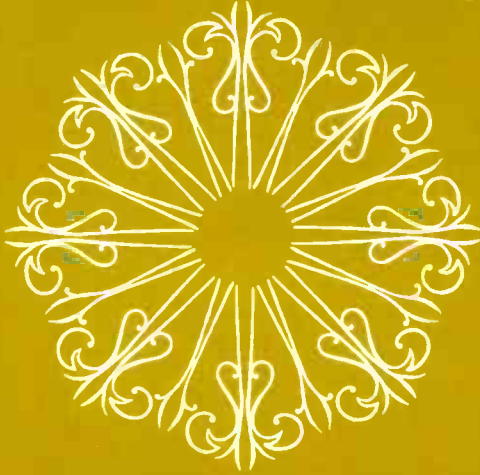
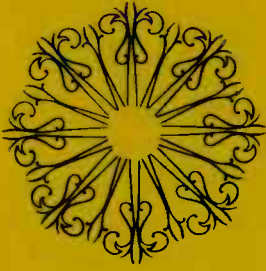


SMOOTH-TOP RANGES



- Servicing Smooth-Top Ranges
- Electronic Tuning
- Torque Wrenches
- Increase Your Profits by Conserving Energy

nri journal

March/April 1978

CONAR Cathode Conductance Tube Tester Kit



CONAR VALUE PRICED AT ONLY

Stock No. 224UK
13 pounds
Parcel Post Insured

\$67⁹⁵

ALSO AVAILABLE WIRED

Stock No. 224WT
13 pounds
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\$84⁹⁵

SPECIFICATIONS

CASE: Blue, leather-like fabric, hinged lid with safety catch; PANEL: Satin finish, aluminum; PANEL LETTERING: Red; METER: Double-jeweled, D'Arsonval type; accurately balanced and factory calibrated to within 2% accuracy; SAFETY FEATURE: Test circuit transformer isolated from power line affords utmost safety to operator and instrument; POWER REQUIREMENTS: 50-60 cycle, 110-120 volt ac only; WARRANTY: Standard EIA warranty on all parts; DIMENSIONS: width 15 1/2"; length 10 1/2"; depth 4 1/4"; ACTUAL WEIGHT: 10 pounds; SHIPPING WEIGHT: 13 pounds, Parcel Post Insured.

TEST FEATURES

ACCOMMODATE ALL SERIES STRING AND OTHER UP-TO-DATE TUBE TYPES: 17 individual filament voltages from .75 to 110 volts. Tests all standard base types: 4, 5, 6 and 7-pin large, octal, locial, 7, 9 and 10-pin miniatures, 5-pin novistor, novar, compactron, and magnoval. Checks 17 individual filament voltages from .75 to 110 volts. Tests multi-section tubes, gas rectifiers and remote control gaseous types. Has open-close "eye" tests for cathode-ray indicator tubes, and visible filament continuity check to show up open filaments regardless of pin position.

Twelve lever element selector-distribution system enables you to select the individual elements of the tube you're checking and simplifies cathode leakage tests and inter-element short tests. Most important, this feature provides you with flexibility and gives you insurance against obsolescence as new tubes reach the market.

Designed around the approved Electronic Industry Association's Emission Circuit, the Model 224 uses a precise, accurate, double-jeweled meter movement. It's balanced and factory calibrated within 2% accuracy. Large, easy to read — with clear plastic case and two 2-color scales.

Test sequence set up to reveal quickly open filaments and shorts. The time-saving feature rejects an "open" or "shorted" tube and lets you proceed with more detailed checks right away. For maximum safety to you and the instrument, the test circuit transformer is isolated from the power line.

Durable, black, leather-fabric case makes the Model 224 attractive as well as functional. The hinged lid is removable. When the lid is on, a snap lock holds it securely.

Lever switches and other controls are conveniently grouped to eliminate wasted motion. This minor but thoughtful feature is typical of the care put into the Model 224.

The instrument manual for the Model 224 is written with the same high standard that went into the circuit design — with huge picture diagrams to guide you every step of the way.

Building the Model 224 is easy. Using it is even easier. The operating simplicity makes it a pleasure to use. Just 10 pounds — it's a pleasure to tote along on service calls, too.

TESTS SPECIAL TUBES: Tests special purpose tubes and gas rectifiers as OY4, OZ3, OZ4, and remote control gaseous types such as OX4. TESTS MULTI-SECTION TUBES: Individual test for each section of multi-section tubes. Open-close "eye" test for cathode-ray indicator tubes. HOT CATHODE LEAKAGE TESTS: Reliable, sensitive neon method quickly shows up cathode leakage. INTER-ELEMENT SHORT TESTS: Made simple by CONAR 12-lever element selector system. METER: Large, easy to read with clear plastic case. Accurately balanced and factory calibrated to within 2% accuracy. Double-jeweled D'Arsonval type. LINE ADJUSTMENT: Continuously variable, heavy-duty line voltage control. SEPARATE WINDING ON POWER TRANSFORMER FOR TEST VOLTAGE: Filament voltage taps are not used for test voltage supply.

Completely new, modestly-priced Tube Tester Kit, designed by men with unequalled experience in training technicians — understanding their equipment needs and servicing problems. No unnecessary frills added to the Model 224's specs. Only those features most essential to a technician's work are built in.

Every technician — full or part time — needs the Model 224 for his bench. Helps you make better job estimates and pass for itself quickly in extra profits. Perfect for experimenters and hobbyists, too.

Tests all series string and up-to-date tubes as well as the standard base types — 4, 5, 6, 7-pin large octal, locial, 7, 9 and 10-pin miniatures, 5-pin novistor, novar, compactron, and magnoval. Checks 17 individual filament voltages from .75 to 110 volts. Tests multi-section tubes, gas rectifiers and remote control gaseous types. Has open-close "eye" tests for cathode-ray indicator tubes, and visible filament continuity check to show up open filaments regardless of pin position.

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Picture Tube Adapters

- | | |
|-----------------|---|
| 70°-90° Adapter | Lets you test TV picture tube in a receiver or in factory carton. Test includes cathode emission check and check for shorts between various tube elements. Stock No. 3AD. Price \$4.50. |
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| Color Adapter | Tests 70°-90° color picture tubes. Stock No. 9AD. Price \$12.00. |

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In this issue, we bring you a dissertation on that hot new appliance item, the smooth-top stove. Also, NRI development engineer Jim Lytle explains electronic tuning and tells us why it will soon become universal. Finally, we offer discussions of torque wrenches and energy conservation to save your knuckles and your pocketbook, respectively.



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

The Model 255 is 100% solid-state for superior stability, reliability, and ease of maintenance; has direct-coupled vertical and horizontal amplifiers which are ideal for measuring dc voltages and very low frequency waveforms; uses a triggered sweep generator rather than the usual recurrent sweep generator.

The cathode ray tube is a modern flat-face tube (RCA 4572 or equivalent) fully-shielded, and operates from a full 2000 volt power supply. The screen is calibrated graticule with ten division in the horizontal direction and either in the vertical direction. Each division equals one centimeter. Reference marks at 10% and 90% are provided for convenience in making rise time measurements.

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

boards. Both dies of each board are readily accessible for easy assembly and servicing.

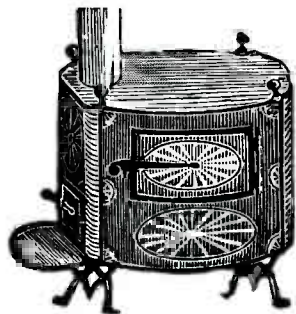
The direct-coupled deflection amplifiers extend response to dc. The 11-position calibrated vertical attenuator makes voltage measurements a snap, whether the voltages to be measured are ac, dc, or a combination of both. To measure a voltage, you merely note the height of the waveform in centimeters, as displayed on the graticule, then multiply the number of centimeters times the attenuator setting.

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

SPECIFICATIONS

Vertical Channel — Sensitivity: 2 mV maximum, uncalibrated. Calibrated ranges: 10-20-50-100-200-500 mV. 1-2-5-10-20 volts/cm. Input impedance: 1 megohm, 30 pF. Frequency response: DC to 6 MHz + 3db. **Horizontal Channel** — Sensitivity: 50 mV. Frequency response: 3 Hz to 1 MHz + 3db. **Sweep Type:** Triggered (internal, external, line). **Calibrated ranges:** 1-2-5-10-20-50-100-200-500 us, 1-2-5-10-20-50 ms. **Source:** internal, external, time. **Other Features:** 5" flat face CRT — calibrated graticule 8 x 10 cm — mumetal shield or CRT — Z axis input — sweep sawtooth output — focus intensity and astigmatism controls — X10 low capacity probe available — all solid state (including integrated circuits) — printed circuitry construction. Overall dimensions: 12" x 9" x 16", including knobs, handle and feet. Weight: 17 lbs. Power Supply: 110-120 volts, 60 cycle AC.

Servicing



SMOOTH-TOP RANGES

Glass-ceramic material made by Corning® has been used in various types of cookware for many years, and is the same material used to make the decorative tops for the new smooth-top ranges. Unlike the conventional range in which the heating element is placed directly on the range top, the smooth-top range has a heater panel made of glass-ceramic material separating the heating element from the cookware.

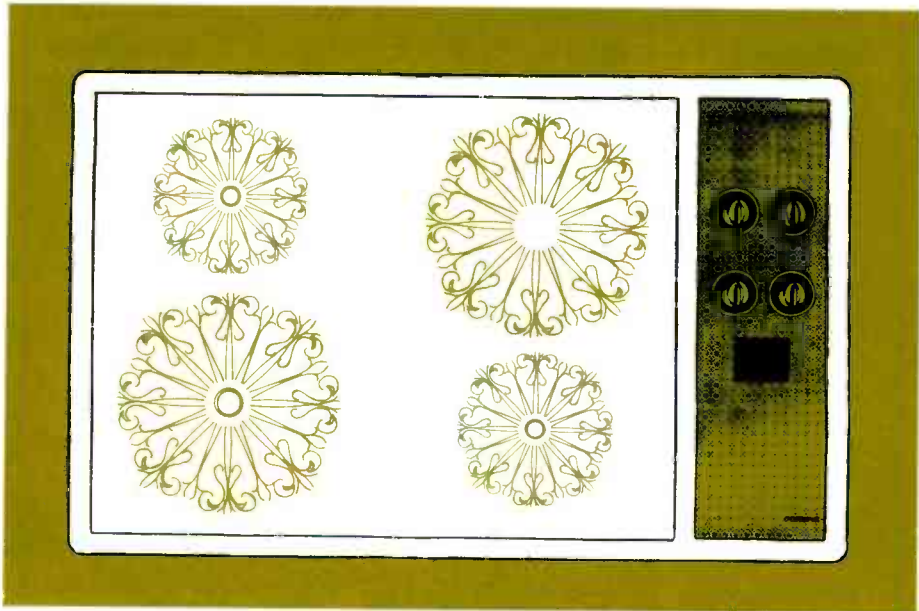
The material used for the heater panel is a special type of glass-ceramic material which is stain-resistant and quite strong. The panel is about 3/16

inch thick with the area heated by the heating element (see Fig.1) shown by a decorative pattern. Since the glass-ceramic material is actually a poor heat conductor, only the area heated by the heating element will get hot. The surrounding area will remain much cooler.

Although the heater panel is very strong, it can be broken. A defect in the glass, extreme heat, or a sharp mechanical blow will cause the panel to break.

A defect in the glass may cause a thermal break like that shown in Fig.2(A). As you can see, this type of break will cause the fracture lines

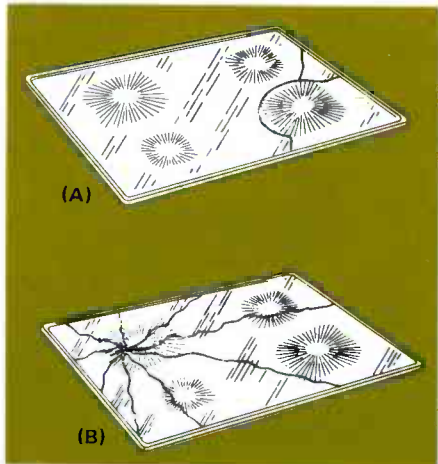
Mike Taylor



Courtesy Amana Refrigeration, Inc.

FIGURE 1. THE DECORATIVE PANEL OF A SMOOTH-TOP RANGE.

to be well-defined and long. A mechanical break, however, will look like



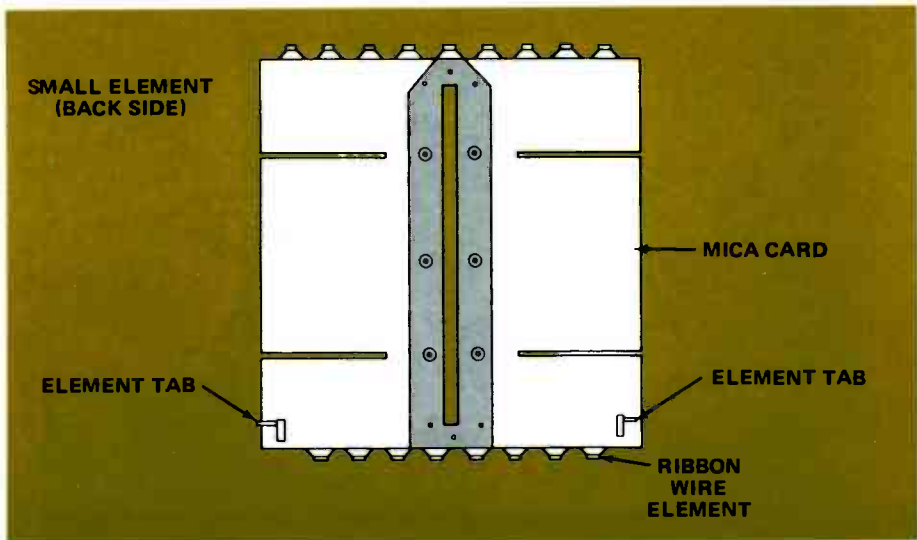
Courtesy Amana Refrigeration, Inc.

