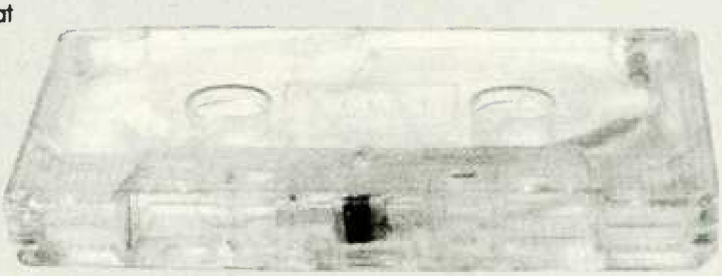
Build The AUDIO COUPLER



Add an audio input to any cassette deck without altering the unit in any way

BY GREGORY R. MCINTIRE

What modern semiconductor technology has done to miniaturize electronic devices in recent years is quite amazing. Take small handheld scanners and ham transceivers for instance. Handheld units will do most everything that the larger table models will do. But, there is one area where they are lacking, at least for some applications.

I recently bought a handheld two-meter ham transceiver, which I decided to use as a mobile rig. It has one drawback though: The audio output and the tiny little speaker work just fine in a relatively quiet environment; but there is nowhere near enough sound coming out of the little rig to overcome vehicle noise and road noise for mobile applications. What could I do?

The first thought to come to mind was to build a small amplifier and speaker unit to be mounted somewhere in my small automobile. Bad idea, the car is too cramped already. Then another thought struck: simply mount some kind of switch and jumpers in the existing radio/tape-player so I could use the audio amplifier and speakers already in the car; that was another bad idea. The car's radio/tape-player is miniaturized, and permanently mounted. Putting a switch and input wiring into the unit would be a big job. Finally I arrived at the perfect solution: Simply input the handheld's audio into the existing tape player at the same place that a cassette tape does—via the tape head!

All that is required, is to place a small coil of wire in an audio cassette-tape body. The small coil must be mounted so that it fits snugly against the tape head in the tape-player. The wires from the ends of the coil are then connected to the audio output of the scanner, handi-talkie, or any other audio device that needs a little more power.

Construction. You'll need to find an old cassette tape held together with small screws. Also the cassette cartridge must have a small flat metal tab with foam or felt on it (normally used to press the tape against the tape head) as opposed to the type that only has a piece of thick foam glued to the cartridge body. Hunt for a bargain since you won't need the tape itself. (I found cassette tapes at three for a dollar at the local discount store.)

To begin, the metal tab will be used to mount the coil. Next, take the cartridge apart and throw out the tape and little rollers, etc. If there is a small flat metal plate behind the metal tab, throw it away too. Next, remove the small metal tab that the foam pad is glued to, and wrap one layer of masking tape, or any thin adhesive-type tape, around the foam or felt pad. The purpose of that is to cover the sharp edges of the attached metal piece. Next, wind between 200 and 400 turns of no. 36 or no. 40 enameled wire around the tab and pad. It takes about about 1-½ feet of wire. That wire is very fine and very easy to break, so be careful. You can salvage some out of an old speaker, earphone, a small toy motor, or even a small audio transformer. It may not be necessary to use wire as small as I used. Larger wire may require more turns though, and there is not a whole lot of room for the coil if it is too large. After the coil is wound, apply a small amount of quick-drying epoxy cement to hold the coil in its place.

Next prepare a length of two-lead wire or shielded cable by connecting a phone plug on one end and tinning the leads on the other. With a small file, saw, or hot knife, cut a small notch in the cassette cartridge in a spot where the wire can enter/exit the cartridge without interference from the tape player. Also, it should be located so that when the tape cartridge is plugged into the tape player, the cable will protrude from the end of the cartridge that is closest to the player opening. Most automobile tape players that I have seen leave one end of the cassette sticking out in the open. If your tape player completely consumes a cassette, you may be able to use a thin flat wire that can be routed so that it exits the tape-player opening without too much stress.

Now drill a small hole in the cassette cartridge right behind the metal tab so that the tiny wires from the coil can pass through it into the body of the cartridge.

Remove the enamel coating at the coil ends by passing them through a

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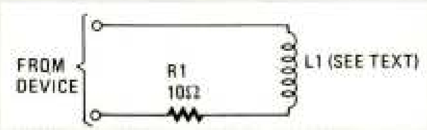


Fig. 1. The terminals to the unit should be connected to the appropriate plug for the device you wish to amplify.

