NRI news

February/March 1963

"LIZ" MORALES OF THE INSTRUCTION DEPARTMENT LISTENS TO THE MODEL '300' STEREO. READ ABOUT IT ON PAGE 1.

ALSO IN THIS ISSUE

SERVICING CATHODE RAY OSCILLOSCOPES

MAKING YOUR FCC LICENSE PAY OFF

NRI NEWS

VOL. 20, NO.7.

FEBRUARY/MARCH 1963

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Editorial: THE GROWTH OF OUR ELECTRONICS INDUSTRY

The past year was an exciting one in the realm of electronics and aerospace achievements. The successful orbiting of astronauts Glenn, Carpenter and Schirra and the historic Telestar satellite all point to the perfection of electronic devices that make such achievements possible.

We are engaged with a science and related sciences that are limited only by man's comprehension. They are currently feeding an industrial complex ranking fifth among the nation's producers of goods and services. This complex, whose origin goes back to the invention of the audion tube by Lee DeForest in 1906, has grown into a producer of goods having a factory value of $11.8 billion or more.

The vast majority of our graduates and students are, or will be, engaged in the sales and services of consumer products. Chester D. Tripp, President of Television-Electronics Fund, Inc., recently stated that factory sales in the consumer area, which amounted to $1.5 billion in 1955 were expected to be at the $2.1 billion level in 1962.

In the component end of the business, factory sales of $765 million were achieved in 1961. They rose to $795 million in 1962 and are expected to reach $900 million by 1965. It is estimated that the annual retail bill for servicing of home electronic appliances, together with revenues from broadcasting, will be around $5.8 billion by the end of 1965.

This figure could be higher if the UHF TV stations can attain an economic operating level. All in all - the future of electronics is limitless and we hope that all of you prosper in this exciting industry.

J. M. Smith
President

HOW YOU CAN HELP NRI GIVE FASTER SERVICE

When you write to NRI—whenever you send a payment, lesson or order, please be sure to give your full name, complete address *and* your NRI Student Number. If you are a *graduate, write* "Grad" after your name or "G" after your Student Number. If you will remember always to do this, we will be able to give you quick efficient service.

CONAR Model '300' Stereo System

By
J. B. Straughn
CHIEF, CONSULTATION SERVICE

To many people, a stereo system means a big investment since it requires two separate amplifiers, a stereo record player and separate speaker enclosures. A selling price of $300 to $500 for a complete system is not unusual. Here at CONAR we asked ourselves why stereo should be so expensive and if it wouldn't be possible to produce a stereo outfit within the pocketbook range of the average family. Investigation showed that it was indeed possible and the CONAR Model 300 is our answer to this long felt need. Let's see just how the job was done to produce not a hi-fi package, but a system which would provide fine stereo listening at a reasonable price.

The Model 300 is a complete stereo system consisting of a right and left channel amplifier on a single chassis, with metal cabinet, two bass reflex speaker enclosures with 8" high efficiency speakers, and a high-grade, four-speed record changer with turn-over ceramic stereo cartridge, diamond LP needle and connecting cables. TV type twin lead-in (not supplied) or the regularly supplied 10' speaker cables may be used to connect the loudspeakers to the amplifier outputs. The front cover photograph shows a typical installation.

The record changer is complete except for the easy-to-install cartridge which is furnished. The speakers are already mounted in their enclosures, ready to hook up and use. The amplifier is in kit form with detailed assembly instructions which results in a considerable saving and offers a few pleasurable hours of construction.

THE POWER SUPPLY

The schematic diagram of the stereo amplifier is shown in Fig. 1. Note that a common power supply is used for both channels and that silicon rectifiers have been used to eliminate the drain of a rectifier tube filament and to reduce heat. SR8A and SR8B, together with capacitors C1 and C2, form a full-wave voltage doubler. This furnishes about 275 volts dc at the filter input.

The plates of the 6BQ5 output tubes are fed from the input of the filter. This is possible because the plate currents of pentode tubes are insensitive to rather large variations in plate supply voltage. The 120 cycle ripple voltage at the filter input will not cause hum current to flow in the primaries of the output transformers.

Thus, we avoid the large voltage drop which would occur across R23 if the 6BQ5 plate currents flowed through this resistor. Permitting this to occur would call for a reduction in the ohmic value of R23 and the consequent reduction in filter efficiency would call for an increase in the capacity of C3A. You can see that by using this simple circuit innovation a definite cost saving is obtained at no loss in efficiency.

The screens of the 6BQ5 tubes are fairly sensitive to voltage variations and they are consequently fed from the output of the filter. The supply voltage for tubes V1B and V3B must be more completely filtered because any hum voltage would divide between plate load resistors R18 and R19 and grid resistors R20 and R21 with most of the hum voltage appearing across R20 and R21. There the hum voltage would be applied directly to the control grids of the 6BQ5 tubes. R22 and C3B act as the plate supply filters for V1B and V3B. Additional plate supply filtering for V1A and V3A is obtained with resistor R6 and capacitor C3C.

In addition, R22-C3B and R6-3C3 serve to decouple the supply points from each other and avoid feedback. For example, any signal voltage at the screens of the 6BQ5 tubes is prevented from reaching the 6BQ5 control grids through plate loads R18 and R19 and the

.1-mfd coupling capacitor by the decoupling action of R22 and C3B. In the same manner, any signal voltage across C3B (due to the plate current demands of V1B and V3B) is prevented from traveling toward the input by R6 and C3C.

The photo in Fig. 2 of the underside of the amplifier chassis shows that twisted leads connect the phono and tuner input jacks to the phono-tuner switch SW. The use of twisted leads eliminates the necessity of using shielded cables because either the phono or tuner jacks are always grounded. Thus, one lead in each twisted pair acts like a grounded shield. The twisted leads are much easier to

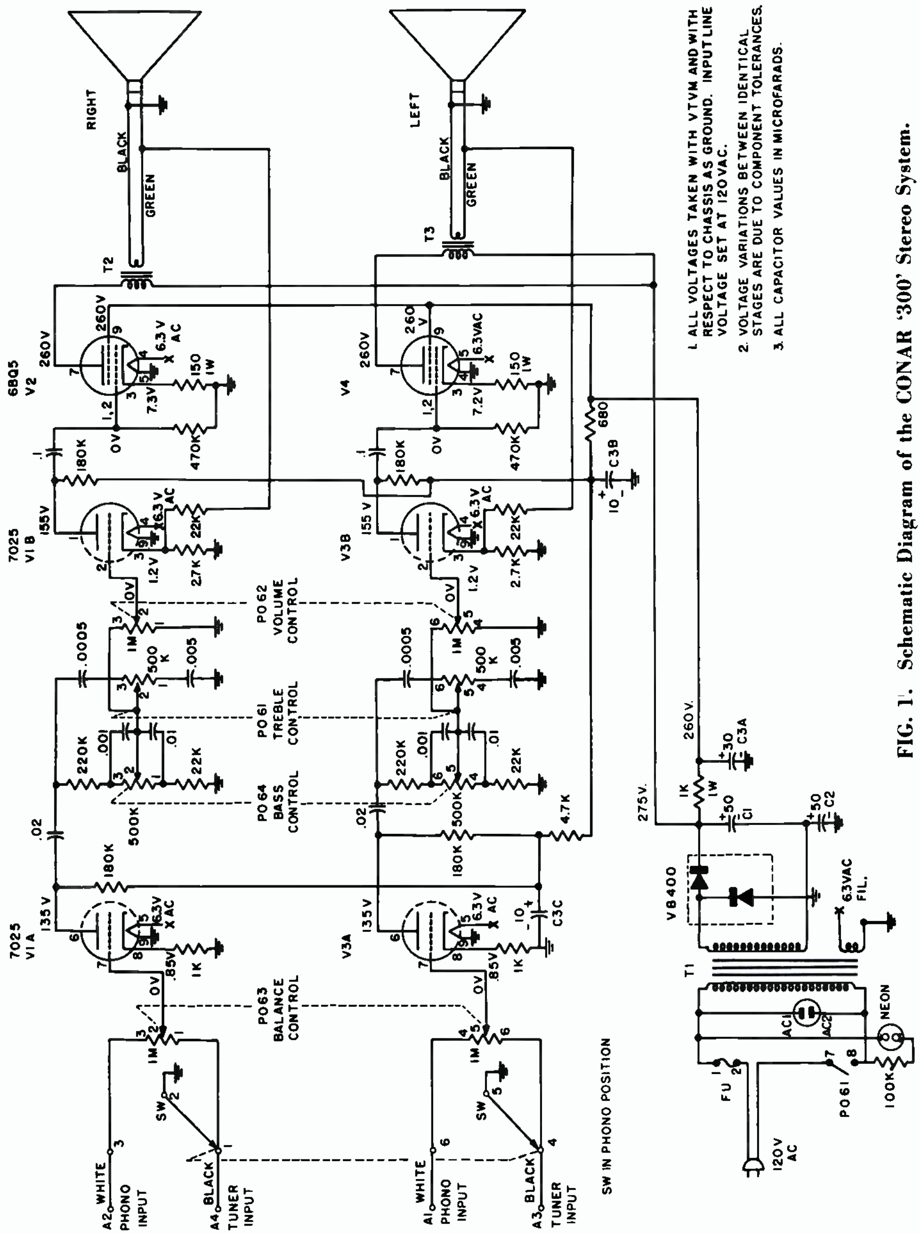


FIG. 1. Schematic Diagram of the CONAR '300' Stereo System.

handle and install than shielded cable. These leads are furnished pre-twisted in the amplifier kit and pre-twisted wires are also supplied for the power transformer primary connections and for all filament wiring.

THE AMPLIFIER CIRCUIT

You will note that four inputs are available - two for the output of the stereo phono pick-up and two for the output of the stereo FM tuner. With the switch in the phono position, the FM inputs are grounded. Throwing the switch in the other position grounds the phono inputs and permits tuner operation. Because the unused inputs are grounded, feedthrough from the unused source is impossible.

R1 and R1A are ganged 1-megohm potentiometers and are used to adjust the input signals so each amplifier receives equal drive. These potentiometers are called the balance control because turning the control so the sliders approach lugs 3 and 6, respectively, increases the phono input to V1A while reducing the input to V3A. Turning the control in the opposite direction reverses the effect.

In tracing the signal through the amplifier, we will discuss only tubes V1A, V1B and V2 because the action in the other channel using V3A, V3B and V4 is identical. Remember that the two bass tone controls R9, R9A, the treble controls R12-R12A, the two volume controls R13-R13A are ganged and work in unison. Increasing the bass, treble or volume in one amplifier channel causes the same change in the other amplifier channel.