FIGURE 2. ALTHOUGH VERY STRONG, THE HEATER PANEL CAN STILL BREAK. A THERMAL BREAK (A), AND A MECHANICAL BREAK (B).

Fig.2(B). The glass will appear to shatter away from the point of impact. This type of break will only result from a mechanical blow. If you are doing warranty work, a mechanical break like this would not be covered.

Customers who are not familiar with smooth-top ranges may question small pinholes that occasionally appear in the glass surface. These pinholes are not defects and will not affect the performance or strength of the heater panel. You will have to explain this to the customers, or refer them to the local retailer.

The heating elements are located directly below the heater panel. They are similar to the heating elements found in an electric toaster. The two sizes of heating elements most commonly used with cook tops are a 9-inch element and a 6-1/2-inch element. Depending on the manufacturer, the



Courtesy Amana Refrigeration, Inc.

FIGURE 3. A TYPICAL FLAT RIBBON TYPE OF HEATING ELEMENT FROM A SMOOTH-TOP RANGE.

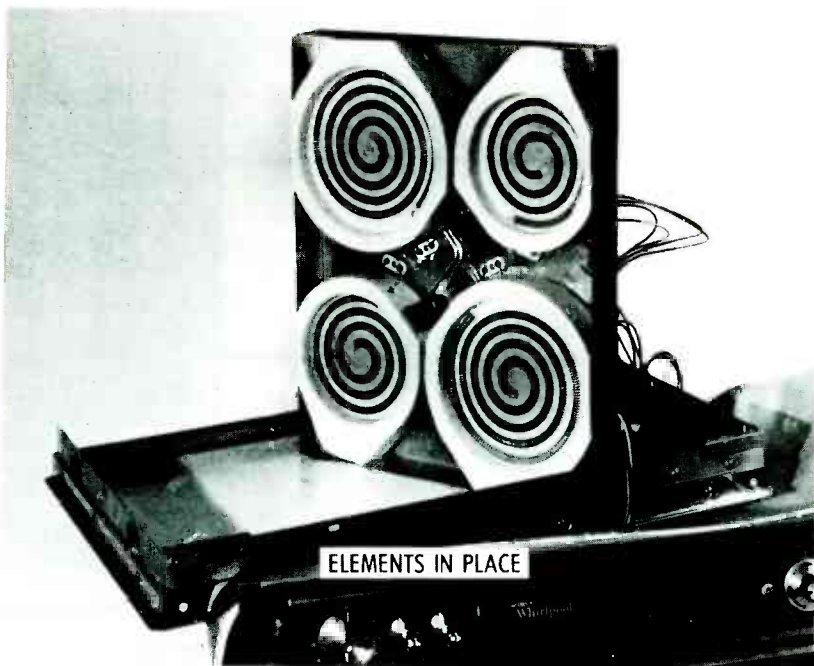
9-inch element will have a rating somewhere between 1700 watts and 2200 watts at 240 volts. The 6-1/2-inch element will have a rating between 1100 and 1200 watts. Some manufacturers will operate this element from 240 volts, others will operate it from 120 volts.

There are also basically two types of heating elements used with smooth-top ranges. One type is shown in Fig.3 and uses a flat ribbon-resistance wire wound on a mica card. Power leads to the element are spot-welded to each end of the element winding. The other type of element, shown in Fig.4, is made of resistive wire in the form of a coil. The element is partially encased in an alumina silicate casting with the power leads attached to the element by stainless steel strips through the casting. Both of these types of elements, along with leads and terminations, are made of high-temperature material and cannot be repaired. If a heater lead or its terminal fails, the entire heating element

is usually replaced.

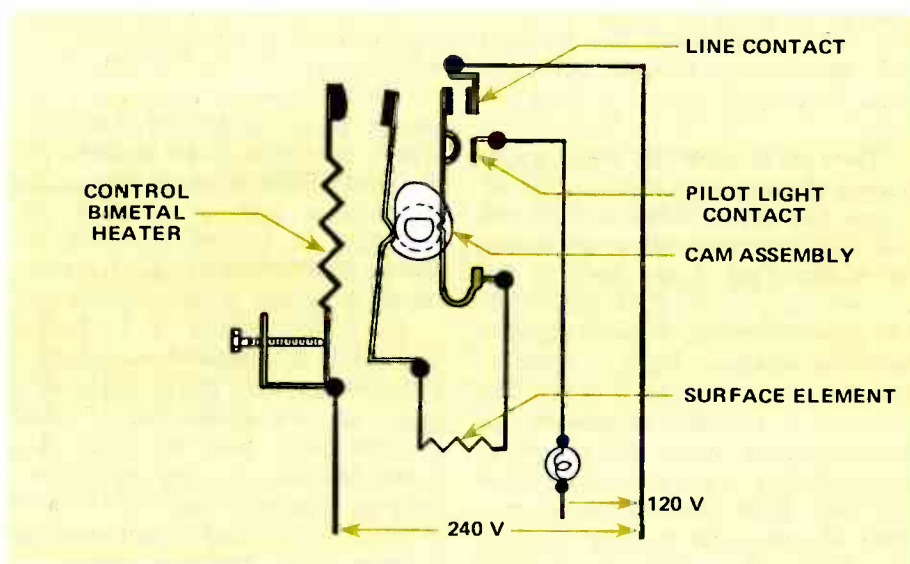
As in the conventional range, the elements of the smooth-top range are usually controlled by infinite-heat switches mounted on the console. Here, with the switch set on the high setting, the switch keeps the surface unit element on all the time. At a lower heat setting, the unit is cycled on and off by the switch. That is, at the high setting the surface unit is energized continuously; at the warm setting, the surface unit is only energized approximately 6 percent of the total on-time.

The on-off cycling of the heating element is accomplished by a bimetal strip in the switch. This strip is made of layers of two metals, one of which expands more than the other. This causes the strip to bend as its temperature changes. Since the heating element is connected in series with the bimetal switch, the same current that flows through the heating element will flow through the bimetal switch. The bimetal switch will therefore be heated



Courtesy Whirlpool Corp.

FIGURE 4. A TYPICAL COIL-TYPE HEATING ELEMENT.



Courtesy McGraw-Hill Book Company

FIGURE 5. A TYPICAL INFINITE-HEAT SWITCH.

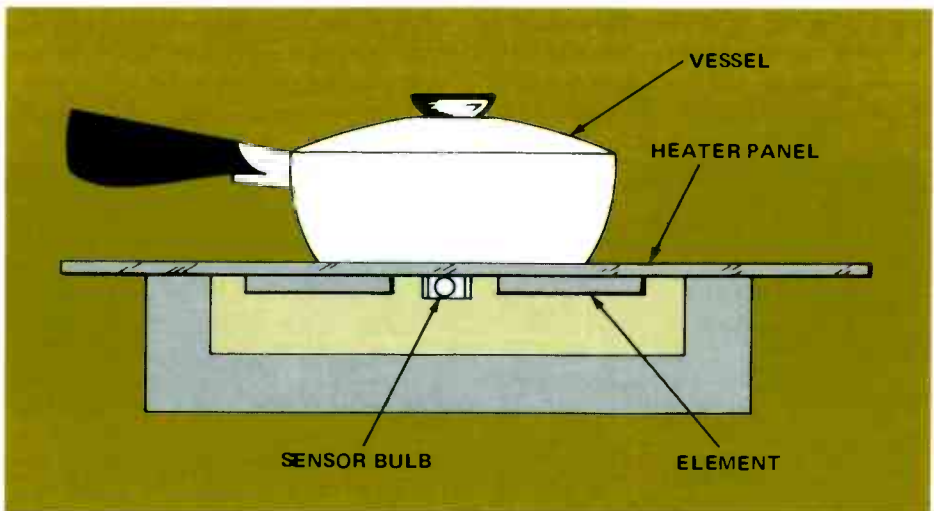
and bent in direct proportion to the amount of heat produced by the heating element.

A typical infinite-heat switch is shown in Fig.5. One of a pair of contacts is attached to the end of the bimetal switch and is moved away from the other contact by the bending of the bimetal. The distance between the contacts is changed when the switch setting is changed by a cam attached to the shaft of the control. This cam moves the second contact closer to or farther from the cycling contact on the heated bimetal arm. In this way, it determines the amount of bending arm required to open the contact. Since more heat is required for more bending, the on-time is increased or decreased by the setting of the switch.

The pilot or indicator light, on the other hand, is turned on by a separate set of contacts in the switch. It is on all the time the switch is turned to any position but off.

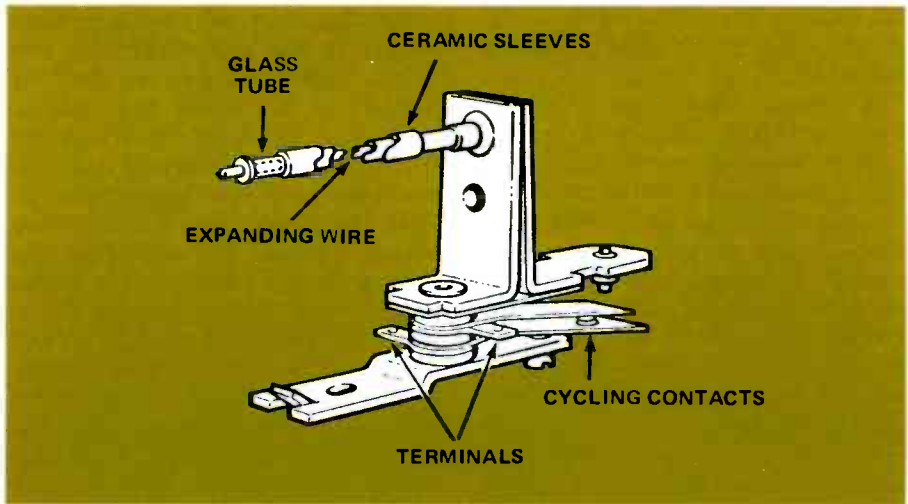
Another type of heating element control is the hydraulically actuated switch. Refer to Fig.6, and note the position of the sensor bulb directly under the heater panel. The sensor bulb is filled with oil, and directly senses the temperature of the heating element. When the surface control is set to any setting between low and high, the heating element contacts close. As the heating element begins to heat, the oil within the sensor bulb begins to expand. As the oil expands, it exerts pressure through a capillary tube to the control switch. The expanding oil causes the switch to actuate and open the heating element contacts. This turns the line voltage off to the element.

Then, as the heating element cools, the oil within the sensor bulb contracts. The pressure within the capillary tube and switch decreases, and the heating element contacts close again. This turns the line voltage back on to the element. Turning the switch shaft will change the



Courtesy Amana Refrigeration, Inc.

FIGURE 6. THE SENSOR BULB FOR HYDRAULIC SURFACE CONTROLS WILL DIRECTLY SENSE THE SURFACE TEMPERATURE OF THE HEATER PANEL.



Courtesy McGraw-Hill Book Company

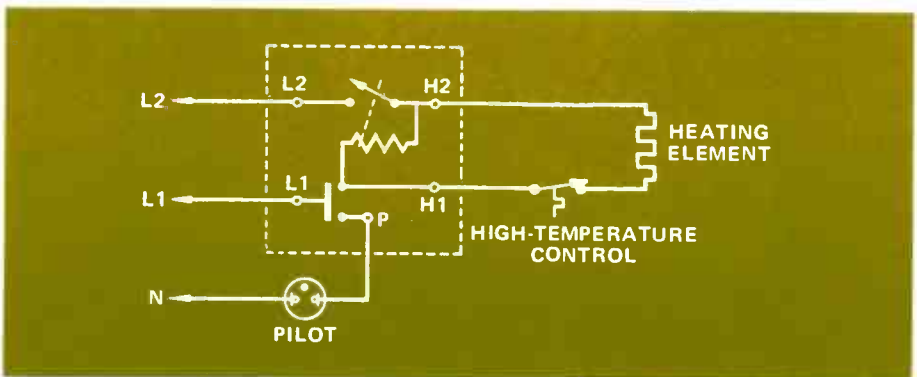
FIGURE 7. TYPICAL HIGH-TEMPERATURE LIMIT CONTROL.

pressure needed to open the switch contacts and the surface temperature is thereby controlled. The on and off cycling is repeated until the control is set to off. However, the indicator or pilot lamp will glow when the control is set to any setting between low and high.

In addition to the surface controls, all smooth-top ranges will have a high-

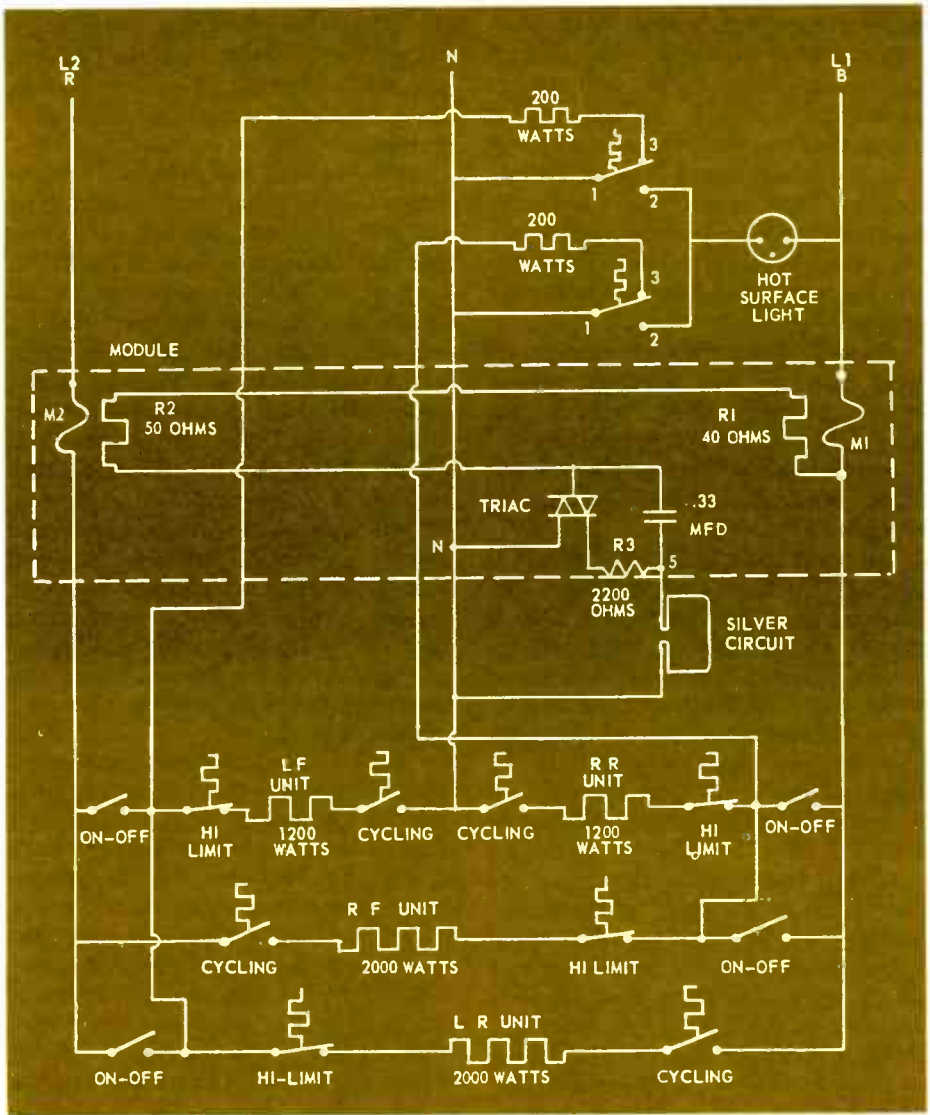
temperature limit switch. A typical high limit switch is shown in Fig. 7. It is used to protect the element and glass-ceramic top from extreme heat. The switch is used in the circuit for all surface control settings with the switch contact in series with the heating element. This is shown in the wiring diagram of Fig. 8.

