesday, April 17); and Pittsburgh (Thursday, June 6).

Alumni News

NRIAA OFFICERS

George Stoll	President
Morris E. Anderson	Vice-President
Charles L. Graham	Vice-President
John Rote	Vice-President
Bailey Mark	Vice-President
Tom Nolan	Exec. Secretary

As you can see, we have a busy schedule coming up for the remainder of this year and the beginning of 1974.

Inasmuch as we have had few communications from the chapters due to the summer season, I thought you'd like to see some pictures of chapter meetings in past years including some showing our former Executive Secretary, Ted Rose, and our retired member of NRI, Blan Straughn. These pictures should bring back memories to a lot of the members.

Detroit Chapter, 1970.

Springfield, Massachusetts Chapter, 1958

Southeastern Massachusetts Chapter, 1958

Flint-Saginaw Valley Chapter, 1963.

Pittsburgh Chapter, 1958.

Former Executive Secretary Ted Rose and retired NRI member Blan Straughn at the Philadelphia-Camden Chapter, 1964.

Toronto Chapter, 1970.

Season's Greetings

This Christmas—make it memorable. Order the NRI Official School Ring—for the man in your life. (Men make sure your wife sees this!)

A
RING
YOU'LL WEAR
WITH PRIDE
FOR A LIFETIME

You will be proud to wear this distinguished ring in any company. It identifies you as a man of ambition and achievement who is dedicated to success through education. The ring speaks well of both you and your school.

Your official NRI school ring is a masterpiece of jewelry created to NRI specifications by the L. G. Balfour Company, makers of the most distinguished school rings in America. A full 9 pennyweight of brilliant, durable 10 kt. gold gives the ring the heft and feel you would expect of a university style ring. The smooth, round-top stone is a sparkling ruby-red, the color which identifies your school.

The famous NRI symbol boldly dominates one side of the ring. The opposite side features an American eagle and a symbol representing both the space age and electronics – concepts to which your school is dedicated.

Order your ring now and wear it with pride for a lifetime.

HOW TO ORDER YOUR OFFICIAL NRI SCHOOL RING

BE SURE TO GIVE US YOUR CORRECT RING SIZE. You may pay for your ring in three ways: (1) Send $64.95 with your order. (Add 5% sales tax only if you live in Washington, D.C.); (2) If you have an open account with Conar Instruments Division of NRI, simply ask to have the ring added to your account; or (3) send a $5.00 down payment and ask to open a Conar credit account. Be sure to fill in the credit application on the back of the order blank.

BE SURE TO TELL US YOUR RING SIZE

The best way to find our your correct ring size is to ask your local jeweler to measure your finger. Otherwise, use the ring chart below. Wrap a strip of paper or adhesive tape around the largest part of your finger. Mark where it overlaps and cut off the excess paper or tape. Measure it on the chart below. If it falls between sizes, choose the next size.

RING SIZES FOR MEASURING FINGER

Official
NRI School Ring

$64.95
Stock No.IDS
P.P. Insured

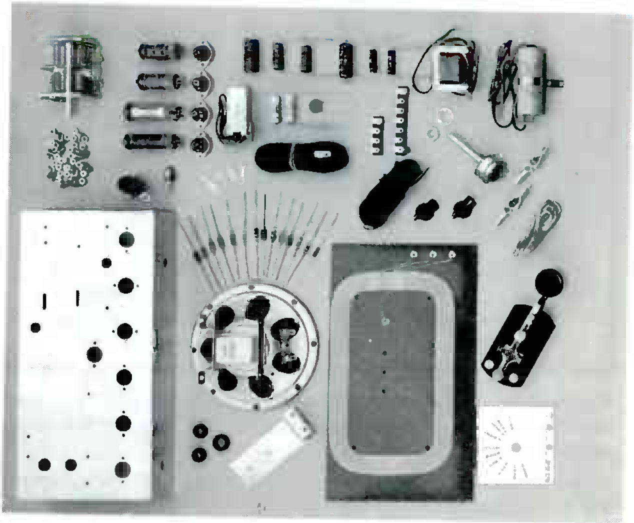
Note: Due to the tremendous increase in the cost of gold, we have been forced to raise the cost of the ring.

USE CHRISTMAS ORDER BLANK FOR SPECIAL HANDLING

Adventures In Electronics Kit

FROM CONAR . . .

The Perfect Gift for Some Lucky Boy (or his Dad)!



