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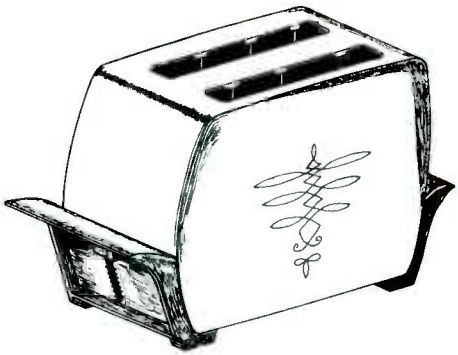
## ON OUR COVER

NRI Graduate Stanley Cmielewski has parlayed his interest in electronics, beginning at the age of 10, into an early partnership-managership in a chain of three electronics sales-and-servicing stores in Newark, N.J. For him "there's never a dull moment". His story begins on Page 13 of this issue.



# AUTOMATIC TOASTERS: PRINCIPLES, OPERATION, AND MAINTENANCE

*By Joseph Schek*

Effective small appliance servicing is an important and continuous source of customer contact which is vital to every appliance service technician in building up and sustaining an active and profitable appliance servicing business.

One of the most widely enjoyed small appliances is the automatic toaster. There are probably more automatic toasters in homes today (would you believe more than 100,000,000?) than any other small appliance. And this huge number continues to increase, attesting to the growing popularity of serving toast for just about every meal and snack. Hence, the appliance service technician who has the "know-how" and related experience in automatic toaster servicing will not only get all the profitable toaster work he can handle, but satisfied customers will call on him to service their other appliances as well.

The purpose of this article is to provide information showing how to understand and correct the electrical and the mechanical operation of automatic toasters.

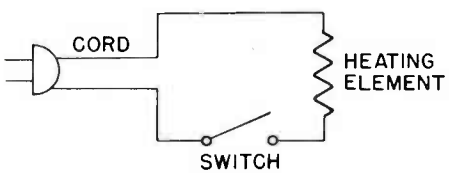



Fig. 1. The basic electrical circuit.

## The Electric Circuits

The electric circuit of an automatic toaster can be represented by a simple diagram. Fig. 1 shows this power circuit. The line cord hooks up to the toaster terminals. The load consists of the center and outside toaster heating elements. The power to this load is adjusted by means of the timer-switch, with a speed control knob, so that the heating of the elements starts and stops at the proper time, providing satisfactory toast - neither underdone nor burned to a crisp.

Fig. 2 shows a refinement of the automatic timer circuit. In addition to a switch-timer, a thermostat is placed in series between the elements and the timer clock switch. Incidentally, this switch may also be in the form of a thermo mechanism utilizing a bimetal strip whose position varies with its operating heat, as shown in Fig. 3. By controlling the gap between the bimetal strip and the switch, the timing sequence can be controlled and serve the same purpose as a mechanical clock timer.

Returning to Fig. 2, an automatic toaster with both a thermostat and a clock or bimetal timer can be adjusted to regulate the amount of heat in relation to the period of time that toasting takes. In this way, control is provided not only over the

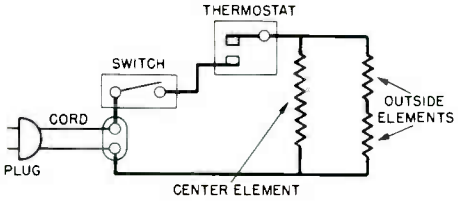



Fig. 2. Circuit position of thermostat.

color of the toast, but also its degree of hardness, or its amount of moisture.

That is, if the timer is set for a relatively short duration of toasting time and the thermostat is set so that the full heat will be on throughout that time, you will get toast that is crisp on the outside but soft on the inside. At the other extreme, one could set the time for a long duration and the thermostat for minimum heat, and obtain toast that was light but dry (moistureless) all the way through. Home toasters with this feature of dual control are probably the most completely automatic now available.

While the electric circuits of these toasters appear to be simple on-off switch and load circuits, and actual electrical troubleshooting consists of locating open circuit conditions by resistance checks and by visual inspection, the automatic mechanical systems are sometimes complex, requiring delicate adjustments. These automatic toaster operations always follow a logical step-by-step sequence, and since the operation of all automatic appliances follows the same procedures, training and experience with automatic toasters can be applied when analyzing and servicing other appliances that use timers and thermostats.

**Automatic Toaster Devices.**

Mechanical watches and clocks operate on the slow and gradual release of energy that is stored in a wound spring. To obtain this slow and gradual release of energy from the wound spring, an escapement device is required. Fig. 4 shows a simple but effective escapement mechanism.

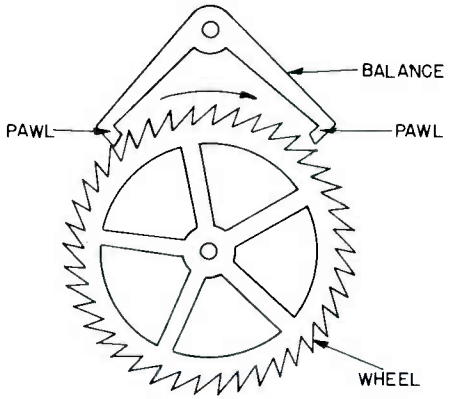



Fig. 4. A simple escapement mechanism.

In this arrangement, the slow, steady, controlled release of energy, provided by the wound spring through the escapement mechanism permits the rotary motion of the wheel-gear to operate cams, which in turn actuate power switches.

The wheel-gear is attached to the spring. When the spring is wound, as for example

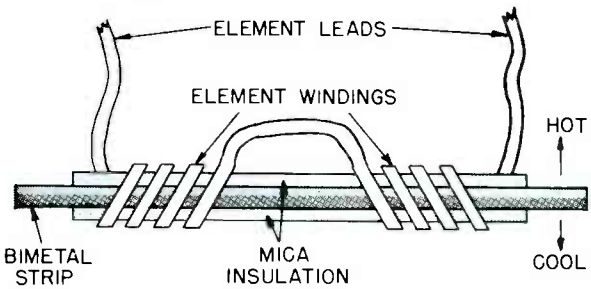



Fig. 3. Bimetal strip used to operate a mechanical timer.

when the toaster carriage is pushed down, the pressure of the spring to uncoil provides the energy to turn the wheel gear. For the purpose of this illustration we will assume that this direction is clockwise, as indicated by the arrow.

As the wheel attempts to turn in the direction indicated by the arrow, the action of a tooth on the left-hand pawl forces that side of the balance to move in an upward direction. When the left-hand side of the balance moves up, the right-hand side is forced down, and the right-hand pawl prevents the wheel from moving more than the distance between the teeth.

The left-hand pawl then drops down between the next two teeth, and the right-hand side of the balance rises, allowing another tooth to pass the right-hand pawl before the left-hand pawl is again forced up by the next tooth. Thus the balance is continually rocking back and forth, allowing the wheel to turn, one tooth at a time. This action is exactly what takes place in a mechanical clock.

The speed at which the balance arm rocks back and forth rotating the wheel can be reduced or varied by placing different amounts of spring tension against the rocking motion of the balance arm, or by varying friction against any other rotating parts of the clockwork mechanism.

When timers are used in toasters, the spring is wound or placed under tension by moving a lever which controls the time that the mechanism is to run. The rotary motion produced by the spring and controlled by the escapement mechanism is used to operate either a cam or a rack and pinion arrangement, which will shut off an electrical switch when the spring has unwound to a predetermined point.

In addition to cutting off the current to the toaster, the cam (or rack and pinion) may release a mechanical latch and allow the toast to pop up when done. That is, the carriage with the toast will pop up by means of a spring uncoiling. The spring was pressed down when the carriage was pushed down at the start of the toasting cycle.

If you have determined that the timer in a toaster is faulty, do not attempt to repair it. Worn or broken timer parts are difficult or impossible to repair. Also, the parts cannot usually be obtained separately; instead, it is generally necessary to replace the complete timer. Timing units are readily available at most parts distributors.

### Cams.

Fig. 5A illustrates the use of a cam to operate an electrical switch. When the spring is wound, the cam will rotate in a clockwise direction until what is now the upper end of the detent is in contact with the top blade of the switch. This forces the switch to remain closed until the detent has rotated far enough in a counterclockwise direction to allow the upper spring blade of the switch to rise and break the electrical contact. Thus, the length of time that the toaster circuit remains energized will be determined not only by the speed at which the timer operates, but also by the length of the detent on the cam. The simple switch shown here consists merely of two spring blades with contacts at one end, separated by an insulator at the other end. The electrical connections are made under the holding screws.

### Rack and Pinion.

Fig. 5B illustrates the use of a rack and pinion simply to operate the same kind of switch shown in 5A. In this arrangement, instead of rotating a cam, the timer rotates a gear or pinion which is meshed with a rack. The rack is nothing more than a bar with teeth in one side. This mechanism is shown in the position it would assume after the clockwork mechanism has been wound. As the timer rotates the pinion in a clockwise direction, the rack moves to the left, allowing the switch spring to move far enough to break the electrical contact.

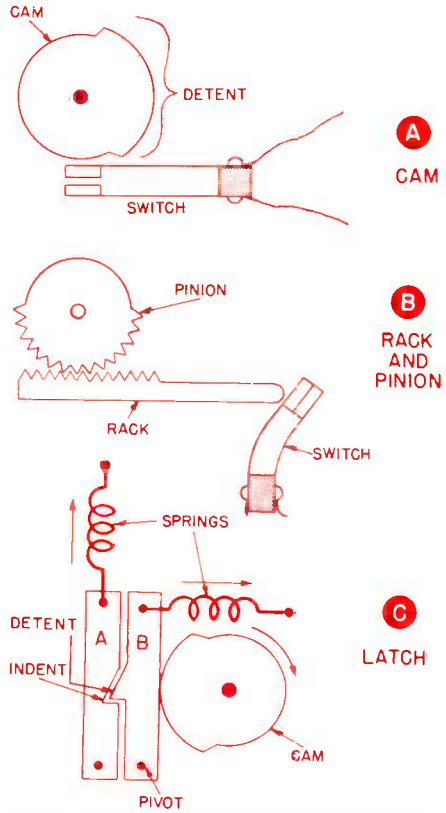



Fig. 5. (A) Cam; (B) Rack and Pinion; (C) Latch.

**Latch Mechanism.**

Fig. 5C illustrates a cam-operated latch mechanism. This mechanism, however, could just as easily be operated by a rack-and-pinion arrangement. Latch mechanisms of some type are always used with fully automatic toasters. When the handle which lowers the bread into the toaster is pushed down, the spring in the timer is wound. The cam being driven by the timer rotates in a counter-clockwise direction. At the same time, bar A is forced down. The cam moves bar B to the left, forcing the detent on bar B into the indent on bar A as shown.

As the timer unwinds, the cam rotates in a clockwise direction, as indicated by the arrow. There is spring tension on the two bars, indicated by the arrows alongside the springs, but as long as the detent on bar B is in the indent in bar A, bar A will be held down.