Here we have a set of normally



Courtesy McGraw-Hill Book Company

FIGURE 8. TYPICAL HIGH-TEMPERATURE CONTROL CIRCUIT.



Courtesy McGraw-Hill Book Company

FIGURE 9. A SIMPLIFIED WIRING DIAGRAM OF A TYPICAL SMOOTH-TOP RANGE.

the water to come to a complete boil. The water should boil in about 12 to 13 minutes.

To check a large cooking surface, use a five-quart saucepan filled with about

three quarts of tap water. It should take between 13 and 14 minutes for the water to boil.

You may also want to provide your customer with some hints on cooking

closed contacts actuated by a heat-sensitive wire. When the temperature of the surface above the element reaches approximately 950°F, the wire expands and opens the switch contacts. This will turn the line voltage off to the heating element. Then, as the element cools, the heat-sensitive wire contracts and allows the switch contacts to close. This turns the line voltage back on to the heating element.

In some cases, the high-temperature limit switch is used when the surface control is set to high heat. In this setting, the surface is controlled by the high temperature limit switch and will cycle when the panel temperature reaches 950°F.

To warn the user that the surface is hot most manufacturers will use a "hot surface" light. The hot surface light is turned on by one or more thermostatically controlled switches mounted under the cook top near the elements. When the top is hot, one or both of the switches will close the circuit to the light and the words "hot surface" will appear in red at the rear of the smooth top. To turn the light on quickly, a 200-watt heater in contact with the thermostat is energized whenever the surface control is turned on. This heater is turned off when the thermostat turns on the light. The thermostat will keep the light on as long as the surface is hot, and this is usually above 120 to 150°F.

Some smooth-top ranges will employ a slightly different method of warning the user that the heater panel is hot. In these, when the heater panel becomes warm, the decorative design on the top turns a certain color. When the switch is turned off, the cooking area cools and returns to the original white color.

Some smooth-top ranges will have a special safety circuit to protect the user against a damaged panel. A typical sensor for a broken panel is a ribbon of silver film deposited on the underside of

the panel. The silver film completes a circuit from a neutral line to the gate terminal of a triac. (A triac is a solid-state switching device similar to a transistor.)

If the ceramic top and silver film are broken, an ac voltage will be applied to the gate of the triac through a capacitor and resistor (see the circuit of Fig.9). As long as the gate is connected to the neutral line through the silver film, it will not conduct. But should both the heater panel and the silver film break, an ac voltage will be applied to the gate and the triac begins to conduct. The conduction current of the triac flows through a resistor encased around a thermal fuse. The current causes the resistor to heat, melting the fuse element. This, in turn, breaks the circuit to the heating element. Therefore, no heat can be supplied to the cooking top if the silver ribbon breaks. A new top must be installed and new fuses installed to restore operation.

Some of your customers may complain of the poor performance of their smooth-top ranges. It may simply be a case of not being familiar with the small differences between the smooth-top range and conventional electric range. Here, I would suggest you have the customer make a performance check of the unit before making a service call. It won't take too much time, and may save the cost of a service call.

To make a performance check on the small cooking surfaces, set the service control to high for the small element to be checked. Also set the control to high for any two other elements. Allow approximately five minutes for the elements to preheat. While the elements are preheating, fill a 1-1/2-quart saucepan with one quart of tap water at about 60°F. Cover the saucepan and immediately place it on the small cooking surface being checked. Then, time the number of minutes it takes for

with the smooth-top range. It is extremely important that the cooking utensils have flat bottoms. Warped or uneven utensils will cause a loss of heat and slower, uneven cooking. To determine the flatness of a utensil, turn it over and check the bottom with a straightedge such as a ruler. Be sure to rotate the straightedge in all directions as shown in Fig. 10.

Also, in many cases it is recommended that some cooking actually be done with the unit set to off. This uses the retained heat in the heater panel. For example, when perking coffee, bring it to a boil at the highest setting. Then, turn the unit off. The coffee will continue to perk. After the perking is completed, set the control to its lowest setting. This will keep the coffee at serving temperature.

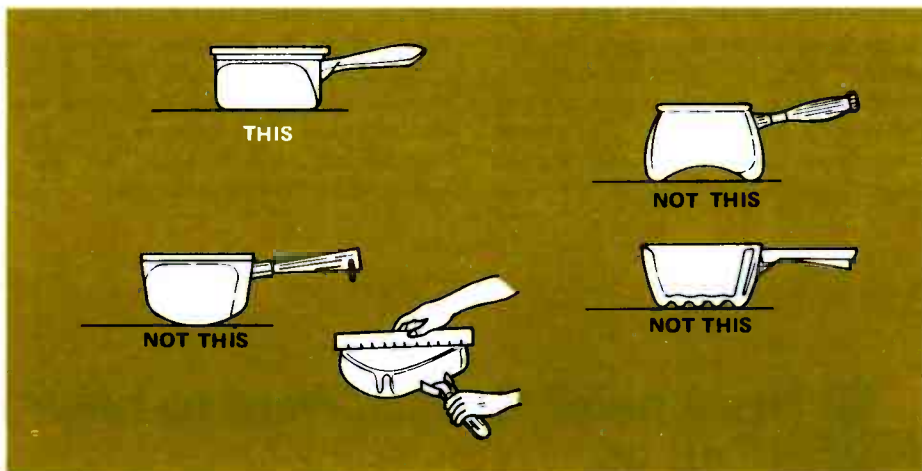
Not only is it important to use a flat-bottomed utensil, but also to use a utensil with a tight-fitting lid. For example, when cooking frozen vegetables, bring the vegetables to a rolling boil at

the highest setting. Separate the vegetables and place a tight-fitting lid on the utensil. If the vegetables are to cook for five minutes or less, turn the unit off. The vegetables will continue to cook from the retained heat in the panel.

To fry bacon and eggs, use a medium-weight aluminum or cast-iron skillet with a flat bottom. Use a medium heat setting. Turn the control off when the bacon is turned to the second side. Pour off the excess fat, add eggs, and a few drops of water. Cover and cook on the retained heat until done.

You should also use a medium-weight skillet or griddle to cook pancakes or French toast. Preheat the utensil at a medium heat setting until a drop of water sizzles. Leave the control at the same setting and place the food on the utensil for cooking. Do not preheat the skillet at high. The heat would be harder to control when turned to the lower setting.

When boiling water, start at a high



Courtesy Amana Refrigeration, Inc.

FIGURE 10. ALWAYS USE UTENSILS WITH A FLAT BOTTOM. YOU CAN CHECK FOR A FLAT BOTTOM WITH A STRAIGHTEDGE SUCH AS A RULER.

heat setting and be sure to use a utensil with a tightly fitting lid. This is especially important for large quantities of water. Large cookers, canners, and boilers must make even contact with the top. Otherwise it will take a long time to reach the boiling point, and the heat held between the pan and the smooth top may overheat the glass-ceramic material. When liquid is just ready to bubble, turn to a lower setting.

This brings up another typical customer question and that is the proper care and cleaning of the smooth top. To minimize cleaning, always make sure the bottom of the cookware and the cooking area are clean and dry before cooking. Select cookware large enough to accommodate the liquid, to eliminate boil-overs and splattering. If possible, wipe up food spill and splatters from adjacent cooking areas.

The basic cleaning method is to regularly use a cleaner conditioner especially formulated for Corning® glass-ceramic. Apply a dab of cleaner/conditioner to the center of each unit to be cleaned. Start with about one-eighth teaspoon of cleaner/conditioner and apply more if needed. Using the cleaner/conditioner every few days will allow you to clean the unit by simply wiping with a clean damp paper towel. After applying the cleaner/conditioner, wipe off with

another clean damp paper towel and wipe dry.

Do not use a wet sponge or cloth to remove spillovers from a warm cooking area. The sponge or cloth may leave a film of soil-laden detergent water on the unit which will turn brown the next time the unit is heated. If this should happen, the cleaner/conditioner will remove it.

Never try to clean the unit with household cleaning products. If stains cannot be removed with the cleaner/conditioner, use only recommended material such as Delete® or baking soda. Never use heavy-duty cleaning powders. These cleansers can scratch the glass-ceramic top.

Servicing smooth-top ranges is not too different from servicing conventional electric ranges. When replacing the heating element assemblies, take care to avoid damage to the alumina silicate castings. The casting is fragile and will break when subjected to undue pressure. Do not install an assembly if there is a break or void in the heater casting. Also keep in mind that if a heating element requires replacement, always check the high limit control for proper calibration with the replacement element installed. Since designs of the elements and their controls vary, the adjustments should only be done according to the service manual.

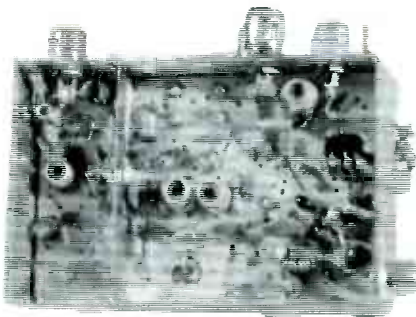
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Call us.**
Red Cross is counting on you.

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& The Advertising Council



Jim Lytle

It has been said that the perfect machine should have absolutely no moving parts. Electronics has gone further than any other science toward realizing that perfection in many of the machines we use in our daily lives. Take wristwatches, for example. Most of you have seen and probably own an electronic watch. It doesn't tick, it doesn't hum—it just goes on silently measuring the passage of time with an accuracy not possible using the wheels, gears, and springs of its mechanical counterpart. Nowhere has the electronic takeover been more complete or dramatic than in the calculator field. Many of us who take our pocket calculators for granted have never even seen, let alone used, the mechanical monstrosities they have almost entirely replaced.



What about television sets? They are just about the most sophisticated unit of electronic equipment you're likely to encounter in any home. Yet, until recently, the very heart of the TV set, the tuner, was always an electromechanical device. The trend now is toward the elimination of this last vestige of mechanical imperfection as more and more sets use total electronic tuning.

Figure 1 shows a block diagram of a typical vhf TV tuner. Its purpose is to select a band of frequencies approximately 6 MHz wide (the desired TV channel), amplify them, and convert them to the standard TV i-f. VHF channels may fall somewhere within the

54-MHz to 216-MHz frequency range. The rf circuits shown in Fig. 1 must tune over this range if they are to

Electronic Tuning

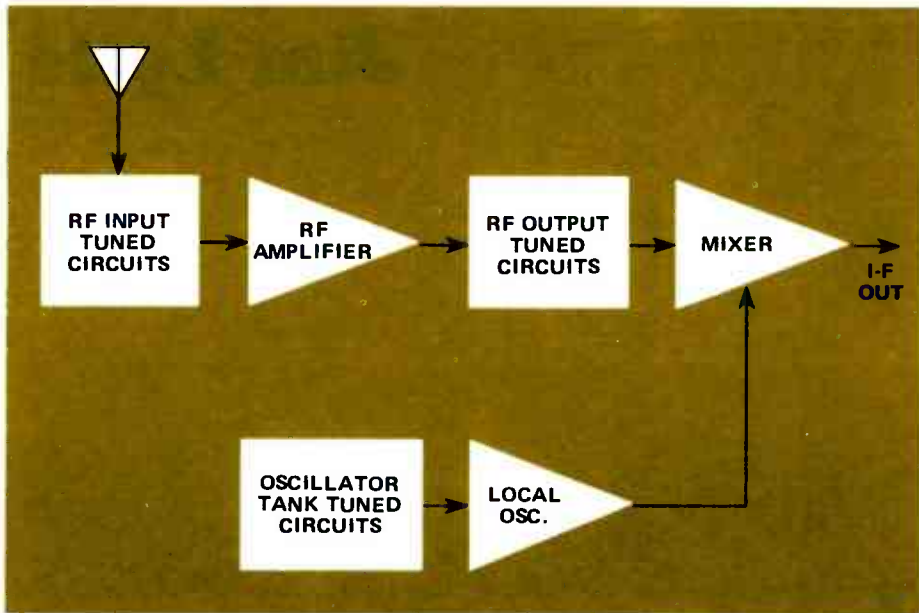


FIGURE 1. BLOCK DIAGRAM OF A TYPICAL TV TUNER.

have the capability of receiving all the vhf channels. The local oscillator tank circuits must also tune over this wide frequency range. Figure 2 illustrates one of the ways in which this tuning is accomplished in mechanical tuners.

