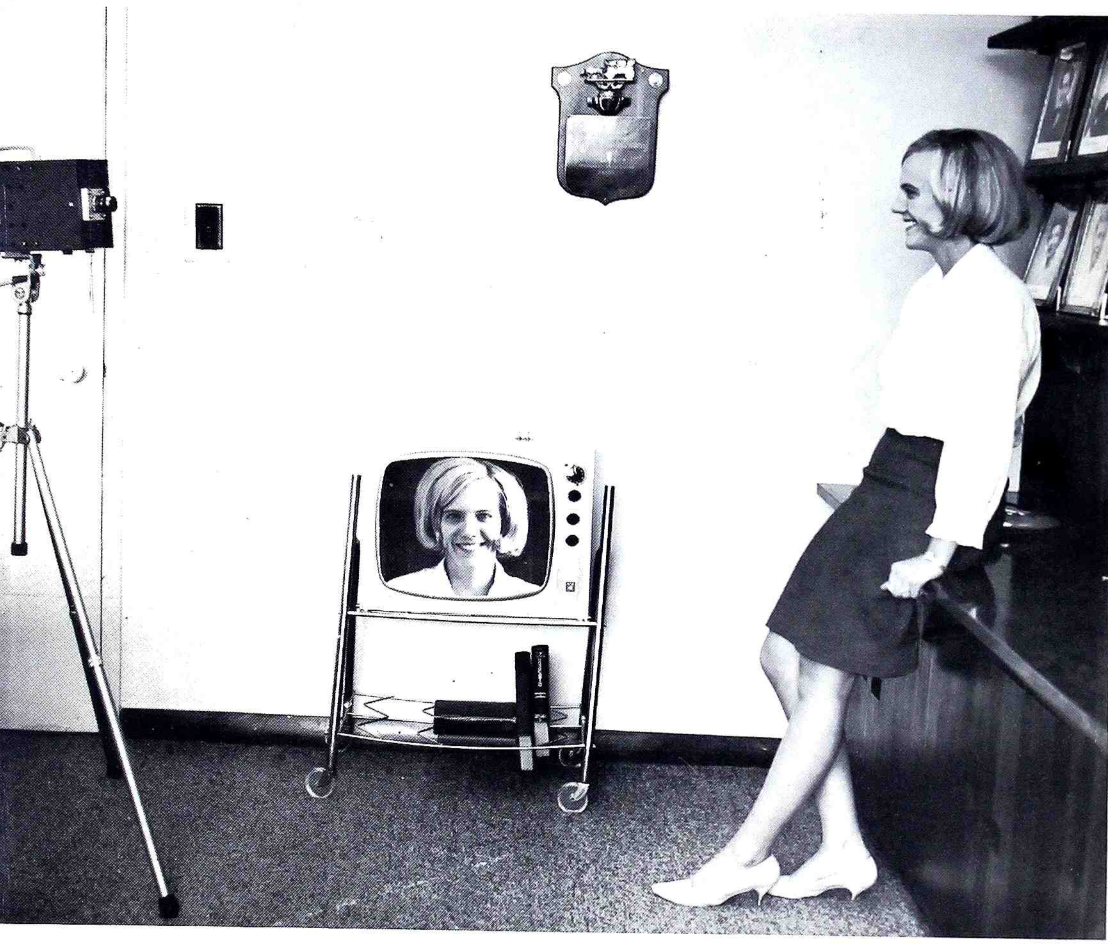
nri journal

November-December 1965 *35 Cents*



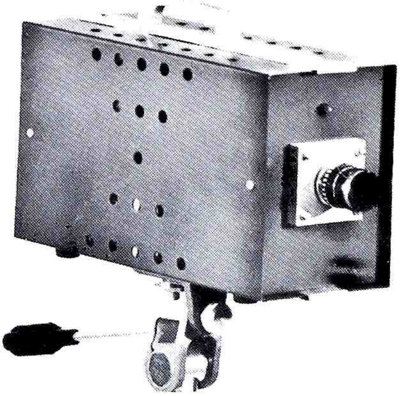
NTHIS SSUE:

- THE CONAR MODEL 800 VIDICON CAMERA
- TRANSISTOR SERVICING
- FUNDAMENTALS OF AM/FM SERVICING
- RECIPE FOR INSTANT GRADUATION

ALL NEW FROM CONAR!

orders now being accepted for December delivery

MODEL 800 TV CAMERA KIT



- **Lowest priced complete TV camera on the market!**
- **Connects instantly to any standard TV set!**
- **1,001 uses in homes, schools, offices, factories, stores, industry!**
- **On the air in less than 8 hours assembly time!**

With this issue of NRI Journal, Conar proudly announces the new Model 800 TV Camera Kit—a versatile, low cost, closed circuit camera for use in countless applications. Your own imagination is the only limit to the number of uses for the Model 800—store minder, baby sitter, swimming pool guard, plant security, production line control, window display, auditoriums, classrooms—to name just a few. Use the Model 800 to attend sick persons or infants. Stage your own TV programs! Use for surveillance anytime, anywhere.

Unlike other closed circuit cameras, the Model 800 *does not* require expensive monitor sets. It can be connected instantly to the antenna terminals of any standard TV set—or connect up to *six* standard sets without loss of picture quality. Simply tune your camera to an unused channel in your area (from channel 2 to channel 6), connect camera, switch channel selector and you're in business! Camera will not interfere with normal program reception. The Model 800 can be located as much as 1,000 feet from the TV receiver without noticeable loss of picture quality.

Precision ground 25mm f 1.9 lens supplied with kit gives clear, sharp pictures even under shaded conditions. The light from two 100 watt bulbs is entirely adequate for indoor use. The Model 800 even gives a discernible picture in bright moonlight!

Early indications are that the initial inventory of Model 800 kits will be a Christmas sell-out. As a suggestion, place your order now for one of the most outstanding kit values offered by any manufacturer. You're in for a pleasant surprise when you see this one perform! Conar's usual *full year* guarantee on all parts of course with exception of vidicon tube which carries 90-day warranty.

SPECIFICATIONS

Size: 5" wide, 7" high, 12¼" deep. *Weight:* 11 lbs. including lens. *Power Consumption:* 45 watts, 120v, 60 *cycle,* AC only. *Output:* Modulated rf, any channel from 2-6. *Output Level:* Greater than 100,000 mv. *Output Impedance:* 75 ohms. *Sweep Rates:* Random interlace, horiz. 15,750 cps; vertical 60 cps line locked. *Resolution:* 240 lines; 3 mc. *Controls:* Horiz. Freq., Target, Beam, Focus, On/Off. *Adjustments:* V. Height, V. Centering, H. Width, H. Linearity, H. Centering, Channel Adjust, High Peaker. *Tubes:* 5 dual-purpose, 9 semi-conductor diodes give 12 tube performance. *Standard Lens:* 25mm, f 1.9 focusing 2' to infinity. Click stop iris to f22. Standard "C" mount included.

amazing value at

Kit Price — $209.50

(Stock #800UK) (includes vidicon, standard lens, tubes, cabinet, assembly-operating manual—nothing else to buy!) Shipped Express, COD for shipping charges.

OPTIONAL ACCESSORIES: *Wide Angle Lens;* 12.5 mm, F 1.9, focusing 10' to infinity. Click stop to f22. $36.00 additional. *Telephoto Lens:* 50mm, f 1.9, focusing 2' to infinity, Click stop to f22. $28.00 additional. Professional type tripod with "C" mount. $21.00 additional. Complete camera also available factory assembled at $249.50.

nri journal

NOVEMBER/DECEMBER 1965
VOL. 22, NO. 6

Published every other month by the National Radio Institute, 3939 Wisconsin Ave., N.W., Washington, D.C. 20016. Subscription $2.00 a year. Printed in U.S.A. Second-class postage paid at Washington, D.C.

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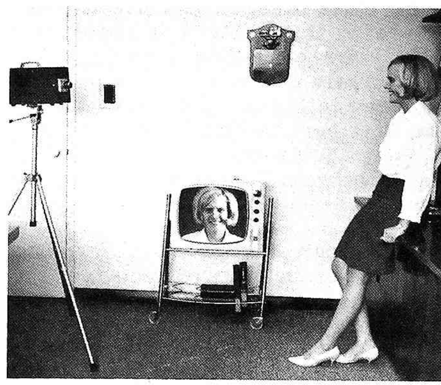


ON OUR COVER

Alice Buckingham of NRI's Student Service Department gets a preview of CONAR's new Model 800 Vidicon TV Camera (discussed in an article beginning on Page 3). She thought the idea was great, but that's not the only reason for the happy smile on her face: She had gotten her ring just before the picture was taken, and "I've been grinning all over all day!"

THE NEW CONAR MODEL 800 CLOSED-CIRCUIT TV CAMERA

By ROBERT L. CARLSON

Everybody knows what television is, of course, but what is closed-circuit television? Is it anything like "regular" TV? What is it used for? Is it expensive? Is it complicated? Before we specifically answer these questions by discussing the new CONAR Model 800 closed-circuit TV camera, let's answer the questions first in general terms.

As you know, the TV signal you receive at home originates at a distance at the television station. The station broadcasts its programs to TV receivers in the area by means of radio waves. Closed-circuit TV, on the other hand, is sent directly from the camera to the receiver or receivers by a direct wire connection (usually a coaxial cable). There may be more than one receiver connected to the cable; however, the important thing here is that the camera signal is NOT broadcast--there is a closed (wire) circuit between the camera and receiver, hence the name closed-circuit TV.

Closed-circuit TV (or CCTV for short) is very similar in many respects to "regular" TV. A visual image is scanned and transformed in a camera into an electrical signal and sent to a receiver where it is transformed back into a visual image. To do this, the CCTV signal must have sync and blanking signals like regular TV, and if standard TV receivers are to be used as receivers, or monitors, for CCTV, then the scanning rates must be the same for CCTV as for regular TV. The CCTV system, then, is a regular TV system in miniature, having a camera and a sync generator and the necessary amplifiers and mixers to produce a composite video signal. Some CCTV systems also include rf generators and a modulator, so the signal from the camera may be processed by a standard TV receiver merely by connecting a cable to the antenna terminals of the receiver. Other systems do not provide an rf signal and so must use either a special monitor receiver or special video connections to a standard receiver.

CCTV was first used in industrial applications for observing various manufacturing operations and for security surveillance purposes.

Gradually, other uses were found for CCTV. Banks use it for protection and signature verification, hospitals show patients their children on CCTV, drama schools use it to advantage for studying technique, hotels and apartments use CCTV in many ways for guest convenience, small businesses use it for shop protection and display purposes, and many other people use it in any number of ways for various surveillance jobs. At home, for example, CCTV makes an excellent baby sitter, door protector, or swimming pool guard. Portrait photographers use CCTV for "instant proofs"--even faster than Polaroid, and larger pictures, too.

Until CONAR announced their Model 800 CCTV camera, CCTV systems would have to be classed as "rather expensive". Not the sort of thing one would REALLY use around the house or small shop. Prices, even for the SIMPLEST system, started at around the $400 level and went up--and up! A good quality industrial CCTV system could easily cost $10,000 or more, depending upon the number of cameras and receivers and the length of cable required. Today, the CONAR Model 800 CCTV camera at $249.50 assembled or $209.50 as a kit, represents the lowest priced

Fig. 1. The CONAR Model 800 Vidicon TV Camera.

CCTV system available, putting it well within the reach of individuals and small businesses for use in a variety of applications.

Just how does the Model 800 stack up with other CCTV cameras? The rest of this article will give you some idea of what the Model 800 is and what it can do.

DESCRIPTION

The Model 800 is a complete CCTV station. When you buy a Model 800, you get everything you need to set up an operating CCTV camera --lens, coaxial cable, and camera with rf output on standard TV channels 2 through 6. The coaxial cable is even supplied with the proper fittings for the cable socket on the camera.

LENSES

The standard lens supplied with the Model 800 is a quality, high-speed C mount TV lens. Focal length is 25mm and the maximum aperture is f 1.9 for excellent low light applications. A 12.5mm, f 1.9 wide-angle lens and a 50mm, f 1.9 telephoto lens are also available as accessories from CONAR.

The standard 1" C mount used on the Model 800 allows the use of any lens with a similar mount. Many such used lenses (from 16mm movie cameras) are to be found in camera stores and pawnshops for those who would like to have a number of different lenses for their Model 800.

PHYSICAL DESCRIPTION

The Model 800 shown in Fig. 1 is housed in an attractive lightweight aluminum cabinet painted a light shade of blue. It measures 5" × 7" × 12-1/4" and weighs less than 12 pounds. On the front panel are the lens mount, lens and pilot lamp. Putting the pilot lamp on the front panel lets those in front of the camera know when they are on camera.

The rear panel, shown in Fig. 2, has four operator controls, in addition to the on-off switch, the coaxial cable connector, the one ampere fuse and the 12' ac line cord. The four operator controls, while conveniently handy, will rarely need attention once they are properly set. Only if there is an extreme change in light level will it be necessary to adjust the controls. The extra long ac line cord allows the Model 800 to be set up in any location within 12' of an ac wall outlet without having to use an extension cord. Extension cords may be used, however, if needed.

On the bottom of the Model 800 are four soft plastic feet that allow use on any flat surface

Fig. 2. Rear panel of the CONAR vidicon camera.

such as a chair or table. In addition, there is a tripod socket, positioned at the balance point of the camera, that is tapped for standard photographic camera tripods (also available from CONAR as an accessory). The bright-finish handle on the top of the camera provides a convenient means of carrying the Model 800 from one spot to another.

CIRCUIT DESCRIPTION

A block diagram of the Model 800 is shown in Fig. 3. The heart of the camera is the sensitive vidicon pickup tube, V1. This tube is the same type that is used in TV film cameras and in many color TV cameras. It is small, rugged, lightweight, and very sensitive in very dim light.

The video signal produced by the vidicon is extremely small. For this reason a very high gain four-stage video amplifier raises the vidicon signal to a level of approximately 1 volt peak-to-peak.