A signal applied to the grid and cathode of V1A is amplified and the signal appears across plate load resistor R4. Some of the amplified signal also appears across cathode resistor R2 and, being out of phase with the input signal, the signal applied between the control grid and cathode is reduced. This is a form of degeneration. The resultant grid-cathode signal is the difference in signal between the input signal and that across R2 due to the signal plate current flowing through R2. Ordinarily, you might just expect a reduction in grid-cathode input signal and this is what happens as long as the output signal waveshape is the same as the input signal waveshape.

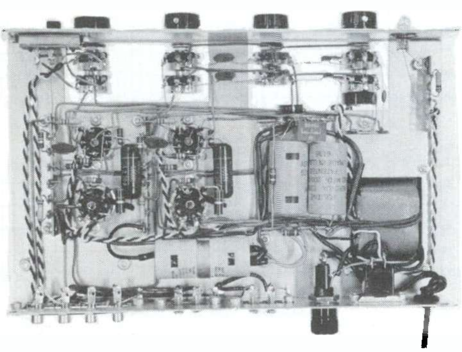


FIG. 2. Photo showing chassis wiring of the amplifier.

However, suppose distortion occurs in tube V1A and something is added to or taken away from the input waveshape. If the waveshape amplitude is excessive at some point, the resultant excess feedback reduces the gain and tends to restore the original waveshape. The reverse is true if there is an undesired dip in the output signal because then there will be less feedback and more gain at this particular point, with a tendency to fill in the dip. The correction is not 100% but this type feedback removes considerable distortion.

Looking ahead in the circuit you will note that the cathode resistors of V1B and V2 are also unbypassed, so they too will have signals across them out of phase with the input signals.

The Tone Controls

The signals applied to the input of V1A are amplified to a very high level and appear across plate load R4. The signal level at this point is so high that we have signal strength to throw away and this is exactly what we do to achieve tone control. The signals are passed through the tone controls which act as bass and treble channels. The signals are then re-combined before the composite is fed to the volume control.

Because of the high level signal across R4, loser type controls are used. The bass control can pass just about all of the original bass across R4 and progressively drop out the higher frequencies while the treble control can pass practically all the higher frequencies at R4 and progressively drop out the lower frequencies.

Fig. 3 shows some of the almost infinite response curve shapes available by adjusting the bass and treble controls. The frequencies passed by the two controls are made to overlap so the middle frequencies are not lost. Let's take a look at the individual controls and see how they work.

The Bass Control Circuit

A simplified schematic of the bass control is shown in Fig. 4. Due to the relatively large size of C4, practically all of the signals across R4, regardless of frequency, will appear across points A and E.

This tone control acts as a signal voltage divider. The division will vary with frequency and with the capacitive reactance introduced by C6 and C7 in series. Since R9 can be adjusted to short out either C6 or C7, the capacitive reactance can also be varied and it is this feature which permits us to cut more or less of the high frequency spectrum at will. With the highs cut and the bass constant, we get the effect of an increase in the bass response.

From Fig. 4 you can see that signals dropped between A-C do not appear at the output. The signal division between AC and CE depends upon the impedance of the various branches. The resistance of R7 is always fixed at 220 ohms regardless of frequency. This is also true of the resistance between D and E which is always 22K ohms. The reactance of both C6 and C7 will vary with frequency becoming less as the frequency increases. With an increase in frequency, more of the signal will be dropped across R7 and less will be available at the tone control output. If the frequency decreases, less signal will be dropped across R7 and the signal at the tone control output will increase. Thus, this tone control normally favors the low frequency end of the audio spectrum.

As you know, two capacitors in series will have a combined capacity less than the smaller in the series circuit. As the slider of R9 is moved toward R7, the .001-mfd capacitor C6 is gradually shorted out of the circuit. As the reactance of C6 is decreased in this manner, a smaller reactance of C7 becomes effective in the voltage divider circuit and more and more of the higher frequencies are dropped across R7, leaving only the lower portion of the bass spectrum available at the output.

When the tone control is turned toward R10, C7 is gradually shorted out of the circuit and the high frequency portion, as well as the low frequency portion, of the bass spectrum is available at the output. Thus, the presence of higher frequencies in the lower portion of the audio spectrum can be varied at will.

The Treble Control Circuit

The operation of the treble control, shown in Fig. 5, is quite simple. Again we have a voltage divider from the output of C4 to the chassis. That portion of the signal dropped across C10 is not available at the output of the tone control. Due to the impedance presented by C10, R12 and C11, most of the lower frequencies are dropped across C10 and the higher portion of the audio frequency spectrum is present from the top of R12 to the chassis. When the tone control (R12) is turned toward C10, the greatest amount of high frequency response is obtained. As R12 is turned toward C11, the proportion of higher frequencies decreases until at the end of rotation, most of the highs are eliminated. These effects can be seen by examining the response curves in Fig. 3.

Now, going back to the complete schematic you will see that the outputs of the bass and the treble controls are fed to terminal 3 of

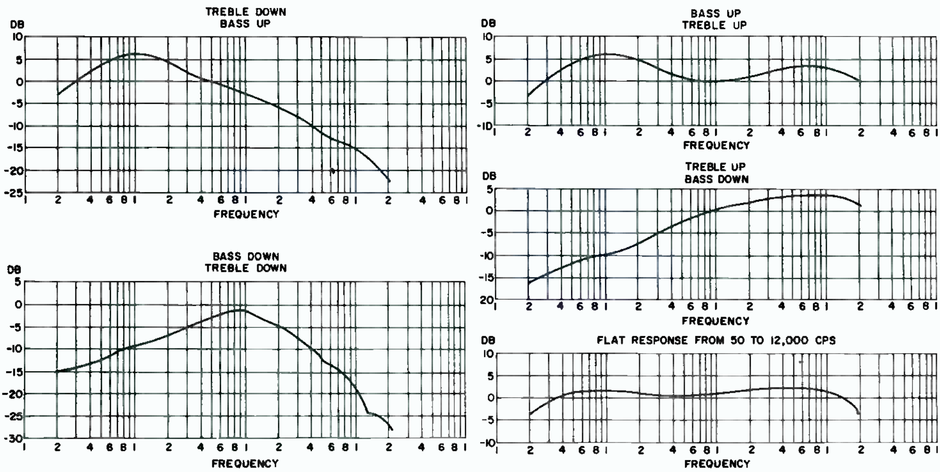


FIG. 3. Response curve shapes available by adjusting the bass and treble controls.

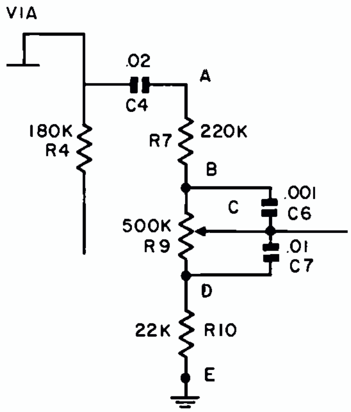


FIG. 4. Bass circuit.

the volume control. There they are recombined to produce any desired variation in the over-all response curve as shown in Fig. 3.

The signal strength across R13 is quite low due to the cutting action of the tone controls and the signal must again be built up to be strong enough to drive the output tubes. This is accomplished by tube V1B and its associated circuitry.

The signal at the input of V2 is every bit as large as that across R4 and is shaped to give the desired frequency response. This signal is amplified by the 6BQ5 tube and delivered to the speaker voice coil by means of output transformer T2.

Note that one side of the voice coil is grounded. The signal at the ungrounded side is 180° out of phase with the signal fed to the grid-cathode of V1B. Therefore, by feeding a portion of the signal back to the cathode of V1B, degeneration occurs and we obtain additional cancellation of distortion produced in the 6BQ5 and the output transformer. The amount of feedback is dependent on the ratio of resistors R14 and R16. Increasing the value of R16 would reduce the feedback and increase both distortion and the power output. Reducing the value of R16 would reduce distortion and also reduce power output.

The value used for R16 was chosen to give us satisfactory output at a distortion figure which wasn't noticeable.

By satisfactory output we mean a sound level which the average listener would consider too loud in the average living room. Excess volume can, of course, be reduced with volume control R13. The sound level has little to do with the amplifier electrical power output. It is more nearly dependent upon loudspeaker efficiency. In ultra-ultra hi-fi systems, the loudspeaker efficiency is so low that 15 or 20 watts of electrical power to the speakers is required to produce the same loudness level we obtain with 1.5 watts per speaker in the CONAR 300. The Model 300 is not hi-fi in the accepted sense but it will cover the hearing range of most people with only a noticeable drop-off of the extremely low and high frequencies.

Getting back to the amplifier, you will notice that single ended stages (V2 and V4) are used. If push-pull amplifiers were to be employed, somewhat more volume would be available and there would be a drop in measurable distortion. These desirable results must be measured against the resulting increase in cost which such a change would incur.

First, two more 6BQ5 tubes with their circuitry would be required. Then would follow an increase in the cost of the power transformer to supply these tubes. Provisions for dissipating the increase in heat would have to be made. Different and more expensive output transformers would be needed and an additional triode tube would be required as a phase inverter to feed out-of-phase signals to the two new 6BQ5 tubes.

If you went this far without any usable increase in sound level and with no change in distortion noticeable to the average ear, you might as well go "whole hog". Put in more powerful output tubes, jack up the power supply to accommodate them, use low efficiency woofer and tweeter speakers and cross-over networks and have a conventional hi-fi system. But the idea of the Model 300 was to make a pleasant listening stereo system available to the average family at a price they could afford. So we will stick to the Model 300 and if it meets the acceptance we expect, we may eventually come out with an additional system, tailored to the needs of the true audiophile. Before this, however, we expect to introduce a stereo FM tuner as a companion piece to the Model 300.

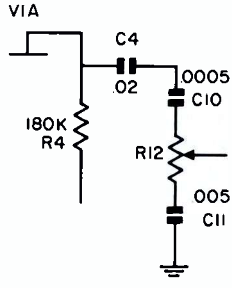
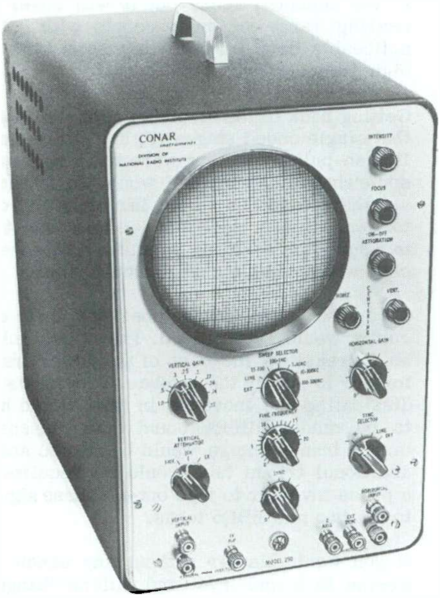


FIG. 5. Treble circuit.