All of the inductance in each of the three tuned circuits of the TV tuner is mounted on a 3-section, 13-position rotary switch [Fig.2(A)]. As the switch is rotated through the various channel positions, the proper amount of inductance is selected to resonate with C1 [Fig.2(B)] at the desired frequency.

The tuning arrangement shown in Fig.2 has one major shortcoming. Eventually, the plating on the switch contacts wears off. The result is a poor electrical contact and a good deal of electrical noise. This, of course, degrades the picture.

The tuned circuit of Fig.2(B) is tuned by varying the inductance. Tuning could just as easily be accom-

plished by varying the capacitance of C1. This is the approach taken in electronic tuning systems. However, the capacitor used is somewhat unconventional in that its capacitance can be varied electrically. It is called a varactor diode.

The varactor diode, sometimes called a voltage-variable capacitance diode or varicap, is the solid-state equivalent of the conventional variable capacitor. This solid-state device has the unique characteristic of undergoing a capacitance change with a change in applied bias voltage. To see how this device works, refer to Fig.3.

In Fig.3 you can see the semiconductor structure which makes up an ordinary diode. As you may know, the current carriers in n-type semiconductor material are free electrons, and the current carriers in p-type semiconductor material are holes. In the vicinity of a

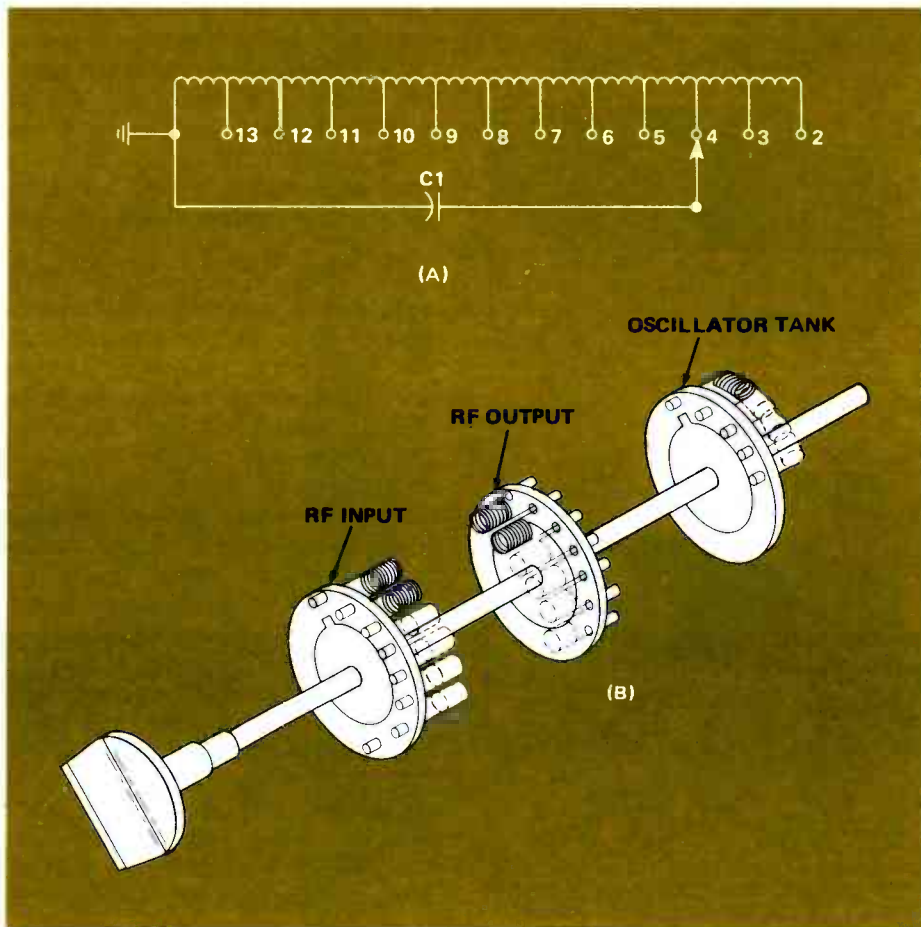


FIGURE 2. ILLUSTRATION SHOWING THE METHOD OF TUNING EMPLOYED IN SOME MECHANICAL TUNERS.

pn junction, some of the free electrons in the n-type material move across the junction to fill holes in the p-type material. This movement results in an area centered about the pn junction where no free current carriers exist. This area, called the *depletion region*, has the characteristics of an insulator.

Since those portions of the device outside the depletion region still contain their free current carriers, they retain their characteristics as conductors. What we have, then, are two conductors separated by an insulator, which just

happens to describe a capacitor. All pn junctions have some capacitance, and in most cases this is a nuisance. In the case

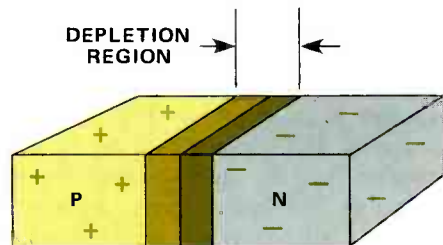


FIGURE 3. A PN JUNCTION SHOWING THE DEPLETION REGION.

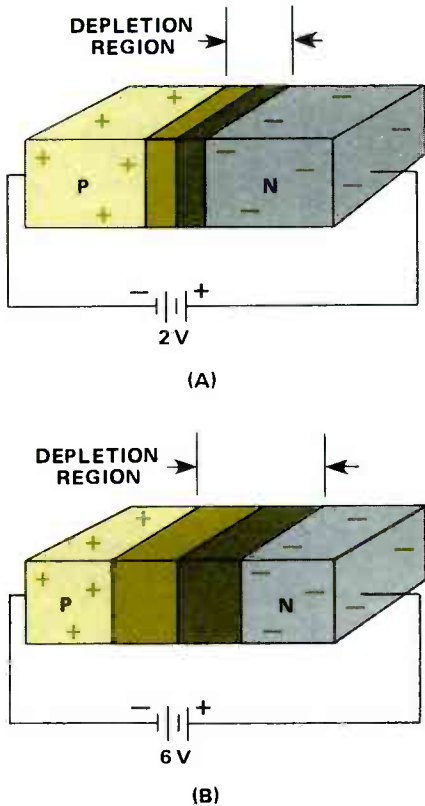


FIGURE 4. PN JUNCTIONS SHOWING THE EFFECT OF REVERSE BIAS ON THE WIDTH OF THE DEPLETION REGION.

of a varactor diode, however, this capacitance is the most important characteristic of the device.

We know that the value of a capacitor is dependent upon (among other things) the distance between its plates. Increasing this distance decreases capacitance and vice versa. Referring to Fig.4(A) you can see that we have applied a small reverse bias to a pn junction. The result is that the current carriers in the p-type and n-type materials are drawn away from the junction, effectively widening the depletion region. This means that there is a greater distance between the “plates” and, therefore, decreased junction

capacitance. In Fig.4(B) a larger reverse bias is applied, which widens the depletion region still more and further decreases junction capacitance. If we decrease the reverse bias, the depletion region narrows, the “plates” are closer together, and the capacitance increases.

Figure 5 shows how the varactor diode is used in a tank circuit. Capacitor C1, in conjunction with the capacitance of the varactor diode, resonates with L1 at some frequency. The reverse bias on the varactor is determined by the setting of R1. Moving the arm of R1 upward picks off a more positive voltage, thereby increasing the reverse bias on the varactor. This causes its capacitance to decrease and the resonant frequency of the tank circuit to go up. Moving the arm of R1 downward decreases reverse bias, increases capacitance, and lowers the resonant frequency of the tank.

If all the tuned circuits in the tuner of Fig.1 were of the type shown in Fig.5, we would have an electronic tuner like the one shown in Fig.6(A), channel switching being accomplished by adjusting a single potentiometer.

The disadvantage of this circuit is that you must tune through all the

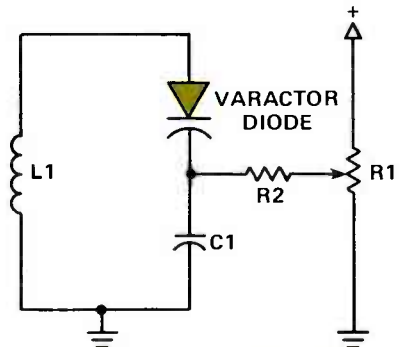


FIGURE 5. BASIC ELECTRONICALLY TUNED TANK CIRCUIT.

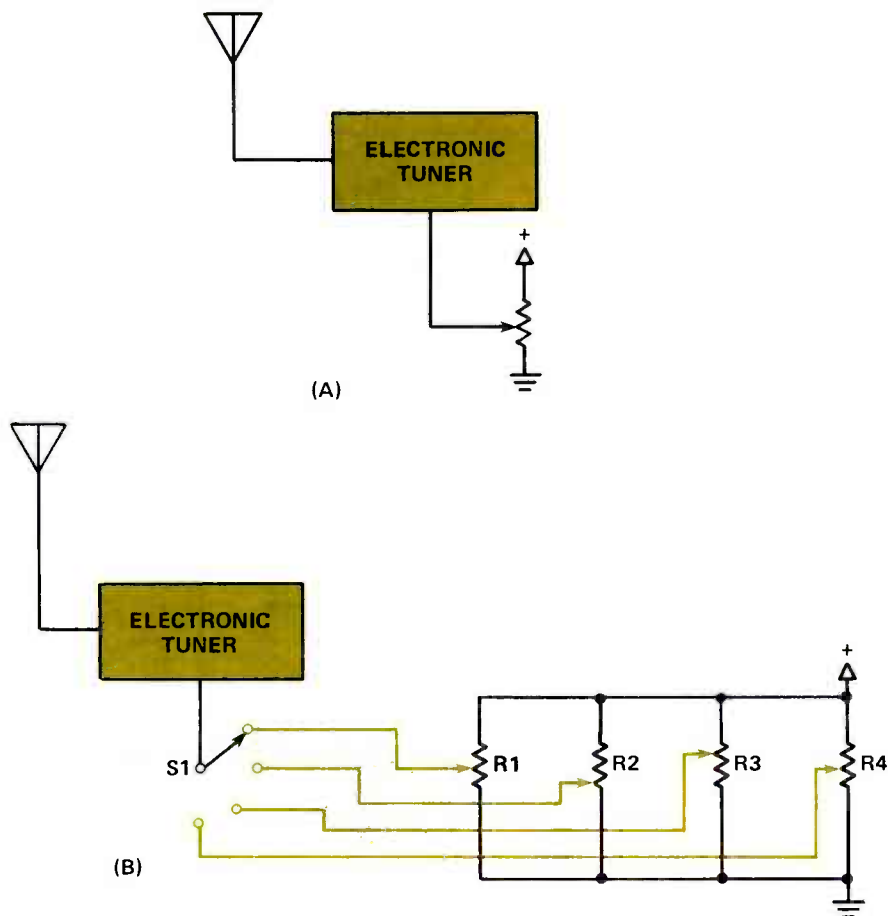


FIGURE 6. BASIC ELECTRONIC TUNING SYSTEMS.

channels in the spectrum sequentially. That is, if you were tuned to channel 4 and wished to go to channel 8, you'd have to tune through channels 5, 6, and 7 before you came to 8. (Unless, of course, you went around the other way - 4, 3, 2, 13, 12, 11, 10, 9, 8.)

The arrangement shown in Fig.6(B) partially overcomes this disadvantage. Here, up to four different channel selection voltages can be preset with R1 through R4. By rotating the selector switch, you can select, in turn, each of the four preset channels. Some manufacturers actually use this kind of tuning

system, with up to 16 potentiometers. As many as 16 different channels can be preset in this manner. Using this tuning method, only the channels active in a given area need be selected.

Although the system illustrated in Fig.6(B) is in use, it really doesn't solve the basic problem of mechanical tuners. The switch contacts are just as likely to eventually cause trouble here as they are in the old tuners.

The tuners themselves are all quite similar in the various electronic tuning systems. Variations from one

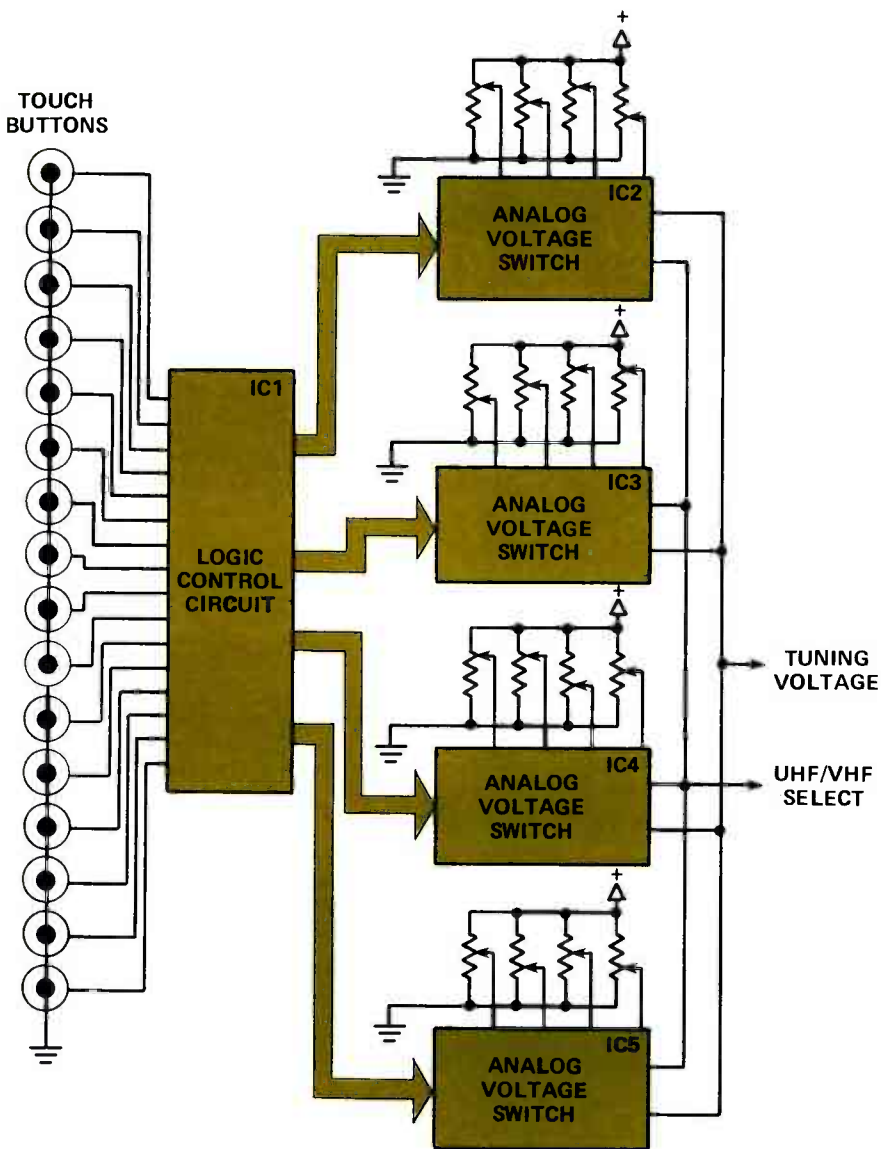


FIGURE 7. A PRACTICAL ELECTRONIC TUNING SYSTEM WITH 16 PRESET CHANNELS.

system to another are more a matter of *how* the tuning voltage is derived.