The video amplifiers, V2 and V3, in addition to supplying high gain, must also have a wide bandwidth to accommodate the high-frequency video signals. The over-all bandwidth of the system is slightly greater than 4 mc, which corresponds to a resolution capability of about 320 lines. However, the system resolution will be determined primarily by the receiver used with the Model 800. Most standard re-

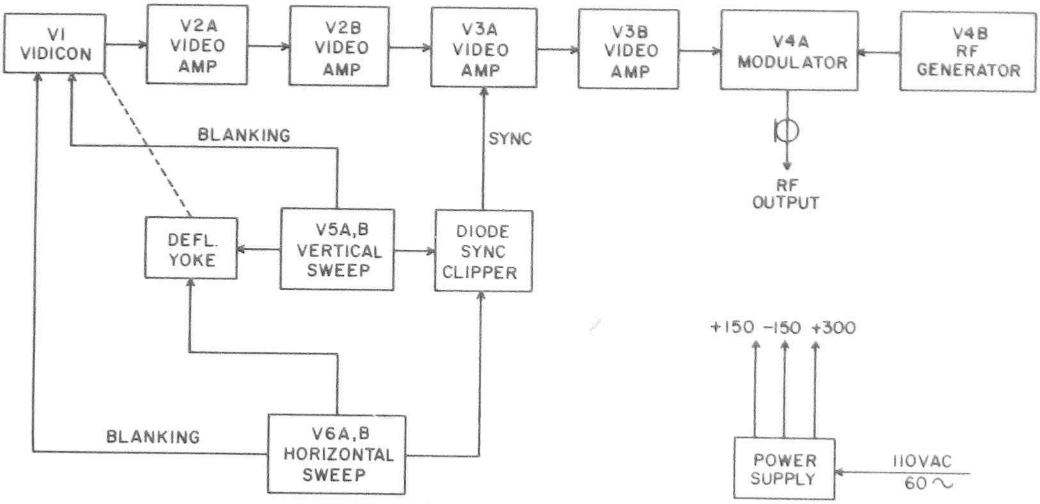


Fig. 3. Block diagram of the Model 800.

ceivers have a video system capability of from 2.5 mc to 3.5 mc (advertising claims to the contrary!), which means system resolution will be set by the receiver rather than by the camera.

A combined horizontal and vertical sync pulse is mixed in the third video amplifier, V3A, with the video signal. A keyed diode circuit is used for this purpose. The composite video signal is amplified by V3A and V3B and applied to the modulator, V4A. V4B is the rf carrier generator and is adjustable for channels 2 through 6.

V5 and V6 are the vertical and horizontal sweep generators respectively. V5A amplifies and shapes a pulse derived from the 60 cycle ac line and passes it to V5B, a cathode follower. The vertical winding of the vidicon yoke is directly connected to the cathode of V5B. A negative going pulse is taken from V5A and applied to the sync clipper along with a horizontal pulse from V6. A second pulse, positive going, is taken from the cathode of V5A and applied to the cathode of the vidicon, V1, to insure vertical retrace blanking of the vidicon.

There are three setup controls in the vertical sweep section of the Model 800--height, linearity and position. These controls perform the same job for the camera that similar controls perform for the receiver. There is no vertical hold control because the vertical sweep is not a free-running oscillator, but an overdriven amplifier fed from the 60 cycle ac line. For this reason, the Model 800 can be used ONLY with the NTSC (American) type receivers and MUST operate from a 60 cycle ac power source.

The horizontal sweep section, V6, uses a free running, cathode-coupled multivibrator circuit. The horizontal deflection coils are placed in the cathode of V6B. Setup controls consist of width, linearity and centering controls which affect the magnitude, shape and dc component of the waveform applied to the horizontal winding of the yoke. A separate rear-panel mounted, horizontal-hold control allows the operator to adjust the frequency of V6 within the range of the receiver horizontal oscillator. Pulses from V6 are fed to the sync clipper and to the vidicon for sync and vidicon blanking respectively.

An interesting feature of the horizontal circuit is its automatic sweep failure protection for the vidicon. If for any reason the horizontal oscillator were to fail, the beam of the vidicon would not be swept across the vidicon screen (target) horizontally. If this were allowed to continue for even a few minutes, the sensitive target could be damaged by the finely focussed electron beam tracing up and down (vertically), without being deflected horizontally. If this were to happen, when sweep is restored there would be a dark vertical line, a scar, in the center of the image which might or might not "heal" and disappear. To protect the vidicon in the event of such a failure, the magnetic focus coil of the vidicon is placed in the cathode of V6B, the dc plate current providing the required focus current to the coil. If the oscillator were to stop, the plate current of V6B would change, either up or down, and cause the focus current to change and defocus the vidicon beam. The large spot thus produced is much less likely to damage the vidicon target with no horizontal sweep.

POWER SUPPLY

There are actually three power supplies in the Model 800 camera: +150v, +300v, and -150v. The +150v supply is the workhorse supply and is used for the video amplifiers, rf generator and modulator, and the horizontal oscillator. The +300v supply is used for the vertical sweep circuit and for the gun supply for the vidicon. The -150v supply provides bias for the grid of the vidicon. All three supplies are derived from a single untapped secondary winding on the power transformer. The +150v supply is a husky half-wave rectifier circuit. The +300v supply is a half-wave doubler in conjunction with the +150V supply, while the -150v supply is yet another half-wave circuit. All three power supplies use silicon rectifiers for improved efficiency and cooler operation of the camera. A separate center-tapped 6.3v ac winding on the power transformer supplies balanced ac for the filaments of all tubes.

Operating the Model 800 is very simple; a few minutes' practice will make anyone an expert. After the initial sweep adjustments and channel selection (preset at the factory on assembled units) have been made, there are only four operator controls to be concerned with. Actually, once these have been set for given light/subject conditions all you have to do is turn the camera on and off.

Referring once again to Fig. 2, which shows the rear panel of the Model 800, here's how you would operate the camera (Actually DOING the job takes a lot less time than the explaining takes!). The HORIZONTAL and FOCUS knobs should be turned first fully clockwise (to the right), and the BEAM and TARGET knobs fully counterclockwise (to the left). With the rf cable connected to the antenna terminals of a TV receiver and the receiver "on" and set to whatever channel you are using, (an unused TV channel in your area), plug the camera power cord in and turn the switch "on".

In a few seconds you will see many, many lines or specks on the receiver screen, which will appear to move and change in number as the camera warms up. Slowly turning the HORIZONTAL control to the left will change the number of these lines until finally there will be no more and you will see a clear, blank screen. Further turning of the HORIZONTAL knob to the left will give the characteristic "out of sync" look to the TV screen. You should set the HORIZONTAL control for a normal raster with no lines.

Next, set up some subject such as a person or a picture in front of the camera, and set the focus scale of the lens to the approximate distance from the lens to the subject. The lens opening should be set to 1.9 indoors under normal room lights. The next step is to adjust the BEAM and TARGET controls, first turning the TARGET knob no more than 1/8 turn to the right. Slowly turning the BEAM control to the right should produce some sort of change on the TV screen, but not a clear picture yet. Turning the FOCUS knob slowly to the left should bring the picture into fairly sharp focus and make the image recognizable. Readjusting the optical focus (lens) will bring the focus the rest of the way and put you into the CCTV business.

CONSTRUCTION--KIT OR ASSEMBLED?

The Model 800 CCTV camera is supplied by CONAR in a ready-to-use assembled form as well as in easy-to-assemble kit form to suit individual needs. Either version represents a good buy for the person in the market for a CCTV camera. Both versions give you everything you need for a complete CCTV system (except a TV receiver, but ANY receiver will do) for use in the home or in business. The same quality components and circuit board construction are used in both models. Now let's look at the construction of the Model 800 in a little more detail.

UNIQUE STRUCTURE

The Model 800 uses a unique chassis/panel/cabinet construction that allows the easiest possible sub-assembly type of construction. The front and rear panels are fastened to the vertical chassis to form a single rigid assembly. This rigid structure is necessary in the vidicon-to-lens assembly for assuring correct optical alignment over long periods of time. A steel chassis is used to make the entire assembly strong and sound.

Two separate side panels make up the "cabinet" of the Model 800, each being easily removable for access to tubes, adjustments, components and wiring inside the camera--no more "horsing" the unit in and out of a wraparound cabinet! The removable panels make servicing the Model 800 (if it is ever needed) a real breeze.

Most of the wiring of the Model 800 is on the large printed circuit board shown in Fig. 4. This board contains all tubes but the vidicon and all of the circuits except the power supply, controls and deflection/focus coil. This means about 80% of the parts are on the circuit board, making assembly an easy job.

ASSEMBLY INSTRUCTIONS

The Model 800 kit contains complete instructions for each stage of assembly, plus a list of parts. Assembly instructions also give, in detail procedures for making initial tests and adjustments of the various circuits. Detailed operating instructions are given in a separate manual which is also supplied with the factory-wired Model 800 camera.

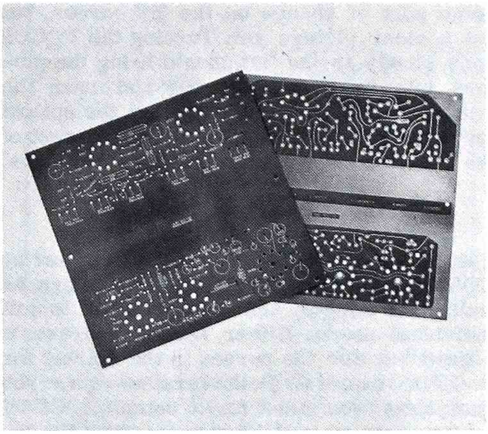


Fig. 4. Circuit board for the Model 800.

MODEL 800 SPECIFICATIONS

The table below lists some of the specifications of the CONAR Model 800 CCTV Camera:

Power input:	118v 60 cycle ac nominal
Power Consumption:	45 watts
RF Output:	Greater than 100 mv.
Channels:	TV channels 2 through 6
Lenses:	25mm, f 1.9 standard lens supplied 12.5mm, f 1.9 wide angle* 50mm, f 1.9 telephoto* *(not supplied, optional at extra cost.)
Resolution:	Approximately 200 to 320 lines
Dimensions:	5"W × 7"H × 12-1/4"D
Weight:	Approximately 12 pounds with lens
Mounting:	Standard tripod socket or feet
Construction:	Single unit, steel chassis, aluminum panels

EMPLOYMENT OPPORTUNITIES

The following firms have requested that they be listed as continuing prospective employers of NRI graduates in the designated capacities:

STATION WFMD
No. 1 West Seventh
Frederick, Md.

Opening for technician with first-class license

RCA SERVICE CO.
5400 Lafayette St.
Hyattsville, Md.

Needs several radio-TV technicians

C. A. LEPPERT ELECTRICAL APPLIANCES
623 "H" St., N. W.
Washington, D. C.

and

836 Leesburg Pike
Falls Church, Va.

Occasional openings for appliance servicemen

Ashton Berry
AERO TV AND APPLIANCE CO.
7314 Little River Turnpike
Annandale, Va.

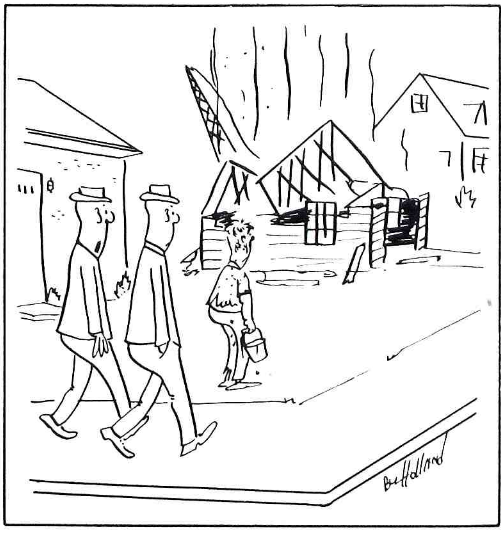
Appliance Servicemen

ALL-TRONICS, INC.
560 Portage St.
Kalamazoo, Mich. 49006

Electronics technician

UNITED AIR LINES
Washington National Airport
Washington, D. C.

Radio technician



"Wasn't he the one building his own ham shack?"

AM/FM SERVICING FUNDAMENTALS

Substantial Radio Market Makes Knowledge Of All Phases Essential To The Technician

BY STEVE BAILEY

When the modern technician goes into commercial servicing, he usually does so with the idea of doing mainly, and sometimes strictly, television repair. However, the well-rounded technician will see that he is kept up to date in all phases of servicing, including radio repair.

Due to the widespread use of printed circuits and transistors, plus advances made in vacuum tube design, manufacturers are now able to offer am and am-fm receivers to the public at prices that are lower than ever before. This has been coupled with a substantial rise in am and fm station license applications to the Federal Communications Commission. The natural result is that the public is buying more and more radios which will eventually require repair.

A substantial part of the radio market is am-fm receivers, both transistor and tube types.

EQUIPMENT

The equipment required for am-fm servicing consists of a reliable vtvm, tube tester, signal generator, signal tracer, and oscilloscope. This is standard equipment which can be found in any well-equipped service shop.

CHECK OUT

Certain sections of an am-fm receiver will be used for fm reception only. Other sections will be used for am reception only. There will also be certain sections, the power supply for example, that will be used for both purposes. So, when an am-fm receiver comes in for repair, the first step will be to turn it on and listen to the am reception and then the fm reception. Note whether the trouble is in the am position, the fm position, or both. Also, try to classify the trouble as a dead receiver, distortion, oscillation, weak reception, or intermittent reception. If there is an afc (automatic frequency control) switch, turn it to the Off position. Then, tune to an fm station. Once this is tuned in exactly, tune slightly off the station so you can just hear it. Then turn the afc switch on. You should notice the station comes in more clearly and is now locked in. If it has no effect, there is trouble in the afc circuit.

THE AM SECTION

The schematic diagram of a typical am-fm receiver is shown in Fig. 1. Examination shows that this receiver uses an fm-rf stage, separate converter stages, separate first i-f transformers, a common first i-f amplifier, a combination 10.7 mc -455 kc second i-f transformer, a combination third fm i-f and am detector, an fm ratio detector, two common audio states and of course, a common power supply (not shown). A block diagram of this arrangement is shown in Fig. 2.

If trouble occurs only in the am section of the receiver, the defect must be in the am converter stage, the first i-f transformer, or one-half of the second i-f transformer. Trouble in the remaining sections will also affect the fm operation, so they can be virtually eliminated as possible trouble spots.

The same troubles will occur in the am section of this receiver as will occur in a regular am receiver. The main difference, of course, is that there are fewer sections to check when the trouble is in the am position only. Some of these troubles and their cures will be discussed here. This will be done briefly, as we wish to place the major emphasis on troubleshooting the fm section.

WEAK RECEPTION

This trouble is normally not too difficult to diagnose. Signals are usually either weak or they are strong, even though they may be accompanied by other symptoms.

The first step would be to test the tubes in the am section, using a high quality tube tester such as the CONAR Model 221, which can show weak emission, leakage, and shorts. If the complaint is intermittently weak reception, each tube tested should be left in the tester for several minutes. By tapping the tube after it is hot, you should be able to get an indication of a short if one is present. Needless to say, all tubes that are even slightly suspect should be replaced.