SEE PAGE 20 FOR MORE INFORMATION ON THE "300" STEREO SYSTEM

CONAR

5″ wide band oscilloscope



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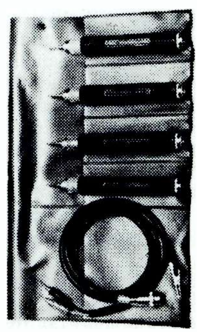
For the first time -- your opportunity to own the professionally-rated Model 250 Scope and Probe Set at a worthwhile savings of $8.50. Here's how . . .



Place your Model 250 order before April 1, 1963 -- cash or terms -- and you pay 1/2 price for this heavy duty Probe Set -- designed specifically for use with the Model 250.

Four-probe set (pictured at right) includes high impedance probe, low capacity probe, crystal demodulator probe, resistive isolating probe, shielded direct probe and sturdy roll-up carrying case. Shipped fully assembled; ready to use with detailed instructions. Regular price - $16.95.

You pay just $8.45 for the complete Set during this limited offer. Use order blank on page 17, but do it now! Orders received after April 1 will be filled at the regular price only.

Advanced design, newest circuitry, exclusive features — a truly professional oscilloscope for laboratory or service shop. The Model 250 is ideally suited for color and monochrome TV, AM-FM and transistor radios, hi-fi and stereo amplifiers, plus numerous industrial electronic applications.

Note these Conar Model 250 features:

- Uses 2400 volts on the cathode ray tube — 50% more than most scopes. Trace remains clear, distinct, bright, with increase in sweep frequency or vertical-horizontal expansion. Forget about darkening room to observe traces on your Model 250 screen!
- Vertical gain control is calibrated for direct reading of peak-to-peak voltages. Simply multiply vertical gain control setting by attenuator setting by trace heighth for quick, accurate peak-to-peak readings. No need to remember special formulas or "feed-in" calibrating signals.
- New improved scope circuitry gives excellent linearity at low frequencies without limiting the production of high frequency sweep signals.
- *Two stage* retrace blanking amplifier gives 100% retrace blanking at all frequencies produced by the scope sweep generator. Retrace lines *will not* confuse the display at high sweep frequencies.
- Accurately measures ripple output of power supplies; checks auto radio vibrators dynamically.
- Intensity and focus controls use special insulated high voltage potentiometers to eliminate leakage and shock hazards.
- Has push-pull outputs balanced by separate phase splitter tubes in both horizontal and vertical amplifiers.
- Built-in flyback checker gives rapid, in-circuit testing of flybacks, transformers, yokes, coils, loop sticks. Eliminates need for a separate flyback tester costing from $40 to $70.
- Sweep range — 10 cps to 500 kc — *five times* the range of most other scopes, using special linearity circuit.

The Model 250 can be assembled in less than 15 hours — even by an inexperienced kit builder. Uses only top grade, U.S. made components; all name brands. Most parts are over-rated for their job giving you an extra margin of dependability plus years of trouble-free service. And — there's no trouble finding replacement parts if ever needed. (Of course, we stock complete inventory of parts, too.)

Step-by-step assembly instructions include big 17" x 22" picture diagrams plus 12 full pages of comprehensive operating instructions with more than 30 illustrations showing wave forms and connecting points.

SPECIFICATIONS

VERTICAL SENSITIVITY: .023 VRMS

VERTICAL FREQ. RESPONSE: Flat 13 cps to 2.5 mc, Down .05 db at 11 cps, Down 1.5 db at 3.58 mc (color burst), Down 3.5 db at 4.5 mc

HORIZONTAL SENSITIVITY: 1.0 VRMS

HORIZONTAL FREQ. RESPONSE: Flat 20 cps to 90 kc, Down .8 db at 12 cps, Down 3 db at 250 kc

RISE TIME: .05 ms

SWEEP FREQUENCY: 10 cps to 500 kc

TUBES: 11 (equivalent of 19 using dual-types)

PUSH-PULL ON-OFF does not upset other adjustments

CONTROLS: Intensity, Focus, On-Off, Astigmatism, Horiz. Centering, Vert. Centering, Horiz. Gain, Vert. Gain, Sweep Selector, Vert. Attenuator, Fine Frequency, Sync Selector, Sync

CABINET: Heavy gauge steel, baked-on black wrinkle finish, rubber feet, chrome handle

PANEL: Satin finish aluminum (not painted) with black lettering

BINDING POSTS: 5-way type to accommodate all connectors

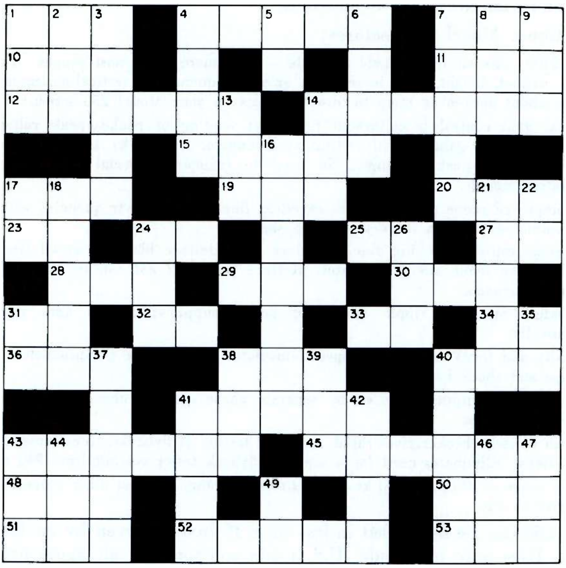
DIMENSIONS: 9⅜" x 13¾" x 15½"

POWER SUPPLY: 110-120 volts, 60 cycle AC, fused circuit

ACTUAL WEIGHT: 21 lbs.

SHIPPING WEIGHT: 23 lbs., shipped via express for safest handling

Graduate Robert W. Hanes of Perry Point, Md. sent in the following Electronics crossword puzzle. Nearly all the terms are in the radioman's vernacular. We thought other students would like to try to solve it. Answer on page 28.



ACROSS

1 Television interference
4 ___ and Beta for transistors
7 Power source for solar cells
10 Electrified particle
11 Remuneration
12 Stage before amplifier in hi-fi
14 Current unit
15 In sailing, masts, jibs, and ___
17 Super___receiver
19 1st pers. sing. possessive
20 Kilocycles
23 Armstrong's modulation
24 Pennsylvania
25 End of message (Morse)
27 Pronoun
28 Instrument landing system
29 Cathode___oscilloscope
30 Unit of conductance
31 Glass tube
32 455 kc.
33 Manuscript
34 1,000 meters
36 Readability and signal strength
38 Distress signal
40 1200___per minute
41 Direction-finding system for aircraft
43 Leads should be___before soldering
45 To separate audio from rf
48 Distance measuring equipment
50 Latitude
51 Iron core and___core
52 Radios and telephones have them on the front
53 Wily

DOWN

1 Point
2 An aircraft guidance system
3 Gases are active or ___
4 Segments of a bridge
5 Dynamic and___speakers
6 Goals or objectives
7 To talk
8 Large paddle for boat
9 Caustic soda
13 Type of radar scope
14 Exist
16 Flier
17 High frequency
18 Transmits
21 Inductance used to block high frequency from power supply
22 Southeast
24 Greek letter
26 Root mean square
31 Green
35 Millivolt
37 Separate unit besides amplifier and speaker in a complete hi-fi system
38 Grass being transplanted
39 "___sack"
40 Rolls of film
41 Main component of solder
42 Press reports
43 "Today" - ham parlance
44 Question mark, Morse
46 California
47 "Teletype" - ham parlance
49 1/1000 amp.

Servicing Cathode Ray Oscilloscopes

by

Bill Dunn

DIRECTOR OF EDUCATION

No doubt many servicemen who have been confronted with a difficult servicing problem have wished they could see inside the circuit and observe what was actually happening. Well, the fact is you can look into a circuit to see what's happening; the cathode ray oscilloscope will show you what is happening. The oscilloscope will show you what's happening in each stage just as clearly as you could see what was going on if you could actually look into the circuit.

To get the most use out of an oscilloscope, it must be in perfect operating condition. Often, technicians let their test equipment deteriorate gradually until eventually a point is reached where the instrument no longer can be relied on. In this article we will discuss some of the things that can affect the operation of an oscilloscope, how to spot them and how to correct them.

OPERATION OF THE OSCILLOSCOPE

First, let's briefly review how the scope works. As we do this, we'll divide it into sections and later discuss defects in these sections of the instrument. As an example, we'll use the CONAR Model 250 Oscilloscope since it is typical of the scopes used by service technicians.

The Power Supply

The power supply in the scope is a dual supply. It must supply the B+ operating voltages for the various amplifier and oscillator stages in the instrument, and at the same time supply a much higher voltage to operate the cathode ray tube. Usually, the B+ supply which is called the low-voltage supply, puts out a voltage between 250 and 400 volts whereas the output from the output from the high voltage supply for the crt is between 1200 and 2500 volts.

The Sweep Circuits

The sweep in the scope moves the electron beam across the face of the crt. The beam must move at a linear rate from the left side of the tube to the right.

The sweep voltage needed to accomplish this is generated in the sweep oscillator and then amplified by a number of amplifier stages. The signal is then split by a phase splitter so that signals of opposite polarity can be applied to the opposite horizontal deflection plates of the crt. As we will see later, there are many defects which can upset the operation of the sweep circuit.

The Vertical Amplifier

The vertical amplifier in the scope amplifies the signal that is to be studied. It is called the vertical amplifier because the signal to be observed is applied to the vertical deflection plates of the scope.

In most instances it is the design of the vertical amplifier which determines the usefulness of the scope. If the vertical amplifier is going to faithfully amplify the signals applied to it, it must have a bandwidth wide enough to accommodate the signal being viewed.

Defects which develop in the vertical amplifiers may reduce the gain of the amplifier or may introduce distortion into the signal being viewed. Defects which cause distortion are particularly troublesome because sometimes they are not too easily noticed.

The Sync Circuit

In addition to the circuits already mentioned, some scopes will have one or more sync amplifier stages. These stages amplify the sync signal which is obtained either from an external source or from the signal being viewed through the vertical amplifier. The amplified sync signal is then used to control the frequency of the horizontal oscillator. Defects which occur in the sync circuit will result in instability in the sweep oscillator circuit so the patterns on the screen will not remain still. The CONAR 250 scope gets its sync signal from the output of the vertical amplifier. Since a high amplitude signal is available at this point, no sync amplifier stages are needed.

Retrace Blanking

Most scopes have some type of retrace blanking circuit. This circuit feeds a high-voltage positive pulse to the cathode of the crt or a high-voltage negative pulse to the grid during the interval when the sweep is moving the electron beam rapidly from the right side of the crt back to the left side. Either pulse drives the crt to cut-off so that there is no trace produced on the crt screen during the retrace period. In the CONAR 250, a separate retrace amplifier is used to amplify this blanking pulse which is fed to the grid of the crt.