We've seen that the simplest and most direct method of obtaining the tuning voltage is from a potentiometer connected from a voltage source to ground. The more potentiometers used in a system, the more channels.

Figure 7 shows a practical electronic tuning system that uses preset potentiometers to obtain the tuning voltages for 16 channels. In response to a signal from one of the touchbuttons, the logic control circuit selects one of the analog voltage switches and one of the potentiometer inputs to that switch. The

voltage from the selected potentiometer is then applied to the tuning voltage line. In this manner a unique tuning voltage may be selected by each of the touchbuttons.

The touchbuttons consist of two concentric metal rings molded into a plastic panel on the front of the TV set. All of the inner rings are connected to ground, while each of the outer rings is connected to one of the inputs of the logic control circuit. When you touch one of the buttons with your finger, an electrical path is completed between the inner and outer rings through your fingertip. They are actually electronic pushbuttons with no moving parts

Another feature which you may have noticed in the system of Fig.7 is the uhf/vhf select line. The tuning voltage is applied to both the uhf and vhf tuners simultaneously. However, only one of the tuners will have an operating voltage applied at any one time. Actual B+ switching is accomplished by the signal on the uhf/vhf select line. The signal to

select either the uhf or vhf tuner is generated by connections made at the analog switches during initial setup of the system.

The system shown in Fig.7 contains five integrated circuits and is relatively simple as these systems go. It is probably the most popular electronic tuning system in use today. Figure 8 shows a system which uses a different method of obtaining a tuning voltage. Let's see how this system works by going through an initial setup routine.

With S2 set in the "manual" position, we can tune the TV set manually with R1. Let's say we adjust R1 until we receive channel 13. The voltage from R1, besides being fed to the tuner, is also applied to an analog-to-digital converter. This circuit converts the tuning voltage to a digital "word," which is then applied to the 16-word memory.

Next, we depress the numbers 1 and 3 on the key-pad. The key-pad signal is converted to a digital signal by the BCD

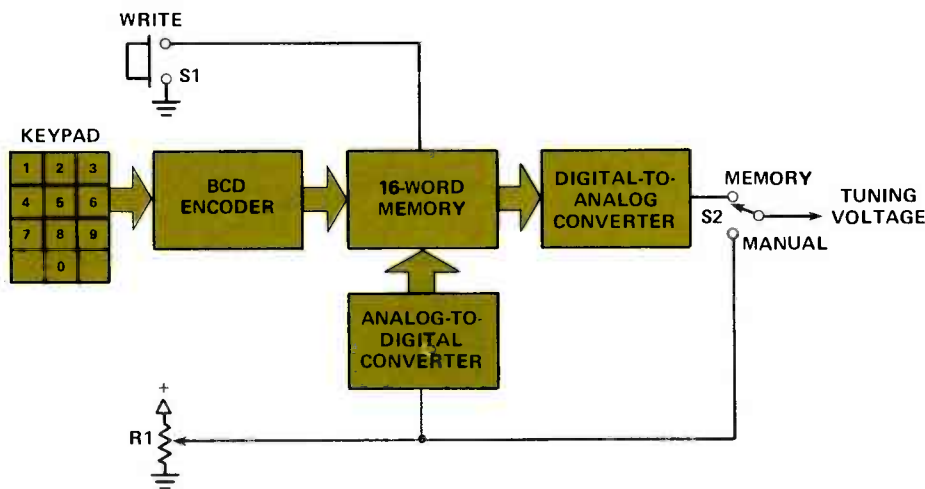


FIGURE 8. AN ELECTRONIC MEMORY TUNING SYSTEM.

encoder and applied as an address to the 16-word memory.

Now, we momentarily depress the "write" button which stores the digital word representing the channel 13 tuning voltage into location 13 of the memory.

Once the system has been initialized in this manner, S2 is set to the memory position. The desired channel number is entered by way of the key-pad and becomes an address for the 16-word memory. The digital word stored at that address is applied to the digital-to-analog converter where it becomes the required tuning voltage for the selected channel.

The memory in the system of Fig.8 retains the tuning information only as long as power is applied. For this reason, a tuning circuit such as this one

must always remain powered, even when the TV set is turned off. Sets which have this type of electronic tuning are usually equipped with a small battery which preserves the tuning information in the event of a power failure, or if the TV set is temporarily unplugged for some reason.

In this article we've discussed several electronic tuning systems representative of those in use today. As these systems become simpler and cheaper, they'll be used on more and more TV sets and even radios. Eventually, all of the tunable electronic devices in our homes will take that final step toward mechanical perfection.

Helpful Hints

No.13

Not too long ago, it was possible to buy blank cassette tapes in standard lengths of 15 minutes per side, 22.5 minutes per side, 30 minutes per side and 45 minutes per side. These cassettes are referred to as C30, C45, C60 and C90 respectively. Newer manufacturing technology now allows enough tape to be put into the standard cassette to allow a full hour of recording on one side of the tape (C120). At the same time, the shorter tapes (C30 and C45) are becoming less and less available.

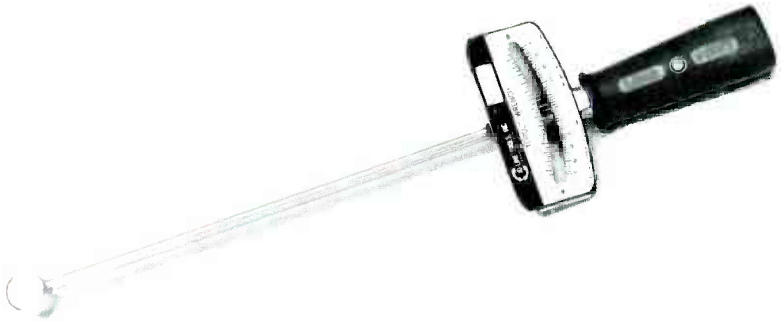
For many applications we do not need or want the long tapes, yet we cannot buy the shorter ones from the major manufacturers. Here is how you can overcome this problem.

Lafayette and Radio Shack offer an inexpensive (about \$5) cassette splicing machine. Using this machine

you can make cassette tapes of any length you would like. The procedure is to record whatever you wish on a good quality tape of your choosing, then splice the recorded tape into another cassette housing. To get the extra cassette housing, shop around for some "bargain" tapes at discount stores, remove and discard all the tape from the housings, leaving only the leaders at the ends attached to the spools inside the housing.

I have been able to buy "junk" tape at three C60's for a dollar, giving three housings for thirty cents each, which I use primarily to hold short computer programs. The short, custom tapes can also be used to record "singles" or a selection of your favorite musical pieces.

—Ted Beach



Almost everyone who has ever worked on engines or machinery has, at one time or another, twisted off a bolt.

torque wrench is the tightening of a bolt.

TORQUE

You are putting something back together and you want to make sure the bolt is tight enough. You give the

This article is not concerned with *how* to use a torque wrench, but rather what this tool is intended to do and *why*. To understand *why*, we have to know more about the characteristics of bolts and other threaded fasteners.

WRENCHES

wrench one more hard turn and the bolt lets go. You have not only a broken bolt, but probably some badly skinned knuckles as well. The tool that is designed to prevent these problems is the torque wrench.

We will confine ourselves to steel fasteners of the kind commonly used for the assembly of internal combustion engines.

The torque wrench that is commonly used today is really a type of measuring tool. It is a tool that can be compared with the micrometer, dial indicator, vernier caliper, and other accurate measuring devices. It is calibrated or set in such a way as to make possible the measurement of the resistance to turning. Torque is the force which tends to twist a body about an axis of rotation. A typical application of the

Steel bolts come in a wide variety of shapes and sizes, but there are only two main features that determine how strong a bolt is. These features are the type of steel used to make the bolt and the cross-sectional area of the shank of the bolt. Within reason, the length of the bolt and the number of threads is of little importance in determining how tightly a bolt will hold two objects together.

Edward Cochran






Fine or Coarse Thread Fastener	Grade Designation	Tensile Strength (minimum)	Material	Tensile Strength by Bolt Diameter		
				1/4 inch	3/8 inch	1/2 inch
 Cap Screw	S.A.E. 2 steel	04,000 p.s.i.	Low carbon steel	3142	7069	12,566
 Cap Screw	S.A.E. 3 steel	100,000 p.s.i.	Medium carbon steel	4909	11,045	19,635
 Cap Screw	S.A.E. 5 steel	105,000 p.s.i.	Medium carbon steel or low alloy heat-treated	5154	11,597	20,817
 Cap Screw	S.A.E. 6 steel	133,000 p.s.i.	Medium carbon steel, quenched and tempered	6529	14,689	26,114
 Cap Screw	S.A.E. 7 steel	133,000 p.s.i.	Medium carbon alloy, quenched, tempered, roll threaded	6529	14,689	26,114
 Cap Screw	S.A.E. 8 steel	150,000 p.s.i.	Medium carbon alloy, quenched, tempered	7363	16,567	29,452

FIGURE 1. TENSILE STRENGTHS OF SOME COMMON BOLTS.

Tension is a stretching force. When you stretch a rubber band, you are applying tension. The more tension you apply, the more the rubber band stretches. If you apply too much tension, the rubber band will break since you have exceeded its elastic limit.

A bolt is much like a rubber band. When tension is applied, the bolt will stretch, and when the tension is released the bolt will return to its original length. Also, if enough tension is applied to exceed the elastic limits of the steel, the bolt will fracture or break. The critical point here is to know how much tension a bolt can stand and how to apply the desired tension accurately.

The tensile strength of a bolt is measured in pounds and tells you how much tension the bolt can stand before it fractures. Tensile strength is determined by the type of steel used and the heat treatment that is applied during manufacturing. You will usually find

that the stronger the bolt, the more expensive it will be.

Figure 1 shows the strengths of some common bolts made of six different grades of steel. The type of steel used to make the bolt is indicated by the marks on the bolt head. The more marks, the stronger the bolt. The tensile strength of stock steel is measured in *pounds per square inch* (psi). Since no common bolt has a shank cross-sectional area of one square inch, you must use a conversion factor to find the tensile strength for each size. The following are cross-sectional areas of some common sizes:

1/4 inch	= 0.049 square inch
5/16 inch	= 0.077 square inch
3/8 inch	= 0.110 square inch
7/16 inch	= 0.150 square inch
1/2 inch	= 0.196 square inch
5/8 inch	= 0.306 square inch
3/4 inch	= 0.442 square inch
7/8 inch	= 0.601 square inch
1 inch	= 0.785 square inch

ASSEMBLY CHARACTERISTICS

At one time or another, everyone has seen metal fatigue. Take a piece of sheet metal like the lid of a tin can and bend it. Then, straighten it out and bend it again. Repeat this enough times and the metal will break at the bend. It has failed from metal fatigue because each time it was bent, part of the metal was stressed beyond its elastic limit.

Bolts can also fail from metal fatigue if they are repeatedly subjected to varying tension loads. Areas where this kind of varying load occurs in an internal combustion engine are the connecting-rod bearing-cap bolts and head bolts.

Figure 2 shows two steel plates held together with a bolt and nut. The bolt has been tightened until the initial tension is 1500 pounds. This means there is a 1500-pound force between plates A and B.

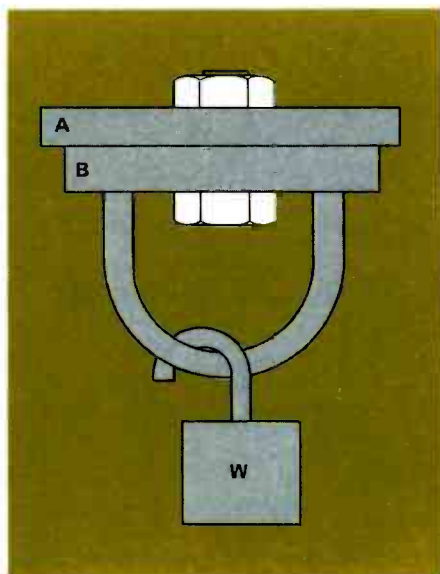


FIGURE 2. A RIGID ASSEMBLY.

Now, we hold plate A stationary and suspend a 1000-pound weight from plate B. The bolt now supports the 1000-pound weight and still exerts a 500-pound force between plates A and B. The tension in the bolt has not changed.

If a 1500-pound weight were used instead of 1000 pounds, the tension in the bolt would not be increased appreciably, but the force between the plates would be reduced to practically zero. Therefore, the bolt is not likely to be subjected to fatigue because there is no increase in tension due to the external load.

If W were increased to 2000 pounds, the bolt would be required to support a load of 2000 pounds. This is an increase in tension of 500 pounds over the initial tension of 1500 pounds. If the load is a fluctuating load, the tension in the bolt can vary widely. If the fluctuating load is applied for a long enough time, the bolt will fail from fatigue.

The assembly shown in Fig. 2 is called a rigid assembly. Plates A and B are clamped together, metal-to-metal, without a gasket. This would be like a bearing cap bolted to a connecting rod.