If the trouble is not found to be due to a tube defect, further tests are in order. To begin

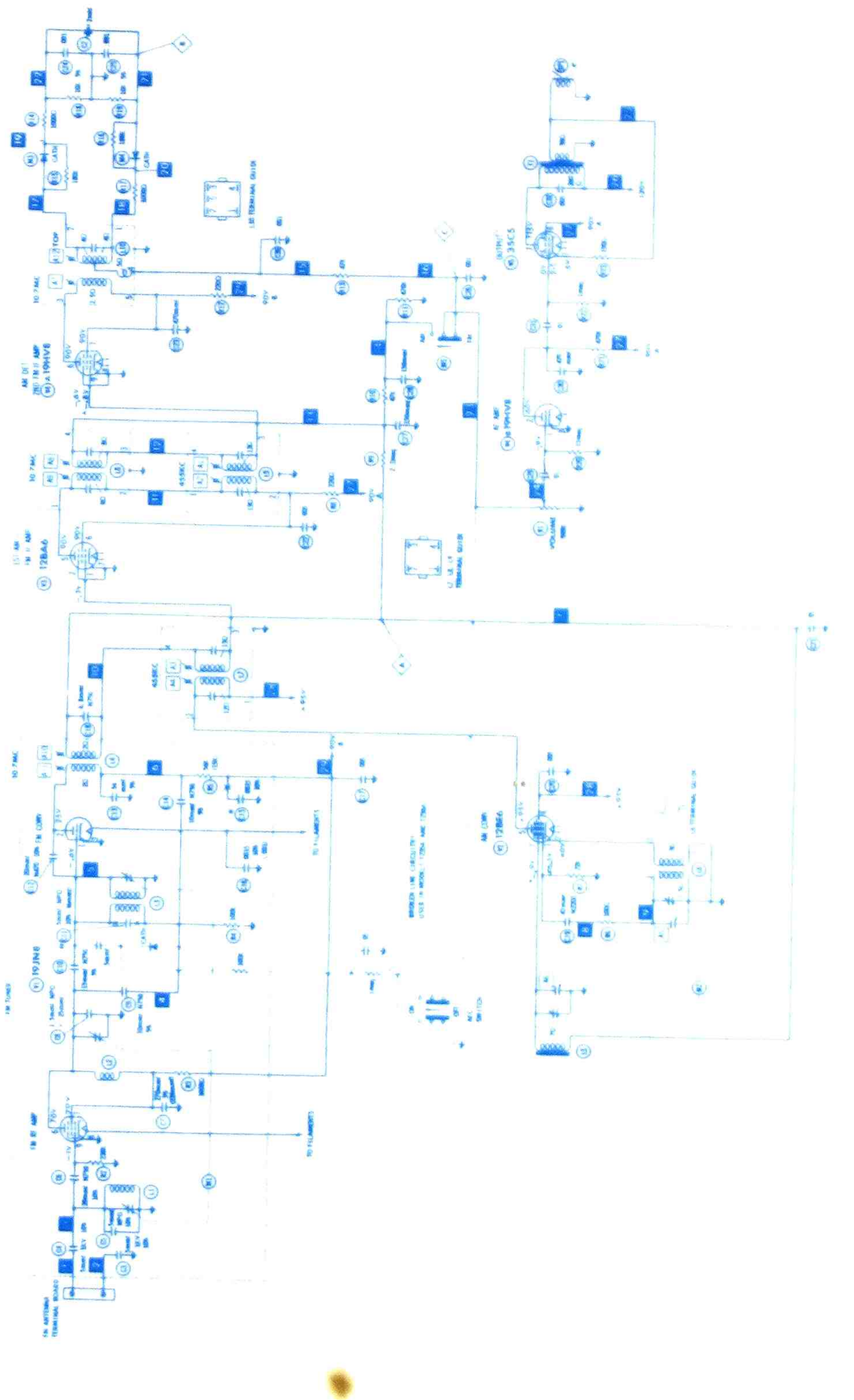


Fig. 1. A typical AM-FM Receiver.

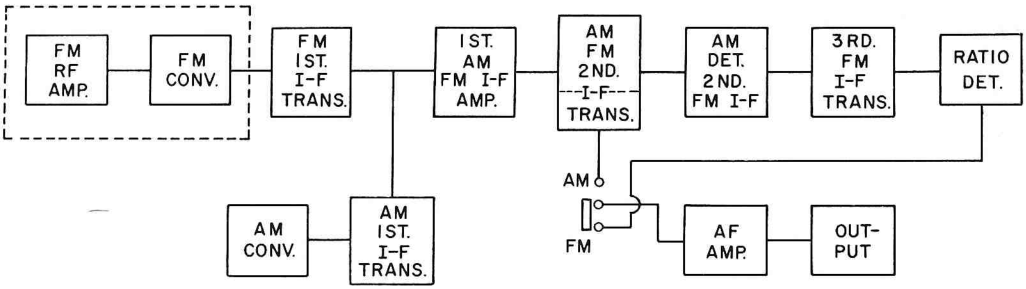


Fig. 2. Block diagram of the receiver shown in Fig. 1.

with, we know that the signal must be present at all points along its normal signal path, but some circuit is not operating at full efficiency.

One method that could be used to locate the inefficient stage is signal tracing. This involves using a high quality signal-tracing instrument such as the CONAR Model 230 Signal Tracer. Using an instrument such as this, you would sample the signal at the grids and plates of the various stages until the weak stage is located. You could then make voltage and resistance measurements to locate the exact defective part in that stage.

In general, weak reception will be found to be due to a defective antenna, defective rf, i-f, and audio transformers, improper alignment, excessive avc (automatic volume control voltage), and low plate and screen voltages. By using a tube tester to check the tubes, a signal tracer to locate the defective stage, and a vtvm to locate the defective part, a complaint of this type should be easy to locate.

DISTORTION

The same checks described for weak reception in the preceding paragraph can be used in checking for distortion. The main difference is that instead of making gain measurements, you can use the Signal Tracer to pick up the signal at various points and listen to it through the Signal Tracer speaker. For example, if the signal is of good quality at the control grid of the am detector, V4A, the sound will be clear and undistorted. So, you would move your probe to the ungrounded side of the volume control, R_1, and note the quality of the signal here. If it is distorted, the defect is between these points.

DEAD RECEIVER

If the receiver is completely inoperative in the am position, we can eliminate the possibility of an open filament, since this is a series filament circuit. If an open filament did occur, the receiver would not operate in either the am or the fm position.

The first point to check would be the am-fm function switch. An ohmmeter test across the switch should tell us whether the switch is open in the am position due to lifted contacts. If we find that the contacts are not open, a voltage measurement at pin 1 of the am converter, V2, should determine whether the oscillator is operating. If we measure very little or no negative dc voltage here, the defective stage has been located. A check of the components in the oscillator circuit should locate the trouble.

If the oscillator circuit is found to be operating, the defective stage could be located by injecting an rf signal with a signal generator beginning at the am detector and working back towards the antenna. A check of the audio stages is unnecessary since the fm portion is working.

THE FM SECTION

In the next part of this article, we are going to discuss servicing the fm section only. This is very similar to the am section except for the frequencies involved (88-108 mc frequency range and 10.7 mc i-f) and the fact that it used an rf stage, and a third i-f stage.

WEAK RECEPTION

Many am-fm receivers currently in use are found in stereo consoles. The antenna sometimes consists of a piece of twin lead tacked around the inside of the cabinet. As with am receivers, the orientation of the antenna determines the number and strength of the received stations. Of course, when the antenna is mounted in this fashion, free adjustment is not possible. It may be necessary to try an external antenna or relocation of the console. This should be kept in mind when making house calls in an fm fringe area for this complaint. Much valuable time could be lost in making service checks when the trouble is merely due to an improper or an improperly located antenna.

If the antenna is good and is properly located, the fm-rf amplifier tube, the 19JN8, should be tested, preferably by substitution. Since this is a dual purpose tube, you are also substituting the converter tube. This eliminates the first two stages as possible sources of trouble or else solves the problem. It is unlikely that V3 or V4 are defective as the am section would be affected. We are assuming that the am section is working properly.

The new tube should solve the problem, but if it doesn't, use a signal generator to inject a 10.7 mc signal at the antenna terminals. If it is reproduced very weakly in the speaker, inject the signal at the grid of the rf amplifier. A strong signal now would indicate a defect in the antenna coupling circuit.

If the trouble cannot be found by signal injection, measure the voltages at the rf amplifier and the converter. Look for low plate and screen voltages and both excessive and low grid bias voltages.

DISTORTION

Distortion problems in fm receivers are very similar to those in am receivers. The chief causes of distortion are poor alignment and defects in the antenna system or input circuit. They may be preventing sufficient signal voltage from reaching the rf or converter grid. It is also worthwhile to add that extremely weak signals may come out as distorted signals merely because of insufficient signal strength.

Sometimes you may service a receiver where the complaint is distortion, but the receiver may work very well for you when you check it out. This is generally caused by the customer not being familiar with the necessity of precise tuning of fm receivers. You should point this out and also demonstrate the use of the tuning eye or bar if the receiver has one. Needless to say, you should be very tactful when doing this, so as not to embarrass the customer. If this is done properly, you will have not only your service fee, but also the assurance that you have added another regular customer.

DEAD RECEIVER

As previously mentioned about servicing a completely inoperative am receiver, the first step would be to check the am-fm function switch to see if the fm position is open. This can be done by using an ohmmeter for a continuity test, or you could use a signal generator to inject a signal first at point C, then at the ungrounded side of the volume control. If the signal cannot be heard from point C, but can be heard from the volume control, the switch is defective.

If the switch is in good condition, you can use the signal generator to trace for an open or inoperative stage by injecting a 10.7 mc signal at the control grid of the second fm-if amplifier. A distinct tone should be heard in the speaker. If none is heard, the trouble is in the third fm-i-f transformer or the ratio detector circuit. If one is heard, it can be assumed that the circuit is good from this point to the speaker.

The next point to test would be the plate of the first fm-i-f amplifier. If a signal can be heard from this point, the second i-f transformer is in good condition.

Moving the test probe of the signal generator to the grid of the first i-f amplifier, you should notice a louder signal from the output. This indicates that the stage is amplifying properly. If the signal is very weak or is not present at this point, the tube should be checked for a grid-cathode short. Of course, you will notice that since the tube is also used in the am section, the am would probably not work either when a defect of this type occurs.

Should normal results be obtained here, you would then continue making the same checks in the rf and converter sections. The main thing to remember is that when you inject a signal and get no response, the trouble is between that point and the last point where you were able to obtain a signal output. Voltage and resistance checks could then be used to locate the exact defect.

AUTOMATIC FREQUENCY CONTROL

Because of the frequencies involved in fm, the receivers are extremely sensitive to oscillator drift. Therefore a special circuit is used to "lock-in" desired frequencies. This is what is known as the afc circuit.

In Fig. 1, the dotted lines indicate the afc circuit. As you can see, the afc circuitry consists of a switch, a 1 megohm resistor, a .05 capacitor, a 100K resistor, a diode, and a 5 mmf capacitor.

The principles of operation of this circuit will not be discussed here since this subject is covered thoroughly in the Servicing course lesson on control circuits. However, a study of the schematic shows several possible causes of trouble.

The method for checking the afc circuit was described earlier in this article. Normally, you will find that the afc either works completely or not at all.

A completely inoperative afc circuit would certainly be caused by an open or short in one of the circuit components. However, one very important thing to keep in mind is that the afc operation is dependent upon the fm circuit alignment. One readily recognized symptom of misalignment is improper afc operation which may be accompanied by either distortion, noisy operation, or both.

AM AND FM OPERATING IMPROPERLY

When both sections of the receiver are operating improperly, you can assume that there is a defect in a section that is common to both. Of course, there is a possibility that there are two separate defects present, but this is not too likely.

In the case of a completely dead receiver, a check of the On-Off switch and the filament string in the power supply shown in Fig. 3 should locate the trouble. Also, notice whether all of the tubes are lighting or if some are lighting and others are not. If the latter occurs, you should check for a shorted capacitor between the filament string and ground.

If all tubes are lighting and the power supply source voltages are good, start testing the common stages. A good place to start would be the audio stages. You can use a signal generator to inject a 400-cycle audio signal into the grid of the audio output stage. The signal level control of the generator and the receiver volume control should be turned up, as only a weak signal can probably be detected. If you receive good results here, move to the plate of the af amplifier. No signal from here would probably be due to an open .01 coupling capacitor. Should you receive a good signal here, move to the grid of the amplifier and inject the signal here. The next test point would then be the center tap of the volume control. After this point, however, you would have to change the signal generator setting to either the am i-f frequency (455 kc) of the fm i-f frequency (10.7 mc). Of course, the receiver function switch would have to be changed accordingly.

If the complaint should be distortion in both sections, the easiest way to locate the trouble would be to use your signal tracer to check the am section by sampling the signal at various points as previously described. The trouble will probably be found to be due to a defect in a common component, such as a shorted combination i-f transformer. Replacing this should restore proper operation to both sections.

ALIGNMENT

The alignment of an am-fm receiver should be taken in two parts, the first being alignment of the am section; the second being alignment of the fm section.

AM alignment should be no real problem. You will need an accurate signal generator, preferably a CONAR Model 280 or one of equivalent quality, and an output meter. Your vtvm could serve as an output meter when connected across the speaker voice coil terminals. You would begin by injecting a 455 kc modulated signal and aligning the am i-f slugs, A1, A2, A3, and A4. When this is perfect, you would then align the oscillator and rf trimmers to 1620 kc and 1400 kc, respectively.

The fm i-f alignment should be approached

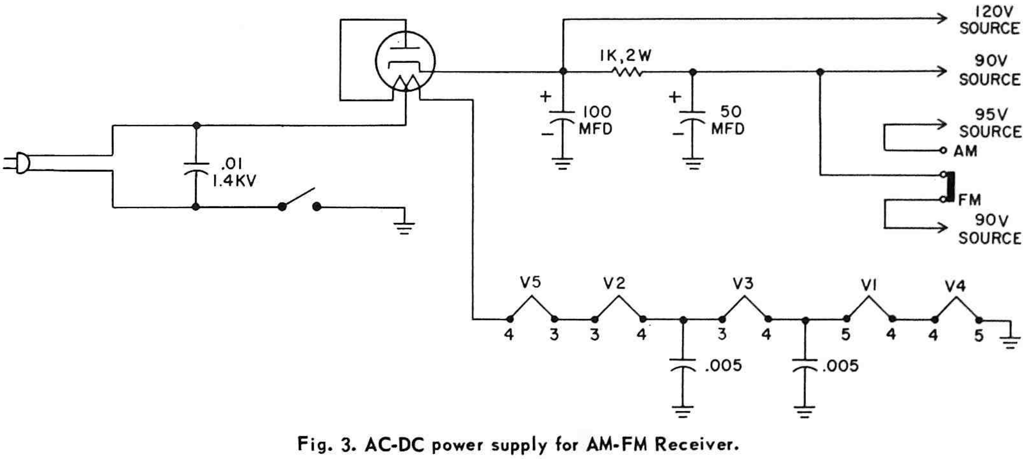


Fig. 3. AC-DC power supply for AM-FM Receiver.

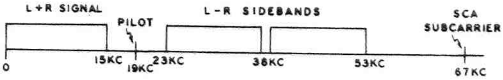


Fig. 4. The frequency spectrum used for transmitting fm/stereo.

in the same manner, using a signal generator and an output meter. You would align the i-f slugs A7, A8, A9, A10, A11, and A12 to exactly 10.7 mc.