When the cam has rotated far enough in the clockwise direction, its raised surface will no longer be bearing on bar B and the spring attached to bar B will pull it to the right, thus pulling the detent out of the indent. Bar A will be raised by the spring, and since bar A is attached to the carriage, the toast will pop up.

Similar latch mechanisms are used in toasters which utilize the action of a bimetal strip for timing.

**Bimetal Blade.**

Let us again refer to Fig. 3 which illustrates a type of bimetal blade or strip used in some toasters to operate a mechanical timer. In this application, although the blade is used with a mechanism which both operates a switch and pops up the toast, it is not actually a part of the switch and no current flows through the blade. The strip is generally heated by an element wrapped around it. However, in some cases the heat of the toaster elements is added to the heat from the element wrapped around the strip, thus speeding up the timing operation if the toaster is hot.

The bimetal strip is mounted at the center, and both ends are free to bend when it is heated or when it cools. By restricting the movement of one end, it is possible to increase or decrease the movement of the other. When the toaster is energized by pushing down the bread-lowering level, current flows through the heating element wound around the strip and the strip bends in an upward direction.

When it moves up, one end of the strip operates a latch mechanism which closes a switch, cutting the bimetal heating element out of the toaster circuit. The latch mechanism also sets up another latch which, when the bimetal cools and bends in the opposite direction, shuts off the current to the toaster elements, and pops up the bread.

The length of time that it takes for one end of the bimetal to bend up, shut off the switch, and bend down on the cool-off cycle can be varied by adjusting the gap in which the other end of the strip bends back and forth. A smaller gap will result in more rapid action at the other end.

### The Dashpot.

A dashpot is generally used in automatic toasters to prevent the carriage from rising so quickly that the toast is thrown out of the toaster. The action of a dashpot is exactly the same as a door check. That is, these devices consist of a cylinder fitted with a piston that is linked to the carriage or bread rack in the toaster or in the case of the door check, to a rod that is attached to the door.

When the latch is released, the carriage of the toaster rises and the piston in the dashpot cylinder moves. The air at the top of the piston is compressed and trapped within the cylinder. This trapped air acts as a cushion, so that the carriage rises slowly as the air is allowed to leak from a small opening in the top of the cylinder.

With the foregoing information on basic circuits and mechanical devices used in toasters, you are now prepared to go into a more detailed study of a widely known and used automatic toaster - the two-slice Westinghouse Model TO-521.

### Westinghouse Model TO-521.

This is a two-slice automatic toaster using a clock timer and a thermostat to control the toasting cycle. The clock timing mechanism releases the carriage at the end of its time cycle, usually about 9%.

The thermostat of this toaster is placed adjacent to one of the heating elements and will be subject to the same heat as the bread. After a definite amount of heat has been supplied, the thermostat will break the circuit, regardless of the time remaining on the timer.

The bread will stay in the toaster well until the timer trips the carriage release latch. A control knob linked to the thermostat allows the user to vary the length of time that the heating elements are energized while the bread is in the toaster well. In this manner, the user may have toast that is soft inside and crusty or crisp on the outside, or toast that is crispy throughout.

Now let us look at the disassembly of each part of the toaster.

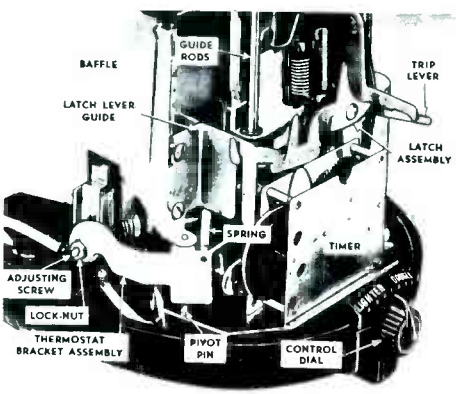
### Disassembly.

The carriage handle is removed by pressing it down far enough to clear the fixed portion, and removing the set screw from the side. The outer casing must be removed to remove the two casing handles.

The handle on the carriage side is held on by two screws, one from the inside of the casing and the other from the outside. The handle opposite the carriage side may be removed by taking out the self-tapping screw from inside the casing.

### Outer Casing.

You can remove the carriage handle and turn the toaster upside down to remove the four sheetmetal screws in the base, and then turn it right-side up again. Lift the casing off at an angle so that the car-



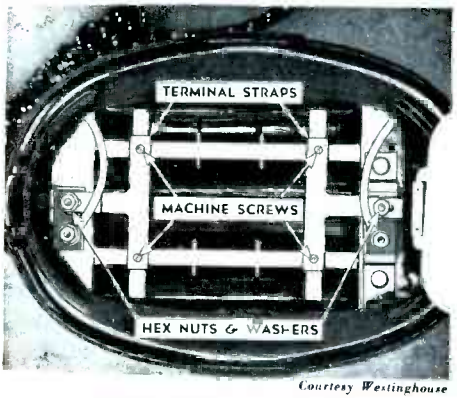

*Courtesy Westinghouse*

Fig. 6. The thermostat, timer, and latch assemblies of a Westinghouse Model.

riage lever is the last part cleared. While the casing is off, check for proper clearance of wires and thermostat movement. See Fig. 6.

### Baffle.

The baffle is a heat shield and is held in place by a speed-dash clip. Remove the carriage handle and the outer casing, and then turn the control dial to the darkest position. By turning the speed-dash clip a quarter turn, you can lift it off easily. Then the baffle may also be lifted off. Observe the position of the baffle in order to replace it correctly. Check the clearance of parts adjacent to the baffle.




*Courtesy Westinghouse*

Fig. 7. Underneath view.

### Toaster Base.

After removing the carriage handle, the outer casing, and the baffle, pull out the control knob to remove it. Remove the screws holding the end supports to the base. After lifting up the frame, slide it up the control shaft until it clears the base.

Turn the frame upside down and remove the terminal leads held in place by two hex nuts and washers (see Fig. 7). Remove the cord from the base after unwrapping the leads and then scrape the lugs of the hinge holding the bottom cover, and remove the cover from the base.

### Cord.

Open the bottom cover and disconnect the cord leads by removing the two hex nuts. Cut the plug end off the cord and pull the cord through the inside of the toaster. If the cord is to be replaced, it is best to use one with a detachable plug to avoid further disassembly of the toaster. The cord terminals and binding make it difficult to put the cord through the hole from the outside.

### Heating Elements.

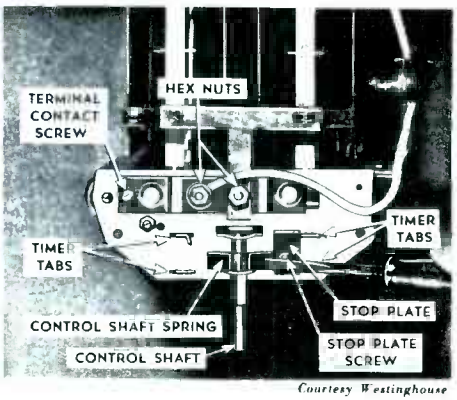
With the toaster set upside down, open the bottom cover as indicated in Fig. 7. Remove the four machine screws that will be found on the ends of the two terminal straps. Remove these screws as well as the two hex nuts holding each terminal strap to the frame. The elements may now be lifted out of their slots.

The outer elements have a higher wattage rating than the inside elements. These may be identified by inspecting the screw holes at the bottom of the elements. The holes of the inside elements are tapped and those for the outside elements are not.

In replacing the elements, be sure that they have slight play in all directions. If not, they will buckle when heated and the toast will have dark and light spots.

### Time Cam.

Fig. 8 shows the frame turned upside down with the outer casing and baffles removed and the base free from the control shaft. From this point remove the




*Courtesy Westinghouse*

Fig. 8. Underneath view with outer casing and baffles removed.

stop-plate screw and stop plate, which are on one side of the control shaft tension spring. Remove this tension spring by relieving tension on the shaft and pushing it toward the left. Pull out the control shaft, straighten the tabs coming through from the timer, and place the frame in an upright position. Slide the timer to the right to clear the supports, and then move it away from the front support, rotating it until it clears the latch assembly.

The latch assembly will come out with the timer when it clears the carriage and the lever guide.

### Contact Terminal Assembly.

Follow the instructions under the Timer Section until the frame is inverted, then remove the two hex nuts and washers from the contact terminal assembly at the control end of the toaster.

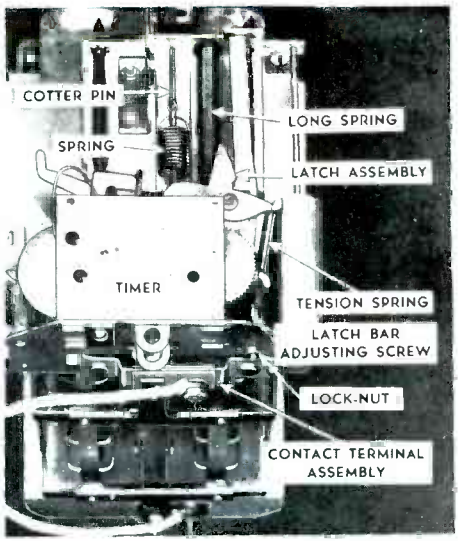
Remove the single screw holding the contact assembly to the frame. Then remove the two machine screws holding the tee-terminal to the terminal straps, and release the tee. Remove the thermostat wire connection and slide the terminal contact out of the slot at the opposite end from its holding screw.

### Contact Carrier.

The carrier and contacts are attached to one another; therefore, if either needs replacement, both must be replaced. Remove the timer, latch assembly, and contact terminal assembly as previously described, and then lift out the two guide rods.

With a pair of pliers, remove the long spring (see Fig. 9) which connects the carriage and the front support. With pliers, open the slotted opening in the contact carrier; this allows the spring and cotter pin to be removed.

Now straighten the slotted opening and remove the carrier by lifting the carriage assembly with one hand while tilting the lower part of the contact carrier forward.




Courtesy Westinghouse

Fig. 9. Adjusting contact carrier assembly.

### Guide Rods.

Having removed the outer casing and the contact terminal assembly as previously described, remove the guide rods by pulling up on the bottom of the rods. Make sure these rods ride freely when reassembling.

### Carriage Assembly.

To remove the shaft and washer, remove the contact carrier as previously described and straighten the tab on the dashpot. Carefully line up the carriage lifting bars with the cross slots of the toaster frame, and pull the carriage out through the slots. Remove the carriage springs and cotter pins.

### Thermostat Bracket Assembly.

This assembly is in one piece (see Fig. 10) and is installed adjacent to the outside element on the side of the toaster marked Single Slice. To remove this assembly, remove the outer casing and the two screws holding the leads to the thermostat. With longnosed pliers, remove the spring from the bracket assembly.