Figure 3 shows the condition which exists when a gasket is placed between plates A and B. This is called a flexible assembly. To illustrate this, a coil spring has been shown between plates A and B in place of a gasket. Again, the bolt has been tightened until an initial tension of 1500 pounds is created in the bolt.

Now, if a 1500-pound weight is suspended from plate B, the bolt will stretch slightly, but this slight stretch will not appreciably reduce the load of 1500 pounds exerted by the spring. The bolt will have to withstand a load of 3000 pounds. The cylinder head to cylinder block assembly of an internal combustion engine is an example of a flexible assembly with a gasket. In a flexible assembly it is impossible to

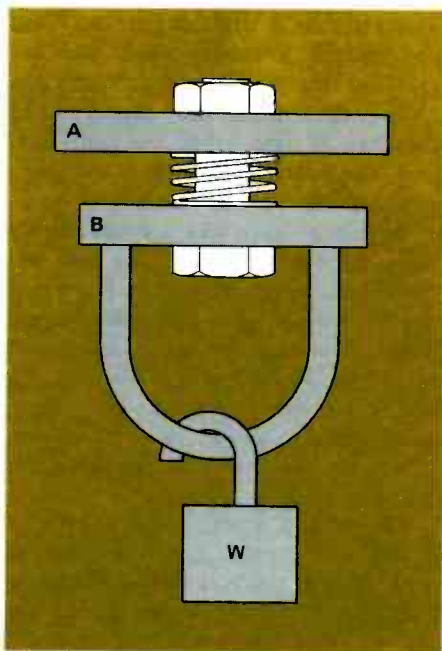


FIGURE 3. A FLEXIBLE ASSEMBLY.

eliminate a fluctuating stress in the bolt. The length of time before fatigue failure can be extended by using larger and stronger bolts.

TENSION AND TORQUE

We've talked about bolts, and how they work in an assembly. It should be apparent that initial tension, or preload, is very important if a bolt is to do its job properly. This job normally is to hold parts of a machine together. We'll leave choosing the type and size of bolt and determining the initial tension to the designer of the machine. However, the service technician is often faced with reestablishing initial tension when a machine has been disassembled for repairs and is being put back together.

There are several ways to determine initial tension in a bolt. One way is to

measure how much a bolt stretches when it is under tension. A bolt will stretch approximately 0.001 inch per inch of length for each 30,000 pounds per square inch tensile stress that is created.

Suppose we have a 1/2-inch stud bolt as shown in Fig.4. If the bolt is tightened to 5880 pounds tension ($0.196 \times 30,000$), the bolt will stretch 0.001 inch as measured at L. This is a clumsy method at best and impossible in most circumstances.

A much simpler way is to use a torque wrench. There is a direct relationship between the torque required to tighten a bolt and the tension created in the bolt. The more torque used to tighten a bolt, the more tension created in the bolt. This is true regardless of the size of the bolt or the type of wrench used. The advantage of the torque wrench is that it lets you measure accurately how much torque you are applying, and therefore the bolt tension.

Torque specifications are provided for almost all machines that have a need for preloading bolts. These specifications have been determined by the manufacturer and should always be adhered to.

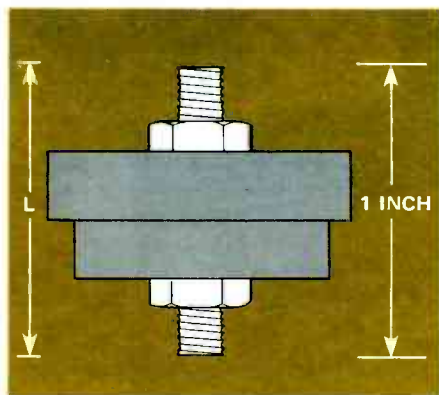


FIGURE 4. MEASURING THE STRETCH OF A BOLT.

Bolts should be chosen that will be working close to the recommended maximum tension with enough pre-load to prevent early failure from stress fatigue. Larger bolts are wasteful and smaller bolts will fail quickly.

If you do not have specifications, there are a number of tables available that give typical torque values for different sizes and types of bolts. If you do not have a table, and know the initial tension desired, you can find the approximate torque required by using the formula

$$T = 0.2 \times D \times L$$

where

T = torque in inch-pounds

L = initial tension in pounds

D = bolt diameter in inches

For example, you want 5000 pounds initial tension using a 3/8-inch mild steel bolt.

$$T = 0.2 \times 0.375 \times 5000$$

$$= 375 \text{ inch-pounds}$$

$$= 31.25 \text{ foot-pounds}$$

There are several things that affect the torque required to arrive at the desired bolt tension. One is the number of threads per inch. A fine thread will require about 5 percent more torque than a coarse thread. The reason is that a fine thread has a larger thread area and thus more friction is present when the threads are under tension.

The recommended torque given in most specifications is for new steel bolts. New bolts still have a residue of oil after the manufacturing process that acts as a lubricant. Using engine oil on

the bolt threads will not change the torque required. Graphite mixed with heavy oil used as a lubricant will reduce the required torque by about 5 percent. It is just as important to lubricate under the bolt head and under the nut as it is to lubricate the thread.

When you have a cadmium-plated bolt, use 90 percent of the torque recommended for a steel bolt. If the bolt and nut are both cadmium-plated, use 80 percent of the recommended torque. This is because cadmium plating acts as a lubricant.

We have referred to bolts throughout this article, even though the information refers to all threaded fasteners. This includes machine screws, bolts with nuts, studs, and cap screws. Although we have used steel bolts in the examples, other metals such as brass and aluminum, which are also used for threaded fasteners, follow the same principles. There are special charts for torque values for these materials. The main thing is to get the initial tension correct so you will get the longest life from a bolt or other threaded fastener.

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It is the goal of most NRI students to begin a business of their own, either on a full-time or part-time basis. The NRI courses are designed to allow you to do just that.

The principal goal of any business is to make a profit. In fact, the success of a business is judged by how profitable it is. You could have a booming business with several hundred customers and still lose money. You must make a profit or you won't be in business very long.

As an NRI student or graduate, you are—or probably soon will be—employed in a service business. That is, you will be selling a service such as repairing television sets, appliances, air conditioners, engines, or automobiles. You may also be selling a product such as tubes, replacement parts, or a variety of other small items. But unless you are able to maintain a high product volume, the primary source of your profit will be from your service business.

Your costs for servicing a customer's television receiver, appliance, or automobile can be broken down into three major categories: parts, minimum service charge, and labor. There is only a small profit in replacement parts. You buy a part at cost from a wholesaler, and charge a customer the retail price for the part. Unless major repairs are done, your profit from replacement parts on most jobs will not amount to more than a few dollars.

A minimum service charge is a set fee which is charged, even if the repair takes only five minutes. For in-shop repairs, this charge may be nominal. For service calls made to a customer's home, the

charge might be in the neighborhood of \$20 to \$30, and include the first half-hour's labor.

Labor is where the money is and labor charges will either make or break you. Labor charges can be broken down into direct cost, overhead, and profit. The direct labor cost is how much your time is worth or how much you pay your employees per hour. If you pay an employee \$5 an hour, and charge your customers only \$6 an hour for labor, you won't be in business long. You must consider your overhead.

Overhead is the cost of the many expenses incurred by your business over a given time. Table 1 is a list of items which may be included in overhead and the estimated costs for a small service shop. If you have been in business for some time, you have a pretty good idea of what these costs are for your particular situation. If you are just starting out, you will have to estimate these costs. If you do estimate, it is better to overestimate than underestimate.

Once you have estimated your overhead costs, you must distribute them so that each service job will pay a

Table 1

Item	Monthly Expense
Rent	\$150
Depreciation of equipment	50
Advertising	35
Insurance	15
Car or truck operation	50
Utilities	100
Taxes, permits, etc.	10
Miscellaneous	30
Total	\$440

share of overhead. For example, suppose you begin by estimating you will spend 100 hours per month doing actual service work. If your monthly overhead expenses are \$440, then the overhead cost per hour is:

$$\begin{aligned} \text{Overhead per hour} &= \frac{\$440}{100 \text{ hours}} \\ &= \$4.40 \text{ per hour} \end{aligned}$$

This means that in addition to whatever your direct charge for labor is, you must add an additional \$4.40 per hour to cover your overhead expenses. In addition, you will have to add the amount of profit you wish to make on an hourly basis. Remember, it is always a good idea to check with competing shops to determine if your charges are in line with theirs.

In equation form, your labor charges can be written as

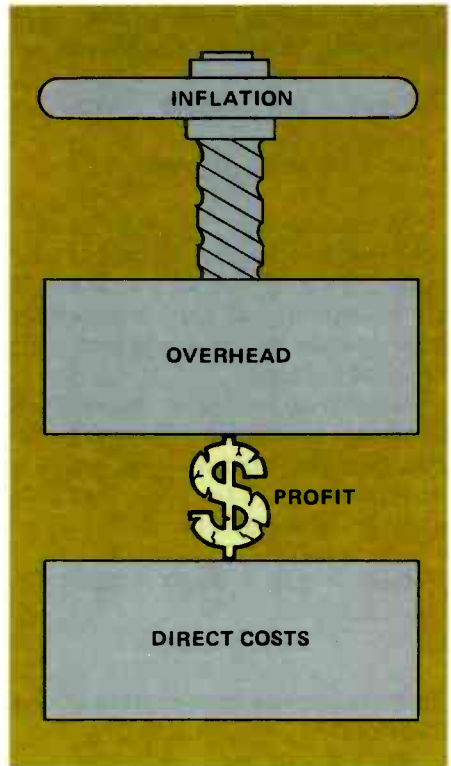
$$\begin{aligned} \text{Labor charges} &= \text{direct cost} \\ &+ \text{overhead} \\ &+ \text{profit} \end{aligned} \quad (1)$$

Solving this equation for profit,

$$\begin{aligned} \text{Profit} &= \text{labor charges} \\ &- \text{direct cost} \\ &- \text{overhead} \end{aligned} \quad (2)$$

By looking at this form of the equation, you can see that if you reduce your overhead, your profit will increase. Many service technicians do not fully understand the importance of controlling overhead expenses. They have the opinion that "if my overhead goes up, so what? I'll just pass the increase on to my customers." Sure, you can pass the increase on to your customers, but think carefully before you do it.

Increasing your overhead means that you have to charge more for your services. If you are in a competitive



marketplace, you may price yourself out of business. Consumers are more price-conscious now than ever before. They shop around to get the best "deal." If they find they can't get it from you, they will get it from someone else. Thus, increasing your overhead will increase your costs, and will result in fewer customers.

By looking at Eq.2, you can see exactly what must be done if you wish to maintain the same profit margin even though your overhead increases. For example, suppose your labor charges are \$15, your direct labor costs are \$6.60, and your overhead is \$4.40. Then by Eq.2 your profit would be:

$$\begin{aligned} \text{Profit} &= \$15 - \$6.60 - \$4.40 \\ &= \$4.00 \text{ per hour} \end{aligned}$$

Suppose now your overhead went up to \$6 an hour. Now your profit would be:

$$\begin{aligned}\text{Profit} &= \$15 - \$6.60 - \$6.00 \\ &= \$2.40 \text{ per hour}\end{aligned}$$

As you can see, an increase in overhead results in a direct decrease in your profits. Thus, if you wish to maintain the same profit, you must increase your labor charges by the amount of your overhead increase.

However, a decrease in overhead will result in a direct increase in your profit. For example, suppose your overhead decreases to \$3.50 per hour. Then your profit per hour would be:

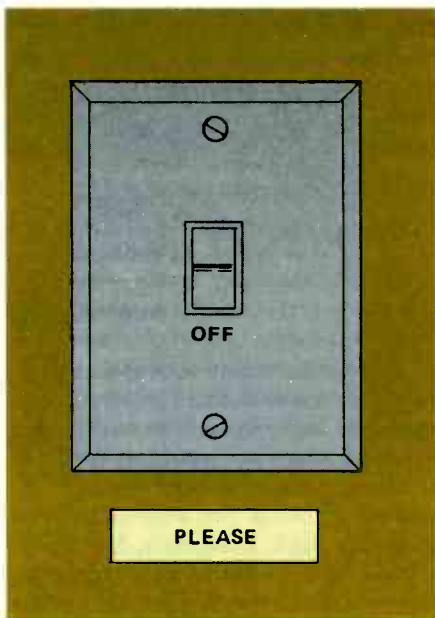
$$\begin{aligned}\text{Profit} &= \$15 - \$6.60 - \$3.50 \\ &= \$4.90 \text{ per hour}\end{aligned}$$

That's an increase in your profit of over 20 percent.

As you can see, controlling your overhead is extremely important. If you look back at Table 1, you can also see that many of your overhead costs are fixed. For example, there isn't much you can do to change your rent or insurance premiums. However, two items you can control are vehicle operation and utility costs. A very practical way of reducing these costs is through a program of energy conservation.

Certain energy conservation measures, such as the installation of additional insulation, can be quite costly. If your business is small, you may not be able to afford such an investment. However, many energy conservation measures are very simple, and can be done with little or no investment of additional money.

For example, you can probably reduce your lighting costs by 25 percent with little, if any, investment. Although lighting costs may only be about 10 to



20 percent of your total utility bill, lighting conservation offers immediate energy and dollar savings. Turning off lights or equipment when they are not in use is the most obvious method of lighting conservation. The most common culprits are the lights in storage areas or lavatories, which are left on all the time and should be on only when in use. A simple sign saying "turn it off" can be used as a reminder to conserve electrical energy.