This is the proper position for the coil.

PARTS LIST FOR THE AUDIO COUPLER

L1—200–400-turns of No. 36 or 40 enameled wire
R1—10-ohm, ¼-watt resistor

Cassette-tape housing (see text), fast-drying epoxy cement, shielded audio cable, phone plug (if necessary), etc.

Sound-Activated KALEIDOSCOPE

Generate eye-catching patterns that change in cadence with an audio signal with this sound-activated kaleidoscope

BY DR. DON H. ANDERSON

Kaleidoscopes have been popular for ages, and over the years, a wide variety of kaleidoscopes have been developed. Most have depended on rotation of either the mirrors, or particles imaged in them, to provide a multiplicity of changing patterns.

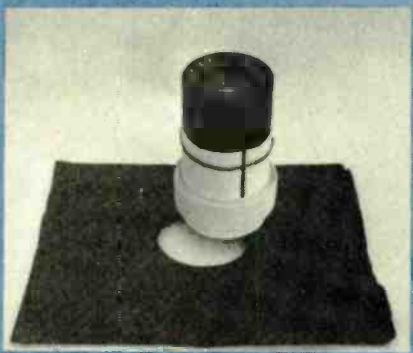
In the 1950's, a kaleidoscope in which the particles were caused to move in cadence with music was shown on television. The *Sound-Activated Kaleidoscope*, described in this article, accomplishes the same thing using readily available materials.

The kaleidoscope can be built to be viewed directly, and sound (be it from radio, tape recorder, or the human voice) can be used to move the particles. It can also be coupled to a musical instrument through a contact microphone.

I've had the greatest success when I coupled the kaleidoscope to an electric organ and projected the image of the moving particles on a screen in front of the organist. The heart of that unit was a small speaker.

Getting Started. For your first experiment, I suggest that you use a 4-inch speaker that has a well suspended cone. The speaker cone is expected to bear the weight of the mirrors and the mount, which may result in severe distortion if the speaker cone is not rugged enough.

The mirrors are, ideally, of front surfaced thin glass or plastic. Front surfaced mirrors are available in a variety of sizes and thicknesses. To help determine mirror size, it is suggest that you build an experimental unit using reflective foil. Many art stores sell reflective foil by the foot. It is easily peeled from its substrate and transferred to a piece of very smooth cardboard or plastic sheeting. The surface that holds the reflective foil should be as free from defects as possible because the film will bring out any the defects in the surface.



Shown here is the projection lens mounted in a cardboard tube ready for installation on a cloth-covered cardboard base.

Because the unit is to be experimental, its assembly need not be super critical. The mirrors, angled at 60°, are mounted on a thin aluminum plate, which is then mounted on a small paper cylinder. That assembly is then glued to the cone of the speaker.

For particles, crumpled bits of aluminum foil—either plain or colored (like florists use)—works well. Bits of plastic insulation from some brightly colored wire can be used. Another alternative, provided you are located in an area of low humidity, is to use the brightly colored particles (sprinkles) that are used as cake and cookie decorations (high humidity would cause the sprinkles to bond together).

Construction. Begin construction by cutting two pieces of cardboard or plastic to about 2-by-3¼ inches. Be sure they are the same length and width; they'll be used to form the reflecting surfaces in the kaleidoscope. Apply the foil to the cardboard or plastic.

Use thin transparent plastic film to provide the window area. Be sure that the film is stiff enough to hold the mirrors in position after cementing, without buckling. The clear film is the window through which the display will be photographed if you use a video camera. If you make a projection unit, the window will be used to illuminate the particles.

For assembly, a support can be made by gluing two pieces of corrugated cardboard together with the corrugations at right angles. The window material is cut about ⅞-inch wider than the mirror panels, but of equal length.

Refer to Fig. 1. As shown, one of the mirror panels is pinned to establish the spacing of the parts during cementing. Pinning the window material down (as shown in Fig. 2.) allows the two mirror panels to be properly arranged. Two pieces of masking tape placed along the bottom and top edges serve as a temporary support during the cementing process.