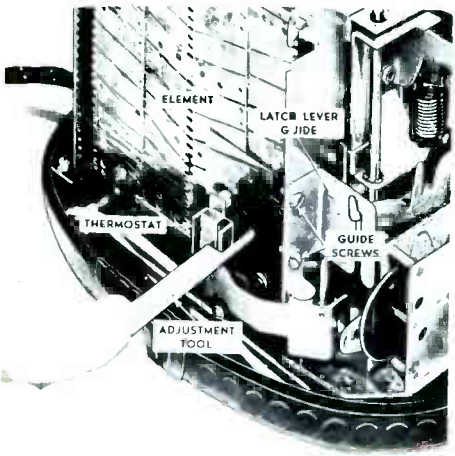
This spring holds the bracket against the adjusting knob. Remove the two screws

and washers, holding the large-lever guide, and lift it off to release the bracket swivel pin, which will drop through the bottom when the bracket is lifted.

Reassembly of the above groups is done in the reverse order.

### Adjustments.

The timer should be set to operate between 90 and 105 seconds. Adjustment can be made by turning the latch-bar adjusting screw. One complete turn will make a difference of about 12 seconds.



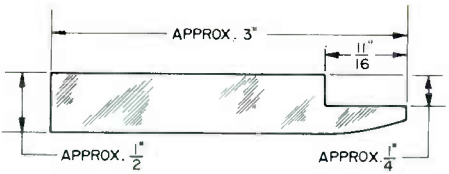

*Courtesy Westinghouse*

Fig. 10. Adjusting thermostat bracket assembly.

The thermostat bracket assembly should be adjusted so that the outermost point of the bracket is 11/16" from the element. See Fig. 10. This adjustment may be made by loosening the latch-lever guide and moving it in the necessary direction to get this clearance.

The adjusting screw for thermostat calibration is held in place by a lock nut. Loosen the lock nut and turn the screw counterclockwise to get darker toast and clockwise for lighter toast. If you cannot get the desired result with one half-turn of the adjusting screw, the thermostat bracket assembly should be replaced.

When checking the timer, put a small amount of silicon grease on the gear's pivot points and let it work in. Check the latch and carriage assembly to see that it is operating smoothly, as it may affect the results of the timer. The thermostat adjustment tool, shown in Fig. 10, can be made by cutting an 11/16" piece from a small piece of sheet steel or any other sturdy metal that will hold its shape. The complete dimensions and appearance of this adjustment tool are shown in Fig. 11.

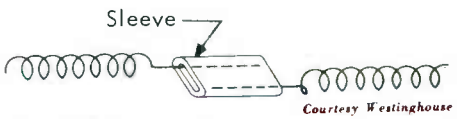



*Courtesy Westinghouse*

Fig. 11. Adjustment Tool.

### Toaster Servicing Accessories.

Occasionally, you will service an appliance with a broken heating element. If you do not have a replacement element and are unable to obtain one, you can make a temporary repair using a mending sleeve, as shown in Fig. 12. A mending sleeve is a short length of metal tubing used for emergency splices of this type. Push both of the broken ends into the sleeve and squeeze it tight against the wires. This will usually restore operation until you can replace the element. Mending sleeves are available from the Rogers Supply House, 4214 N. Milwaukee Avenue, Chicago 41, Ill.




*Courtesy Westinghouse*

Fig. 12. Broken heating element repaired with a mending sleeve.

This company also supplies a special flux for repairing broken heating elements whose ends can be brought closely together. This flux is applied across the open ends, and the toaster current turned on. The resulting heat from the current passing through the heating elements causes the flux to harden and form a

strong, conducting bond between the broken element and the ends.

The Rogers Supply Company, 4214 N. Milwaukee Ave., Chicago, Ill. 60641, is an excellent source of heating elements for various makes and models of automatic toasters.

## *REPAIRING TOASTERS*

### Toaster Fails to Heat Up.

When an automatic toaster fails to heat up after the bread carriage lever has been properly depressed, it is evident that an open circuit exists within the toaster, in the cord or its attachments. With a circuit tester such as the CONAR Model 200 Appliance Tester (or any ohmmeter) you should check the complete toaster circuit until the open circuit condition is located. You then repair or replace the inoperative parts.

If the electrical contacts of the timer or thermostat need cleaning, disconnect the power cord and clean these contact points with a very fine ignition file and fine emery or crocus cloth.

### Toaster Fails to Pop Up.

When the toast fails to pop up after the toasting cycle is completed, it is usually due to a binding pop-up lever or knob, a defective thermostat or timing clock, welded contact points on the thermostat, bent or defective pop-up wire, broken carriage elevator springs, or binding dashpot piston.

The contact switch assembly and contact points must always be clean. On any toaster with a pull-type slide carriage spring, be sure that it's not jammed.

### Lack of Uniformity.

In modern toasters, the individual elements are measured for resistance, graded, and matched at the factory, so as to obtain substantially uniform toasting on all of the four faces comprising the two slices of the bread in the toaster at any one time.

To accomplish uniform toasting, the center element has a somewhat higher heating capacity than the outside element, so that when the toaster is cold, the inside surfaces (those facing the center element) may come out slightly lighter than the other two surfaces.

With correctly-matched elements and uniform conditions of bread surfaces, there should not be any difference in color as the toaster heats up. It should, therefore, not be assumed that elements are mismatched unless several tests are made and judgment passed on the average result. After such tests, if the inside surfaces consistently toast lighter or darker than the outside surfaces, replace them with a set of matched elements designed for this particular toaster model.

### Preventive Maintenance.

An automatic toaster troubleshooting chart is shown in Fig. 13.

Most of the troubles that develop with toasters are mechanical rather than electrical. Crumbs accumulating inside can readily jam up the release mechanism, the control switch, the wire guides that hold the bread in place, and other sections of the mechanical assembly.

Some toasters have clean-out traps in the bottom. These should be opened once every couple of weeks. Toasters without such traps can be turned upside down and shaken vigorously.

The automatic toaster carriage guide rod must be clean and straight, or else the carriage will be slow in lifting and pop-up action will not be satisfactory. Carefully and periodically apply lighter fluid to each carriage guide rod to clean the gummy deposits that form on this rod. Then, lubricate the rod with one or two drops of a good light oil.

Make sure that all current-carrying parts and leads are properly supported so that they cannot later come in contact with other parts and cause a short circuit or ground. Any ground between the power circuit and the automatic

| PROBLEM | CAUSE | CORRECTIVE ACTION |
|---|---|---|
| Fails to heat. | No power at outlet. | Check house fuse. |
| | Defective cord. | Repair or replace power cord. |
| | Loose connection. | Clean and tighten connections. |
| | Switch not making contact. | Repair or replace switch. |
| | All elements burned out. | Replace heater elements. |
| Toast will not stay down. | Hold-down latch won't lock. | If bent, straighten to correct position. |
| | Bind in toast carriage. | If binding, clear bind to allow free operation. Clear the cause of bind. |
| | Broken latch spring. | Replace spring. |
| Toast will not "pop up". | Toast carriage binds. | Clear bind to allow free operation of carriage. |
| | Release latch binds. | Check latch bind and clear it. |
| | Broken power spring. | Replace spring. |
| Toast lifts slowly. | Bind in slide rods. | Clear and lubricate rods. |
| | Leak spring. | Adjust or replace spring. |
| Toast lifts too rapidly. | Excessive spring tension. | Adjust tension on lift spring. |
| | Dashpot not effective. | Repair piston or washer in dashpot. |
| Toast too light or dark. | Incorrect adjustment of timer mechanism. | Adjust timer setting. |
| | Defective thermostat on timer. | Replace defective parts. |
| One side untoasted. | Defective heater element. | Replace defective heater element. |
| Shocks user. | Grounded wire. | Locate ground and eliminate this dangerous condition. |

Fig. 13. AUTOMATIC TOASTER TROUBLESHOOTING CHART.

toaster case or its related parts constitutes a highly dangerous condition for the toaster user.

### *SUMMARY*

With the information in this article you have a good start in servicing almost any automatic toaster brought to you for service. As you encounter different automatic toaster makes and models, you may wonder why there should be so many different ways of doing the same thing - such as measuring the time that the heat is on. In most cases, patents are the cause of the sometimes unorthodox, often unusual, methods of controlling the toasting time. In other words, in efforts to get around some controlling patents, toaster designers achieve some rather fantastic devices.

But regardless of toaster designers' brainstorms, you can keep the toasters popping up by carefully analyzing their faults and operation and by applying the procedures discussed here and by other sources of information.

# 30 Years Ago

*As Recorded in The National Radio News*

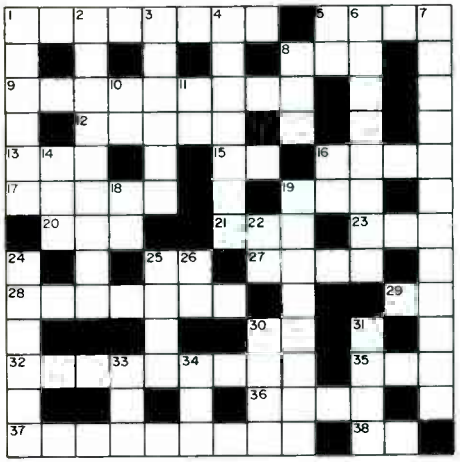
President Franklin Roosevelt sent a letter to NBC's Lenox Lohr upon the dedication of the new headquarters for radio stations WRC and WMAL in Washington, D. C. The President predicted that TV would be established in homes throughout the United States sooner than many realized, and that before long, radio would "make it possible for us to visualize at the breakfast table the front pages of daily newspapers or news reports, no matter how remote we may be from the place of their publication and distribution."

The coronation procession of King George VI of England was successfully televised in the rain by the BBC. The equipment for the telecast was similar to that of the RCA system used in the United States. Thousands of people as far as 30 miles from London watched the event.

Charles K. Munn of Union, New Jersey was awakened one night by strange voices and mumblings from his cellar. Searching with a flashlight in one hand and a baseball bat in the other, Munn found nothing. After several nightly vigils and more noise, however, he heard the call letters of a local amateur radio operator coming from his gas meter. A unit in the meter had been intercepting radio waves and, by vibration, had been acting as a speaker. Another radio amateur complained that an electric cooking range downstairs -- just below his transmitter -- repeated every word he spoke into his microphone.

More uses for loudspeakers were announced regularly. In a Belmont, North Carolina hosiery mill, for instance, speakers brought radio music to every worker. If the noise in the factory was great, the volume was simply turned up more, and several extra pairs of stockings were produced each day by each worker. In certain Mohammedan areas of the Far East, on the other hand, holy men installed public address systems in the towers of their temples; giant loudspeakers blared out calls to prayer each day.

# ELECTRONICS CROSSWORD PUZZLE



*By James R. Kimsey*

Solution on Page 22.