POWER SUPPLY DEFECTS

The circuit of the power supply used in the CONAR Model 250 scope is shown in Fig. 1. It is a typical dual supply such as found in most service type scopes. The low dc voltage for the instrument is rectified by V10 which is used in a typical full-wave rectifier circuit. Three different low dc voltages are then produced by means of different values of filter resistors.

The high-voltage circuit is made up of the portion of the transformer winding between the high-voltage rectifier tube V9 and the ground connection of the transformer high-voltage winding. The rectifier is a half-wave rectifier and it is arranged so that the positive side of the high-voltage output is grounded. The voltage at pin 9 of V9 will be about 2500 volts negative with respect to ground.

Low-Voltage Defects

The output voltage at the cathode of the low-voltage rectifier tube V10 should be about 400 volts. If the voltage is lower than normal, it may be due to a defective rectifier tube, a defective input filter capacitor, C33D or it can be a defect elsewhere in the scope that is loading the power supply excessively and pulling the voltage down. In servicing a scope of this type when the voltage at the cathode of the low-voltage rectifier is low, replace the rectifier tube first to see if this brings the voltage up to normal. If it doesn't, check the operating voltages throughout the rest of the oscilloscope looking for voltages much lower than normal.

Notice there are three different output volt-

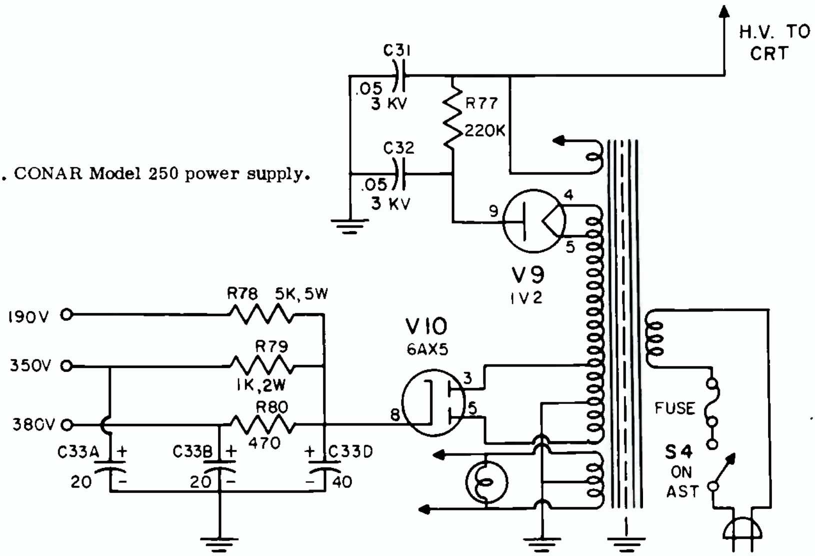


FIG. 1. CONAR Model 250 power supply.

ages obtained from the low-voltage supply. Lower than normal voltage at one of these outputs indicates a defect in the scope that is loading that circuit. The defect may be a shorted tube or capacitor. You can check tubes simply by removing them, capacitors by disconnecting one of their leads. If you cannot find a defect which is placing an excessive load on the power supply, the chances are the input filter capacitor is defective.

High Voltage Defects

Although the high-voltage power supply has an output voltage of over 2000 volts, it can supply only a very low current. The high-voltage power supply and the connections from it to the crt are shown in Fig. 2.

A small amount of leakage in C31 or C32 will load the supply excessively. If the voltage is a good bit lower than normal and almost the same across C31 as across C32, try a new 1V2 rectifier, and if this does not bring the voltage up to normal, check C32 for leakage and also look for leakage around the high-voltage rectifier socket and the lead connected from the high-voltage socket to the terminal strip to which C32 is connected.

In checking for leakage across C31 or C32, first make sure the scope is completely disconnected from the power line and then short pin 9 of the 1V2 high-voltage rectifier to the chassis with the metal blade of a screwdriver. Hold the blade in place long enough to allow both C31 and C32 to discharge. Next measure the resistance between pin 9 of the 1V2 and ground. You will normally get a reading of about 8 megohms as you read through R77, R71, R72, R74, R75 and R76 to ground. If you get a lower than normal reading, try to determine if the reading is lower across C31 or C32 to try to pin down the leaky capacitor. Of course, a zero reading between pin 9 of the 1V2 and ground would indicate that C32 is shorted, whereas a reading of 220K would mean that C31 is probably shorted.

If the high-voltage power supply is working the way it should, you should be able to turn down the horizontal and vertical gain controls and then adjust the intensity, focus, astigmatism, and positioning controls to get a fine spot on the face of the tube. If you do not get a spot at all, you may have a defective crt, or there may be some defect which is driving the beam off the face of the tube. We'll discuss these defects later.

Assuming you get a spot, you should be able to extinguish the spot on the tube by turning down the intensity. If the intensity control will not control the brightness of the spot, the intensity control may be defective, there may be

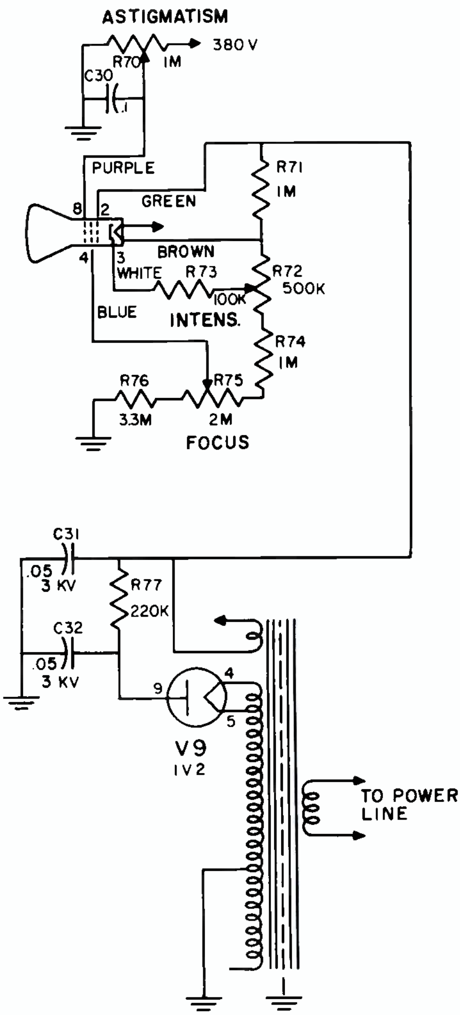


FIG. 2. 1+V power supply and connections to crt.

a short in the circuit around the intensity control or there may be a cathode to heater short in the cathode ray tube.

The electron beam is focused to a fine spot by adjusting the focus and the astigmatism controls. If you cannot focus the beam to a fine spot, either control might be defective, C30 might be shorted or there could be a defect in the high-voltage supply or divider network which is upsetting the voltage across the focus control. Check the values of R71, R74 and R76 to see if they have changed. A defect in the low-voltage supply could upset the voltage across the astigmatism control. If all voltages on the crt are normal and you still cannot focus the electron beam, the chances are there is some defect in the gun of the crt.

In checking the high-voltage power supply, remember that the voltage is high enough to give you a very serious, and perhaps fatal, shock. If you take voltage measurements in the high-voltage section, you should observe the standard precautions for taking measurements in high-voltage circuits. Be sure to clip one lead of your voltmeter to the chassis. Remember that the chassis is the positive side of the high-voltage supply. Touch the other probe of your meter to the point in the circuit where you wish to measure the voltage. Be sure to avoid touching the circuit, and also avoid the chassis while you are holding the voltmeter lead to any part in the high-voltage circuit.

SWEEP CIRCUIT DEFECTS

Sweep circuit defects can be divided into two general classes: one that results in complete failure of the sweep and the other that introduces distortion or partial failure into the sweep. Of the two, defects which cause complete failure of the sweep are easier to find than defects which cause only partial failure of the sweep.

Complete Failure

When the sweep fails completely, the electron beam will not move across the face of the tube. The trouble can be in either the sweep oscillator or somewhere in the sweep amplifier.

When the horizontal sweep fails to operate, you should try to isolate the defect to either the oscillator or the amplifier stages of the sweep circuit. This is usually easy to do. Most service type scopes have a "line" position on the horizontal sweep selector. In this position the horizontal sweep oscillator is disconnected from the amplifier and the driving signal is obtained from the power line through one of the low voltage windings on the power transformer. Put the sweep selector in the "line" position. If the beam is now swept horizontally across the tube, the defect is in the horizontal oscillator stage whereas if you still do not get any horizontal sweep, there is trouble in the amplifier circuit.

Once you have isolated the trouble to a section of the sweep circuit, it is usually not too hard to find the defective part. If the oscillator fails to work, you should try new tubes even if the old ones test good in a tube tester. Also check operating voltages on the oscillator tubes.

If the defect is in the horizontal amplifier, you can easily isolate it to one stage. The horizontal sweep amplifier of the CONAR Model 250 scope is shown in Fig. 3. To find a defect in the amplifier section of this scope, simply put the sweep selector in the "line" position, then with a vtvm, check the ac sig-

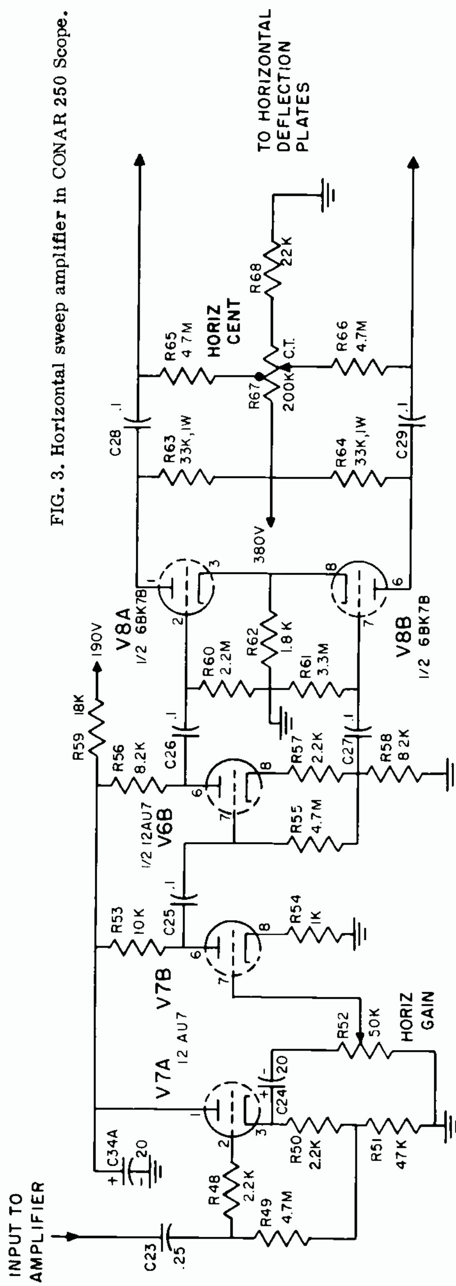


FIG. 3. Horizontal sweep amplifier in CONAR 250 Scope.

nal voltage between pin 2 of V7A and ground. It should be about 3 volts. Next, check the ac voltage at the output of the stage by measuring the voltage between pin 3 and ground. The voltage will be a little less than between pin 2 and ground because the stage is a cathode follower and will have a gain less than 1.