The fm oscillator and rf adjustments are not quite so simple. These must be done with extreme care as the adjustments are quite critical. The minimum equipment needed will be a signal generator and a vtvm. The signal generator should be capable of producing a 108.5 mc signal or a harmonic of that frequency. Preferably, though, you should use an oscilloscope in conjunction with the above equipment to obtain perfect response curves.

You will not find it necessary to align many fm receivers, but when you do, be sure to follow the alignment instructions exactly as given in the service information for the receiver. If you do this, alignment will present no problems.

FM STEREO MULTIPLEX

FM stations all over the country are expanding their facilities to include the broadcasting of stereo recordings. Many am-fm receivers now contain a special multiplex unit that can reproduce these broadcasts, provided, of course, the receiver has a stereo amplifier and speakers. The result is that stereo is no longer limited to records or tape recording played through a stereo system. This feature is called fm stereo multiplex.

Sooner or later when servicing am-fm receivers, you will encounter one containing an fm multiplex stereo section that requires repair. Most repairs can be made using a vtvm and an oscilloscope, although a stereo generator is necessary for certain jobs.

Before getting into some of the servicing checks, let's see what this circuit consists of. Fig. 4 shows the frequency spectrum of modulation used for transmitting FM Stereo and Fig. 5 shows a block diagram of a typical circuit.

In this circuit, the composite signal from the fm detector is fed through an amplifier to a 53 kc low-pass filter. This filter allows the L+R, L-R, and the 19 kc pilot signal to pass and, at the same time, blocks any SCA (commercial background music) signals that may be present. The 19 kc signal is then removed and fed to the 19 kc amplifier, after which it can be used to sync the 19 kc oscillator. The output of the oscillator is doubled to 38 kc and fed to the demodulator.

Meanwhile, back at the 19 kc take-off point, the composite signal (minus, of course, the 19 kc pilot signal) is fed to the transformer secondary center-tap. Both the L+R and the L-R sidebands are present at this point. The diodes, D1 and D2, will rectify the positive half of the L+R sidebands that are present at this point. The diodes, D1 and D2, will rectify the positive half of the L+R signal, so this voltage appears across each diode load at all times. The 38 kc signal will be applied to the diode 180 degrees out-of-phase. The +(L-R) signal will be across the D1 load and the -(L-R) signal will be across the D2 load. When the L-R signal present at the output of D1 is added to the L+R component, the R voltages will cancel, leaving only the L portion. The -(L-R) signal at the output of D2 will combine with the L+R present and the output will be only the R signal. The L and R signals are then amplified and fed to a stereo speaker system.

SERVICING MULTIPLEX

Most FM stereo troubles are caused by de-

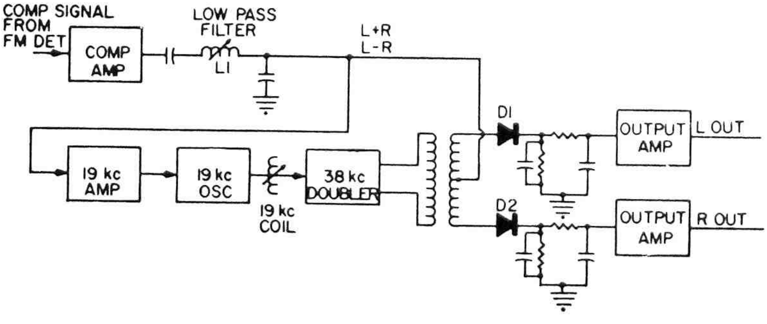


Fig. 5. A typical FM/stereo circuit using an unbalanced demodulator.

fective tubes, weak signals, and poor antennas. The standard fixed antennas used for fm may not be satisfactory for fm stereo. Of course, the best way to check this is by substitution.

A receiver that works properly on fm, but not fm stereo, can be checked quickly by going directly to the multiplex circuit. It may need alignment if the complaint is insufficient separation or a fluttering 400-cycle tone received along with a stereo program. Whistles would indicate a defective or improperly adjusted low-pass filter failing to block SCA transmissions.

Whenever alignment is called for, be sure you have the proper equipment and the manufacturer's information before starting. This will avert a possible complete alignment job later, whereas only a touch-up would have been required in the beginning.

In this article, we have covered fundamental am-fm servicing and have briefly examined multiplex circuits. As you can now see, basic servicing procedures and standard test equipment can be used to quickly isolate defects whether you are working on a standard am receiver or a combination am-fm stereo receiver. Through proper application of your NRI training and effect-to-cause reasoning, you can convert those "tough dogs" to ordinary repair jobs. □

NRI GRADUATE ORGANIZES 'HAM' CLUB, SCHOOL; J.E. SMITH IS AWARDED HONORARY MEMBERSHIP

ROCHESTER, N.H.--J.E. Smith, founder of the National Radio Institute, was able to see some of the effects of the "arrow shot into the air" some 20 years ago on a recent visit here.

The opportunity came when Lucien Pettit, a 1942 graduate of the Radio-Servicing course of National Radio Institute, invited Mr. Smith to speak at the monthly meeting of the Regional Amateur Radio Association in nearby Sanford, Me.

Pettit was instrumental in organizing the association in 1961, as a natural culmination of his several years spent in passing on to others, principally interested high school students, the fundamentals of amateur radio procedures and codes.

Mr. Smith, after a brief talk at the meeting on NRI and courses it offers in electronics and communications, was presented an honorary life membership in the association.

"Hams' best friend" in the area is perhaps the best way to describe Pettit, an ex-World War II fighter pilot. As a radio operator in the Citizens Band, frequency allotted by the FCC for business communications, he became interested in the more relaxed aspects of licensed amateur radio operation.

Of the 30 or so who are now active members of RARA, the majority hold either Technician or General Class licenses--- and the rest have license applications in the works. The club's basic purpose is to promote the building and operating of radio transmitting and receiving equipment for ham radio stations.

However, RARA traditionally conducts an annual radio seminar as well, aimed mostly at high school students who are interested in ham radio operation. "Our main purpose in organizing the club and the radio school was, and is, to help youngsters, especially high school students who would like to take up something like this," Pettit says.

Towards this end they also hold a weekly class for anyone interested in amateur radio, giving instruction in code and theory. In addition, code practice for beginners is given on the air in the six-meter band three nights weekly.

Pettit, now past president (Paul R. Leturneau succeeded him recently) still acts as instructor for the club's monthly meetings, assisted by John Myers.

TRANSISTORS SIMPLIFIED

The Serviceman Who Wants To Stay In Business Should Learn Rudiments Of How To Repair Them

BY WILLIAM F. DUNN

Many radio-TV servicemen who have been servicing for some time, and are thoroughly familiar with vacuum-tube circuits, are reluctant to service transistorized circuits. In most cases this is because they have not taken the time to learn how transistors work. This is a luxury that they can ill afford because it is just a matter of time until they will have to service transistorized equipment to survive in business.

When transistors were first introduced, many said that within a few years the vacuum tube would disappear from entertainment devices such as radio and TV receivers. Several years have passed, and still almost all television receivers made today use vacuum tubes. This might at first make the technician who does not want to learn about transistors feel secure, but this is a false sense of security. A brief look at what has happened will show that the transistor has made terrific inroads into circuits formerly using vacuum tubes.

The portable radio receiver is an example of a case where the transistor has taken over completely from the vacuum tube. There have been no vacuum-tube type portable receivers made for a number of years. As a matter of fact, many people have vacuum-tube portable type receivers that are in good operating condition but do not use them, because they have a transistorized portable which uses more economical batteries and provides much better battery life.

Another place where the transistor has taken over is in the automobile radio. The automobile radios of the early 1950's used the same tube-types that were found in conventional home-type radios. The B supply voltage required to operate the tubes was produced by means of a vibrator and a power transformer. In the middle 50's, when the automobile manufacturers switched to 12-volt ignition systems, a special series of 12-volt tubes -- tubes that would operate with plate and screen voltages of 12 volts -- were developed. Many automobile radios were made using these tubes in the rf, mixer, i-f and first audio stages with a transistor power amplifier. At first, it looked like this type of receiver, which was called a hybrid receiver, might last for a number of years, but it had a very short life, because transistors which operated efficiently as rf, mixer and i-f stages were soon available at reasonable prices. Now, all automobile radios manufactured for the major automobile manufacturers are completely transistorized. You could not buy a new tube-type radio for a new car even if you wanted to. The transistor made possible smaller automobile radios which dissipated less heat, and are more maintenance-free, even though they may not work as well as the vacuum-tube type of receiver.

Another field into which the transistor has made great inroads is the high fidelity - stereo field. It is true, there are many excellent high fidelity - stereo amplifiers in use today using vacuum tubes. These amplifiers are still being made, and in general work just as well or in most cases better than comparatively priced stereo amplifiers. However, the public has, in general, been sold on the idea that transistorized equipment lasts forever without any maintenance. Any serviceman can tell you that this is not the case. Transistorized equipment usually does not require as much maintenance as the vacuum-tube type equipment, but it is far from maintenance-free. However, regardless of the fact, the public in general has been sold on transistorized stereo equipment, and if the public is going to buy this type of equipment, the serviceman must be prepared to service it or else he will lose this business.

What about television? There are a few transistorized television receivers on the market today. These are for the most part small portable type TV receivers. However, almost all major manufacturers have additional transistorized TV receivers on the drawing boards. How soon they will be in general distribution is anybody's guess. At this time there is a tremendous boom in color television. Most major television manufacturers have devoted all their efforts to design and production of color television receivers using tubes, and are therefore not too eager to put their engineering staff to work on transistorized black-and-white sets. In addition,

there are enough problems in color TV sets using vacuum tubes without trying to redesign them using transistors, so as long as the boom in color TV sales continues, the chances are that this will stall off for some time the complete switch from tubes to transistors in television receivers. However, this is only a breathing spell; it will give the technician a chance to catch up on transistors; you can be sure that it is just a matter of time until there is a switch from tubes to transistors in both black and white and color television.

TRANSISTOR MATERIALS

The complete theory of how transistors operate, how they are made, etc., can be quite complex. However, there are many things about the transistor that are relatively unimportant to the service technician. The technician needs to have a general understanding of the basic transistor operation so he can service transistorized equipment intelligently, but he need not go into transistor theory to the extent that the design engineers must.

Transistors are made of two types of material, germanium and silicon. The first transistors were made from germanium. Relatively few silicon transistors were made in the early days of transistors, except for the military and for special applications. The cost of silicon transistors was simply too high. However, in recent years new developments have brought the cost of silicon transistors down, so that today there are probably more silicon transistors being made than germanium. In any case, the theory of operation of the two is basically the same.

Pure germanium and pure silicon are relatively poor conductors of electricity. If you compare them to a metal like copper or silver, they act almost like insulators. However, the conductivity of silicon and germanium can be greatly improved by adding certain types of impurities to them. The manner in which the impurities act to improve the conduction is not too difficult to understand.

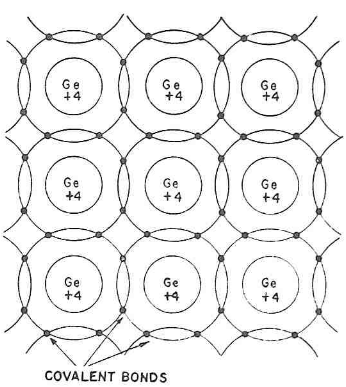


Fig. 1. Lattice structure of a germanium.

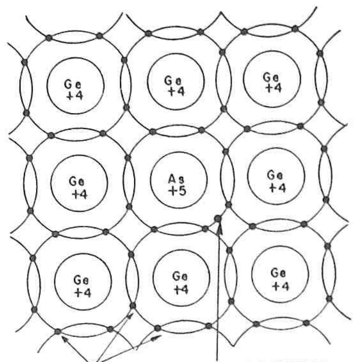


Fig. 2. Germanium with arsenic added.

Germanium and silicon both have four electrons in their outer ring. Both are poor conductors because this outer ring is relatively stable and does not give up or accept an extra electron willingly. The germanium and silicon atoms form what are called covalent bonds. This means that neighboring atoms share their electrons more or less, as shown in Fig. 1, to form what is called a lattice structure. The figure shows the atoms in a germanium crystal, but silicon forms the same type of covalent bonds.

If an impurity such as arsenic, which has five electrons in its outer ring, is added to the germanium or silicon, it forms a covalent bond with the neighboring germanium atoms, but there will be one electron left over, as shown in Fig. 2. This electron is relatively free to move about, and will change the germanium or silicon from a poor conductor to a relatively good conductor. This type of impurity is called a donor, because it donates an electron. The material having these surplus electrons is referred to as N-type material.

If instead of a material with five electrons in the outer ring a material such as indium, which has three electrons in the outer ring, is added to the germanium or silicon, the situation such as shown in Fig. 3 develops. Here the impurity forms a covalent bond with the neighboring germanium or silicon atoms, but it leaves a hole in the lattice structure. This type of material is called a P-type material, and the impurity which produces it is called an acceptor material, because it leaves a hole in the lattice structure free to accept an electron.

So far the important points you have to remember about semi-conductors are that if we add an impurity with five electrons in the outer ring to the germanium or silicon we form N-type material which has free electrons, and if we add a material with three electrons in the outer ring as an impurity we form a P-type material which has holes in the crystal structure.

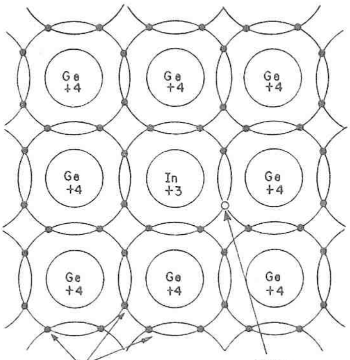


Fig. 3. Germanium with indium added.

N-P JUNCTIONS

Adding a donor type impurity to germanium or silicon produces free electrons. These electrons have a negative charge. However, since no charged atoms are actually added to the material, the overall charge of the N-type material is zero. In other words it's neutral, but the free electrons themselves do have a negative charge. Similarly the holes in a P-type material represent areas of a positive charge. However, the overall charge of the material again is zero, because no charged atoms are actually added to the material.

Now when an N-type material and a P-type material are placed together to form a con-junction, there is some drifting of electrons and holes across the junction. The electrons from the N-type material will drift across the junction into the P-type material to fill holes in the P-type germanium or silicon. Similarly holes will drift across into the N-type material. Another way of looking at this is that the electrons from the N-type material move across into the P-type material into the junction and fill the holes, leaving holes behind in the crystal structure in the N-type material. This movement of holes and the electrons sets up charges near the junction as shown in Fig. 4. The electrons that have moved into the holes in the P-type material produced negatively charged ions. These electrons set up a barrier to prevent any further movement of electrons from the N-type material over into the P-type material. Similarly, the holes formed on the N side of the junction set up a positive charge to prevent the migration of any additional holes from the P-type material over into the N-type of material. The barrier set up by the electrons and holes is called a potential

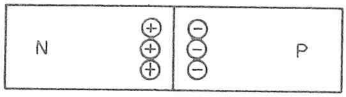


Fig. 4. An N-P junction.

barrier. It is also called a depletion layer because there are electrons missing on the N side of the junction and holes missing on the P side.