**ACROSS**

1. An electromagnet having a movable iron core.
5. The practical unit of voltage.
8. _____ magnet, a magnetized length of steel used as a permanent magnet.
9. Severe or stormy (as with weather).
12. A type of direction finder.
13. Seventh Greek letter. (initials)
15. Equipment used for generating an intelligence signal into space. (abbr.)
16. A calibrated scale.
17. The spread of frequencies over which you can tune a coil.
19. A discharge of electricity in air.
20. Pulse-code modulation. (abbr.)
21. A system which controls the phase of a source of oscillations.
23. Possess.
25. The oscillator that establishes the carrier frequency of a transmitter. (abbr.)
27. Sacred image.
28. The portion of stored information with which the arithmetic element performs its operation.
29. Band elimination. (abbr.)
30. Luminous intensity expressed in candles. (abbr.)
32. A peak beyond the desired terminating point on a pulsed wave.
35. American wire gauge. (abbr.)
36. Break_____, a runaway increase in an electrode current.
37. A device for measuring magnifying power.
38. Double-throw. (abbr.)

**DOWN**

1. Highly flexible fiber ring in a loudspeaker.
2. The common dry cell.
3. Stylus.
4. The property of matter that resists a change of motion.
5. The unit of apparent power in an ac circuit containing reactance. (abbr.)
6. A camera tube in which a beam of low-velocity electrons scans a photoemissive mosiac.
7. The major portion of the decay of a pulse. (2 wds.)
8. An English measure of heat (abbr.)
10. _____ and behold.
11. One thousandth of an ampere. (abbr.)
14. A connection made somewhere along an inductance or resistance, other than at ends.
16. Doctor. (abbr.)
18. Designation for the mutual conductance of a vacuum tube.
19. Type of material which has three electrons in its valence shell.
22. Ratio of circumference to diameter.
24. A doughnut-shaped coil.
25. The property of a body that determines the acceleration it will have when acted upon by a given force.
26. Switch position.
30. Colored bands are a _____ _____.
31. Surface between two adjacent grooves of a mechanical recording.
33. Radio Manufacturers Assoc. (abbr.)
34. The name of a color such as red, yellow, blue or the like.

**Stanley Cmielewski**

# EARLY INTEREST, TRAINING BY NRI SPARK A CAREER

YOU HEAR A LOT THESE DAYS about how young people have a hard time making up their minds what they want to do. But they're not talking about Stanley Cmielewski of Wallington and Newark, N. J. He decided his field was electronics when he was 10 years old!

At that time a neighbor and 1949 NRI graduate, Hans Hamdorff, gave him the old textbooks from his NRI Radio Course, and Stan "became interested" ... and for him that was the shortest distance between two points . . . his course was set.

At 14 he decided it was time he took an advanced television course, and . . . But let him tell it in his own words.

"I had learned so much from these books that I decided if I were to take any course, NRI would be the one. I wrote to your school and they advised me that while it was unusual for a 14-year-old to take the advanced television course, they would permit me to do so as long as I had good theoretical knowledge of radio", and could keep up with the work.

He did. In fact, he breezed through the course in six or seven months, making good grades all the way. Then, in high school, he got a job at Parts Unlimited Electronics Center in Newark part-time after school.

When he finished high school, his parents moved to Long Island, New York, and he went to work for Grumman Aircraft Engineering Corp. as a computer technician. He stayed there two years, working at the same time part-time for Armor TV Service in Hempstead, Long Island. The owner of Armor was going into another business, and wanted to sell out, "so I purchased the store from him. The business had been neglected for many years, and when I took over the operation it was doing very poorly --

"Investing quite a few dollars into remodeling the store, replenishing the stock, and rebuilding customer good will, my efforts began to pay off, but the success was short-lived. The Urban Renewal Project came into our neighborhood and demolished most of the buildings in the area, forcing me to sell out."

Now you think that maybe this is the end of the success saga? You don't know Stan. He remembered his old job at Parts Unlimited, called his former employer, Bill Wagenheim, and was offered the job of service manager with the possibility of a partnership later on.

By this time he was married, and "my wife and I decided to take the chance, uproot ourselves, and move back to New Jersey. Although I did not know it at the time, this proved to be the turning point of my career."

After working as an employee for a short time, opportunity came knocking again for Stan. Wagenheim and his partner, Harry Ehrenkranz, decided to expand and asked Stan if he would be interested in a partnership in a new store.

"We agreed on terms, and with careful planning and proper merchandising we were able to open up the new store with a $20,000 inventory in a well-developed

shopping center in uptown Newark."

Now the trio own three stores, doing a yearly gross of $100,000 per store on sales and service, and with Stanley--now a ripe old 22---as full partner. He sells, he services, and does just about everything else necessary to keep the concern going. Until very recently he was assisted by his wife ("In fact I couldn't have made it without her"), who did the bookkeeping, worked the counter, etc. A former legal secretary, her efficiency was a major contributing factor. But she's gone into another "business" now . . . the Cmielewskis became the parents of a daughter, Debbie, in March.

The Parts Unlimited Electronics Centers, according to Stanley, operate "in quite a unique way, discounting all tubes, needles, cartridges, etc., 40%. We cater to the do-it-yourselfer, giving him all the help we possibly can in the way of technical information. Selling him the parts and tubes as we do at discount prices creates a lot of good will . . .

"If he finds that his problem does not lie in tubes or minor adjustments, we advise him to bring his set to us and we will give him a free estimate on repairs. All the work we do is done on a cash-and-carry basis, with a flat rate labor charge of $8.50 plus parts on black-and-white TV, and $12.50 plus parts on color TV.

"All parts used in repairing his set are sold to him at a 40% discount, insuring


him of the best possible break he could get . . . if the set is too old, or would be too costly to repair, we recommend that the customer get a new set. This has proved to be a good selling point, because our customers know us to be a reputable and honest dealer, and they know that if we do recommend a new set, it is in their best interests."

A big part of the centers' operation is the selling of new sets. They carry the full line of Admiral, Zenith, Emerson, and Delmonico. Big selections of floor and back-up stock offer the customer any make, model, or style without undue delay. "In most cases delivery and set-up of a new unit is done the same day it is purchased. Our fast service and delivery has netted us many recommendations."

Twenty-page flyers are mailed out twice yearly, early in the spring and late in the fall. The flyers catalogue all parts and services available, plus pictures and information on all the sets carried in stock. Radio advertising attracts new trade ("We saturate the air with commercials every day on a local station"), and service--and a good deal--keeps the old ones.

For Stanley, his part in the operation, which includes managing the Service Department in the new store in the Clinton Hill Shopping Center, repairing sets in between, helping out on the floor, ordering, merchandise, etc., "there never seems to be a dull moment."

As to NRI's part in his success, he sums it up succinctly: "They're the best."


BY
STEVE
BAILEY

DEAR STEVE:

I am presently working on Lesson 11. I can clearly see how a signal is amplified, but I don't understand how the signal is transferred from the plate of one tube to the grid of the next. Please explain.

A. A., N.Y.

To illustrate how a signal is coupled from one stage to another, we can represent the tube by a variable resistor, let C stand for the coupling capacitor, and $R_g$ stand for the grid resistance of the following stage.

Now, let us refer to Fig. 1 shown. Here we have a potentiometer connected to a dc source with the slider arm set to about the middle of the potentiometer. Capacitor C will be charged up to the voltage at this point and when C is charged, no current is flowing, so there will be no voltage drop across resistor $R_g$. The meter has zero marked in the center of the scale and any movement to the left indicates a negative voltage, while movement to the right indicates a positive voltage. This test, incidentally, can be done with the Vacuum Tube Voltmeter you construct in your second kit.

If we move the potentiometer arm up towards plus, the capacitor must charge to a higher voltage. Electrons will flow from point 3 to $R_g$ and into the capacitor plate connected to 4. Electrons will leave the other capacitor plate and flow towards the positive side of the source. This electron flow through $R_g$ makes point 4 positive with respect to point 3, so the meter needle will deflect to the right. As soon as the capacitor is charged up, the meter needle will return to zero because there will no longer be electrons flowing through $R_g$. Now if we move the potentiometer slider down, capacitor C will discharge. Electrons will leave its right-hand plate, and flow through $R_g$ to point 3. This electron flow makes point 4 negative with respect to point 3 and the meter needle will deflect to the left.

Since we have had an actual change in polarity across $R_g$, we have an ac voltage across $R_g$.

This is exactly what happens at the plate of the tube in Fig. 6 of Lesson 11. We have a voltage which increases and decreases, and the grid of the next tube will receive an ac signal. Of course, there

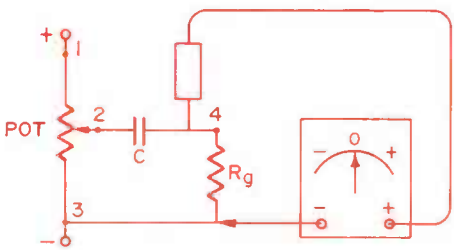



Figure 1.

must be a resistor connected from the right-hand side of the capacitor in Fig. 6 to ground in order to complete the circuit.

DEAR STEVE,

Please explain what a "decibel" is and give an example of its use in power applications.

S. S., Va.

First of all, let us define the decibel. It is a unit of measurement used to express changes in power based on the ability of the human ear to recognize these changes. Research has shown that the human ear is not linear in its response to changes in power as an energy level. For example, let's assume that we have an audio amplifier that is delivering a pure tone and has a power output of 10 watts. Now, let's increase the power output so the ear will hear an increase to 20 watts, or double the original value. To do this, we must increase the output ten times, or to 100 watts. This shows that the ear is less sensitive to changes as the power is increased.

To find decibels, we can use the formula

$$db = 10 \times \log \frac{P1}{P2}.$$

Or, if you wish to eliminate as much math as possible, you can use the table shown in Fig. 2.

Let's see how we use this table. Assume that we have an amplifier that has a power input of 10 milliwatts and an output of 2000 milliwatts.

To determine the gain of this stage, we divide the input into the output. This gives us a gain of 200. This is our power ratio. We must refer to the table to find the db gain. As you can see, there is no power ratio for 200. So, we break this down to 2 × 100. When we locate the ratio for 2, we see that it is equal to 3 db.

| Voltage Ratio | DB | Power Ratio | DB |
|---|---|---|---|
| 1 | 0 | 1 | 0 |
| 2 | 6.0 | 2 | 3.0 |
| 3 | 9.6 | 3 | 4.8 |
| 4 | 12.0 | 4 | 6.0 |
| 5 | 14.0 | 5 | 7.0 |
| 6 | 15.6 | 6 | 7.8 |
| 7 | 16.8 | 7 | 8.4 |
| 8 | 18.0 | 8 | 9.0 |
| 9 | 19.2 | 9 | 9.6 |
| 10 | 20.0 | 10 | 10.0 |
| 20 | 26.0 | 20 | 13.0 |
| 30 | 29.6 | 30 | 14.8 |
| 40 | 32.0 | 40 | 16.0 |
| 50 | 34.0 | 50 | 17.0 |
| 60 | 35.6 | 60 | 17.8 |
| 70 | 36.8 | 70 | 18.4 |
| 80 | 38.0 | 80 | 19.0 |
| 90 | 39.0 | 90 | 19.6 |
| 100 | 40.0 | 100 | 20.0 |
| 1,000 | 60.0 | 1,000 | 30.0 |
| 10,000 | 80.0 | 10,000 | 40.0 |

Figure 2.