Next, follow the signal through the amplifier with your ac vtvm. You should be able to measure the signal voltage between pin 7 of V7B and ground. This voltage should vary smoothly as you adjust the horizontal gain control R52. Finally set R52 to give you a voltage of about 1 volt between pin 7 of V7B and ground and then check the voltage between the plate (pin 6) of this stage and ground. The voltage should be substantially greater than at the grid of the tube.

Continue to follow the signal through the amplifier until you find the point at which it is lost. Then start checking tubes, operating voltages and components between the last point at which you had the signal and the first point where it disappeared.

A somewhat more difficult defect to locate is insufficient width. In this case the oscillator must be working and the trouble due to low gain in one of the amplifier stages. This can be located by putting the sweep selector in the "line" position and then following the signal through the amplifier with your vtvm. You'll find one or more stages either with very low gain or no gain at all. Be sure to remember when you're tracing the signal that it is normal for a cathode follower stage to have a gain less than 1.

Distortion

Distortion is a very common defect in the horizontal sweep circuit. In fact, a certain amount of distortion will be found in most sweep circuits used in service type oscilloscopes. This is because it is very difficult and expensive to produce a perfect sawtooth voltage and amplify it without distortion to provide the voltage needed to sweep the beam across the crt. You can usually expect the sweep to be linear in the center of the tube, but, if you notice some small amount of nonlinearity at the extreme left or right edge of the screen, it may be that this non-linearity is normal and if it does not affect the usefulness of the scope, forget about it. This type of distortion is almost always noticeable if you turn the horizontal gain up high and then move the pattern to one side or the other with the horizontal positioning control. It is a design limitation in the cathode ray tube itself.

When the distortion is excessive, try the sweep on all ranges to see if they are all distorted. If the distortion is present on only one range, look for an oscillator defect. If it is present on all ranges, it can be the oscillator or the amplifier.

The easiest way to find distortion in the sweep circuit is with another oscilloscope. If you have another scope available, look at the signal at the input to the horizontal amplifier. If it is distorted (it should have a sawtooth waveshape) you have oscillator trouble. If the signal is not distorted, follow it through the amplifier with the scope until you find the stage in which the distortion is occurring.

If you haven't a second scope available for signal tracing, you can usually find the trouble with a vtvm and a few replacement tubes. Gassy tubes can cause distortion in the sweep. Gas in the amplifier tubes can be detected by looking for a dc voltage across the grid resistor. For example, in Fig. 3, you can check V6B for gas by connecting a vtvm across R55. There should be no voltage. If the grid end of the resistor has a positive voltage, pull the tube from its socket. If the voltage disappears, the tube is gassy and must be replaced. If the voltage remains, C25 is leaky and must be replaced.

Defective components other than tubes can usually be located by carefully checking the operating voltages throughout the sweep oscillator and amplifier. Usually, a defect that produces distortion will upset the operating voltages sufficiently for you to detect the change with a vtvm.

"FIRST HE CUT HIS RATES, THEN I CUT MINE — THEN HE CUT HIS — I CUT MINE —"

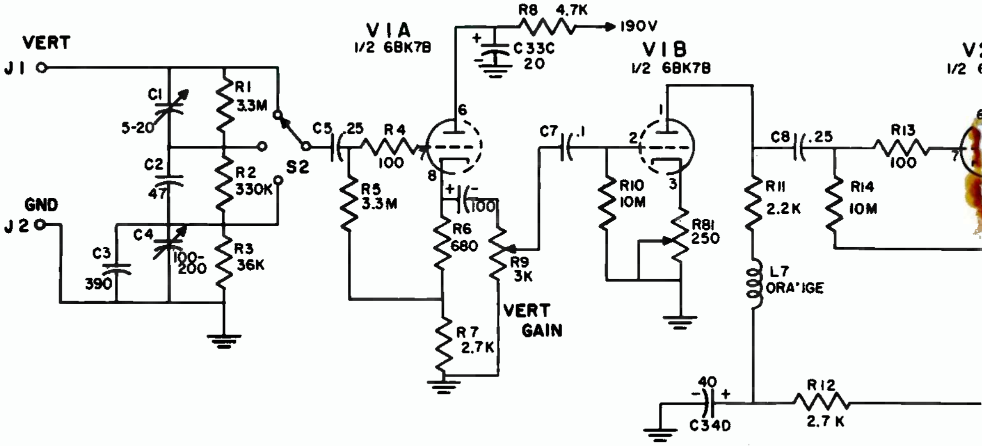


FIG. 4. The vertic

DEFECTS IN THE VERTICAL AMPLIFIER

As we mentioned earlier, the signal to be displayed on scope is usually fed to the vertical amplifier where it is amplified to give it the necessary amplitude to produce a reasonable deflection on the crt. Thus, in the vertical amplifier we have two basic types of defects to be concerned with. There are those defects which affect the gain of the amplifier and those defects which introduce distortion into the amplifier. Of the two, defects which cause distortion are usually the more difficult to locate so we'll consider the easy ones first, (those which affect the gain).

Low Gain

Grouped with those defects which cause low gain in the vertical amplifier are those which cause it to be completely dead. The same servicing technique can be used to locate either.

Using the CONAR Model 250 scope as an example, let's see how we can go about checking the vertical amplifier to locate a defect which has reduced the gain or caused the amplifier to be completely dead. Fig. 4 is a schematic of the vertical amplifier which should provide high over-all gain with very low distortion in applications normally found in servicing.

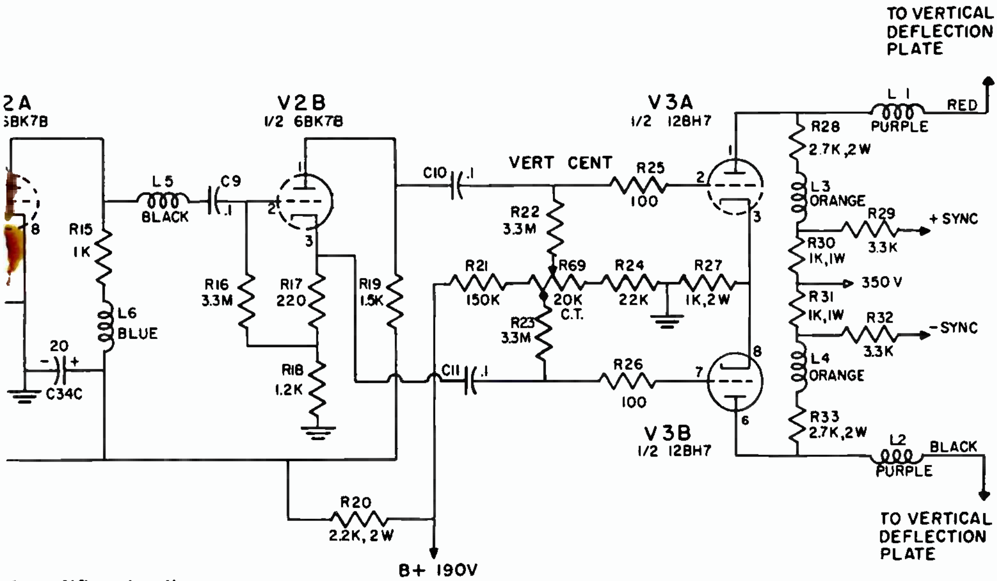
On the front panel of the Model 250 scope is a binding post at which a 1 volt peak-to-peak signal is available. While this signal is intended primarily as a calibration voltage to calibrate the vertical amplifier, it can also be used in servicing the vertical amplifier. Connect the 1 volt peak-to-peak signal to the ungrounded vertical input jack J1. Now use an ac vtvm to trace this signal through the vertical amplifier. Connect the ground lead of the vtvm to the chassis and the vtvm probe to pin 7 of V1A. With the vertical attenuator in the position shown, you should measure about .35 volt rms. Note the reading is given in rms volts which is what most vtvm's are calibrated to read in. All following voltages will be in rms.

Note that V1A is a cathode follower so you check the output voltage at the cathode, pin 8, of V1A. The voltage will be somewhat less than at the grid; usually it will be about .3 volt.

The next stage in the amplifier is V1B. Check the voltage applied to the grid of this tube by touching the vtvm probe to pin 2 of V1. This voltage varies from 0 to about .3 volt as you rotate the vertical gain control. Set the control to give you a convenient reading.

Next, measure the voltage at the plate, pin 1 of V1B. The voltage will vary somewhat with the setting of R81; usually it will vary between 1 and 2 volts with an input voltage of .1 volt, indicating a gain of between 10 and 20 in this stage.

Next, measure the voltage on the grid of V2A. It should be the same as the voltage at the plate of V1B. Then reset the vertical gain control on the scope to bring this voltage down



al amplifier circuit.

to about .1 volt to avoid any overloading in the amplifier. Now measure the voltage at the plate of V2A. It should be about 1.2 volts, indicating that there is a gain of about 12 in this stage.

Follow the signal from the plate of V2A, pin 6, to the grid of V2B, pin 2. The voltage at the grid of V2B should be the same as at the plate of V2A. Now measure the voltage at the plate of V2B. It should be about 1.2 volts.

V2B is a phase splitter. It is used to provide equal amplitude signals of opposite phase to drive the push-pull output stage. Thus, in addition to measuring the output voltages at the plate of this tube, you should measure the output voltage at the cathode, pin 3. This voltage should be fairly close to being equal to the voltage at the plate of the tube. It will be 180° out of phase with the ac voltage at the plate, but of course there is no way you can tell this with your vtvm.

The final step in tracing the signal through the vertical amplifier is to trace the two signals, one from the plate and the other from the cathode of V2B on through the scope to the deflection plates of the crt. With 1.2 volts on the plate of V2B, you should get the same voltages on the grid of V3A, and a signal voltage of about 12 volts on the plate, pin 1 of V3A. You should find the voltage at the deflection plate connecting to the red lead of the crt socket the same.

If you trace the signal from the cathode of V2B, with 1.2 volts on the cathode, you should get the same voltage on the grid of V3B and about 12 volts on the plate, pin 6. The voltage on the deflection plate connecting to the black crt lead should also be about this value.

By using this signal tracing procedure, it should be easy to find a stage that is dead or weak. Once the stage causing the trouble has been located, it is usually a simple matter to find the defective part.

Distortion

The procedure outlined for finding a weak or dead stage can often be used to find the cause of distortion. Though distortion is the most noticeable result of a defect, often the gain of the amplifier may be affected appreciably and thus, by checking the gain of the various stages, you can spot the one causing the distortion.