When a voltage is applied across an N-P junction as shown in Fig. 5, the negative battery terminal pushes electrons through the N-type material to fill the holes formed on the inside of the junction. At the same time, the positive voltage applied to the P-type material attracts the electrons on the P side of the junction towards the positive terminal. The voltage overcomes the potential barrier, and allows further movement of electrons across the junction. The electrons flow from the negative terminal of the battery into the N side of the junction, causing electrons to move through the N-type material and across the junction. At the same time, electrons will move from hole to hole in the P-type material through the material back to the positive terminal of the battery. The electron moving through the P-type material in this way will produce the effect of holes moving towards the junction. As these holes reach the junction they are filled by additional electrons

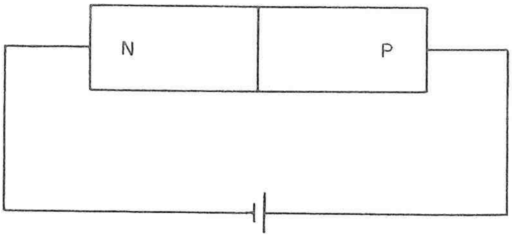


Fig. 5. A forward-biased junction.

coming from the N-type section and these electrons in turn move from hole to hole through the P section to the positive terminal of the battery.

When a junction is biased in this way we say that it is forward-biased or that there is forward bias placed across the junction; that it causes current flow across the junction.

When a voltage is applied across a junction

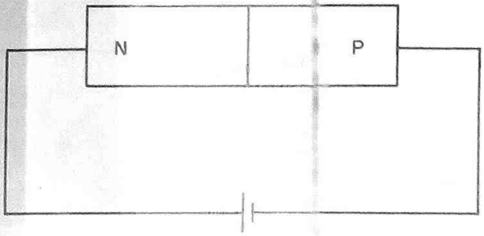


Fig. 6. A reverse-biased [junction].

as shown in Fig. 6 we say [th]at the junction is reverse-biased. The neg[ati]ve terminal of the battery repels the electr[on]s on the P side of the junction instead of att[rac]ting them, so there is no tendency for add[iti]onal electrons t[o] [illegible] [move]s from the N side of t[he] junction over i[nto the] P side of the junct[ion]. At the same time the positive potential [ap]plied to the N material pushes the holes cl[ose]r to the junction and there is no tenden[cy] for additional holes to cross the junction. [Wh]en a junction is reverse-biased there is n[o u]seful current flo[w a]cross the junction.

W[hen a] single N-type and a s[ing]le P-type material, such as shown in Fig[s. 4], 5 and 6 are placed together, we call this [d]iode junction, because there are [illegible] [lea]ds. The junction might be a[n] [illegible] [jun]ction such as we have shown [illegible] [ju]nction which is simply the s[illegible] around. It is relatively unimp[ortant] [illegible] [c]ase of diode junctions but does [illegible] [i]mportance in transistors.

[illegible] JUNCTION TR[AN]SISTOR

The [ba]sic junction transisto[r i]s simply two junctions put together, as is [sh]own in Fig. 7. The transistor may have [an N]PN configuration such as shown in Fig. [7 o]r a PNP configuration as shown in Fig. 8. [No]w let us see how the transistors operate. [We] will take the NP[N] first.

A simple diagram of an NP[N t]ransistor is shown in Fig. 7. The N secti[on o]n the left of this drawing is called the em[itte]r, and the P section in the center i[s] calle[d th]e base. The N section on the right is calle[d t]he collector.

Not[e tha]t the emitter-bas[e ju]nction has a forw[ard] bias placed across i[t b]y the battery labelled "A" and the base-co[lle]ctor junction has a reverse bias placed a[cro]ss it by the battery labelled "B". Battery [A i]s a comparatively low-voltage battery whe[re]as battery B has a voltage several times th[at] of battery A. Now let us see what happens i[n th]e transistor. The forward bias placed acr[oss] the emitter base junction causes electro[ns t]o flow from the N-type emitter mater[ial] across the emitter-base junction into the base. Some of the electrons will flow out the base lead back into the positive side of battery A. However, the majority of the electrons will cross the base region because they will be attracted by the positive charge on the N side of the base-collector junction. The electrons will then flow through the collector to the positive terminal of battery B. Electrons will also flow from the negative terminal of battery B, through battery A and on to the emitter.

A PNP type transistor is shown in Fig. 8. The section on the left is the emitter, the center section is the base, and the section on the right is the collector. In other words, the type of material used in each section of the transistor is simply the opposite of the type used in the NPN transistor.

The PNP transistor is biased in the same way as the NPN transistor. The emitter-base junction is forward biased by battery A. Notice that the battery polarity is reversed from what it was in Fig. 7; however, the negative terminal is still connected to the N section, and the positive terminal to the P section so that the junction is forward-biased. The base-collector junction is reverse-biased by battery B.

With this type transistor battery A draws electrons from the emitter. This creates additional holes which drift over to the emitter-base junction. The holes are filled by electrons from the N-type base material. This creates a hole in the N-type material. The net effect is that you will have electrons moving from the negative terminal of battery A into the N-type material across the junction and moving from hole to hole in the P section back to the positive terminal of the A battery. At the same time, the holes are moving across the emitter, across the emitter-base junction and while some are filled by electrons from battery A, the majority traverse the base material and cross the base-emitter junction and into the collector. The holes will travel through the collector and are filled by electrons from the

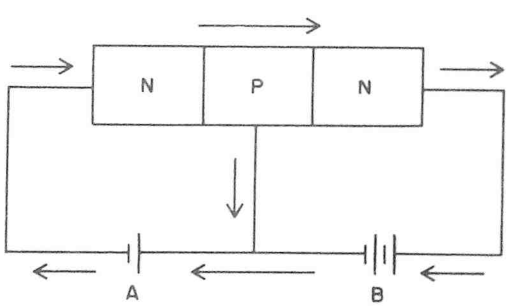


Fig. 7. An NPN transistor.

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Another field into which the transistor has made great inroads is the high fidelity - stereo field. It is true, there are many excellent high fidelity - stereo amplifiers in use today using vacuum tubes. These amplifiers are still being made, and in general work just as well or in most cases better than comparatively priced stereo amplifiers. However, the public has, in general, been sold on the idea that transistorized equipment lasts forever without any maintenance. Any serviceman can tell you that this is not the case. Transistorized equipment usually does not require as much maintenance as the vacuum-tube type equipment, but it is far from maintenance-free. However, regardless of the fact, the public in general has been sold on transistorized stereo equipment, and if the public is going to buy this type of equipment, the serviceman must be prepared to service it or else he will lose this business.

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there are enough problems in color TV sets using vacuum tubes without trying to redesign them using transistors, so as long as the boom in color TV sales continues, the chances are that this will stall off for some time the complete switch from tubes to transistors in television receivers. However, this is only a breathing spell; it will give the technician a chance to catch up on transistors; you can be sure that it is just a matter of time until there is a switch from tubes to transistors in both black and white and color television.

TRANSISTOR MATERIALS

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Pure germanium and pure silicon are relatively poor conductors of electricity. If you compare them to a metal like copper or silver, they act almost like insulators. However, the conductivity of silicon and germanium can be greatly improved by adding certain types of impurities to them. The manner in which the impurities act to improve the conduction is not too difficult to understand.

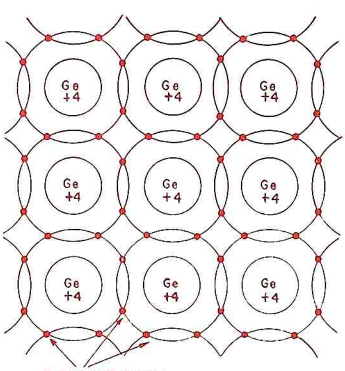

Fig. 1. Lattice structure of a germanium.

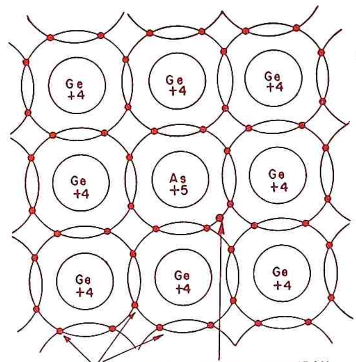

Fig. 2. Germanium with arsenic added.

Germanium and silicon both have four electrons in their outer ring. Both are poor conductors because this outer ring is relatively stable and does not give up or accept an extra electron willingly. The germanium and silicon atoms form what are called covalent bonds. This means that neighboring atoms share their electrons more or less, as shown in Fig. 1, to form what is called a lattice structure. The figure shows the atoms in a germanium crystal, but silicon forms the same type of covalent bonds.

If an impurity such as arsenic, which has five electrons in its outer ring, is added to the germanium or silicon, it forms a covalent bond with the neighboring germanium atoms, but there will be one electron left over, as shown in Fig. 2. This electron is relatively free to move about, and will change the germanium or silicon from a poor conductor to a relatively good conductor. This type of impurity is called a donor, because it donates an electron. The material having these surplus electrons is referred to as N-type material.

If instead of a material with five electrons in the outer ring a material such as indium, which has three electrons in the outer ring, is added to the germanium or silicon, the situation such as shown in Fig. 3 develops. Here the impurity forms a covalent bond with the neighboring germanium or silicon atoms, but it leaves a hole in the lattice structure. This type of material is called a P-type material, and the impurity which produces it is called an acceptor material, because it leaves a hole in the lattice structure free to accept an electron.

TRANSISTORS SIMPLIFIED

The Serviceman Who Wants To Stay In Business Should Learn Rudiments Of How To Repair Them

BY WILLIAM F. DUNN

Many radio-TV servicemen who have been servicing for some time, and are thoroughly familiar with vacuum-tube circuits, are reluctant to service transistorized circuits. In most cases this is because they have not taken the time to learn how transistors work. This is a luxury that they can ill afford because it is just a matter of time until they will have to service transistorized equipment to survive in business.

When transistors were first introduced, many said that within a few years the vacuum tube would disappear from entertainment devices such as radio and TV receivers. Several years have passed, and still almost all television receivers made today use vacuum tubes. This might at first make the technician who does not want to learn about transistors feel secure, but this is a false sense of security. A brief look at what has happened will show that the transistor has made terrific inroads into circuits formerly using vacuum tubes.

The portable radio receiver is an example of a case where the transistor has taken over completely from the vacuum tube. There have been no vacuum-tube type portable receivers made for a number of years. As a matter of fact, many people have vacuum-tube portable type receivers that are in good operating condition but do not use them, because they have a transistorized portable which uses more economical batteries and provides much better battery life.

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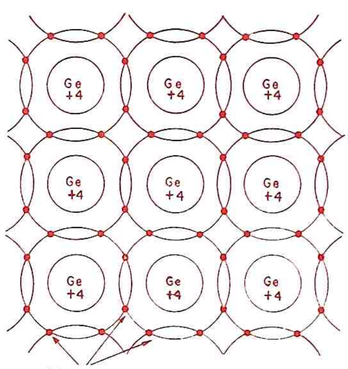

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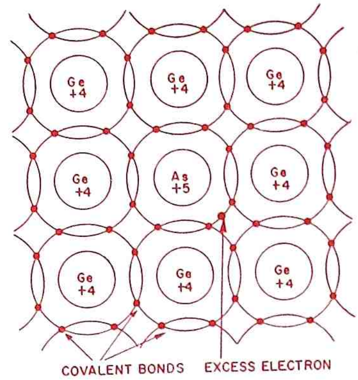

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So far the important points you have to remember about semi-conductors are that if we add an impurity with five electrons in the outer ring to the germanium or silicon we form N-type material which has free electrons, and if we add a material with three electrons in the outer ring as an impurity we form a P-type material which has holes in the crystal structure.

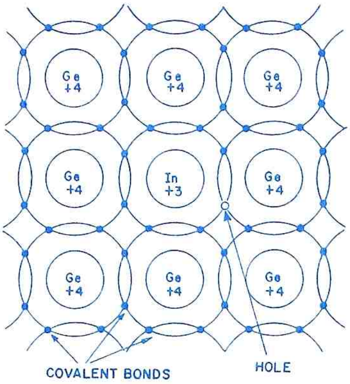


Fig. 3. Germanium with indium added.

N-P JUNCTIONS

Adding a donor type impurity to germanium or silicon produces free electrons. These electrons have a negative charge. However, since no charged atoms are actually added to the material, the overall charge of the N-type material is zero. In other words it's neutral, but the free electrons themselves do have a negative charge. Similarly the holes in a P-type material represent areas of a positive charge. However, the overall charge of the material again is zero, because no charged atoms are actually added to the material.

Now when an N-type material and a P-type material are placed together to form a conjunction, there is some drifting of electrons and holes across the junction. The electrons from the N-type material will drift across the junction into the P-type material to fill holes in the P-type germanium or silicon. Similarly holes will drift across into the N-type material. Another way of looking at this is that the electrons from the N-type material move across into the P-type material into the junction and fill the holes, leaving holes behind in the crystal structure in the N-type material. This movement of holes and the electrons sets up charges near the junction as shown in Fig. 4. The electrons that have moved into the holes in the P-type material produced negatively charged ions. These electrons set up a barrier to prevent any further movement of electrons from the N-type material over into the P-type material. Similarly, the holes formed on the N side of the junction set up a positive charge to prevent the migration of any additional holes from the P-type material over into the N-type of material. The barrier set up by the electrons and holes is called a potential

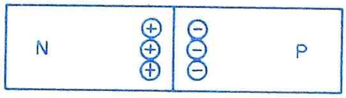


Fig. 4. An N-P junction.

barrier. It is also called a depletion layer because there are electrons missing on the N side of the junction and holes missing on the P side.

When a voltage is applied across an N-P junction as shown in Fig. 5, the negative battery terminal pushes electrons through the N-type material to fill the holes formed on the inside of the junction. At the same time, the positive voltage applied to the P-type material attracts the electrons on the P side of the junction towards the positive terminal. The voltage overcomes the potential barrier, and allows further movement of electrons across the junction. The electrons flow from the negative terminal of the battery into the N side of the junction, causing electrons to move through the N-type material and across the junction. At the same time, electrons will move from hole to hole in the P-type material through the material back to the positive terminal of the battery. The electron moving through the P-type material in this way will produce the effect of holes moving towards the junction. As these holes reach the junction they are filled by additional electrons

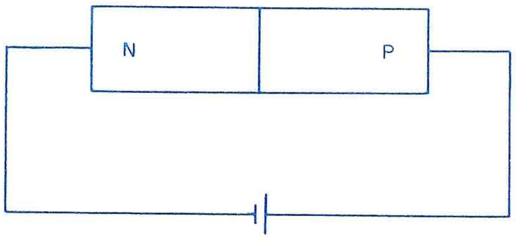


Fig. 5. A forward-biased junction.

coming from the N-type section and these electrons in turn move from hole to hole through the P section to the positive terminal of the battery.