Television antenna manufacturers generally give db gain as a part of the antenna characteristics. This implies that the antenna itself has a power gain. What it really means, though, is that the antenna is more sensitive in one direction than in another. For example, if you had an antenna that was listed as having 6 db gain and the antenna was adjusted to pick up Channel 4 with maximum reception, the Channel 4 signal would be received with a strength of 6 db over other signals.

Decibels are also used to describe voltage and current ratios. For voltage ratios, the formula is:

$$db = 20 \log \frac{E1}{E2}$$

For current ratios, it is:

$$db = 20 \log \frac{I1}{I2}$$

Later in your course, you will study TV antennas and transmission lines. Many of the facts concerning decibels will be explained then. Meanwhile, study all of

the information given here. If you wish to review further, refer to Lesson 17BB, pages 2-10.

DEAR STEVE:

Would you give me further information on harmonic distortion and its causes?

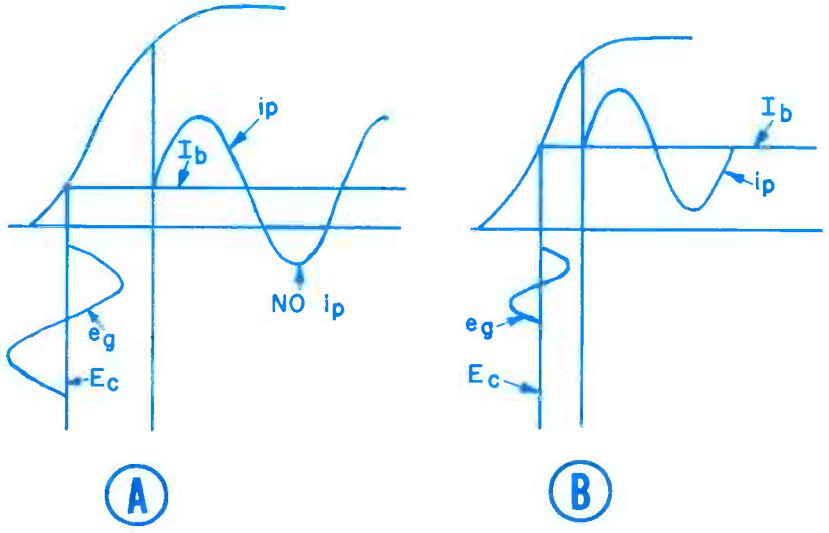
W. D., Md.

The waveforms obtained at the output of an amplifier may be different from the grid signal voltage waveform because of operation on a nonlinear portion of the characteristic curve. This type of distortion is known as harmonic or amplitude distortion and can be caused by incorrect grid bias, too large a grid signal, or both.

We have shown here two diagrams. Fig. 3A shows a case in which the bias is too negative. The bias is so negative that the plate current is cut off (reduced to zero) during a portion of the negative half-cycle. Even during the portion of the negative cycle in which current flows, the waveform is rounded as a result of the curvature near the bottom of the $e_g$-$i_p$ characteristic. If the signal voltages are reduced, current can flow during the entire cycle, but there will still be some waveform distortion as a result of the curved characteristic.

Fig. 3B, shows the correct value of bias voltage. Note that it is approximately halfway between zero and the value for plate current cutoff. Even here, distortion would occur if the value of the signal voltage was increased to such a value that the instantaneous grid voltage went more negative than the cut-off value.

When a portion of the wave is cut off as shown in Fig. A, the instantaneous current rises more in the first half-cycle




$E_c$ = Average cathode-to-grid voltage
$e_g$ = Instantaneous value of AC component of cathode-to-grid voltage
$I_b$ = Average plate current
$i_p$ = Instantaneous value of AC component of plate current

Figure 3.

than it drops in the second half-cycle and the average value of the current is increased. A dc meter in the plate circuit would show this increase. If the ac signal voltage in Fig. A is zero, the dc meter will indicate the value Ib. As the signal voltage is increased, it will be noted that the value of plate current increases. This is a sign of distortion.

As you can see, harmonic distortion can be overcome by proper design. Of course, it can occur if certain changes take place in the circuit which cause the amplifier to operate on the nonlinear portion of the characteristic curve.

DEAR STEVE,

I am having a great deal of trouble with Lesson 15X on algebra and the J-operator. Can you suggest anything to help me understand this better?

H. T., Pa.

The first thing to do is go back to Lesson 9X and review the section on signed numbers and the one on vectors. These form the basis for understanding Lesson 15X. Signed numbers relate to algebra and vectors relate to the J-operator.

After you have done this, go through Lesson 15X again. If you find any particular discussions or explanations that you do not understand, let us know what they are. Try to phrase your trouble in the form of questions so we can see exactly what it is that needs to be cleared up.

After you have completed reading the text, try to practice different problems. This will provide an excellent means for you to employ the procedures described in the text. If you find that there are certain problems you cannot work, go back to the text and review the procedures described for similar problems.

DEAR STEVE,

What does the expression "2M" mean in the formula for total inductance?

L. M., Fla.

To find the total inductance of two series-connected coils, you must take the mutual inductance into consideration. The letter "M" stands for mutual inductance. Since the field for each coil will be cutting the turns of the coil, you must multiply the mutual inductance by 2. Thus, the expression "2M" means that you are to multiply the mutual inductance by 2.

The fields from the coils will either aid or oppose each other. If they are aiding, you add "2M" to the sum of the inductances. For example:

$$L_T = L1 + L2 + 2M$$
$$M = 5 \text{ henrys}$$
$$L1 = 10 \text{ henrys}$$
$$L2 = 5 \text{ henrys}$$

$$L_T = 10 + 5 + (2 \times 5)$$
$$L_T = 10 + 5 + 10$$
$$L_T = 25 \text{ henrys}$$

If they are opposing, you subtract "2M" from the sum of the inductances. Using the same values this would be:

$$L_T = L1 + L2 - 2M$$
$$L_T = 10 + 5 - (2 \times 5)$$
$$L_T = 10 + 5 - 10$$
$$L_T = 15 - 10$$
$$L_T = 5 \text{ henrys}$$

DEAR STEVE,

What is the difference between a voltage amplifier and a power amplifier?

T. S., Ohio

Both types of amplifiers amplify the signal voltage that is applied to the grid. Therefore, to tell the difference, we must look at their individual characteristics and compare them.

Since a voltage amplifier is operated to obtain maximum voltage at the output, the plate load resistance is generally much higher than the plate resistance of the tube.

This way, changes in the plate current

caused by the signal variations on the grid will cause large voltage changes across the plate load resistance. The input signal voltage is usually quite small.

The characteristics of a power amplifier are quite different. For one thing, the plate load resistance is usually the same or close to the plate resistance of the tube. This is to obtain maximum power transfer. Also, the input signal voltage may be quite large.

In addition, the plate resistance of a power amplifier tube is usually quite low so that a high plate current will flow. Thus, the power (E × I) developed will be high.

DEAR STEVE,

What does the term "with respect to" mean when applied to polarity?

M. B., Va.

This term is used to establish the polarity of a voltage at any given point. Therefore, it is used to determine the polarity as compared to another point of a known polarity. So first remember that the term "with respect to" means "compared to."

For example, consider a situation where you have three people of varying heights and you have to tell which ones are tall and which ones are short. Assume that A is 5 feet tall, B is 5 feet, 6 inches tall, and C is 6 feet tall. To find your answers, you would have to compare their heights. You will find that A is short as compared to either B or C. However, B is tall compared to A, but is short compared to C. C is tall compared to either A or B.

In the same way we could say that a point is positive with respect to some other point and at the same time negative with respect to another point.

The general rule for establishing the polarity of a voltage drop across a part is that the end that the current enters is negative, while the end it leaves is positive. Applying this to our previous example, the negative end is negative with respect to, or as compared to, the positive end and vice versa.

# In Memoriam

Since the last issue of the Journal we have received word that the following members of the Alumni Association have passed away. We extend the sympathy of the Alumni Association to their families.

Mr. Stewart V. Sheffer
York, Pa.

Mr. Reuben Hendricksen
St. Kitts, West Indies

Mr. Oswald B. Mayne
Philadelphia, Pa.

Mr. Russell Gould
Lower Burrell, Pa.

Mr. James C. Childress
Savannah, Mo.

Mr. Forrest Dixon
Philadelphia, Pa.

Mr. George Hoeh
Punxsutawney, Pa.

Mr. R. E. Wallace
Columbus, Ind.

Mr. Ernest W. Blake
Springfield, Mass.

Mr. Arnold W. King
Chittenango, N. Y.

Mr. V. O. Guyton
Detroit, Mich.

# NEW BOOKS. . . .

*From Howard W. Sams & Co.*

### SHORT-WAVE ENTHUSIAST?

THE ABC'S OF SHORT-WAVE LISTENING by Len Buckwalter is a revised and updated version which first introduces you to short-wave listening as a hobby, and then describes the short-wave receiver and signal.

The text is written in easily understandable terms, exemplifying the simplicity of short-wave listening; and contains many photographs, diagrams, drawings and charts which offer a handy reference for anyone interested in short-wave listening.

### SMALL APPLIANCE REPAIRS

Want to complement your knowledge about small appliance repairing? Jack Darr has a new book entitled HOW TO REPAIR SMALL APPLIANCES, Vol. 2, which describes common defects of fifteen household appliances and explains repairing techniques for them.

Written for either the man operating a repair business, or one just interested in repairing his own appliances, this book lets you bypass most of the guesswork and experimental stages that take extra time. Appliances covered are portable electric heaters, hair driers, electric carving knives, electric toothbrushes, electric clocks and others.

### ELECTRONIC ORGAN MUSIC

Are you aware of how the pipes in yesteryear's organs have been replaced by electronic parts you can hold in your hand? Norman H. Crowhurst's ABC'S OF ELECTRONIC ORGANS explains the interesting story of how electronics produces the richly varied music of the modern day musical organ.

For those learning to play, there are many short cuts of value to be found; and sections on circuitry, maintenance and troubleshooting and tuning will be of interest to both the technically minded owner and the man who must service the organs.

### TROUBLESHOOTING AUDIO EQUIPMENT

For those interested in servicing hi-fi and other audio equipment, Mannie Horowitz has published a new book entitled TROUBLESHOOTING AUDIO EQUIPMENT.

This book attempts to cover many of the aspects and topics of audio equipment. It takes you through amplifiers and preamplifiers in a stage-by-stage analysis, and discusses operation under normal conditions, followed by possible faults and malfunctions. Among other topics covered are phono pickups, microphones, phase inverters and drivers, tape recorders and stereophonic systems. It is illustrated with photos, diagrams and schematics.