Place a small amount of five-minute epoxy cement along the joints. Be careful that the cement does not get on the mirrored surfaces. The first coat must be solid and completely dry before the second coat is applied. Doing

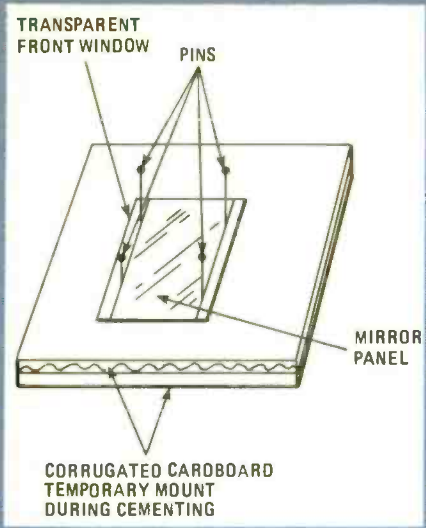


Fig. 1. Pinning one mirror panel to a temporary mount helps to establish the spacing of the parts.

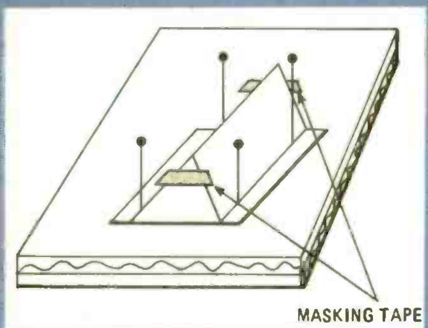


Fig. 2. Two pieces of masking tape placed along the bottom and top edges of the mirror panels serve as a temporary support during the cementing process.

MATERIALS FOR THE SOUND-ACTIVATED KALEIDOSCOPE

- Small speaker (size not critical)
- Front surfaced mirrors or reflective foil
- Plastic sheeting or smooth cardboard (⅛-inch thick)
- Clear plastic, rigid (thickness not critical)
- White glue
- 5-minute epoxy cement
- Flat black spray paint
- Stereo amplifier (optional, see text)
- A small slide projector or halogen flashlight
- Projector lens or simple lens (4- to 6-inch focal length)
- Video camera extension microphone

Note: Front surfaced mirrors are available from Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 08007.

so ensures that the second coat won't run inside the unit. Make sure that the second coat is thick enough to provide good mechanical stability with very rigid joints.

Be particularly careful around the apex of the unit. Any cement that runs inside will forever be a part of image of the kaleidoscope's display.

For the base plate, use aluminum sheeting. You can, if you wish, substitute cardboard if all you are building is an experimental unit. Don't use plastic since it can build up static charges that interfere with the free movement of the particles.

Cut the base plate about ⅞-inch larger than the kaleidoscope and give it a coat of flat black spray paint.

The kaleidoscope is cemented to the painted surface of the plate. The bottom is glued to the paper cylinder. Since white glue and aluminum are not compatible, a self-sticking label was placed on the bottom of the aluminum plate to provide a surface to which the glue would adhere.

Make the cardboard cylinder from card stock: A 5- by 7-inch index card works well. The cylinder is made by gluing 3 or 4 layers together to form a cylinder that's about 2 inches larger than the center of the speaker cone and long enough to extend about ½ inch above the edge of the speaker frame.

While that is drying, mount the kaleidoscope to the top of the base plate. I suggest that you use some cellophane tape for the initial trials. You can cement the assembly in its final position later.

After the paper cylinder is dry, find the balance point of the kaleidoscope by placing it on a finger and moving it around. Glue the paper cylinder at that point. When the joint is thoroughly dry, glue the assembly to the speaker cone. If you ever wish to remove the unit, you'll find that a razor blade or very sharp knife allows you to break