A defect that causes distortion often upsets the dc operating voltages. Thus, they should all be checked and compared with the correct operating voltages.

However, sometimes the cause of distortion is quite difficult to find. In these cases try to isolate the defect. For example, if you have an audio oscillator, or an rf signal generator that has a good sine wave output you could feed the signal generator output into the grid, pin 7, of V2A. If the signal is amplified from that point on without distortion, as viewed on the face of the crt, the defect is in V1A or V1B. If it is still distorted, try moving the generator input to the grid, pin 2 of V2B. If the distortion disappears, V2A is at fault, but if it remains, the distortion is in the phase splitter or the output stages.

If you do not have a signal generator to perform these tests, use the filament supply in the scope. Connect a test lead from either heater terminal, pin 4 or pin 5 of V2A to the grid, pin 7. If this ac signal is amplified without distortion, the defect is in V1. If the signal is still distorted, try feeding the filament to the grid, pin 2, of V2B to isolate the defect further.

If you have another scope available, you can use it as a signal tracer to locate distortion. Feed a signal into the defective scope input and then begin to trace it through the vertical amplifier. You should have no difficulty locating distortion by this method.

Remember that gassy tubes can cause distortion. Don't hesitate to try new tubes in the vertical amplifier even though the tubes in use may test good in a tube tester.

Gassy vertical output tubes can produce another interesting defect. Notice that in the grid circuit of V3A and V3B there are 3.3 megohm grid resistors, R22 and R23. These resistors are larger than the maximum value recommended by the tube manufacturer. However, these large value grid resistors are necessary in order to get good low-frequency response in the amplifier. Unfortunately, with these large value grid resistors, if the tube develops gas, the plate current of one section may rise substantially above that of the other section. This causes an increase in the voltage drop across the plate load resistor which drops the plate voltage on the tube and hence the voltage on the deflection plate in the crt to which the tube is connected. This causes the beam to move either up or down. If you correct the position of the beam with the centering control, you'll find it then drifts off in the other direction. It may drift so far the trace goes right off the screen! Keep this in mind and if you should run into this type of trouble, replace the output tube. Leakage in C10 and C11 will also cause this effect and may also cause V3 to become gassy.

The CONAR 250 scope uses a frequency compensated coarse attenuator in the vertical input. This attenuator has three positions: × 1, × 10 and × 100. The × 1 position offers no attenuation; in the × 10 position, one tenth of the input signal is applied to the first stage and in the × 100 position one one hundredth. If the capacitors in the attenuator are not set correctly, distortion will occur in the × 10 and × 100 positions. This type of distortion is most noticeable in viewing waveforms such as a square wave and will result in distortion

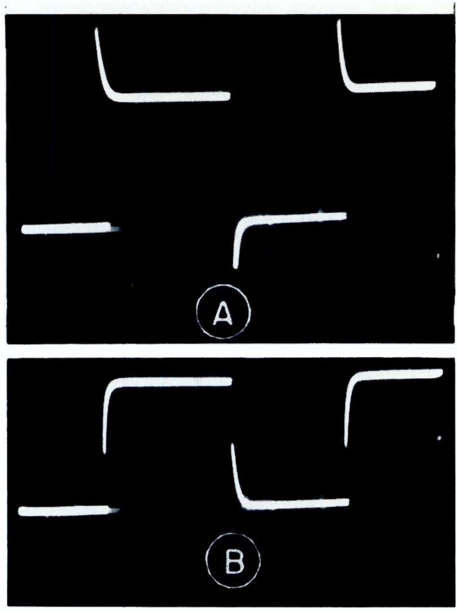


FIG. 5. Square wave distortion caused by improperly set frequency compensating capacitors.

such as shown in Fig. 5. If you are looking at a square wave which is square in the × 1 position, but distorted in the × 10 or × 100 positions, the frequency compensating capacitors should be adjusted.

Summary

There are many defects which can cause trouble in a scope. The servicing procedures outlined in this article should lead you to the cause of most of these defects. As a help in future servicing problems, if your scope operating manual does not contain a set of normal dc operating voltages, it would be worthwhile to make up a voltage chart while your scope is still working normally.

In servicing a scope, remember that in some circuits, the tubes may be quite critical. It's a good idea to try replacement tubes rather than relying on a tube tester to check tubes.

"I tried to repair it three different times."

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70.01-80	8	8	220.01-230	23	22
80.01-90	9	9	230.01-240	24	22
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100.01-110	11	11	250.01-260	26	24
110.01-120	12	11	260 01-270	27	25
120.01-130	13	12	270.01-280	28	26
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150.01-160	16	15			

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Previous Address________________

City & State________________ How long at this address?________

Present Employer________________ Position________ Monthly Income________

Business Address________________ How long employed?________

If in business for self, what business?________________ How long?________

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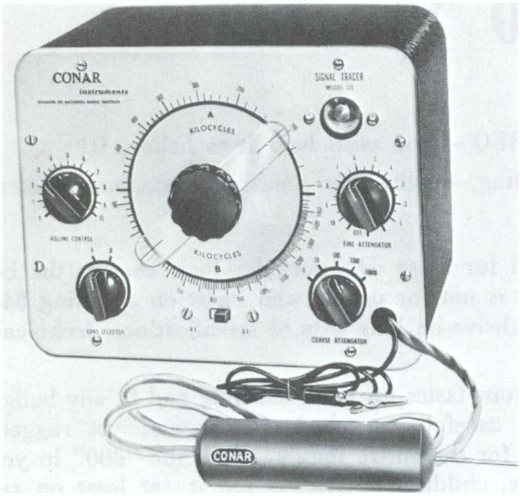
CONAR tuned signal tracer



SPECIFICATIONS

FREQUENCY: 170 kc to 1500 kc (2 bands)

TUNING: Planetary Drive, 3:1 ratio

SPEAKER: 4" PM left side of cabinet (not shown in illustration)

RF TRANSFORMERS: Permeability tuned

ATTENUATORS: Tuned RF and AF

CATHODE FOLLOWER PROBE: (6AB4 tube in special circuit: shipped assembled)

TUBES: (2) 6GM6, (1) 6AV6, (1) 6AQ5, (1) 6E5, (1) 6X4, (1) 6AB4

CONTROLS: Volume, Band Selector, Main Tuning, Fine Attenuator On-Off, Coarse Attenuator, RF-AF switch

CABINET: Steel, black wrinkle finish

PANEL: Steel w/satin finish, black lettering

DIMENSIONS: 9⅞" x 7½" x 6½"

POWER SOURCE: 110-120, 60 cycle AC

SHIPPING WEIGHT: 12 lbs., parcel post

A breakthrough in the servicing of transistor, vacuum tube, or hybrid receivers! Only *tuned* tracer on the market anywhere near the price. Exclusive cathode-follower probe gives outstanding sensitivity for tracing complete circuit from antenna to speaker.

Easily connects to any RF or IF stage with absolute minimum of detuning. Features audio tracing method through built-in PM speaker plus visual indicator using "eye" tube. Quickly locates sources of hum, noise and distortion. Tracks down intermittents, measures gain per stage, accurately aligns radios without signal generator. (Tracer may also be used as sensitive AM radio.) Has *two* stages of RF amplification.

Assembly-operating instructions include more than 12 pages on uses of Model 230. For beginners as well as experienced technicians. Illustrations give test points in different types of receivers. Here's a sensibly engineered instrument designed to pay for itself many times over through years of time-saving, dependable service. (Of course, all parts are U.S. made, top quality.)

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"300" stereo system

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

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

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

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

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The "300" Stereo System includes:

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

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

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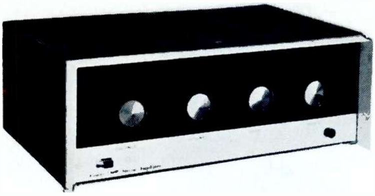
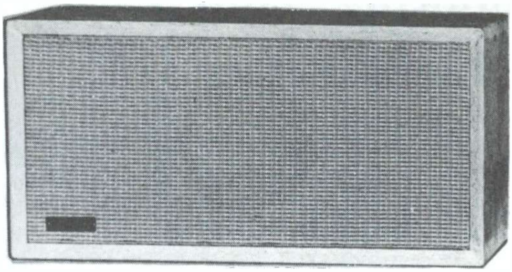
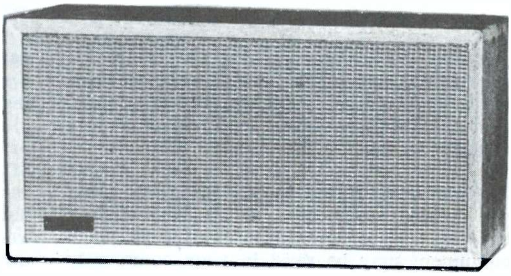






MODEL 300 STEREO AMPLIFIER

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

MODEL 300 SPEAKER ENCLOSURES

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

LESA CD2/21 RECORD CHANGER

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

STEREO CARTRIDGE

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

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

$109.00

Making Your FCC License Pay Off

by
Boyd Daugherty
NRI STAFF

Perhaps you are now working as a Radio-TV serviceman and getting along very well without a commercial radio operator's license. Just the same, a license could be extremely valuable to you.

For example, if you had the proper license, you might easily take on the servicing of two-way communications equipment. This equipment may be used in your community by police and fire departments, taxicab companies, doctors, and servicing organizations. Also in coastal areas there is often a need for servicemen who are qualified to install and maintain marine communications equipment. Finally, a license might very well turn out to be your "ticket" to a responsible, well-paying position in radio or television broadcasting or, perhaps, with a utilities company making extensive use of radio communications equipment.

There are several classes of operator's licenses. Let's discuss them for a moment and try to determine which would be best for you. First of all, there are two basic categories: radiotelephone and radiotelegraph. Considering the radiotelephone category first, we have the following classes:

(1) Radiotelephone First-Class
(2) Radiotelephone Second-Class
(3) Radiotelephone Third-Class
(4) Restricted Radiotelephone

A radiotelephone first-class operator's license, in general, permits the holder to operate, maintain, and repair any commercial radio transmitting station not using telegraph code. This includes radio and television broadcasting stations, land mobile, aircraft, and marine communications equipment, and any other licensed commercial radio stations not using Code.

A radiotelephone second-class operator's license carries exactly the same privilege as a first-class license except that the holder cannot, in general, maintain the transmitting equipment for radio or television broadcasting stations. However, the holder of a second-class license may "operate" a standard AM or FM broadcast station with a power output of 10 kilowatts or less and using a non-directional antenna. "Operation" includes putting the transmitter on and off the air in a strictly routine manner, and making certain minor adjustments to maintain the required output power and modulation levels. If the transmitter fails to operate properly, someone holding a first-class license must be called to correct the trouble.

Holders of a radiotelephone third-class permit may operate certain radiotelephone transmitting stations but cannot adjust, maintain, or repair such equipment. Here again, the holder can operate standard or FM broadcast tramsmitters with 10 KW or less output power and having non-directional antennas.