### THE VERSATILE SCOPE

If you are looking for additional ways of using certain test equipment pieces, Robert G. Middleton's new book, 101 MORE WAYS TO USE YOUR SCOPE IN TV may be a worthwhile purchase.

This book, according to Sams and Co., is written to help the serviceman get the best possible use out of the oscilloscope. It describes additional and slightly more advanced uses of the versatile scope not mentioned in the original volume. Applications explained range from basic troubleshooting procedures to the more complex methods of testing circuit components.

# HIGH POSITIONS OPENED TO NRI GRADUATES

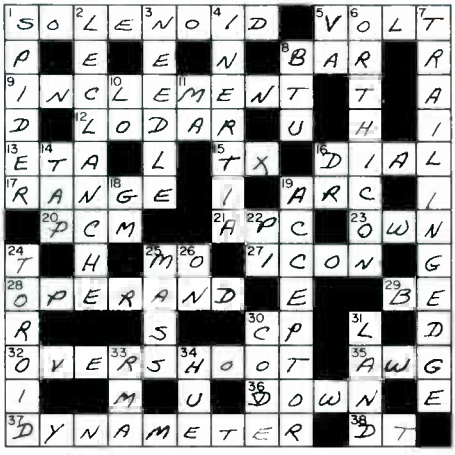
GRADUATE BERNARD SMOLKOVICH
Armor & Engineer Board
Fort Knox, Kentucky

"It is a great pleasure for me to report that NRI has already prepared me for a position as an Electronics Systems Inspector with IBM. I easily passed their written examination in electronics and was offered a position. They seem to place a high value on the merits of NRI training, and technicians are especially impressed with the nature and scope of your training.

"Not being a professional educator, I cannot adequately define the outstanding merits of your teaching methods but do feel qualified to describe another and equally important aspect of your school--the warm, human and very personal relationship you maintain with each of your students."

GRADUATE JOHN EUBANK
202 Navajo St.
Fayetteville, North Carolina

"Thanks largely to NRI and the diploma I hold from your school, I am a very successful and upcoming Communications Technician. I was reaching for a position with the USA Armor & Engineer Board and got it because of my NRI diploma. My future appears secure since my graduation and I highly recommend NRI. My deep thanks to all your fine staff for its unfailing assistance during my course."



# EMPLOYMENT OPPORTUNITIES

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

WEINSCHEL ENGINEERING Co., Inc.
Gaithersburg, Maryland 20760 has immediate openings in Engineering, Repair, and Test Departments. Permanent positions and excellent chance for advancement. Evening and weekend interviews. Contact Mrs. Karen Syence at (301) 948-3434 or write Weinschel Engineering Co., Inc.

GENERAL TELEPHONE OF INDIANA, INC.
501 Tecumseh Street, P.O. Box 1201, Fort Wayne, Ind. 46801. Openings in exchange offices in Indiana.

WESTERN UNION TELEGRAPH CO.
1405 G Street, NW, Washington, DC. Needs electronics technicians. Write or telephone B. L. Krise, Manager, Technical Services.

ARFAX TELEVISION AND RADIO SALES AND SERVICE, 1420 Chain Bridge Road, McLean, Va. Needs TV serviceman for bench or outside work. Experience to include color if possible. Call 356-3600. Ask for Mr. Lake or Mr. Onfrychuk.

POLITO COMMUNICATIONS, INC.,
101 Walnut Street, Rochester, N.Y. has positions available for four or five technicians to service two-way radio equipment. Minimum requirement is a second class radio telephone license. Contact Mr. Joseph Carl Polito.

SUN ELECTRIC CORP., 5708B Frederick Ave., Rockville, Md. is looking for electronics technicians.

RADIO STATION WKRZ,
Oil City, Pennsylvania wishes to employ several first class engineers on its staff.

STATION WFMD,
Frederick, Md. Needs technicians with 1st class licenses.

RCA SERVICE COMPANY, Camden, N.J. Needs TV Servicemen at most RCA Service Factory Service Branches. Technical School training essential, prefer B/W and Color Service experience. Apply at the nearest RCA Branch or write W. R. Speck, RCA Service Co., Cherry Hill, N.J.

THE CHESAPEAKE CORP., West Point, Va. Needs a number of Electronics Technicians. No actual experience is needed, but a good Technical school education very desirable. Applicants should see or write Mr. J. W. Hockman, Personnel and Training Manager.

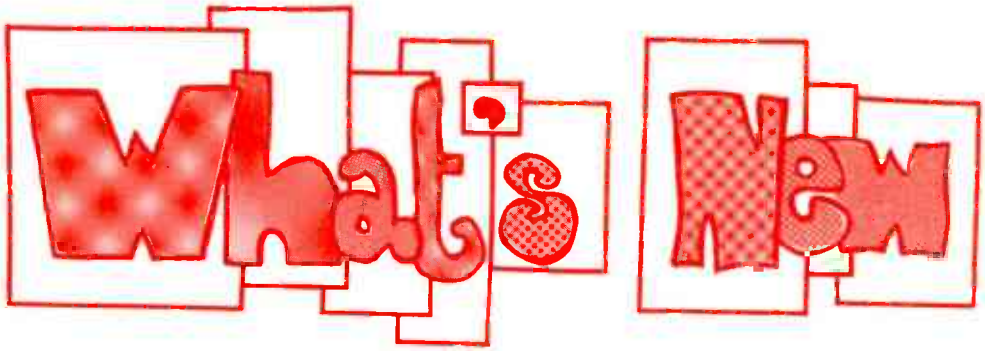
SIMPSON ELECTRIC COMPANY
5200 Kinzie St., Chicago, Ill. 60644
Openings for technicians, design and development engineers, electro-mechanical and production engineers.

AUDIO FIDELITY CORPORATION
6521 West Broad, Richmond, Virginia
Needs two repairmen in Richmond office and possibly one in Roanoke.

UNITED AIRLINES
Wash. Nat'l. Airport, Washington, D. C.
Expects a continual need for radio technicians throughout their system in 1967. Would be interested in talking to any graduates interested in employment.

COMMUNICATIONS ENGINEERING CO.
(Division of Sylvan Electronics) 306 Kennedy St., NW, Washington, DC. Needs technicians with FCC licenses. Openings in TV, Audio, 2-way radio, etc. Call Mr. Brown, 451-5700.

FRED'S RADIO AND TV,
654 Knowles Ave., Southampton, Pa. 18966. There is a steady job in servicing available for a qualified man. Please contace Mr. Frederick Schonbach at the above address.




## TRAIN RESERVATIONS... ELECTRONICALLY

MONTREAL -- Canadian National Railway has initiated an electronic reservation system for trains, the first of its kind in North America. By June, this computer service should be fully operational and all seats on Canadian National's turbotrains will be stored in a memory bank.

A center connects with 36 Canadian cities, across from Victoria, British Columbia to St. John's, Newfoundland, and south of the Canadian border to Chicago.

The system can handle 1000 requests for reservations per hour, 18 hours a day, seven days a week, requests being answered in 10 seconds. Last-minute cancellations are O.K. - and you can reserve seats as far in advance as four months.

## LASER BEAM ERASES

Leland Stanford, Jr. University has been granted a patent waiver by the National Aeronautics and Space Administration on what they call a "laser eraser". NASA reported that the University's patent covers a laser beam that erases, by vaporization, pencil, typewriter ink/carbon, paint and other materials and doesn't harm the base materials.

In this process, radiation is generated at a desired frequency and a chosen power level, and then directed as a beam of controlled size onto the area to be erased.

## ATTENTION ELECTRONIC PARTS BUYER

There may be hope soon for the harassed electronic parts buyer. A new cataloging system has been devised that may answer today's problems.

According to the Components Division of the JFD Electronics Company, the conventional catalog system no longer serves the needs of today's expanded electronics industry. Its answer is a new design called the Composite Catalog System. It combines human engineering concepts with modern techniques from the graphic arts, employing new materials, color keying, accurate photos and orthographic illustrations in an effort to make data quickly and easily accessable.

To speed the user's communications with the manufacturer, self-addressed, postage-paid "feedback" cards which are color keyed to respective product lines are included. With these improvements and its up-to-date one-step reference file, the JFD Company hopes to provide a faster, easier and more efficient system for the electronic parts buyer of today.

## TRAVELING LAB-ON-WHEELS

A traveling lab-on-wheels, built by Clark Equipment Co.'s Brown Trailer Division, is aiding nuclear physicists at Illinois' Argonne National Laboratories and the University of Chicago in looking deeper into the atom, particularly in a detailed analysis of the beta decay of lambda particles.

The 40-foot trailer houses sensitive electronic recording equipment which must be protected against heat and dust in the experimental area. Equipped with a five-ton air conditioner and acoustical tile ceiling, the trailer provides a cool, clean, quiet environment.

## MICROWAVE LINKS AID EDUCATION

Microwave links will soon connect the five educational television stations in the state of New York into a single ETV network. Raytheon Company will furnish the equipment for 17 microwave stations on a route north from New York City to Albany and following the turnpike west to Buffalo.

Although the stations carry state university programs, they seek a general audience, and thus their education courses will be divorced from the classroom. The network will enable the programs to be beamed live throughout the state, eliminating the need for taping the shows and shipping the tapes through the mails.

## MISSING THOSE IMPORTANT CALLS?

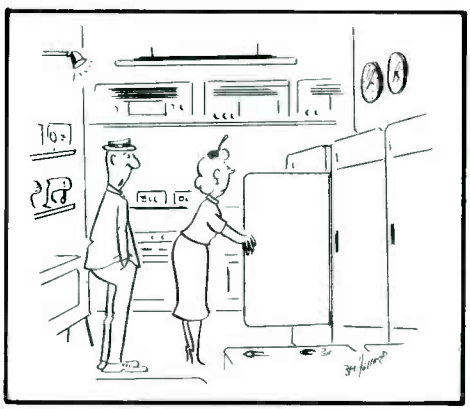
For the person who is constantly on the move, never remaining long at his desk or in his office, there is now a way to prevent missing that all important call that comes while you are away.

The American Telephone and Telegraph Company is testing a new Telecom telephone-and-radio combination that will make it impossible to miss your call. As you travel from room to room, through the plant, building or home, the call can reach you as long as you carry the 31-ounce transceiver that goes with the system. The system also works within a radius of one half-mile outdoors. A transmitter mounted inside the phone will emit a beeper signal that activates the transceiver. You can then speak to the caller without returning to the phone.

## NEW CONCEPT IN LOGIC CIRCUITRY

A new concept in logic circuitry claimed to more than double the operating speed of integrated circuit full adders and subtractors has been developed by Motorola Semiconductor Products.

The technique, called series-gating, is used in a full adder, MC 1019, and subtractor, MC 1021. According to the manufacturer, the new adder and subtractor eliminate the delay-producing cascaded gates required for conventional designs. Instead, the complete gating function, whether sum, carry, difference or borrow, is performed simultaneously. Coupled with the inherently high speed of current mode ECL circuitry, the series-gating technique provides a 4 to 5 to 1 reduction in propagation delay compared to other monolithic full adders.