★ **More Than 100 Parts**

★ **A Dozen Experiments**

$18.95

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Weight 6 pounds
Parcel Post

Ten *fascinating* and *safe* educational projects. This kit is used by teachers in many school classrooms to introduce students to electronics—help them toward satisfying and profitable careers. Here's proof positive of its sound educational value and thorough training.

Kit contains over 100 top-quality parts—name brands you'll recognize. This is not the *"plastic-cardboard-battery"* type experimenter's kit usually found on store shelves. IF PURCHASED SEPARATELY, THE PARTS USED IN THE ADVENTURES IN ELECTRONICS KIT WOULD RUN WELL OVER $30.00.

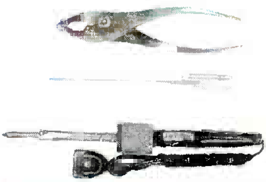
You learn about electronics and *have fun* doing it. Each project graphically demonstrates a number of electronics principles. You're shown "why" and "how" these principles work. You need *no previous electronic training or experience*. Just follow the simple, concise instructions and large diagrams in the 48-page project manual. The manual includes a glossary of common electronics terms for quick and easy reference.

The projects cover a seemingly endless variety of activities:

- You build a Radio Receiver which performs exactly like a manufactured set—picks up local broadcasts and distant stations.
- **You learn about Testing Radio Sets.** In this project you build a signal tracer and use it to find the exact point in a circuit where the signal stops. The signal tracer is a test instrument used by professional electronics technicians.
- **Then you become a Radio Announcer.** You set up a broadcast station, and with the speaker as your "mike," transmit your voice through your radio or a neighbor's set.
- **Now you assemble a "Secret Listener."** The speaker becomes a concealed microphone. Put it in one room and hear any conversations through a receiver without being present. Use it as an electronic "baby sitter." Mother can place the "Listener" near baby's crib and hear cries while she's in another room.
- **You'll experiment with sound.** In one project you build an Audio Oscillator and produce a wide range of sounds. Another experiment teaches how sound is magnified. After putting together an Audio Amplifier, you amplify sounds from a phonograph pick-up.

ALL THE TOOLS YOU NEED ARE INCLUDED FREE

SOLDERING IRON • SCREWDRIVER • PLIERS



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CONAR SELECT-A-PLAN

SELECT YOUR TERMS TO FIT YOUR BUDGET

CONAR FINANCIAL RATES:

STANDARD PLAN—The ANNUAL PERCENTAGE RATE is 17.75%

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TO SPEED SHIPMENT

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3. Insert amount of down payment (at least 10% of total order) and other information in Payment Agreement below.
4. Sign Payment Agreement and fill in Credit Application.

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IF UNPAID BALANCE IS	STANDARD PLAN Finan-cial Charge	STANDARD PLAN Monthly Pay-ments	EXTENDED PLAN Finan-cial Charge	EXTENDED PLAN Monthly Pay-ments
20.01- 25.00	1.05	3.50		
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
400.01-430.00	46.00	31.50	62 20	21 00
430 01-460 00	49.50	34.00	69 00	22.00

ON ORDERS OVER $460 00 THE FINANCIAL CHARGE ON THE EXTENDED PLAN WILL BE 15% AND PAYMENTS WILL BE IN PROPORTION TO AMOUNTS SHOWN ON ABOVE SCHEDULE

HOW TO DETERMINE THE NUMBER AND AMOUNT OF MONTHLY PAYMENTS TO REPAY THE "TOTAL OF PAYMENTS"

Use the Select-A-Plan Schedule to find out what your monthly payment is. Then divide your monthly payment into your "Total of Payments" to find out how many monthly payments you must make. The amount which is left over is your final payment. FOR EXAMPLE, if your unpaid balance is $95, then your monthly payment is $8.75 (using the Standard Plan). If your "Total of Payments" is $104, then your monthly payment of $8.75 divides into that number 11 times with $7.75 left over. This means you make 11 payments of $8.75 each, plus a final payment of $7.75.

PAYMENT AGREEMENT

Enclosed is a down payment of $.................. on the merchandise I have listed on the reverse side. Beginning 30 days from date of shipment, I will pay CONAR $.................. each month for .... months, plus a final monthly payment of $.................. Title to and right of possession of the merchanidse shall remain in you until all payments have been made. If I do not make the payments as agreed, you may declare the entire balance immediately due and payable. In satisfaction of the balance, you may at your option, take back the merchandise, which I agree to return at your request. I understand that a 1% accounting charge will be added to my unpaid balance if my payments become 60 days or more in arrears. I agree that the above conditions shall apply to any add-on purchases to my Select-A-Plan account. The statements below are true and are made for the purpose of receiving credit.