The restricted radiotelephone operator permit has very nearly the same scope as the third-class permit. The principal difference between the two is that a written test must be passed for the third-class, while no test is required for the restricted permit. The restricted permit very conveniently permits aircraft pilots, boatmen, cab operators, and others who have a need, to operate two-way communications equipment without extensive study of radio theory.

In the radiotelegraph group, we have these classes:

(1) Radiotelegraph First-Class
(2) Radiotelegraph Second-Class
(3) Radiotelegraph Third-Class

A radiotelegraph first-class operator's license permits the holder to operate, maintain, and repair any commercial radio transmitting equipment except that for a radio or television broadcasting station. Notice that a radiotelegraph license permits the operation of certain radiotelephone stations, while no class of radiotelephone license permits radiotelegraph operation. The holder of a radiotelegraph first-class license is authorized to serve as the sole operator or chief operator on ocean-going vessels required by law to maintain a continuous radio watch. A radiotelegraph second-class license carries exactly the same privilege as a first class radiotelegraph except that it does not permit the holder to act as sole operator or chief operator on passenger vessels required by law to maintain a continuous radio watch.

The holder of a radiotelegraph third-class operator's permit may operate radiotelegraph and certain radiotelephone stations, but he cannot adjust, maintain, or repair such equipment.

In general, we have covered the scope of the various commercial radio operator's licenses. The license most suitable for you may now be obvious. For example, either a first or second-class radiotelephone or radiotelegraph license will permit you to repair land mobile or marine radio equipment in your present shop. For this purpose, a second-class radiotelephone license would probably be best because it is the easiest of the four to get. It does not require a code test as do the radiotelegraph licenses. Also, the written examination is easier than that for a radiotelephone first-class license.

If you wish to work in radio or television broadcasting, you should plan to get a radiotelephone first-class license. In this case, it would probably still be best for you to get a radiotelephone second-class license first. This is true because there are four separate examinations you must take for first class. For second class, you will be given only three separate examinations and these are identical to the first three that are given for first-class. Once you have a second class license, you can concentrate on preparing for the fourth examination. Also, once you have your second-class license, you will not have to repeat the first three examinations providing you present your second-class license to the examiner when you go for the first-class examination.

Perhaps you would like to be a sea-going radio operator. In that case, you should try for a second or third class radiotelegraph operator's license. Getting the third class first is recommended, for here again, all that is required to advance to the higher class is a passing score on one additional examination. A radiotelegraph first class license cannot be obtained until the applicant has had a total of one year of satisfactory service as an ocean-going radiotelegraph operator. It is also interesting to note that radiotelegraph first-class is the only license which has an age requirement. For this license, the applicant must be at least twenty-one years of age.

Now that you probably know which license you would like, let's see how you go about getting it. First of all, applicants for all classes of licenses must have the ability to transmit and receive spoken messages in English. Second, there is a general requirement that licenses may be issued by the FCC only to U. S. citizens. In addition to these two requirements, all applicants for any license other than a restricted radiotelephone permit must make a satisfactory score on the written tests prescribed and administered by the FCC for the various classes of licenses. Finally, all applicants for the three classes of radiotelegraph licenses must make a satisfactory score on a transmitting and receiving code test.

The scope of the various written examinations has been divided by the FCC into eight groups or areas of knowledge called "elements." The area of coverage for each of the eight elements, as described in Section 13.21 of the Rules of the FCC, are as follows:

1. Basic Law. Provisions of laws, treaties and regulations with which every operator should be familiar.

2. Basic operating practice. Radio operating procedures and practices generally followed or required in communicating by means of radiotelephone stations.

3. Basic radiotelephone. Technical, legal and other matters applicable to the operation of radiotelephone stations other than broadcast.

4. Advanced radiotelephone. Advanced technical, legal and other matters particularly applicable to the operation of the various classes of broadcast stations.

5. Radiotelegraph operating practice. Radio operating procedures and practices generally followed or required in communicating by means of radiotelegraph stations primarily other than in the maritime mobile services of public correspondence.

> Thinking how to do a thing eliminates most of the work of doing it.

6. Advanced radiotelegraph. Technical, legal and other matters applicable to the operation of all classes of radiotelegraph stations, including operating procedures and practices in the maritime mobile services of public correspondence and associated matters such as radio navigational aids, message traffic routing and accounting, etc.

7. Aircraft radiotelegraph. Basic theory and practice in the operation of radio communication and radio navigational systems in general use on aircraft.

8. Ship radar techniques. Specialized theory and practice applicable to the proper installation, servicing and maintenance of ship radar equipment in general use for marine navigational purposes.

For each of the classes of licenses, the applicable elements and code requirements are as follows:

(1) Radiotelephone First-Class: Elements 1, 2, 3, and 4.

(2) Radiotelephone Second-Class: Elements 1, 2, and 3.

(3) Radiotelephone Third-Class: Elements 1 and 2.

(4) Restricted Radiotelephone: No examination; just written application.

(5) Radiotelegraph First-Class: Elements 1, 2, 5 and 6 plus 25 WPM (words per minute) code test.

(6) Radiotelegraph Second-Class: Elements 1, 2, 5 and 6 plus 16 WPM code test.

(7) Radiotelegraph Third-Class: Elements 1, 2 and 5 plus 16 WPM Code test.

In addition to the elements shown above for each class of license, if you wish to operate aircraft radiotelegraph equipment, you must pass the test for Element 7. You must also be at least eighteen years of age. If you pass the examination for Element 7 and meet the age requirement, your radiotelegraph license will have an "endorsement" added to it certifying that you may operate aircraft radiotelegraph equipment. Likewise, passing the test for Element 8 will qualify you to repair ship radar equipment. This will add a "Ship Radar Endorsement" to your first or second-class radiotelephone or radiotelegraph license.

Examinations, both written and code, are given by the FCC at its district offices which are located in principal cities in the United States. In addition, on a quarterly, semi-annual, or annual basis, examinations are given at secondary locations within the districts. To determine where and when examinations are given in your area, write the Federal Communications Commission, Washington 25, D. C. If you prefer, National Radio Institute will be happy to supply this information.

When you take the examinations, you should be prepared to spend at least one whole day in the examining room. There is no time limit, so proceed slowly and cautiously. All questions are multiple choice. If you cannot decide on the correct answer for a question, go on to the next question. Many times you will find a hint as to the correct answer with some question later in the examination. Also, many questions will appear to have more than one correct answer. There is one best answer so read each question carefully and think! You will probably be told in the examination either to draw or to correct the schematic diagrams for a few basic circuits such as amplifiers, rectifiers, oscillators and multivibrators. This will require a thorough knowledge of the fundamental circuits.

You will not be permitted to take anything in the way of an aid to the examination room with you except a slide rule. No books, tables, or notes will be permitted. If you need to make calculations, this can be done on the backs of the answer sheets. If you already have one commercial license and desire another, you will be required to take only the examinations on elements you have not passed previously, provided you bring your present license to the Examination. For example, if you have a third-class radiotelephone license and wish a second class, it will be necessary for you to take and pass the examination for Element 3 only. If you have a second class and wish a first, you must take the Element 4 examination.

What if you fail? Let's hope you don't, but if you do, remember that other good men have too. You will be eligible to repeat the examination in sixty days. Also, you will have to repeat only the examination for elements actually failed. Use the sixty days to "bone up" on whatever caused your trouble the first time.

What is the best way to prepare for an examination? This depends very much upon your technical background. For example, if you have extensive training and experience in radio communications or related fields, acquired through military service, your task will probably be easy. Learn the applicable FCC Rules and Regulations and you should be ready for the examination. The FCC does not publish its examination questions but it does make available a "Study Guide and Reference Material for Commercial Radio Operator Examinations." This booklet may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. The Study Guide lists numerous review questions which are similar to the actual examination questions. This booklet costs $.75 and it is strongly recommended that you get a copy. At the same time, a copy of Volume I of the Federal Communications Commission Rules and Regulations containing Part 13, "Rules Governing Radio Operators" should also be requested from the Superintendent of Documents. The price of Volume I is $2.50. You will also find certain books helpful such as Kaufmann's "Radio Operator's License Q and A" published by John F. Rider, and Hornung and McKenzie's "Radio Operating Questions and Answers", published by McGraw Hill. Both books are available from Allied Radio and other electronics supply houses.

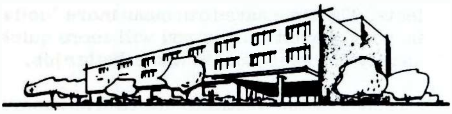
If you need further technical training, a systematic study program is recommended. This can be a study of textbooks on your own, or better still, you can take a course in radio communications. Perhaps night courses are offered in your area. However, many find the fastest and easiest way to get the necessary technical training and knowledge of radio laws and regulations is to study by correspondence. In taking a home study course in radio communications you can progress at your own best rate. If you are familiar with part of the material, you need not waste time in adhering to a rigid class schedule as is necessary in residence schooling. Instead, you will move on quickly to learn new and unfamiliar subjects. The time saved can mean more "dollars in your pocket" since you will more quickly qualify for your license and a better job.

National Radio Institute offers five separate courses in radio communications. The first of these is a comprehensive course which covers technical fundamentals and then gives a thorough treatment of radio and television broadcasting, mobile, marine, and aircraft communications, and includes preparation for a first-class radiotelephone license. This comprehensive course includes numerous kits for building and experimenting with transmitter circuits. For those wishing to specialize in mobile, marine, or aircraft radio, NRI offers three courses without kits in these areas. Finally, for the man having a technical background but needing assistance in preparing for his FCC license, there's NRI's "FCC Course."

In this discussion, we have covered the classes of radiotelephone and radiotelegraph licenses, the duties which the holder of each can perform and the licensing requirements. We have given hints on taking examinations and, finally, suggestions have been made on how you can most effectively prepare yourself to get your license. The tremendous growth of radio communications has made many new jobs available. An FCC license can open the way to increased job security, higher pay and more interesting work.

"And never mind introducing us as your woofer and two tweeters!"

NRI ALUMNI NEWS



CHICAGO CHAPTER, after a period of inactivity last summer and early fall, has resumed its regular meetings. Members will be warmly welcomed at the meetings again, also students and graduates who would like to join. Two new members have already been accepted: Florentine Aquino and John Techman. Congratulations, gentlemen!

CUMBERLAND VALLEY CHAPTER'S Chairman George Fulks was scheduled to give a demonstration on aligning a television receiver with a scope and marker generator.

Francis Lyons is the latest member to join the chapter. Congratulations, George.

DETROIT CHAPTER has continued with the same type of program with which it started the season -- that is, concentrating on demonstrations of troubleshooting TV receivers. One such demonstration that was very good was given by Secretary George Povlich on the HV section of a television receiver.