"Getting to where you can't knock on wood any more...everything's electric."

# NRI HONORS PROGRAM AWARDS

During the months of March and April, 1967, the following NRI graduates received, with their NRI electronics diplomas, Certificates of Distinction under the NRI Honors Program for outstanding grades throughout their NRI training. NRI's worldwide leadership in electronics training is represented by these outstanding graduates from almost every area of the United States, from Mexico, Canada, and other foreign countries. It's not surprising, either, to know that the Armed Forces, which place an emphasis on training and career planning, are also well-represented.

## WITH HIGHEST HONORS

Harris C. Allen
Thompson, Pa.

Willie C. Brooks
Ft. Hood, Texas

C. N. Drinkwine
FPO San Francisco

Elmer Eberley
La Junta, Colo.

W. Terry French
Plentywood, Mont.

John Gondorchin
Akron, Ohio

Robert Haake
Pasadena, Calif.

Benjamin F. Harrison
Laurel, Md.

Elon G. Matthews
Liverpool, N. Y.

Walter C. Mih
S. Beloit, Ill.

Henry A. Nolden
Blythe, Calif.

Gerhard Nordland
Des Moines, Iowa

William C. Roach
Silver Spring, Md.

John D. Rollins
Marshville, N. C.

Herbert W. Rutt, Sr.
Bangor, Pa.

R. H. Seip
Morton, Pa.

W. F. Scheibe
Benton, Ill.

Charles J. Smith
Clementon, N. J.

W. Swianiewicz
Calgary, Alta., Canada

Donald Wilson
Artesia, N. Mex.

Wayne E. Woods
APO San Francisco

## WITH HIGH HONORS

Benhart F. Anderson, Jr.
Las Vegas, Nev.

Robert H. Anderson, Jr.
Silver City, N. Mex.

George Baltzoglou
Athens 610, Greece

Donald L. Beabout
St. Louis, Mo.

Steward F. Caldwell
Norfolk, Va.

Charles S. Clark
Haysville, Kans.

Alberto E. Cooper
Cristobal, Canal Zone

Bert C. DeMott
Clio, Mich.

Robert W. Dyser
Akron, Ohio

Dewey M. Ellis
Statesville, N. C.

Roy D. Fahland
St. Paul, Minn.

James Michael Flynn
St. John's, Nfld., Canada

Frank W. Harper
Belton, Texas

Edward J. Herzog
Houston, Texas

Kenneth L. Hoover
Indianola, Iowa

Harry E. Howell
Jerseyville, Ill.

Elzie C. Jenkins
Peoria, Ill.

Sanford T. Jenkins
Meadville, Miss.

Gary Jerry
Cumberland, Wis.

John B. Jewell
Meadville, Pa.

Harold Ernest Joyce
Fort Erie, Ont., Canada

Wilbert C. Kennedy
Brewerton, N. Y.

Sterling King
Carthage, Mo.
Raymond E. Lee
Carbon Hill, Ala.
Robert E. Lee
Waterbury, Conn.
Robert E. Maher
Metairie, La.
Richard A. Millhouse
Orefield, Pa.
Mitchell Mysliwiec
Chicago, Ill.
Ralph D. Phillips
Lancaster, Ohio
Kenneth Preston
Huntington, W. Va.
Zane L. Prosser
Bethalto, Ill.
Robert D. Ramsey
Creal Springs, Ill.
Paul J. Rodjom
Berea, Ohio
James D. Roush
Beaver, Pa.
Phillip A. Sacco
Seattle, Wash.

Richard O. Shelton
Pocatello, Idaho
William E. Snyder
Columbus, Ohio
Clifford E. Solon
Madison, Wis.
A. H. Soria
Sunnyvale, Calif.
Herbert E. Spair, Jr.
Robbinsville, N. J.
Gordon L. Styles
Silver Spring, Md.
Anthony Terranova
Bergenfield, N. J.
Arastoo Tigrani
Jamaica, N. Y.
Thomas N. Tornberg
San Francisco, Calif.
Ralph E. Trosper
Pontiac, Mich.
James E. Ward
Dover, Del.
Rodney Lee Williams
Sunbury, Ohio
Asbjorn Yri
Vadsoe, Norway

## WITH HONORS

Howard F. Abel
Glenshaw, Pa.
Lewis P. Achen
APO San Francisco
Charles H. Aldrich, III
Ridgefield, Conn.
Robert F. Basenfelder
Rome, N. Y.
James G. Berry
Wisconsin Rapids, Wis.
Heister H. Bittenbender, Jr.
Bloomsburg, Pa.
R. George Bradbury
St. George, Utah
Donald L. Breidinger
Alma, Mich.
Hugh Robert Browne
Takoma Park, Md.
James E. Brugh
Pittsburgh, Pa.
James L. Burgess
Oxon Hill, Md.
Steven J. Candrilli
Washington, D. C.

Orville H. Cavender
Mystic, Conn.
Roy Chastain
Helen, Ga.
Francis Cleverley
Idaho Falls, Idaho
Donald Edward Copeland
St. Catharines, Ont., Canada
Dale D. Dedic
Longmont, Colo.
Edward G. Diem
Clintonville, Wis.
Garland M. Dodge
Fallbrook, Calif.
M. Finley Duke
Palmdale, Calif.
Monroe L. Dutcher
Clarkston, Mich.
William J. Eaton
Burkburnett, Texas
A. K. Forney
Scottsdale, Ariz.
Bertrand Guffens
St-Jean, P. Q., Canada
James H. Harrison
Jacksonville, Fla.

Charles Haznedl
Indianapolis, Ind.
Cecil W. Hobbs, Jr.
Matthews, N. C.
William J. Hoffman
Woodbridge, Va.
Thomas E. Howard
Quincy, Mass.
Ture H. Idengren
San Leandro, Calif
Sterlen M. Kane
Magdalena, N. Mex.
Charles E. Killingsworth
APO New York
Charles Ralston Lowe
St. Joseph, West Indies
Alexander MacKenzie
LaTuque, P. Q., Canada
James I. McFadden
APO New York
Darrel R. Miller
Fort Devens, Mass.
Donald Lee Perdue
Franklin, Ky.
Paul W. Proctor
Pomfret, Md.

Donald D. Quelch
Neptune City, N. J.
David Allen Rigsbee
Durham, N. C.
Ronald F. Saulnier
Haverhill, Mass.
Frederick L. Scheltz
Kettering, Ohio
Earl Seiler
Pittsburgh, Pa.
Charles W. Shaner
Athens, Ohio
Joseph Shapiola
Colonia, N. J.
Peter Shirocky
Alexandria, Va.
Ezra J. Short
Oregon, Ohio
Roger J. Sorenson
Minneapolis, Minn.
Edward A. Spangenberg
Baltimore, Md.
John A. Stafford
Tucson, Ariz.
Howard F. Winner
Sharon, Pa.

# Alumni News

Eugene de Caussin ..... President
Edward Bednarz ..... Vice President
Isaiah Randolph ..... Vice President
Joseph Bradley ..... Vice President
Harvey Morris ..... Vice President
Theodore E. Rose ..... Executive Sec.

## CHAPTERS WELCOME NEW MEMBERS

NEW YORK CITY CHAPTER has welcomed Graduates Julio Luyando and John Robinson, and Student James H. Griffith into its ranks. The Third Section of the Sams' Tape-Slide Lecture on Transistors was shown with great effect. Joseph Pagan brought in a radio program tape-transcript of a discussion of the Consumers' Research charges levelled at TV Repairmen. Pete Carter demonstrated his hook-up of two old TV power transformers to make an isolation transformer for his shop.

David Spitzer gave members the benefit of his experience in running down troubles in the sound section of a TV set, and Al Bimstein brought in a complete all-channel TV Antenna and demonstrated all points in connection with setting it up, discussing various difficulties one might face and how to solve them. Joseph Bradley talked on the Unijunction Transistor and touched on some of the other related devices, such as four-layer diodes of various kinds. A demonstration was given of checking, on a go-no-go basis, all types of semiconductors, as well as capacitors and resistors, using a small transformer and a scope.

Joseph Whitley brought in his new NRI Signal Generator, which was demonstrated, using the Chapter's demonstration board receiver. Several methods of using this device were shown by various members, including Pete Carter and Dave Spitzer. "Sam Antman discovers P and N Materials" proved to be a very interesting basic lecture on this subject which confuses so many.

NORTH JERSEY CHAPTER's Fred Pisano treated his fellow members to a fine talk and demonstration. Speaking on the purity and convergence adjustments in Color TV, he used blackboard illustrations and schematics to give a crystal-clear and understandable lecture. Also, a film on transistors was shown by program chairman George Stoll.

At the very next meeting, George contributed to the major part of the program with a talk on horizontal troubles. George had prerecorded the talk and used a projector and screen. Frank Jessich threw more light on the horizontal circuit with a fruitful talk on the replacement of flybacks in black-and-white and color TV receivers. The remainder of this evening was used to help one of the members with a portable TV set which had a narrow raster.

LOS ANGELES CHAPTER welcomed two new members, Leslie Booker, Long Beach, and Jean P. Denis, No. Hollywood. Earl Allen was forced to resign from his position as Secretary because of health. Fred Tevis was elected to replace him.

An interesting discussion took place about the merits of correspondence courses compared with those of resident training.

The future of the Chapter's Color TV set was discussed next. The questions were raised as to whether work should be resumed on it and whether any more money should be spent on replacement parts, since the set needs a picture tube before it can be checked out. The decision was made to buy a used tube.

DETROIT CHAPTER enjoyed another program conducted by its own John Nagy, who has had a long and varied experience with P. A. systems. This time he brought along a transistor radio, a "charger" for dry cells, several batteries in different stages of discharge, and a wattmeter. Using the wattmeter, he showed the power available from a good battery and from those in various stages of use, and what degree of discharge could be reached before a charger becomes useless.

Encountering different noises as the battery neared its lowest usable condition, John related his experiences with the human element when using test signals for troubleshooting P. A. systems. When he used music and it was distorted, people near the speakers wanted it turned down. So now he uses varying tone signals, changing from one to the other before anyone gets annoyed and complains.

Another meeting featured a talk and demonstration by Chairman Jim Kelley on transistor theory, beginning with a discussion on how a flow of current can be produced in a copper wire due to the atomic structure of copper. A total of 10 drawings were made, starting with the copper atom and following with the germanium, arsenic and the indium atom. Other drawings showed how the germanium is doped when used for diodes and transistors. The Chapter's projector was very useful -- the drawings were projected on a screen so everyone could have a good view. The projector was operated by NRI student Raymond Berus, a former movie projectionist who was a guest of the Chapter.

PHILADELPHIA-CAMDEN CHAPTER has always been enthusiastic about the meeting GE holds for the Chapter about once a year. Mr. George Walker, Technical Specialist who conducted the meeting, gave an excellent performance.