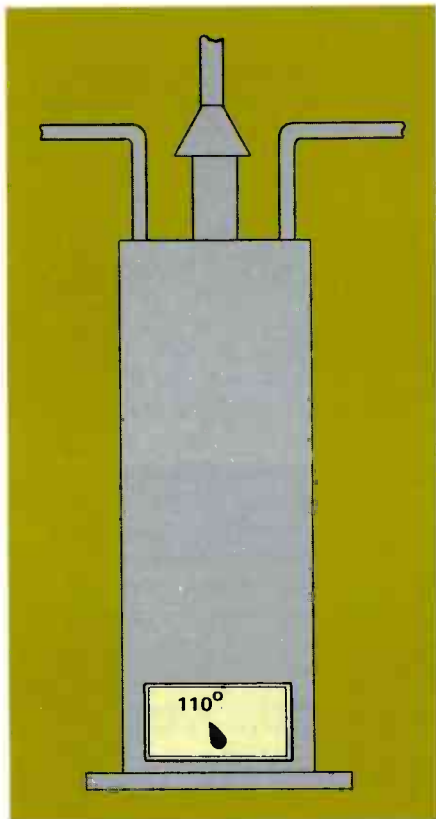
Look around your shop or home. How many sockets have bulbs which could be replaced by one of a smaller wattage? Also, did you know that a fluorescent lamp is about three times more energy-efficient than a standard incandescent bulb? A 25-watt fluorescent lamp will deliver as much light as a 100-watt incandescent bulb. In addition, a fluorescent lamp will last two to three times longer than an incandescent bulb. Perhaps you have seen "long-life" bulbs or are using these types of bulbs in some of your fixtures.

Long-life incandescent bulbs produce less light per watt than standard incandescent bulbs. In other words, a 100-watt standard incandescent light bulb will give off more light than a long-life incandescent bulb and is thus more energy-efficient.

Another important method of energy conservation is temperature control. Turning down a thermostat at night or when the shop is not in use can reduce your utility costs considerably. If you do not like the idea of entering a cold shop in the morning, consider installing a clock thermostat which will automatically turn the heat back up before you arrive. These thermostats now have quartz clocks which utilize rechargeable batteries. The batteries are recharged when the circuit is open. It is very simple to install this type of thermostat and no additional wiring is needed. Your fuel bill will drop approximately one percent for every degree you dial down at night.

Another way to conserve energy that is often overlooked is to keep your service vehicle, whether it's a van or a tow truck, properly tuned. It's amazing how much additional fuel is used by an engine that is not running properly.

If you have a separate water heater, check the temperature of the water coming from the tap. Water in the home should be around 140°F, but water in the shop need only be heated to a



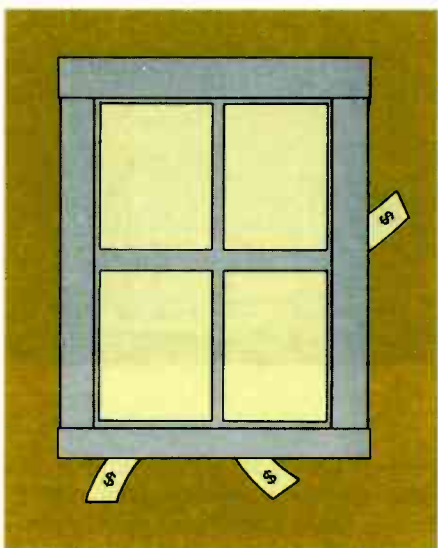
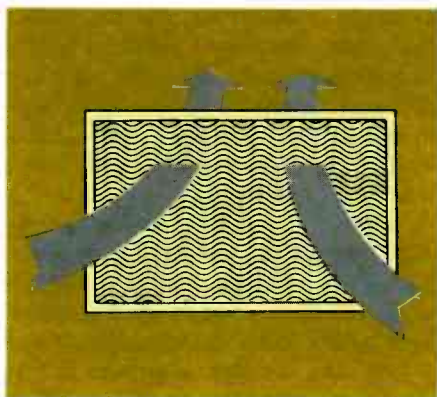
temperature that is comfortable for washing hands—approximately 110°F. In the shop, water from the hot water tap should not have to be mixed with cold water to achieve a comfortable temperature. A lower thermostat setting will also prolong the life of your heater.

Also check for leaky faucets, and replace the washer if necessary. A faucet leaking at a rate of one drop per second will waste over 60 gallons of water per week. If it's from the hot water tap, that's 60 gallons of hot water you're heating but will never get to use.

Infiltration is often a neglected problem in a shop. Infiltration is the entry of outside air into the shop through cracks around windows and



doors. Television service shops are notorious for running antenna leads outside under windows and leaving a crack for the air to enter. Windows and doors should be weatherstripped to reduce air infiltration. One-quarter inch of free open space exposed to a wind underneath a window may result in an additional heating cost of from \$40 to \$60 during a heating season. Also check around the outside of your doors and windows, and caulk them if necessary. In order to caulk, the outside temperature should be above 45°F.



Be sure to change or clean any air filters you may have in your heating or cooling system regularly. Whatever you do, don't remove a filter permanently to get more air or just so you won't have to bother changing it. Permanent removal of the filter will allow dust and dirt to build up on the heat exchangers of your unit, and the efficiency of the unit will be reduced considerably.

The energy conservation measures described here are simple to check and will cost you very little, or nothing, to implement. Yet, these simple measures may save you as much as \$25 per month in utility and vehicle operating costs. Twenty-five dollars per month is \$300 per year, and that \$300 is pure profit for you.

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Ham News



Ted Beach
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Last Fall I was asked to give a technical talk at a symposium of radio amateurs in the Washington area. As a topic for the talk, I decided to use my favorite subject: using integrated circuits in amateur applications.

This in itself does not sound particularly interesting; however, the *types* of ICs that were the subject of the talk were types that are used in TV and audio circuits and *not* generally considered for use in amateur equipment. Generally, I used ICs in ways not originally intended by the manufacturer. Although I discussed several different ICs at the symposium, I will give you a couple of uses of one particular IC here. This is to whet your appetite and perhaps stimulate your interest enough to do a little investigating on your own. After all, that's part of what amateur radio is—to investigate and experiment.

The particular device that most intrigues me for use in amateur applications is the quite common TV audio i-f system. There are many different versions of these chips, but generally they will all have similar circuitry inside. There will be a high gain i-f amplifier/limiter, some sort of quadrature detector and perhaps an audio amplifier or preamplifier. In addition, there will usually be some sort of power supply regulator that may perhaps be used externally in addition to supplying regulated voltages for the circuits within the IC. Another possibility is an electronic attenuator built in so that the audio level can be controlled remotely using a single, unshielded lead in which the audio signal is *not* present—a decided plus.

Figure 1 is a block diagram of the IC I will be discussing, shown connected as it would be in its "normal" configuration in a TV FM audio system. This is an RCA CA3065.

The AMP LIMITER block requires a

low dc impedance between its two input terminals, one of which is ac grounded by a bypass capacitor. This stage has a gain of 67 db up to a frequency of about 5 MHz, at which point the gain falls so that at 10 MHz it has a gain of only about 35 db. (The device was designed to operate at 4.5 MHz.) Even at a frequency as high as 10.7 MHz, this i-f amplifier will provide useful gain, so it can be used at the "usual" amateur intermediate frequencies of 455 kHz, 9 MHz, or 10.7 MHz.

In the FM application, the i-f signal is applied to one input of an internal balanced mixer and to an external quadrature detector tank circuit. This circuit effectively shifts the phase of the i-f signal 90° before passing the signal to the second input of the balanced mixer.

The output of this mixer goes to the electronic ATTENUATOR, which incorporates the FM de-emphasis capacitor, and produces a 100 mv audio signal at AF OUT 1. This output stage is an emitter follower having an output impedance of around 150 ohms.

The audio signal is capacitively coupled to the AF IN pin of the AF AMP. This independent circuit has a fixed gain of 21 db, flat to 1 MHz! The AF OUT 2 pin is also an emitter follower having an output impedance of about 150 ohms. The middle pin of the AF AMP is for the connection of a series-connected RC network which is used as a tone control to roll off the high frequencies.

The actual connections within the AF AMP are such that the AF IN and

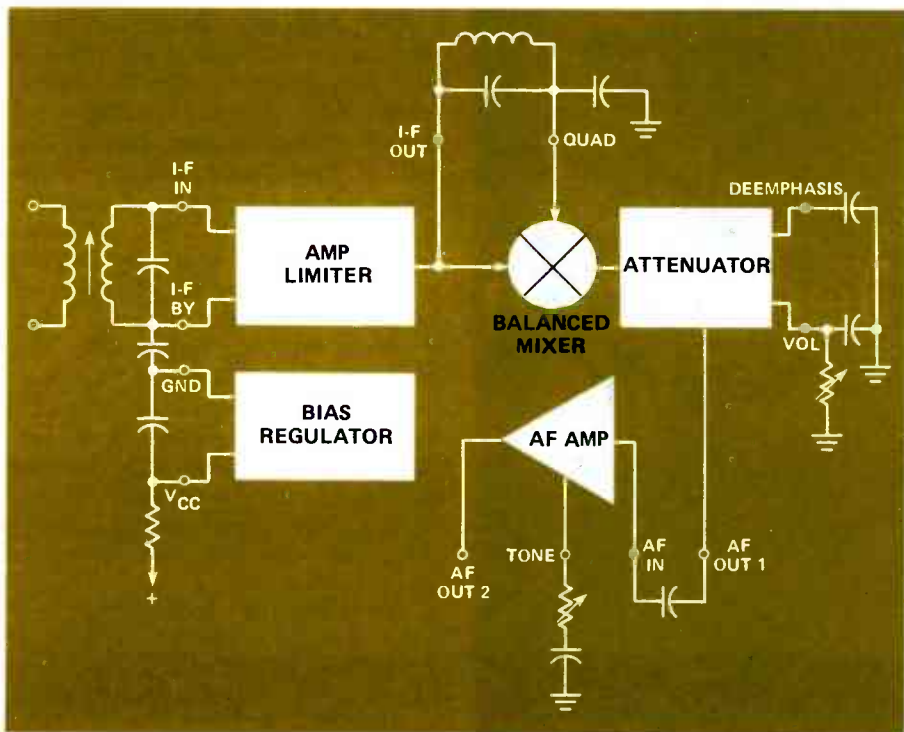


FIGURE 1. BLOCK DIAGRAM OF THE CA3065 TV-I-F SOUND SYSTEM.

TONE pins are the base and collector of a Darlington-connected common-emitter amplifier, with all biasing being taken care of internally. This stage is direct-coupled to the output emitter follower.

Now, how can we use this device in amateur applications? Well, one way is to use the chip as an i-f amplifier/converter in a general purpose receiver setup. The first (high) i-f signal at 10.7 MHz or 9 MHz is transformer-coupled to the AMP LIMITER as in Fig.1. The quadrature tank is *not* connected. Instead, we measure the dc voltage at the (open) IF OUT pin (usually around 4.5 volts) and connect a resistive divider network from AF OUT 2 to ground such that the dc voltage at the junction of the two resistors is the same as at the IF OUT pin. Connect the junction of the two resistors to the QUAD pin. Now we connect a crystal between the AF IN and TONE pins and shunt each end of the crystal to ground with small (10 pf to 30 pf) capacitors to convert the AF AMP into a crystal oscillator!

The balanced mixer will now convert the first i-f to a lower i-f (such as 455 kHz) which will appear at the AF OUT 1 pin. The "volume" control is now an *i-f gain control*. Leave the de-emphasis pin open. The low i-f signal can be capacitively coupled to an i-f transformer, or direct-coupled to a mechanical or ceramic filter.

A second integrated circuit could be connected to the output of the second i-f transformer or filter in exactly the same way as just described. However, the AF AMP would be connected as a crystal BFO to make the balanced mixer in the second IC a product detector. Now, the "volume" control is truly an audio gain control, and the output at AF OUT 1 will be sufficiently large to drive one of the popular IC audio power amplifiers.

Thus, you can see that we can use

two identical ICs to make an effective, low-cost i-f system for a home-brew SSB or CW rig. We could also feed the second i-f signal to another IC, this time connecting it as originally intended, and have the capability of receiving NBFM as well.

There are other ICs you might consider using for amateur applications, but I will not tell you about them right now—they will keep for another time. Also, I have deliberately not given actual circuit details since that would take all the fun out of it for you in *your* experimenting. Besides, no one would want to duplicate exactly the things I have done. Be assured, however, that these ideas *have* been tried and they work as described.

Now, let's see who we have heard from since last time. The first eight in the list are students and graduates of our Amateur Courses, while the other eleven are students and graduates of other NRI courses.

WD4KDD writes that he will probably have traded his Novice license in for a General by the time this goes to press; however we'll still have to list him as Novice until the real time arrives. Lex sent along a very neat home-designed QSL card which he had printed by a local printer. Lex says that after shopping for the "commercial" cards, he found it much less expensive to have them done locally. He also suggested (and we'll put it on the agenda) that we have something on how one goes about making the first contact, and how to "draw out" the other guy to have a real QSO rather than the stereotyped "Name, QTH, Rig, WX HR" QSO. I'm in agreement, and we'll sure have some words here real soon, Lex.

It took W4VVC only two months to receive his Tech ticket after passing the exam. Is this some sort of record? Seems to me the FCC has been taking longer and longer to process new

Lex	WD4KDD	N	Keezletown VA
Roy	W4VVC	T	Riviera Beach FL
Bill	WB6WKS	N	Palm Springs CA
E.W.	WB7AFF	—	West Sedona AZ
Allan	WB7QUI	N	Florence OR
Mike	WA7ZPQ	G*	Miles City MT
John	WD9HGV	N	Berwyn IL
Lee	WB0NIS	E	APO NY
Mike	WB1DJC	T*	Mystic CT
Alan	WB3DEM	G*	Matamoras PA
Verne	K4BBV	A	Pensacola FL
Ulysses	WD5CCM	G*	Franklin LA
Jack	N6QD	E*	Mountain View CA
Lynn	WD8CDQ	A	Droop WV
Ray	WB8MBT	A*	Dayton OH
Al	WD9GID	A*	Rothschild WI
Bob	WD9HCT	G	Madison WI
Jacques	VE2DHE	A*	Montreal PQ, Can
Steve	VE3GGR	A	Huntsville ON, Can

*Just upgraded—congratulations!

licenses recently. Maybe Roy's experience will herald the coming of better and more efficient processing. Let's hope so.

Bill, WB6WKS, writes that he has been having problems making contacts from his QTH. He says he can hear them but can't work them. This is an all too common problem. My best advice is keep at it, Bill, as I'm sure you must be getting out ok. Power is not always the answer. The best solution is a *good* antenna—just as high as possible.