One meeting was taken up mostly with discussion of and experimentation with Leo Blevins' projector. The members finally decided it was what they needed. John Korpalski made good use of it right away. He had built a transistor checker which he brought in for the members to see, used the projector to show the schematic. The Chapter expects to make good use of this projector.

FLINT (SAGINAW VALLEY) CHAPTER members and their wives and families visited the Blue Diamond Picture Tube Factory in Saginaw, which rebuilds and distributes picture tubes. The guests were conducted through the factory and shown the entire process of rebuilding tubes. Afterward they were served a buffet lunch.

There was a very good turnout for the Westinghouse Service Training Program at the December meeting. Various features of the new Westinghouse receivers were discussed and demonstrated. The members were also given an idea appropriate to the time of year: how to make extra money installing a resistor which prolongs the life of Christmas tree bulbs. The Chapter is indebted to Mr. John Hatherhill for putting on such a fine program. This meeting likewise terminated with a tasty buffet lunch.

The newest member to join the Chapter is Paul Crippen of Millington. Welcome, Paul!

LOS ANGELES CHAPTER'S newest (and also youngest) member is George Lee of San Gabriel.

The members were particularly pleased to have George join the Chapter. Immediately after being accepted as a member, he conducted a complete demonstration of the B and K Television Analyst. Attendance at this meeting was one of the largest that the Chapter has ever had.

The Chapter has completed assembly of the CONAR Custom 70 TV Receiver. The members were justifiably proud that, following completion of assembly, when the power was turned on the set produced a perfect picture. The receiver is now being used for demonstrations at the meetings.

MINNEAPOLIS-ST. PAUL CHAPTER members were justly proud at having one of their members, John Berka, elected to the office of President of the NRIAA for 1963. They made quite a ceremony of administering the oath of office to him and photographs were made of the meeting. Up to the time we went to press, however, these pictures had not reached National Headquarters. Maybe we'll have them for the next issue.

NEW ORLEANS CHAPTER has changed its meeting place. Meetings were formerly held at the home of the late Louis Grossman, who organized the Chapter. The chapter now meets at 229 So. Rocheblave, New Orleans. The time remains the same, 8:00 P. M. on the second Tuesday of each month.

NEW YORK CITY CHAPTER is still enjoying the high degree of enthusiasm with which it began the current winter season. In addition to the seven new members reported in the last issue of the NRI News, ten more new members have joined. They are John Douglas Jones, Brian Chin, Jesse Spielholz, David

Sutherland, Joseph Orsini, Albert Birnstein, Eric Wolf, Adam Wagner, Antonio Acosta, Brother Bernard Frey, and Alfred Seemann. National Headquarters congratulates these gentlemen.

Chairman Dave Spitzer is continuing with a popular feature assigned to him: Talks and demonstrations on TV problems and their solutions. Executive Secretary Tom Hull has started a series of illustrations on aligning AM-FM Radios. Vice Chairman Jim Eaddy and Mr. Bradley, Jr., gave a demonstration of a transistor circuit from rf to audio.

The members are looking forward to many more such interesting demonstrations and talks.

All the Chapter's 1962 officers (except former Secretary Alvah Bonham, who decided against running for office again) were re-elected to serve for 1963. They are Dave Spitzer, Chairman; Thomas Hull, Exec. Chairman; Frank Zimmer, 1st Vice Chairman: James Eaddy, 2nd Vice Chairman; Frank Castalano, Treasurer; and Joseph Bradley, Jr. Secretary. Our congratulations, gentlemen.

PHILADELPHIA-CAMDEN CHAPTER'S latest members to join the Chapter are George Simpler of Philadelphia and James Persons of Maple Shade, N. J. It is good to welcome these new members.

The Chapter has lined up a heavy program of speakers for the first five months of this year, featuring mostly representatives of manufacturers and distributors as guest speakers.

Members are still enthusiastic about Chris Urbach's classes in code that he is conducting. This has proved one of the most popular programs that the Chapter has ever undertaken, thanks to Chris.

Another old-time member who has contributed so much to the Chapter and who continues to do so is Harvey Morris. A question-and-answer forum that he led not long ago was so well received by the members that, upon their insistence, he has been scheduled to give another one.

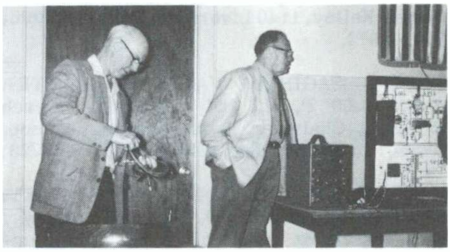
PITTSBURGH CHAPTER was badly disappointed at its December meeting. This was to be one of its very largest, since its Christmas party was to be held at this meeting and Ted Rose and J. B. Straughn were due to attend. But due to heavy snow storms in western Maryland and Pennsylvania, only half the expected number of members showed up. Rose and Straughn did not get there at all; they were marooned for a while in the mountains near Hagerstown and finally had to return to Washington. Their visit has been rescheduled for some time in the Spring.

Elections were, nevertheless, held at this meeting. The successful candidates were: Tom Schnader, Chairman; William Lundy, Vice Chairman; Wm. Sames, Recording Secretary; Howard Tate, Corresponding Secretary; Jack Fox, Treasurer; Joseph Burnelis, Gilbert Harding, and David Benes, Board of Directors. National Headquarters congratulates these officers.

SAN FRANCISCO CHAPTER elected an entire new slate of officers to serve for 1963, as follows: Peter Salvotti, Chairman; Isaiah Randolph, Vice-Chairman; Willie Hawkins, Secretary Anderson P. Royal, Treasurer; Bartolome Flajo and Phil Stearns, Finance Committee. Our congratulations to these officers.

Former Chairman Ed Persau lead a discussion on the article "Servicing Transistor Radios With the VTVM" by J. B. Straughn, which was published in the Electronics World magazine.

The latest member to join the Chapter is Mereland Moore. A warm welcome to you, Mereland.



Former treasurer Charlie Kilgore and present chairman Pete Salvotti giving a demonstration at a meeting of the San Francisco Chapter.

SOUTHEASTERN MASSACHUSETTS CHAPTER has purchased an automatic electric photocopy pacer machine for making copies of schematic diagrams for use of the members at meetings. This will make the discussions more helpful and meaningful.

A good part of one recent meeting was taken up by a discussion of the emission of TV picture tubes.

SPRINGFIELD (MASS.) CHAPTER wishes to call special attention to a change in meeting time and place. The meetings are now held in the shop of Norman Charest, 74 Redfern St., Springfield, on the first and third Saturday of each month.

The Chapter used to hold a party each December, which was called their Christmas Party. But Happy George Desnoyer suggested that this party be held in January hereafter. The suggestion met with great favor and applause.

The Chapter continues to show interesting films at its meetings. Scheduled for future meetings are talks and demonstrations on using the scope by John Parks, on transistors by Norman Charest, and on the B and K Analyst by Joe Rufano.

Jack Zayara was recently admitted to membership. Congratulations, Jack!

Directory of Local Chapters

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

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

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

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

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

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

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

NEW ORLEANS CHAPTER meets 8:00 P. M., 2nd Tuesday of each month at 229 So. Rocheblave, New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P.M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: David Spitzer, 2052 81st St., Brooklyn, N. Y., CL 6-6564.

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

PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: Thomas Schnader, RD 3, Irwin, Pa., 731-8327.

SAN ANTONIO ALAMO CHAPTER meets 7:30 P. M., 2nd Thursday of each month, National Cash Register Co., 436 S. Main Ave., San Antonio. Chairman: Jesse DeLao, 606 Knotty Knoll, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P.M., 1st Wednesday of each month, 147 Albion St., San Francisco. Chairman: Peter Salvotti, 2534 Great Hwy, San Francisco, Calif.

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

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., 1st and 3rd Saturday of each month at shop of Norman Charest, 74 Redfern St., Springfield, Mass. Chairman: Steven Chomyn, Powder Mill Rd., Southwick, Mass.

ANSWER TO PUZZLE

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J. E. SMITH CELEBRATES HIS 82ND BIRTHDAY

Picture on this page look familiar? We're sure it does -- to students, graduates, and millions of other people the world over.

For nearly 50 years, this photo of our beloved founder J. E. Smith (now serving as Chairman of the Board) appeared in hundreds of thousands of magazine ads.

In the month of February, Mr. Smith celebrates his 82nd birthday. It's indeed a tribute to any man to reach the age of 82. But to have taken an active and often strenuous part in what has become the fastest growing major industry -- makes it more than just a birthday for J. E. Each birthday has been a milestone -- a page in history -- as fact-filled as that of Electronics itself.

From the days of "wireless," station KDKA's first broadcast in 1920, crystal sets -- to computers, radar, satellites shadowing the earth, and TV as common as "indoor plumbing," Mr. Smith is one of few men who can vividly recall every major achievement made in the field of Radio-TV-Electronics.

There are many fond memories here -- and a promise of even more remarkable things to come in the ever-growing, multibillion dollar industry. But for Mr. Smith, these memories are secondary.

Want to know where his thoughts are -- for the present, past, and future? There's nothing with more meaning to him than the strong sense of accomplishment and pride he has gained in helping over ONE HALF MILLION men toward a more productive life -- a better standard of living for themselves and their loved ones. Nearly a half century working shoulder to shoulder with YOU -- and the thousands who have gone before building a thriving industry -- an industry now essential to the well-being of every man, woman, and child.

The folks here at NRI want to do something very special for J. E. on this occasion. We need your help to present him with the best possible birthday gift we can think of.

It's not greeting cards, shirts, neckties, or candy. Instead, his lifelong dedication and ambitions make it clear what he'd like most as a gift. It is an OPPORTUNITY -- the OPPORTUNITY to train even more men for successful careers in Radio-TV-Electronics or Appliance Servicing.

You can do your part -- easily -- quickly -- to make it a truly Happy Birthday for Mr. Smith. Just give us the name of one man whom you feel would make a good NRI student. We'll send him an NRI catalog -- won't use your name. But be sure to give us your name and student number so you'll get full credit for your friend's enrollment.

We know we can count on the full cooperation of every NRI man in making this "special gift" an outstanding success.

Just clip the coupon at the bottom of this page and send it along to us -- or use a separate sheet of paper. We'd like to have all names in by March 15th. Won't you please send us one friend's name now -- before it slips your mind?

Our heartfelt thanks to all of you for your help!

The Editors

The Editors, NRI News
National Radio Institute
3939 Wisconsin Ave.
Washington 16, D.C.

Dear Editors:

Here's my contribution toward Mr. Smith's "special" gift. This man would make a good NRI student. Send him the NRI catalog, which describes the course I have checked:

___ Radio-Television Servicing
___ Radio-Television Communications
___ Servicing Electrical Appliances
___ Electronics: Principles, Practices, Maintenance (Industrial Electronics)

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City ____ Zone ____
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