When a junction is biased in this way we say that it is forward-biased or that there is forward bias placed across the junction; that it causes current flow across the junction.

When a voltage is applied across a junction

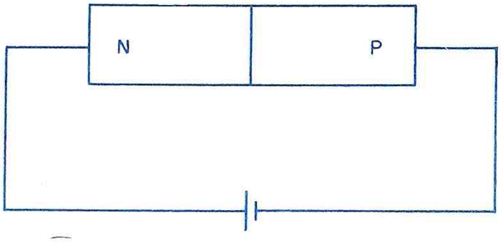


Fig. 6. A reverse-biased junction.

as shown in Fig. 6 we say that the junction is reverse-biased. The negative terminal of the battery repels the electrons on the P side of the junction instead of attracting them, so there is no tendency for additional electrons to cross from the N side of the junction over into the P side of the junction. At the same time the positive potential applied to the N material pushes the holes closer to the junction and there is no tendency for additional holes to cross the junction. When a junction is reverse-biased there is no useful current flow across the junction.

When a single N-type and a single P-type material, such as shown in Figs. 4, 5 and 6 are placed together, we call this a diode junction, because there are two materials. The junction might be an N-P type junction such as we have shown here or a P-N junction which is simply the same thing turned around. It is relatively unimportant in the case of diode junctions but does become of importance in transistors.

THE JUNCTION TRANSISTOR

The basic junction transistor is simply two junctions put together, as is shown in Fig. 7. The transistor may have a NPN configuration such as shown in Fig. 7 or a PNP configuration as shown in Fig. 8. Now let us see how the transistors operate. We will take the NPN type first.

A simple diagram of an NPN transistor is shown in Fig. 7. The N section on the left of this drawing is called the emitter, and the P section in the center is called the base. The N section on the right is called the collector.

Notice that the emitter-base junction has a forward bias placed across it by the battery labelled "A" and the base-collector junction has a reverse bias placed across it by the battery labelled "B". Battery A is a comparatively low-voltage battery whereas battery B has a voltage several times that of battery A. Now let us see what happens in the transistor. The forward bias placed across the emitter base junction causes electrons to flow from the N-type emitter material across the emitter-base junction into the base. Some of the electrons will flow out the base lead back into the positive side of battery A. However, the majority of the electrons will cross the base region because they will be attracted by the positive charge on the N side of the base-collector junction. The electrons will then flow through the collector to the positive terminal of battery B. Electrons will also flow from the negative terminal of battery B, through battery A and on to the emitter.

A PNP type transistor is shown in Fig. 8. The section on the left is the emitter, the center section is the base, and the section on the right is the collector. In other words, the type of material used in each section of the transistor is simply the opposite of the type used in the NPN transistor.

The PNP transistor is biased in the same way as the NPN transistor. The emitter-base junction is forward biased by battery A. Notice that the battery polarity is reversed from what it was in Fig. 7; however, the negative terminal is still connected to the N section, and the positive terminal to the P section so that the junction is forward-biased. The base-collector junction is reverse-biased by battery B.

With this type transistor battery A draws electrons from the emitter. This creates additional holes which drift over to the emitter-base junction. The holes are filled by electrons from the N-type base material. This creates a hole in the N-type material. The net effect is that you will have electrons moving from the negative terminal of battery A into the N-type material across the junction and moving from hole to hole in the P section back to the positive terminal of the A battery. At the same time, the holes are moving across the emitter, across the emitter-base junction and while some are filled by electrons from battery A, the majority traverse the base material and cross the base-emitter junction and into the collector. The holes will travel through the collector and are filled by electrons from the

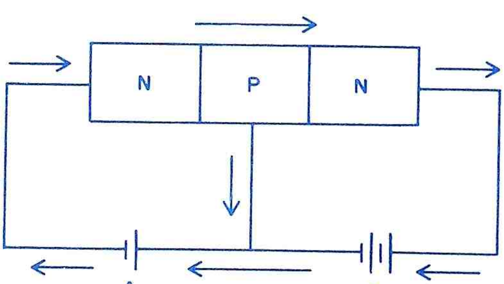


Fig. 7. An NPN transistor.

negative terminal of battery B. These electrons move across the collector from hole to hole, through the base material and then through the P-type emitter material, through battery A and back to the positive side of battery B.

The PNP type transistor is a little more difficult to understand than the NPN type transistor because of the concept of the hole moving through the transistor. If this bothers you, do not worry about it; simply visualize the electrons moving through the transistor in the opposite direction. As the electron enters the P-type collector material it will fill a hole. Then the electron will jump from that hole into another hole filling it. When an electron has moved towards the base material, jumping from hole to hole, the holes move in the opposite direction towards the negative terminal of the battery. The hole is then filled by another electron coming from the battery. The movement of the electrons is shown in this figure by the small arrows and the movement of holes across the transistor, by the large arrows.

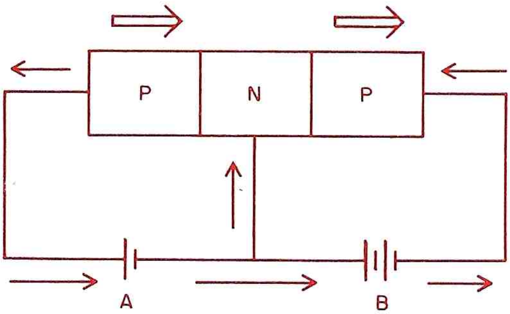


Fig. 8. A PNP transistor.

We have not gone very deeply into transistor theory, but we have gone far enough to enable you to see how a transistor can amplify. Let us look at the circuit shown in Fig. 9.

A typical transistor amplifier, using an NPN transistor in what is called a common base circuit, is shown in Fig. 9. The circuit is called a common-base circuit because the base is common to both the input and output circuit.

Before going ahead with the explanation of how the transistor amplifies, notice the schematic symbol used for the transistor. The emitter is represented by the arrow, the base by a flat thick line and the collector by the

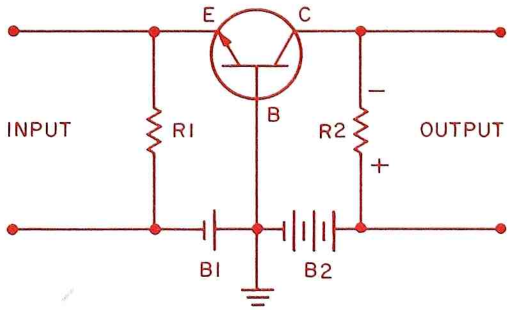


Fig. 9. An NPN common-base amplifier.

line coming off from the base. When the arrow points up like this it represents an NPN transistor. To designate a PNP transistor, the arrow used to represent the emitter is made to point down to the base. You can see this in Fig. 10.

To get back to the circuit, we see the negative terminal of battery B1 connected through R1 to the emitter, and the positive terminal connected directly to the base. This places a forward bias across the transistor emitter-base junction. The negative terminal of battery B2 is connected to the base and the positive terminal to the collector through R2. This places a reverse bias on the base-collector junction. The small emitter-base junction bias in effect controls the current through the transistor. Electrons flow through the negative terminal of B1, through R1 to the emitter, through the emitter section, across the emitter-base junction, through the base, across the base-collector junction and over through R2 to the positive terminal of B2. Electrons flow from the negative terminal of B2 to the positive terminal of B1 and through B1, R1 and back to the emitter. There is a small current flowing from the negative terminal of B1 through R1 to the emitter, through the emitter and across the emitter-base junction and the base to the positive terminal of B1.

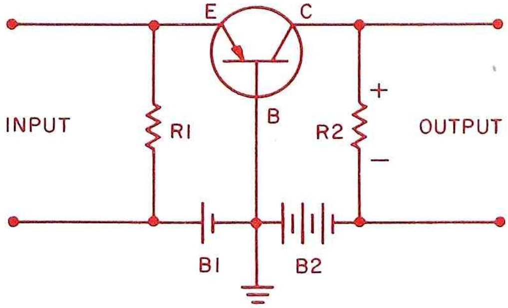


Fig. 10. A PNP common-base amplifier.

When an input signal is applied across R1, the signal adds to or subtracts from the forward bias supplied by B1. When the signal polarity is such that the end of R1 connected to the emitter is negative and the end connected to B1 positive, the signal adds to the forward bias across the emitter-base junction, and the flow of current through the transistor from the emitter to the collector increases. This causes the voltage drop across R2 to increase so that the collector voltage swings in a negative direction. When the polarity of the voltage across R1 reverses so that the end connected to the emitter is positive and the end connected to B1 is negative, it subtracts from the forward bias supplied by B1 and the current flow through the transistor decreases. This causes the voltage drop across R2 to decrease and the collector swings in a positive direction.

Thus, the small voltage variations across R1, that are caused by the input signal, cause current variations through the transistor. These current variations cause a comparatively large voltage variation across R2, because the resistance of R2 is quite large. Thus the signal voltage applied across R1 will appear as an amplified signal voltage across R2.

As we mentioned earlier, some of the emitter current flows to the base and back to the battery B1. This means that the collector current is less than the emitter current. Therefore this type of circuit does not provide current amplification. In other words, the current flowing in the input circuit is greater than the current flowing in the output circuit. The ratio of these two currents is referred to as alpha. The current gain of a transistor in a common base circuit is designated alpha, and it is always less than 1. However, since the current flowing to the base is very small, typical values of alpha are close to 1 -- generally between .9 and .95.

A common base amplifier using a PNP transistor is shown in Fig. 10. Notice that the circuit is identical except that the battery polarities are reversed and the emitter symbol on the transistor points in the opposite direction to designate a PNP transistor.

In this type of circuit the forward bias across the emitter-base junction is supplied by B1. The positive terminal of B1 is connected to the emitter through R1 and the negative is connected to the base. The reverse bias across the base-collector junction is supplied by B2. The negative terminal of B2 connects to the collector through R2 and the positive terminal is connected directly to the base.

In operation, the positive voltage applied to the emitter repels the holes in the P-type emitter through the emitter and across the emitter-base junction. The holes travel across the base to the collector and at the collector terminal are filled by electrons from the negative terminal of B2. The electrons move across the collector, moving from hole to hole, across the collector-base junction, through the base and across the emitter-base junction, through R2 to the positive terminal of the battery B1, from the negative terminal of B1 over to the positive terminal of B2.

When a signal voltage is applied across R1, when the polarity is such that the emitter end of R1 is positive, the forward emitter-base junction bias is increased and the hole flow through the transistor increases. This causes the voltage drop across R2 to increase, because more electrons must flow through R2 to fill the holes arriving in the collector. This causes the voltage of the collector ends of R2 to swing in a positive direction. When the input signal swings in the opposite polarity so that the end of R1 connected to the emitter is negative, the voltage across R1 subtracts from the forward emitter-base junction voltage, reducing the flow of holes from the transistor. This results in fewer electrons through R2 to fill the holes arriving in the collector, therefore the voltage drop across R2 decreases and the voltage of the collector end of R2 swings in a negative direction. Notice that in both circuits the output voltage has the same polarity as the input voltage. In other words, the signal polarity is not reversed in the common base amplifier circuit. The circuit provides an amplified signal voltage because the value of R2 in each case can be made quite high and the current flow through the transistor will then develop a relatively high signal voltage across the output circuit.

The common base circuit can be compared

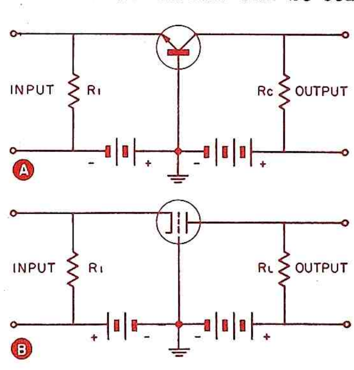


Fig. 11. Comparison of a common-base transistor circuit (A) with a grounded-grid vacuum-tube circuit (B).

A comparison of the two circuits is shown in Fig. 11. Both circuits provide voltage amplification, and in both circuits the amplified output voltage has the same polarity as the input signal voltage.

While a common base amplifier type circuit will be found in some equipment, the more commonly used circuit is the common-emitter circuit shown in Fig. 12. It is called a common-emitter circuit because the emitter is common to both the input and output circuits. This circuit provides both voltage and current gain and it can provide a higher voltage gain than can be obtained in the common-base circuit.

The circuit shown in Fig. 12 uses a NPN transistor. Battery B1 provides the forward bias across the emitter-base junction. Again, battery B2 provides the reverse bias across the base-collector junction.

With no signal applied to the input, the current flow through the transistor is the same as in the common base circuit. Electrons leave the negative terminal of B1, flow through the emitter and across the emitter-base junction into the base. Most of the electrons flow through the base and across the base-collector junction and through R2, setting up a voltage drop up across it as shown. A few electrons crossing the emitter-base junction leave the base and flow through R1 and back to the positive terminal of B1.

When a signal voltage is applied across R1, if the voltage at the collector end of R1 is positive, the signal voltage adds to the forward bias, causing the current from the emitter through the base to the collector to increase. This increases the current flow through R2, causing the collector end to swing in a negative direction. When the input signal voltage polarity reverses so that the base of R1 swings in a negative direction, the voltage across R1 subtracts from the forward bias provided by B1, causing the current through

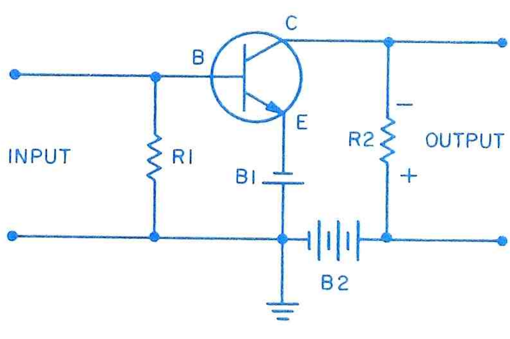


Fig. 12. An NPN common-emitter amplifier.

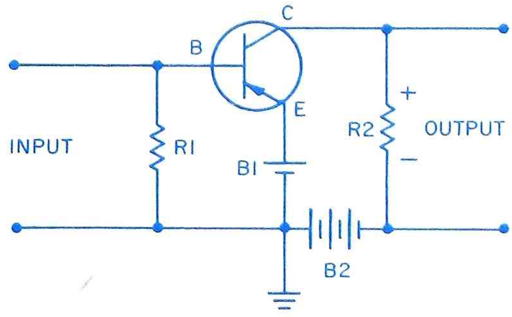


Fig. 13. A PNP common-emitter amplifier.

the transistor to decrease. This results in the voltage drop across R2 decreasing so that the voltage at the collector end of R2 swings in a positive direction.

Notice that when the input voltage drove the base in a positive direction, the collector voltage went in a negative direction, and when the input signal drove the base in a negative direction, the output signal went in a positive direction. Thus the signal polarity is changed 180° in the common amplifier circuit.