DATE .... BUYER SIGN HERE ....

IT'S AS EASY AS A - B - C TO OPEN A CONAR ACCOUNT

PLEASE ALLOW ADEQUATE TIME FOR NORMAL ROUTINE CREDIT CHECK. ONCE YOUR CREDIT IS ESTABLISHED, ONLY YOUR SIGNATURE IS NEEDED TO ADD ON PURCHASES

A →

WHERE DO YOU LIVE?

PRINT FULL NAME .... Age ....

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? ....

B →

WHERE DO YOU WORK?

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

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

PREVIOUS EMPLOYER .... Name .... Address HOW LONG? ....

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

C →

WHERE DO YOU TRADE?

BANK ACCOUNT WITH .... Street .... City .... State ( ) CHECKING ( ) SAVINGS ( ) LOAN

CREDIT ACCOUNT WITH .... Street .... City .... State

CREDIT ACCOUNT WITH .... Street .... City .... State TOTAL OF ALL MONTHLY PAYMENTS INCLUDING CAR $ ....

CONFIDENTIAL

Kit 682 UK

ONLY $89.50

Student Price

$79.50

Wired 682WT

ONLY $121.50

Student Price

$109.00

Seven pounds P.P. Insured

NEW, IMPROVED CONAR MODEL 682 INTEGRATED CIRCUIT

TV PATTERN GENERATOR

- **EXCLUSIVE Digital Integrated Circuits**
- **EXCLUSIVE Four Crystal-Controlled Oscillators**
- **Completely Solid-State**
- **Color Amplitude Control**
- **IC Regulated Power Supply**
- **Modulation Adjustment**
- **TV Station Sync and Blanking Pulses**
- **Ten Patterns**
- **Red, Blue and Green Gun Killers**
- **Compact, Lightweight, Portable**

You can pay much more, but you can't buy more exclusive and up-to-date features than CONAR engineers have built into the new Model 682 TV Pattern Generator. CONAR is first with digital integrated circuits and four crystal-controlled oscillators. Compact and portable, the 682 weighs less than five pounds. Peak accuracy and stability are ensured by cool all-solid-state circuitry and IC regulated power supply. The 682 incorporates a wide range of test patterns, including single and multiple vertical bar, horizontal bar and crosshatch patterns—all with horizontal lines only one raster line thick, as well as a standard ten-bar color pattern. The most modern and versatile color generator on the market, the 682 incorporates 25 semiconductors: 12 digital integrated circuits; 6 2N3692 transistors, 6 silicon diodes and an IC voltage regulator. Oscillators include 189 kHz timing generator, 3.56 MHz offset color subcarrier, 4.5 MHz sound carrier and 61.25 MHz rf carrier (channel 3). Until now, no commercially available color generator has offered so many quality features in a single instrument. You get TV station quality composite video signals. All this, plus CONAR's low prices, make the 682 the absolute tops in dollar-for-dollar value.

SPECIFICATIONS

OUTPUT: RF only; low impedance; approximately 50,000 microvolts into 300-ohm tuner; 100% modulated carrier—composite video. Crystal-controlled oscillators: 189-kHz timing oscillator; 3,563.795-kHz offset color subcarrier oscillator; 4,500-kHz sound carrier oscillator; 61.25-MHz rf carrier oscillator. **Modulation:** single dot; single cross; single vertical line; single horizontal line; full dot pattern; full crosshatch pattern; full vertical line pattern; full horizontal line pattern; keyed rainbow color pattern; blank raster. **Power Requirements:** 120 volts ac, 1.0 watt. **Regulated Power Supply:** Silicon diode bridge rectifier; three-terminal integrated-circuit regulator. **Semiconductor Complement:** Twelve digital integrated circuits; six Type-2N3692 npn silicon transistors; one IC voltage regulator; four silicon rectifier diodes; one modulator diode; one Type-1N914 diode. **Gun Killer Switches:** Permanently wired cable; separate red, blue and green switches; colored switches for rapid location. **Construction:** Aluminum cabinet, chassis, and panel for light weight; printed circuit board 6" X 9"; IC's in sockets. **Size:** 10" wide by 3" high by 9" deep. **Weight:** Five pounds.

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The Headhugger Headset Radio delivers full, rich sound through two 2¼" dynamic speakers. It's lightweight and comfortably padded too. Handy volume, on-off knob and tuning knob.

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