It is no wonder that the members always look forward to this meeting with GE. GE has a spacious auditorium with comfortable plush seats, and George Walker is a skilled speaker who knows how to present his subject as well as give short cuts and shop hints that the members find practicable and valuable.

A previous meeting featured the always-welcome Bill Heath of Westinghouse, an honorary member of the chapter, and Chuck Trout, National Training Representative for Westinghouse. All members at this meeting received ball point pens, memo books, service books on Westinghouse Color TV, and enjoyed an outstanding talk on Color TV by Chuck Trout.

GE hosts to the Philadelphia-Camden Chapter were from left: George Walker, Glenn Meeder and Henry Lapinski.

FLINT (SAGINAW VALLEY) CHAPTER visited Flint College of the University of Michigan where Prof. Mykola DeJenko exhibited the new experimental 3-D photography setup he had designed for the Physics Department.

This equipment will take three dimensional pictures on a single piece of film. Prof. DeJenko also exhibited an experiment used in the college's animal tissue research program in which specimens are magnified more than 400 times.

PITTSBURGH CHAPTER's main speaker at a recent meeting was Mr. Charles Howard, Motorola Factory Representative and an NRI Graduate of two decades ago. He devoted his talk to a Motorola Transistorized 9" TV Receiver. He went through the entire set from tuner to picture tube. The members were heartily in favor of Mr. Howard's returning for another lecture.

The members had an enjoyable round-table discussion at the following meeting. The Chapter has been making plans to establish a chapter school to teach methods of servicing with an oscilloscope in the near future.

SAN ANTONIO ALAMO CHAPTER was pleased to welcome Mr. William Dempsey as a guest. At this meeting Chairman John Chaney conducted a program on amplifiers. A general discussion followed after which refreshments were served by Harold Wolfe.

Sam Stinebaugh and Harold Wolfe were slated to conduct the program at the next meeting following the plan that was adopted: Draw a diagram of a circuit on a blackboard, give the members the actual voltage readings and the correct voltage, then have each member around the table try to determine the cause of defects by asking questions. The members find this plan entertaining as well as instructive. Sam and Harold describe it as "What's my line?"

SAN FRANCISCO CHAPTER wishes to call particular attention to a change in its meeting place. The meetings are now held at the home of Chapter Member J. Arthur Ragsdale, 1526 27th Ave., S.F.

Arthur undertook the demonstration of transistor oscillators. Later a radio with a bad hum was used as a troubleshooting guinea pig. The members collaborated in analyzing the trouble, which was finally found to be a defective filter condenser. Installation of a new condenser eliminated the hum.

After an absence of two years, R. Tomlinson returned to the fold. The members were glad to welcome him back.

SOUTHEASTERN MASSACHUSETTS CHAPTER has reported that its officers for the current year are Walter Adamiec, Chairman; John Alves, Vice-Chairman; Ernest C. Grimes, Secretary; Frank Sarro, Treasurer; Manuel Sousa, Program Chairman.

The Chapter has also reported its largest number of new members to be admitted at one time. They are Dennis Moniz, Gary Stern, Ray Labouliere, Norman Ouellette, all of Fall River, and Romeo Poissant, West Barrington, R. I.

After the new members had been welcomed, Manuel Sousa started off the remainder of the evening with a program on bandpass amplifiers. Frank Sarro as usual livened things up.

The chapter has planned a series of programs on demodulators. Manuel Sousa will start with the first one. Each month a different receiver stage will be taken up and discussed thoroughly.

SPRINGFIELD (MASS.) CHAPTER's shop problem at one recent meeting was a Zenith TV, brought in by Mr. Richardson, that had horizontal trouble -- two pictures on the face of the tube. Effect-to-cause reasoning indicated that either a resistor in the input circuit of the horizontal oscillator had decreased in value or some capacitor was leaky, or a combination of the two. But the set proved to

be a dog and had to be put off until the following meeting.

John Park gave a short lecture on transistor theory. Although it lasted only half an hour, the members nevertheless enjoyed it and John covered a lot of ground.

At the next meeting Albert Petersen gave a brief talk on his duties with Townsend Associates of Agawam. This is an engineering firm specializing in transmitting equipment for Radio and TV stations. Mr. Petersen explained his work in the field of research and development in all types of transistorized oscillators.

## 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: Clyde Morrissett, 514 Gorton Ct., Flint, Mich., 235-3074.

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: Robert McHenry, RR2, Kearneysville, W. Va. 25430.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, at Chairman Eugene DeCaussin's Radio-TV Shop, 4912 Fountain Ave., L. A., Calif., No. 4-3455.

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 Tschoupitoulas 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: John Schumott, 1778 Madison Ave., NYC. 722-4748.

NORTH JERSEY CHAPTER meets 8:00 P. M., last Friday of each month, Players Club, Washington Square (1/2 block west of Washington and Kearney Avenues), Kearney, N. J. Chairman: George Schopmeier, 935-C River Rd., New Milford, N. J.

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: Joseph Burnelis, 2268 Whited St., Pittsburgh, Pa.

SAN ANTONIO (ALAMO) CHAPTER meets 7:00 P. M., 4th Friday of each month, Beethoven Home, 422 Pereida, San Antonio. Chairman: Sam Stinebaugh, 318 Early Trail, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P. M., 2nd Wednesday of each month, at home of J. Arthur Ragsdale, 1526 27th Ave., S. F. Chairman: Isaiah Randolph, 523 Ivy St., S. F.

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 Dr., Springfield, Mass. Chairman: Joseph Gaze, 68 Worthen St., W. Springfield, Mass.

MORE GREAT VALUES FROM

# CONAR

DIVISION OF NATIONAL RADIO INSTITUTE

MODEL 230

$4 Down—$5 Mo.

## CONAR Tuned Signal Tracer

Only tuned tracer on the market anywhere near the price. Exclusive cathode-follower probe gives outstanding sensitivity. Easily connects to any RF or IF stage with absolute minimum of detuning. Features audio tracing method through built-in 4" PM speaker plus visual indicator using "eye" tube. Quickly locates sources of hum, noise and distortion. Tracks down intermittents, measures gain per stage, accurately aligns radios without signal generator. (Tracer may also be used as sensitive AM radio.) Has two stages of RF amplification. Assembly-operating instructions include more than 12 pages on uses of Model 230. For beginners as well as experienced technicians.

SPECIFICATIONS
FREQUENCY: 170 kc to 1500 kc (2 bands)
TUNING: Planetary Drive, 3:1 ratio
RF TRANSFORMERS: Permeability tuned
ATTENUATORS: Calibrated RF and AF
TUBES: (2) 6GM6, (1) 6AV6, (1) 6AQ5, (1) 6E5, (1) 6X4, (1) 6AB4
CONTROLS: Volume, Band Selector, Main Tuning, Fine Attenuator On-Off, Coarse Attenuator, RF-AF switch
CABINET: Steel, blue finish with satin finish panel, red lettering
DIMENSIONS: 9⅞"x7½"x6½"
POWER SOURCE: 110-120, 60 cycle

**$39.95**

Kit—230UK Assem.—230WT, $57.50

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MODEL 280

$2.50 Down—$5 Mo.

## CONAR Signal Generator

Widely acclaimed as most accurate signal generator near the price. Uses Hartley type oscillator circuit with six separate coils and capacitors to give accuracy within 1% after easy calibration. High output of the Model 280 simplifies signal injection for rapid alignment and troubleshooting of transister and tube receivers. Covers 170 kc to 60 mc in six ranges with harmonic frequency coverage over 120 mc. Ideally suited as marker generator for TV alignment. Tuning dial features planetary drive with 6:1 ratio for greater accuracy and elimination of backlash. Scale is full 9" wide with transparent hairline pointer. Has single cable for all outputs, no need to change leads when switching from 400 cycle audio to modulated or unmodulated RF.

SPECIFICATIONS
CONTROLS: High-Low Output Selector, Main-Tuning Dial, Band Selector—A thru F, Output Selector—Mod, RF, Audio, Attenuator/On-Off switch
TUBES: 6BE6, 12AU7
CIRCUIT: Slug adjusted RF coils with mica trimmers on low bands, Ceramic trimmers on high bands
CABINET: Steel, baked-on blue finish; satin finish panel with red lettering
DIMENSIONS: 9⅞"x7½"x6½"
POWER SUPPLY: solid state 110-120 V, 60 cycle AC

**$24.95**

Kit—280UK Assem.—280WT, $35.95

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MODEL 311

$2.20 Down—$5 Mo.

## CONAR Resistor-Capacitor Tester

The Model 311 gives fast, accurate, reliable test on all resistors and capacitors. Measures capacity of mica, ceramic, paper, oil-filled and electrolytics from 10 mmfd. to 1500 mfd, 0-450 volts. Checks for leakage, measures power factor and useful life. Shows exact value of resistors from 1 ohm to 150 megohms. Clearly indicates opens and shorts. Has "floating chassis" design to greatly reduce shock hazards. The Model 311 will also apply actual DC test voltage to capacitors to reveal break-down under normal circuit conditions, a feature far superior to many R-C testers which give low voltage "continuity" tests. Can be used for in-circuit tests in many applications and circuits

SPECIFICATIONS
RESISTANCE RANGES: 0-500 ohms, 100-50K, 10K-5M, 1.8M-150M (extended range)
CAPACITY RANGES: 0.1-50 mfd, .001-5 mfd, .00001-005 mfd, 18-1500 mfd (extended range)
CONTROLS: Range Selector Leakage Test Voltage (0-450), Power Factor (0-60%)
TUBES: 6E5 "eye" indicator 6x4
BINDING POSTS: Special 5-way type
CABINET: Steel, smooth blue
DIMENSIONS: 9⅞"x7½"x6½"
POWER SUPPLY: 110-120 V, 60 cycle AC

**$21.95**

Kit—311UK Assem.—311WT, $31.95

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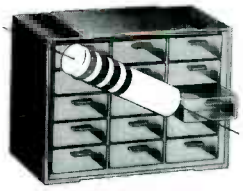
USE HANDY ORDER FORM ON PAGE 27—CASH OR TERMS

# 2 CONAR Best Buys!

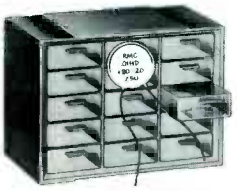


A $38.35 VALUE

## 172 RESISTOR ASSORTMENT

Top-quality, most-needed resistors for hobbyists, technicians, engineers, experimenters. Packed in handy 15-drawer styrene knick-knack cabinet. All are 10%, ½ watt rated or better. 30 values from 47 ohm to 10 meg.

**$15.70** (28 UK)
Shipped Parcel Post



A $41.15 VALUE

## 120 CAPACITOR ASSORTMENT

Top-grade, most-needed capacitors—ceramic, disc and paper. All rated 400V or 600V. Shipped in sturdy 15-drawer styrene knick-knack cabinet for your convenience.

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