This circuit provides current gain because the current flowing in the input circuit, consisting of the emitter-base junction, R1 and B1 will be relatively small. Changes in signal voltage across R1 will cause some change in this current. However, the collector current will undergo much greater changes. Therefore the changes in output current will be much greater than changes in input current. This circuit is capable of providing both voltage and current gain. We designate the current gain obtained from a transistor in a common emitter circuit as beta.

The PNP transistor can also be used in the common emitter circuit. A schematic of this circuit is shown in Fig. 13. The operation of the circuit is identical to the circuit shown in Fig. 12 except that the battery polarities are reversed and we have the hole movement through the transistor. When the signal voltage across R1 drives the base in a negative direction, the voltage across R1 adds to the forward bias provided by B1 and the hole current through the transistor increases. This causes the electron flow through B2 and through R2 to increase so that the voltage at the collector end of R2 goes in a positive direction. Similarly, when the input signal drives the voltage at the base end of R1 in a positive direction, the voltage across R1 will subtract from the forward bias provided by B1, and this will cause the hole current to decrease. This means that the number of holes arriving at the collector will decrease

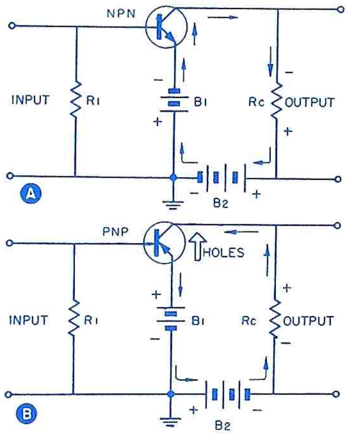


Fig. 14. Comparison of common-emitter transistor circuit (A) and grounded-cathode vacuum-tube circuit (B).

to the grounded-grid circuit in vacuum tubes. and therefore the current flow through R2 will decrease. This will cause the voltage at the collector end of R2 to swing in a negative direction. Again, the PNP common emitter circuit provides a 180° phase shift between the input and output signals. The signal voltage in the output circuit will be amplified because the value of R2 will be much higher than the value of R1. Thus small signal voltages across R1 which cause relatively small changes in forward bias will cause current changes through R2 which will produce relatively large amplified signal voltages. Again, the PNP common emitter circuit also provides current gain, which is designated as beta.

The common emitter circuit can be compared to the conventional grounded cathode circuit in vacuum tubes. Fig. 14 shows both the transistor and tube circuit and you can see the similarity. This transistor circuit provides the maximum gain that can be obtained from the transistor and similarly, the equivalent tube circuit that provides the maximum gain that can be obtained from the tube.

You will remember from vacuum tubes that in addition to the grounded grid and grounded cathode circuits, there is also a vacuum tube circuit known as the grounded plate circuit, or more commonly known as the cathode follower. The equivalent transistor circuit is called the common collector circuit, but

In both the common base and common-emitter circuits shown, we have shown two batteries. It is more economical to use one battery instead of two and this is usually done in most amplifier circuits. A diagram of a practical common-emitter circuit using a PNP transistor is shown in Fig. 15. Here we have only the battery in the circuit.

To see how this one battery can provide both the emitter-base forward bias and the base-collector reverse bias, notice that the positive terminal of B1 is connected to the emitter through R2. R2 is a relatively small resistor and for the present let us forget that it is in the circuit and consider that the positive terminal of B1 is connected directly to the emitter. There is a voltage drop across R1 having the polarity shown, but since this voltage drop is less than the battery voltage B1 the emitter of R1 is negative with respect to ground. This means that the emitter has a positive voltage applied to it, and the base a negative voltage, which are the conditions for forward bias across the emitter-base junction in the PNP transistor.

R2 is inserted in the circuit for stabilization purposes. It is used to prevent excessive heat from causing such a high current flow through the transistor that the transistor will be destroyed. R2 subtracts from the forward bias across the emitter-base junction, but by selecting R1 and R2 of the correct value we can obtain the correct forward bias. If excessive heat causes an increase in current flow through the transistor, this will result in an increase in voltage drop across R2. This reduces the forward emitter-base junction bias, which in turn reduces the current flow through the transistor and protects the transistor.

The reverse bias across the base-collector junction is obtained by selecting the values of R1 and R3 so that the voltage drop across R1 is greater than the voltage drop across R3. This will make the base positive with respect to the collector, which is what we want to reverse-bias the base-collector junction.

In this article we barely skimmed over transistors. There is a great deal more to learn about them, but if you have been remiss in studying transistors, why not use these simplified explanations as a starting point?

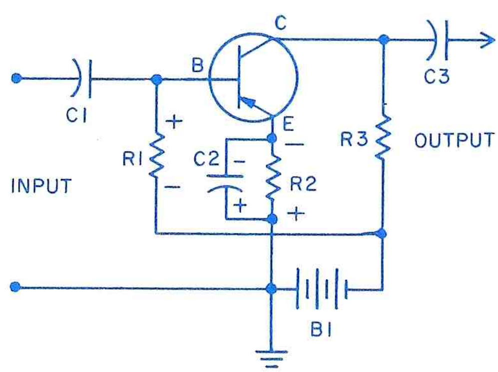


Fig. 15. A practical common-emitter circuit.

resonant circuits. I don't quite see how this is possible. Would you explain?

C. D., Fla.

It is quite true that you will find a voltage step-up in a series resonant circuit and a current step-up in a parallel resonant circuit. This can be attributed to the characteristics of each type of circuit.

First of all, in a series resonant circuit, the circuit will appear as a low impedance at resonance. Since the impedance is low, the current will be high and it will be limited only by the resistance of the circuit. When we consider that E equals I times X_L and E equals I times X_C, we can see that the voltage drops may be several times the source voltage.

In a parallel resonant circuit, the conditions are just the opposite. The parallel resonant circuit will represent a high impedance. Therefore, the voltage drop across the components will be high. Since the coil and capacitor in the resonant circuit are connected in parallel, the same potential will be across each branch. Thus, there cannot be a voltage step-up. However, the coil and capacitor will pass current back and forth. The ac source will provide only the current needed to make up for losses in the resonant circuit, which will be relatively few. Since the resonant circuit current is greater than the generator current, there is what we call a resonant current step-up.

In this lesson, you are given many facts about resonant circuits. Try to concentrate on the main points which are covered by the test questions. In a later lesson you will study resonant facts further and learn how they are used in practical circuits. In addition, you will construct and perform experiments on resonant circuits in one of your experimental kits.

DEAR STEVE,

In Lesson 4BB, the audio output transformer of a radio is described as being a step-down transformer. If we want maximum sound from the speaker, why isn't a step-up transformer used?

B. W., Ark.

In your later lessons, you will learn about a thing called "Impedance Matching." Also, you will learn that the object of the output transformer is to transfer the maximum amount of power from the output circuit to the speaker. This can be done only when the impedance of the output circuit is matched to the impedance of the speaker.

It has been found that the output transformer can properly match the two impedances if the secondary has a smaller number of windings than the primary. Keep in mind that this is not for stepping up voltage so much as it is for matching the impedances so that the output circuit will be matched to the input circuit and the maximum amount of power will be transferred.

Needless to say, you will study this further in later lessons.

DEAR STEVE,

In lesson 10BB, we are told that there is a 180° phase shift in a grounded-cathode amplifier. How does this phase shift occur?

W. G., Canada

The output signal in a grounded-cathode amplifier is 180 degrees out of phase with the input signal. The output signal will move in a negative direction when the input signal is moving in a positive direction. When the input signal is moving in a negative direction, the output signal will move in a positive direction.

When you have a negative signal applied to the grid of a tube, the flow of electrons through the tube will be restricted. Of course, if there are less electrons, this means that the tube resistance has effectively increased. The number of electrons flowing throughout the circuit will decrease, also. Thus, the voltage drop across the plate load resistance will drop. This means that the voltage across the tube will be greater because of the higher resistance. Since the voltage is greater, we say that it is moving in a positive direction.

When a positive signal is applied to the input of a tube, the electron flow through the tube will increase. Thus, the tube resistance has effectively decreased. Since the effective tube resistance has decreased, the voltage drop across the tube will decrease and the voltage drop across the plate load resistor will increase. Since the voltage drop across the tube has decreased, we say that it is moving in a negative direction.

Since these changes in plate voltage are caused by a simultaneous change in the grid circuit, we say that the output voltage is following the variations of the input signal. Thus, the signal has been transferred and amplified, but it is 180 degrees out of phase with the input signal. □

For 'Instant' Graduation

BY ALLENE MAGANN

NONHECKLING WIFE IS AN ASSET, STUDENT GERALD GORDON FINDS

Want a good recipe for success?

You might try that of Gerald A. Gordon, an officer in the Air Force, who just sped through the complete NRI radio-television servicing course in a record 4-1/2 months, and graduated with a rating of "excellent" to boot.

(The usual completion time is 24 months, based on spending an average of 1-1/2 hours per day in study, Student Service Director Harry Bennett estimates; many who have more time to spend on the studies do finish in far less time, setting their own rates of progress according to personal circumstances.

(Mr. Gordon figures he averaged five or six hours a day on the lessons, and more on weekends. He conceded, too, that occasionally during his working day there were intervals of comparative quiet when he could sandwich in a little study, which, with lunch hours and coffee breaks, helped to speed things up.

("I kept the books handy, and grabbed them every chance I got.")

Back to the recipe, you start with more or less equal parts of interest, determination, a zest for learning and a challenge, patience, good use of free time, stick-to-itiveness, and more than a pinch of curiosity. Stir in a quantity of good advice. Then combine with a wife who is understanding and doesn't heckle and you've got it made!

At least that's the way Mr. Gordon must have figured it. The zest and most of the rest of it he already had; the free time evolved because he was temporarily out of a hobby; the interest generated from a walkie-talkie that didn't work; the good advice came from NRI staffers, and the last, and probably the most important ingredient, just came built that way!

"She was interested, and encouraged me," he said. "She didn't heckle me about wanting to go out or spending more time on her, and it really helped. I could study whenever I found the time without interruptions."

Mrs. Gordon has been more than casually interested in his servicing course. She "couldn't keep from learning" as she watched and helped him throughout the practical training portions of the course. She was constantly available to "please hand me this or please hold this for me".

"I asked literally hundreds of questions." she said, "and he explained to me just what he was doing and what he expected to happen." Of utmost concern to her was how could he tell when a part was electrically defective, when it looked brand-new?

Thus she became familiar with the tube tester and the resistor-capacitor testing procedures. The tube tester she calls "mine, or it will be when Jerry goes into full-time servicing." Meaning that she has every intention

" Why NRI ? Everybody's so darn nice ..... "

"We ought to give the wives one (diploma), too," said NRI president J.M.Smith, at left.

of sharing the work load with him at that time, now less than four years away.

So as a special reward, Mr. Gordon arranged for J. M. Smith, president of NRI, to present his diploma, with Mrs. Gordon to be included in the ceremonies. On the appointed day it was raining heavily, but it didn't dampen the spirits of either of the Gordons. Both are outgoing and ebullient.

Mr. Gordon's attitude about his wife's attitude was echoed by Mr. Smith as they were ushered into his office.

"You know," Smith said to her, "I'm glad you came along. We really ought to give the wives diplomas, too!"

WANTED TOUR OF FACILITIES

Being stationed in the Washington, D. C. area has given Mr. Gordon a chance to meet some of the NRI staffers, and he had been in the building before, but he had never had a complete tour of its facilities.

Nor had he met Mr. Smith. "This is a big day for us," he said.

"Well," Mr. Smith laughed, "it's a big day for me, too. I don't get to do this very often."

Was Mrs. Gordon surprised that her husband finished the course so fast?

"Oh, Jerry is just like that," she said. "He cannot rest until he is learning something new, and then he cannot rest until he has mastered it. His reflexes are...well, very fast, and he enjoys every minute of learning."

"Something new" has in the past included Spanish, chiropractic, singing, writing giving talks, and playing the violin, guitar and mandolin. The Spanish he started learning from his wife shortly before their marriage. Of Spanish extraction, she started teaching him about two months before he was sent to Germany in 1954. By the time she got there to marry him a few months later, he had taken correspondence courses through the Air Force and received a rating of "fluent".

That's about the way he got interested in electronics, too. "I built a set of walkie-talkies, from a kit, and occasionally something would go wrong with them. Then I built a set of C. B. transceivers, and then I had more problems. I realized that if I intended to rely on their operation, I had better learn how to service them."

"It was really because of the hunting and fishing," Mrs. Gordon interpolated. "He loves them both so much, and there really isn't any close place to go for either, and his hunting dog was killed, so he had all that free time and no hobbies to pursue..."

Free time, you understand, is a relative term, with all the aforementioned hobbies. Then, too, the Gordons recently adopted a son, Michael, who gets a fair share of time. "I suppose you could call my getting up every Sunday morning at 4 a. m. and helping him deliver newspapers a 'fair share,'" he chuckled. "After all, I'm not doing anything but sleeping then."

After he decided to study electronics, there was the question of choosing which home-study school.

Why NRI?

"Well, I checked, and knew it was a good school, and then when I called and the lady who answered was so darn nice and helpful about answering all my questions, it seemed like a good idea.

LIKES THE GENERAL ATTITUDE

"And everybody else has been equally nice ever since. I think mostly it's the attitude you seem to have here. If you ask Joe something, he seems to feel it's his job to do, and he'll answer it, not say 'let John do it.' It goes that way through the whole school... they all do a little bit more than they have to. I asked some lulus of questions, too."

Now that the formal training is over, one would assume that Mr. Gordon would again have some free time, but it seems he's started his own radio-TV servicing shop, where he spends most of his off-duty hours.

After the diploma, the tour; here with consultant Steve Bailey in research lab.

In less than four years he will complete 20 years of active duty with the Air Force, and upon his retirement they plan to move to Idaho and open a full-time servicing business.

"After the freezer is full of rainbow trout and elk steaks," he joked, "I might just have a little free time to fix an occasional radio or TV set." ☐

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets 8:00 P. M., 2nd Friday of each month, St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich., VI-14972.

FLINT (SAGINAW VALLEY) CHAPTER meets 8:00 P. M., 2nd Wednesday of each month at Andrew Jobbagy's Shop, G-5507 S. Saginaw Rd., Flint. Chairman: Henry Hubbard, 5497 E. Hill Rd., Grand Blanc, Mich., 694-4535.

HACKENSACK CHAPTER meets 8:00 P. M., last Friday of each month, St. Francis Hall, Cor. Lodi and Holt St., Hackensack, N. J. Chairman: Matthew Rechner, 42 Campbell Ave., Hackensack, N. J.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month at George Fulk's Radio-TV Service Shop, Boonsboro, Md. Chairman: Francis Lyons, 2239 Beverly Dr., Hagerstown, Md. Reg 9-8280.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, 4912 Fountain Ave., L. A. Chairman: Eugene DeCaussin, 4912 Fountain Ave., L. A., NO 4-3455.