WB7AFF writes that he has upgraded his course rig to something a bit better,

and if there is anyone who would like to have a good Novice rig, drop him a line. His address is:

E. W. Bourne — WB7AFF
P.O. Box 3197
West Sedona AZ 86340

WA7ZPQ says that he is now enjoying chasing DX using his KWM-2 and HQ-14 vertical antenna. Mike also has dipoles for 80 through 10 and a mini-quad for 20 through 6. He mostly uses 20 and 15 phone, and 10 CW with a little time thrown in on two-meter

simplex. Mike says that the next time the FCC examiner comes to Montana (semiannually!), he plans to take the Advanced test. Good luck, Mike, we're rooting for you.

Lee, WBØNIS, is a 1974 graduate stationed in Germany (DA1MJ) at the present time. He went through all the amateur ranks, beginning with Novice in 1974, General in December 1974, Advanced in 1976, and Extra in 1977. Lee says the code was no problem for him, but adds that he had a rough time with the theory, taking two tries each for the Advanced and Extra. Lee will be retiring from the military in April of this year, and plans to get on the air from Louisiana as soon as he settles down. We'll be listening for you, Lee.

Mike, WB1DJC, says that he enjoys Ham News in the *Journal*, and that as a result of his studies in the Complete Communications course he was able to upgrade from Novice to Technician this past November. Right now, Mike is rushing through his lessons so that he can get to the NRI training kits that include the synthesized two-meter transceiver. It's a good rig, Mike, and I'm sure you will get a lot out of it.

I believe that K4BBV is the first student I've heard from enrolled in one of our non-electronic courses. Verne is taking our Automotive Repair course, and we would sure like to hear from others of you out there. Verne sent a QSL card on which he indicated his station consists of the Drake TX4C and R4C with an all-band dipole. He has been licensed since 1931 and is a member of QCWA. Fine business, Verne, and it's nice to hear from you.

WD5CCM saw his name and call back in the July/August *Journal*, and since that time has graduated from the Color TV course, upgraded to General, and acquired a brand new Yaesu FT101E rig. That's quite a bit in such a short time, Ulysses, and we are happy that

you are doing so well.

N6QD makes the second "Extra" listed in one issue, and I think that's some sort of record. The last time Jack wrote, he was W8LDY, and has since been W6RUV until he got his present call along with the Extra ticket. He has plenty of current projects going, including building an accukeyer, a 160-meter converter, a Heath SB-614, and an ASCII keyboard. Good luck! His present station consists of an all-band vertical used with the CONAR transmitter and a Hammarlund HQ-215 receiver. In regard to the latter, Jack says that the entire stock of manuals and spare parts of the defunct Hammarlund organization now belongs to an outfit called Hammarlund Radio, 100 E. Montauk Highway, Lindenhurst, NY 11757 for those of you who may need this information. Jack also thought he detected an error in the "revised" antenna coupler described in the November/December *Journal*. Sorry, Jack, but the diagram is correct. Put your specs on and look again—I think you'll see that everything is ok.

WB8MBT has a very interesting job. Ray is in the Air Force and is a crew member of one of the only eight EC135-N aircraft in the world. This is a huge airborne tracking station with a 6.5-foot steerable dish antenna. Ray's job is to point this dish at the various rockets and missiles launched from Cape Canaveral. As part of his assignment, he is frequently stationed at Ascension Island, so he got an amateur call (ZD8RW) from the British government and is able to operate from that rare DX location. Back at home, Ray has a shiny new Kenwood TS520S, an elderly Heath HD10 keyer, and a 40-meter inverted vee antenna. Without a tuner, he uses this antenna only on 40 and 15, using a Drake W-4 wattmeter to help make the setup work right.

Bob, WD9HCT, got his license back

in July and expects to get on the air this spring with some surplus gear. He is a self-avowed "tube-type," although he does compromise sometimes and throws a transistor or two into his various construction projects. Bob likes to build things and has an active interest in the "top" band, 160 meters.

VE2DHE writes that he has great difficulty working anyone at all from his apartment using an EICO 753 and a dipole (close to the building) on 20 meters. This is no real problem, however, as he has access to a club station which has a Heath HW101 and a TA33 beam on a 50-foot tower. Fine DX work from that station, says Jacques.

Finally, we had a newsy note from

another Canadian, VE3GGR. Steve writes that, in addition to his own activities, he operates a repeater on 28/88 for the Muskoka Repeater Association. He is active on all bands, including CW and SSB on two. Steve's equipment includes an 18 AVT-WB vertical, a Yaesu FT101, Heath HW7 and HW202, and a Kenwood TR2200. On top of all that he is in the process of building our new two-meter synthesized transceiver. When do you find time to study, Steve?

Well, that wraps it up for another one. We'll see you in a couple of months. Until then, be sure to write and let us know what you are doing out there. We love hearing from you. Very 73, Ted—K4MKX.

	Rule Change	Date Effective
1	Conditional Class License eliminated. Novice power limit upped to 250 W.	June 25, 1976
2	Technicians given Novice privileges.	July 23, 1976
3	No new distinctive Novice call signs, although Novices may sign "/N."	October 1, 1976
4	No requirement to sign "portable" or "mobile" except foreign operators using reciprocal licenses.	November 26, 1976
5	First "comprehensive" cw exam given in Washington, D.C. office. No solid copy for one minute requirement.	January 1, 1977
6	Court case "temporarily" suspends all license fees.	January 1, 1977
7	New "interim" licenses issued upon upgrade of license class at an FCC office.	March 1, 1977
8	Secondary station licenses eliminated.	March 3, 1977
9	97.95(a)(2) deleted. No notification of new address required.	March 9, 1977
10	New emission purity standards. All spurious emissions down 40 db for transmitters operating below 30 MHz, down 60 db for transmitters of 25 watts or more operating between 30 MHz and 235 MHz (97.73).	April 15, 1977
11	Code sending test deleted from Commission-administered examinations.	August 26, 1977
12	97.95(b)(2) rescinded. Maritime Mobile in Region 2 may use all amateur frequencies. In foreign waters may use only frequencies authorized by regional government.	September 12, 1977



Alumni News



FLINT/SAGINAW VALLEY CHAPTER

We had a very good meeting on December 14. Chairman Andy Jobbagy discussed a TV repair that he had just completed—after three months. It was a Zenith chassis No.14DC15 with insufficient high voltage and no brightness. This problem was a real stumper. Even Tom Nolan, the past Executive Secretary and Harry Taylor, the new Executive Secretary from NRI, had their hands in it, but did not locate the trouble.

After thoroughly checking or replacing all components associated with high voltage—horizontal oscillator,

horizontal output, high-voltage transformer, deflection yoke, etc.—Andy called the factory representative who told him the VDR was probably bad. However, the VDR checked okay.

Finally, Andy located and tried the brightness range control. Bingo! The set produced normal brightness and sufficient high voltage. This proves that in troubleshooting, you must always be on the alert.

Steve Avetta then gave a short talk. He gave a few pointers on how to read the code on Zenith TV sets to find out the year of manufacture. He also told how to read the manufacturer's code on picture tubes. Steve explained the purpose of the black putty found

around the horizontal output and damper tubes in some TV sets. The putty blocks the "singing" noise that can come from the horizontal output or damper tubes.

PITTSBURGH CHAPTER

The Pittsburgh Chapter elected new officers at our annual luncheon on December 1. George McElwain was elected Chairman for the coming year. Our past Chairman, James Wheeler, was named to the Board of Directors.

The Chapter held a service meeting on January 5. The meeting centered around the troubleshooting and repair of an RCA portable color TV set with vertical jitter and reduced width. The trouble was traced to a couple of resistors that had changed value.

We are going to continue to have service meetings. Members are requested to notify Jim Wheeler of the make and model of any set they want to work on during the meeting, so that we can obtain schematic diagrams and other service data.

SPRINGFIELD CHAPTER

The Springfield Chapter meeting opened on December 7 to honor the retirement of Tom Nolan and to welcome Harry Taylor as the new Executive Secretary for the NRI Alumni Association. We wish Harry many happy years of working with the Springfield Alumni Chapter.

The minutes of the last meeting were read, and no members were reported sick or in distress. Lyman Brown took this opportunity to tell Tom Nolan that he would be writing a letter to Mr. Smith, the former President of NRI, to wish him well in his retirement.

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets at 8 p.m. on the second Friday of each month at St. Andrews Hall, 431 E. Congress Street, Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Michigan. 841-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m., the second Wednesday of each month at Andy's Radio and TV Shop, G-5507 S. Saginaw Road, Flint, Michigan. Chairman: Andy Jobbagy.

NEW YORK CITY CHAPTER meets at 8:30 p.m., first Thursday of each month, at 1669 45th Street, Brooklyn, N.Y. Chairman: Sam Antman, 1669 45th Street, Brooklyn, New York.

NORTH JERSEY CHAPTER meets at 8 p.m. on the second Friday of each month at the Players Club, located on Washington Square in Kearny, New Jersey. Chairman: Al Mould. Telephone 991-9299 or 384-8112.

PHILADELPHIA-CAMDEN CHAPTER meets on the fourth Monday of each month at 8 p.m. at the home of Chairman Boyd A. Bingaman, 426 Crotzer Avenue, Folcroft, Pa. Telephone LU 3-7165.

PITTSBURGH CHAPTER meets at 8 p.m. on the first Thursday of each month in the basement of the U.P. Church of Verona, Pa., corner of South Avenue and Second Street. Chairman: George McElwain.

SAN ANTONIO (ALAMO) CHAPTER meets at 7 p.m., fourth Thursday of each month, at the Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (three blocks north of Austin Hwy.), San Antonio. Chairman: Robert Bonge, 222 Amador Lane, San Antonio. All San Antonio area NRI students are always welcome. A free annual chapter membership will be given to all NRI graduates attending within three months of their graduation.

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

SPRINGFIELD (MASS.) CHAPTER meets at 7:30 p.m. on the second Saturday of each month at the shop of Norman Charest, 74 Redfern Drive, Springfield, Mass. 01109. Telephone (413) 734-2609. Chairman: Preston Atwood.

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

Tom Nolan gave a detailed talk on CB sets and the required service equipment. He noted that NRI has an excellent course for any members who are interested in learning CB servicing.

Harry Taylor was then welcomed by the Chapter and gave a short talk on the benefits of NRI courses. He also solicited comments from the Chapter on the subjects to be covered in future technical training sessions. Tom and Harry were asked many questions on the Chapter's current problems and these were resolved nicely.

When the meeting adjourned, Chairman Norman Charest showed the members to a buffet table. In addition to the other good things to eat, there was a decorated layer cake. Everyone took delight in helping Tom Nolan polish it off. The cake was to show Tom the Chapter's appreciation for all the fine work accomplished during his tenure in office and to wish him the best of things to come during his retirement. Our thanks to the Charest family for putting on the excellent banquet during the visit from our distinguished Washington guests.

NORTH JERSEY CHAPTER

We were pleased to welcome two new members to our December meeting: Paul Howard and Herman Bruns.

After a discussion of the availability of training materials in electronics, the Chapter Secretary was instructed to seek training films from local electronics manufacturers and factory branch offices. We hope to contact Panasonic, Kenwood, RCA, and Bell Telephone.

The remainder of the meeting was taken up with TV problems—some TV sets and a scope were brought in by members for troubleshooting and repair. The members enjoyed the challenge and the problems were corrected.

NEW YORK CITY CHAPTER

The New York City Chapter held its regular meeting on December 8. The meeting featured a discussion led by outgoing Executive Secretary Tom Nolan. Tom talked about the new two-meter amateur transceiver now being supplied to students of the new NRI Complete Communications Electronics Course. He discussed the circuit design, mechanical design, and capabilities of the transceiver.

Tom also discussed troubleshooting electronic circuits. During a question-and-answer session, Tom fielded questions on many different subjects—primarily on radio and TV.

The new Executive Secretary of the Alumni Association, Harry Taylor, was introduced to the members. Harry spoke briefly about the goals of the Association and he stated that the school will continue to give high priority to questions and requests from members of the Alumni Association.

THE SECRETARY SPEAKS

Fellow members of the Alumni Association, it is always a pleasure to read about or hear of the activities of our local Alumni Chapters. The zeal and enthusiasm of those who attend the regular monthly meetings is contagious. I hope you will continue to participate and to enjoy your Chapter activities.

I regret to report that I did not receive news from all of our Chapters for this issue of the *Journal*. Some may have been sent to the school but not delivered to my office. I feel that these Chapter reports are very important, because they tell all of our readers what you are doing. This exchange of information is essential to the value of the organization.

The Winners...

The new President of the NRI Alumni Association for 1978 is Boyd A. Bingham of Folcroft, Pennsylvania, Chairman of the Philadelphia-Camden Chapter.

Boyd's Vice Presidents will be Norman Charest of Springfield, Massachusetts; Barry Goodwin of Scranton, Pennsylvania; James Dawson of Franklin, Indiana; and Eldred Breese of Pineville, Ohio.

We congratulate all of our new NRIAA officers, and offer them our best wishes for the coming year.

We'll be telling you more about these newly-elected officers and their NRIAA activities in future issues of the Journal.

Remember—The NRIAA welcomes your ideas and suggestions, and your criticisms if such there be. Take a few minutes of your time and jot them down, then send them in to Harry Taylor, your NRIAA Executive Secretary. Do it now.

J. B. Straughn

Long-time members of the NRI Alumni Association will be saddened to learn that J. B. Straughn passed away on December 8, 1977. Blan served for many years at NRI as the Assistant Director of Education and will be remembered by the Alumni members for the talks he gave at the various chapters. After his retirement, Blan moved to Shorter, Alabama where he purchased a farm, continued doing TV repair work, and frequently wrote articles for the NRI Journal. We at NRI who worked with Blan will surely miss him.



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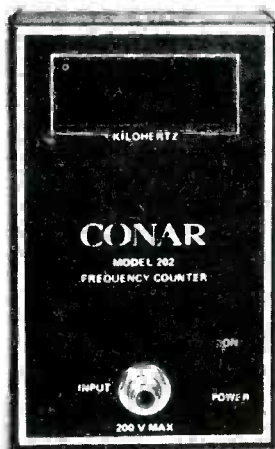
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