MINNEAPOLIS-ST PAUL (TWIN CITIES) CHAPTER meets 8:00 P. M., 2nd Thursday of each month, at the homes of its members. Chairman: Edwin Rolf, Grasston, Minn.

NEW ORLEANS CHAPTER meets 8:00 P.M., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P. M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: Frank Lucas, P. O. Box 343, Newark, N. J., 672-6958.

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: James L. Wheeler, 1436 Riverview Dr., Verona, Pa. 793-1298.

SAN ANTONIO ALAMO CHAPTER meets 7:00 P. M., 4th Friday of each month, Beethoman: Sam Stinebaugh, 318 Early Trail, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P.M., 2nd Wednesday of each month, Sokol Hall, 739 Page St., San Francisco. Chairman: Isaiah Randolph, 523 Ivy St., San Francisco,

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month at home of John Alves, 57 Allen Blvd, Swansea, Mass. Chairman: Daniel DeJesus, 125 Bluefield St., New Bedford, Mass.

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

CONAR EASY PAYMENT PLAN

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

Enclosed is a down payment of $________ on the equipment I have listed on the reverse side. Beginning 30 days from the date of shipment I will pay you $________ each month until the total payment price is paid. You will retain title of this equipment until this amount is fully paid. If I do not make the payments as agreed, you may declare the entire unpaid balance immediately due and payable, or at your option, repossess the equipment. Your acceptance of this will be effected by your shipment to me of the equipment I have listed.

Date ________________ Your written signature ________________

CREDIT APPLICATION

Print Full Name ________________ Age ________

Home Address ________________

City & State ________________ How long at this address? ________

Previous Address ________________

City & State ________________ How long at this address? ________

Present Employer ________________ Position ________________ Monthly Income ________

Business Address ________________ How Long Employed? ________

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

Bank Account with ________________ Savings ☐ Checking ☐

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

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

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

Alumni News

David Spitzer	President
Jules Cohen	Vice President
F. Earl Oliver	Vice President
Joseph Stocker	Vice President
James L. Wheeler	Vice President
Theodore E. Rose	Executive Sec.

MEET HOWARD TATE, NEW NRIAA PRESIDENT

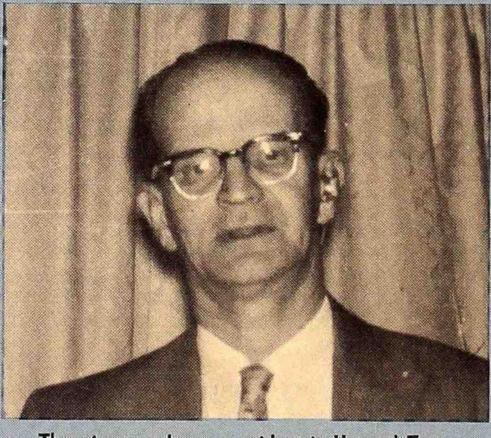
It seemed to be a long time in coming for one so worthy, but at last Howard Tate of the Pittsburgh Chapter has attained the highest honor in the NRI Alumni Association--the Presidency. The current President, David Spitzer of New York City, will terminate his tenure of the office on January 1 and will be succeeded by Howard Tate for the year 1966. Our heartiest congratulations, Howard.

Eugene DeCaussin came in second. The probability that he would was forecast by the primary, in which he was also the runner-up, but he nevertheless made a good showing.

Earl Oliver of Detroit led the successful candidates for Vice-Presidencies, as he usually does when he's in the running. The other three to win Vice-Presidencies are Joseph Bradley of New York City, Edward Bednarz of Fall River, Mass., and Isaiah Randolph of San Francisco. This is the first time that the last three mentioned have been elected to national office. Our congratulations to them.

Tate first saw the light of day in Lawrenceville, a Pittsburgh suburb. Upon graduation from high school he attended Carnegie Tech for five semesters of night classes. Following twenty-six months' service in the Navy during World War II, he took two courses from NRI between 1943 and 1948.

He began working at seventeen with the Oil Well Supply Company as a messenger, then went to work for the Peoples Trust Company in the stock transfer department and later with the Firefoam Sales Company as an Industrial Fire Prevention Engineer. Then, as a result of his NRI training, he established the Radio Laboratory -- his own Radio-TV business -- in 1952 and still operates it.



The winner and new president is Howard Tate.

He joined the Radio Serviceman's Association in 1935. This was reformed in 1948 to the present Radio and Television Servicemen's Association of Pittsburgh. He has been on the Board of Directors of this organization ever since 1957.

Tate, together with Frank Skolnik (who is himself a former President of the NRIAA) started the ball rolling in 1952 on the formation of a local chapter of the NRIAA in Pittsburgh. Tate has held various offices in the Chapter: Treasurer, Corresponding Secretary, Vice-Chairman and finally Chairman, also Editor and Publisher of the Chapter's publication, The Circuiter.

Tate is single. His hobbies are model railroading and rifleman; he is a lifetime member of the National Rifleman's Association.

DETROIT CHAPTER had its first meeting after the summer vacation, took up the entire meeting with a discussion of plans for the new 1965-1966 season.

The chapter wishes to remind all its members that beginning this season meetings will be held only once a month, on the second Friday of each month, instead of twice a month as in past years.

HACKENSACK CHAPTER'S George Schalk gave a fine talk on TV troubleshooting. He had literature pictorially describing a number of symptoms appearing on the TV screen, along with an analysis of the trouble, the various steps required to isolate the stage or circuit and the proper method of checking for faulty components. His talk prompted a great deal of discussion among the members and many helpful ideas were suggested.

The feature of the following meeting was a talk by Secretary George Schopmeier on the oscilloscope. He discussed the requirements of the service scope and troubleshooting with it.

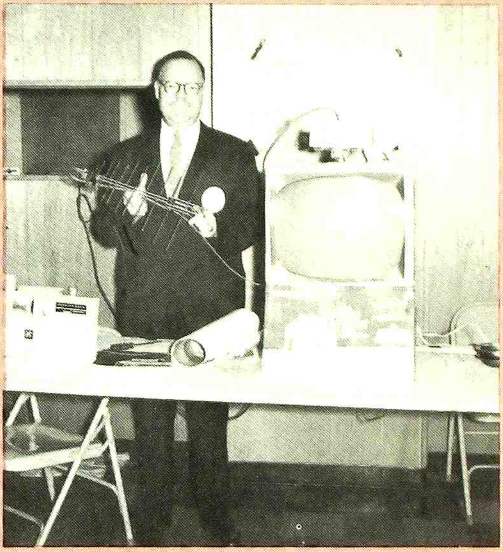
Some excellent programs were scheduled for future meetings: a lecture on transistors by RCA, a lecture and film by Bell Telephone; future lectures from Howard Sams Company; and a lecturer from Motorola on either color TV or auto radio.

Because many regular members and prospective members cannot attend meetings on the Chapter's present meeting-night, the last Friday of each month, the Chapter is considering the possibility of having two meetings per month instead of only one. If any NRI graduate or student in the area would be interested in the Chapter's establishing such a second meeting, the chapter would like to hear from him with suggestions on what the second meeting night should be.

LOS ANGELES CHAPTER members were saddened by the passing of one of its members, William G. Edwards. At the first meeting subsequent to his death a minute of silence was observed, then a voluntary collection was taken up among the members and the proceeds were contributed to the widow, Mrs. Stella Edwards.

Two excellent films were shown. One, the "TV Unchained Goddess", was all about the weather and weather forecasting with the aid of electronic equipment. The other, called "The Voice Beneath The Sea", was about the laying of telephone cables in the Atlantic Ocean and showed the part played by electronics in the amplification of the human voice during transmission of voice calls through the cables.

The chapter has purchased a color TV set for experimental purposes and also plans to use slides and lectures obtained from Howard Sams at future meetings.



Factory representative Austin Gutman demonstrated a Blonder-Tongue UHF converter to Philly-Camden.

PHILADELPHIA-CAMDEN CHAPTER started the first meeting of the 1965-1966 season with a program of great interest to almost all of its members -- in fact, to all Radio-TV servicemen. Blonder Tongue factory representative Mr. Austin Gutman gave a very thorough and comprehensive talk on his company's UHF Converter. He used a Philco portable about nine years old and with his inside antenna and the converter, he showed how easy it is to use the converters to make some easy money. The pictures came in very well, as good as on the VHF channels. Literature was given out to aid in following Mr. Gutman's talk. He donated the converter he used for demonstration purposes for a door prize. The members were well pleased with this demonstration and agreed that they got much useful information.

The latest members to be admitted to the Chapter are Darrell Nichol, NRI student, and John Griffith, NRI Graduate, both from Philadelphia. Our congratulations to these two members!

PITTSBURGH CHAPTER was delighted with a show put on for them by Westinghouse. It was conducted by Westinghouse representatives Glenn Mumper and John Burn, who are also members of the chapter. The feature of the show was the presentation of the new Westinghouse 19" All-Transistorized (except the high voltage rectifier) Television Receiver. In the words of Chairman Jim Wheeler, "This television set really takes the cake. . . the best picture ever seen at any of our meetings. Even with the light from a projection machine on the face of the tube, it was perfectly clear." It took John Burn two and a half hours to go through the different phases and explain how they are set up.

Even allowing for the fact that the chapter customarily has interesting and entertaining meetings, this one was nevertheless unusually good. The members fully appreciated John's and Glen's efforts and are grateful to Westinghouse for this excellent program.

SAN ANTONIO ALAMO CHAPTER is fortunate to number John Chaney, Jr. among its members. He is a radar repairman at Kelly Air Force Base. Because of his training and experience, he speaks with authority on the fields of electronics with which he comes in contact through his work. At one recent meeting he spoke on klystrons and at the following meeting on waves and waveforming. The members eagerly look forward to these talks by John.

The newest member to be admitted to the chapter is C. W. A. Hoffman. Welcome to the chapter, Mr. Hoffman!

SAN FRANCISCO CHAPTER recently admitted its newest member, Graduate Eric E. Ahllund. Our congratulations, Eric!

Phil Stearns brought in a Radio with a loud hum. With the assistance of Peter Wivel it was found to be caused by a faulty filter condenser. The defect was discovered by "bridging" with a good condenser.

Secretary Art Ragsdale discussed an article on Ohm's Law by William F. Dunn, NRI Director of Education, which appeared in the NRI Journal.

The Chapter is considering the possibility of moving to a more suitable meeting place. All members should submit their ideas on the subject without delay.

The chapter has been holding its meetings on the first Wednesday of each month but is now meeting on the SECOND Wednesday of each month. □

STRAUGHN, ROSE CONTINUE VISITS TO AA CHAPTERS

For the past several years J. B. Straughn, Chief, NRI Consultation Service, has accompanied NRIAA Executive Secretary Ted Rose on the latter's annual visit to the local chapters of the NRI Alumni Association. At these meetings Mr. Straughn delivers lectures and holds demonstrations, particularly on Radio-TV service problems but also on other Electronics subjects. Chapter members always warmly welcome these two NRI representatives.

All NRI men, students and graduates alike, whether or not members of the local chapter, are cordially invited to chapter meetings and especially so when Messrs. Straughn and Rose make their annual visit. You are urged to take advantage of this invitation. See the "Directory of local chapters on Page 28 for full information on the meetings.

The schedule of the remaining visits for the 1965-1966 season is as follows:

CHAPTER	DATE
Philadelphia-Camden	November 8
Hagerstown	November 11
New York City	November 18
New Orleans	March 8
Hackensack	April 29
Pittsburgh	May 5

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION (Act of October 23, 1962; Section 4369, Title 39, United States Code).

1. Date of Filing: October 1, 1965
2. Title of Publication: NRI Journal
3. Frequency of issue: bimonthly

4. Location of known office of publication: National Radio Institute, 3939 Wisconsin Ave., N. W., Washington, D. C. 20016.

5. Location of the headquarters or general business offices of the publication: 3939 Wisconsin Ave., N. W., Washington, D. C. 20016.

6. Editor and Publisher: William F. Dunn, 6314 Tulsa Lane, Bethesda, Maryland: Managing Editor: Allene Magann, 220 E. Windsor Ave., Alexandria, Va. 22301.

7. Owner (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given).

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Elsie Smith Davis, RFD 1, Rochester, New Hampshire.
Carol Smith Galbraith, 430 E. Ledbetter Drive, Dallas, Texas.
Michael Morrison Galbraith, 728 W. Dempster St., Apt. 110H, Mt. Prospect, Ill. 60057.
Gail Alexandra Peek, 305 N. Virginia Ave., Falls Church, Virginia.
The National Radio Institute Charitable Trust, % J. E. Smith, 1121 Crest Lane, McLean, Virginia.
James E. Smith, Sarah Morrison Smith, 1121 Crest Lane, McLean, Virginia.
Emma Smith Stuart, 21 Sewall Rd., South Berwick, Maine, 03908.
James Morrison Smith, James Morrison Smith, Jr., Terry Morrison Smith, 1123 Crest Lane, McLean, Virginia.
Lee Morrison Smith, Americana Glenmont Apts., 2386 Glenmont Circle, Silver Spring, Maryland.
Marjory M. S. Sarich, Charles B. Sarich, James R. Sarich, 1125 Crest Lane, McLean, Virginia.
David H. Smith, RFD 1, Box 395, Rochester, New Hampshire.

8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities (if there are none, so state): none.

9. Paragraphs 7 and 8 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such person is acting, also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. Names and addresses of individuals who are stockholders of a corporation which is itself a stockholder or holder of bonds, mortgages or other securities of the publishing corporation have been included in paragraphs 7 and 8 when the interests of such individuals are equivalent to 1 percent or more of the total amount of the stock or securities of the publishing corporation.

10. This item must be completed for all publications except those which do not carry advertising other than the publisher's own and which are named in Sections 132.231, 132.232, and 132.233, postal manual (Sections 435a, 435b, and 4356 of Title 39, United States Code).

A. Total number copies printed (Net Press Run) November/December 1964 through September/October 1965: 231,000; average number copies each issue during preceding 12 months: 38,500; single issue nearest to filing date: 38,500.

B. Paid circulation.

1. Sales through dealers and carriers, street, vendors and counter sales: none.

2. Mail Subscriptions: average number copies each issue during preceding 12 months: 170; single issue nearest the filing date: 135

C. Total Paid Circulation: Average number copies each issue during preceding 12 months: 170; single issue nearest to filing date: 135.

D. Free Distribution (including Samples) By Mail, Carrier or other means: average number copies each issue during preceding 12 months: 36,654; single issue nearest to filing date: 34,951.

E. Total Distribution (Sum of C and D): Average number copies each issue during preceding 12 months: 36,654; single issue nearest to filing date 35,086.

F. Office use, Left-over, Unaccounted, spoiled after printing: average number copies each issue during preceding 12 months; 1676; single issue nearest to filing date: 3414.

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I certify that the statements made by me above are correct and complete. Allene Magann.

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