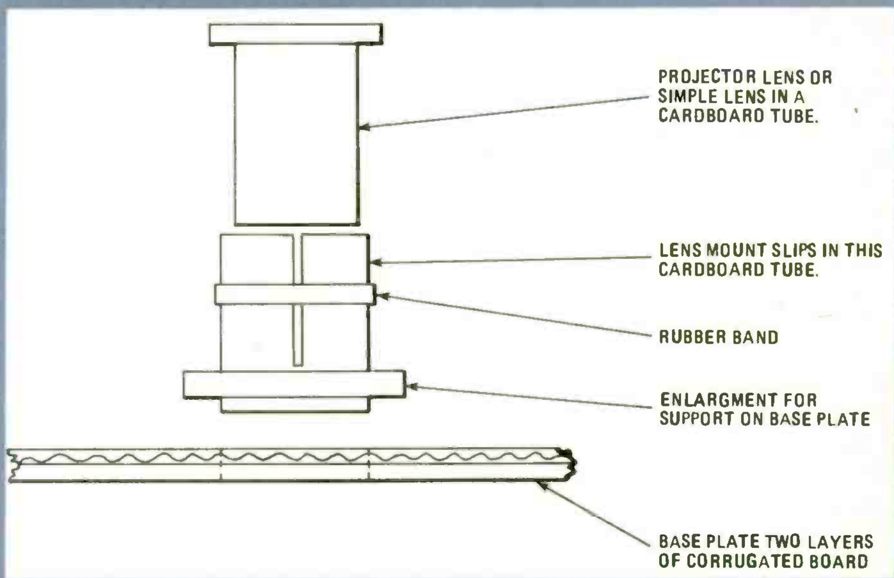


Fig. 3. A lens from a slide projector can be held in place by a cardboard tube wound tightly around the lens. That assembly is placed inside another cardboard tube and held in place by friction, supplied by a rubber band.

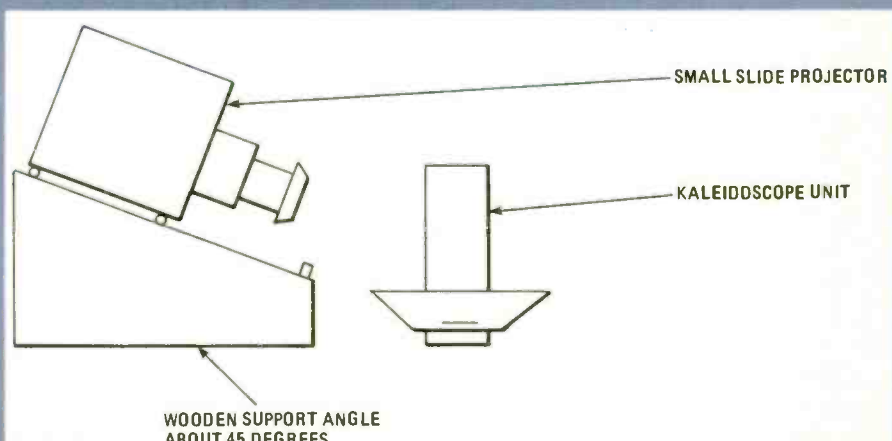


Fig. 4. A slide projector can be mounted on a rack in such a way that the light is emitted at a 45-degree angle into the apex of the kaleidoscope.

the joint between the base plate and the cylinder.

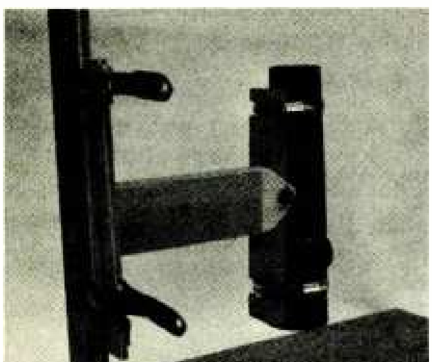
When all joints are set, you can put particles into the kaleidoscope unit and test it with a small radio. You'll find that the load of the kaleidoscope results in some audio distortion. With some speakers, the distortion is so small that it is of no concern.

Optics. The projection lens need not have all the optical quality of a typical slide projector lens. Since the kaleidoscope particles are in motion and at times are flying above the surface, the image is constantly changing in and out of focus. You might try using a simple double convex lens as a start.

Depending on the size of your kaleidoscope, you will need to use a lens with a focal length of 4 to 6 inches. You can try lenses from small hand magnifiers or the so-called close up lenses used with cameras. They usually have the focal length marked on them. A quick way to check your lens is to focus the image of a distant object on a white card. If the distance from the lens to the card is about 4 to 6 inches, it's worth a try.

Some ingenuity may be required to mount the lens. If it is a loose lens, mount it in a cylinder made from several layers of card stock. A ring of cardboard glued on each side of the lens will hold it securely in place. It is suggested that you build a model before building the final carrier. Your final unit can be as professionally finished as your time and talent allow.

If you are using a projection lens from a small slide projector, it can be held in place using the method illustrated in Fig. 3. The cardboard tube is wound tightly around the lens, glued securely in place, a collar mounted to the assembly, and the whole thing glued to a corrugated cardboard panel. When thoroughly dry, one or two slits are cut and a rubber band provides the friction to hold the lens.



This simple mount can be used to hold a flashlight at almost any angle for video taping or projecting the images.

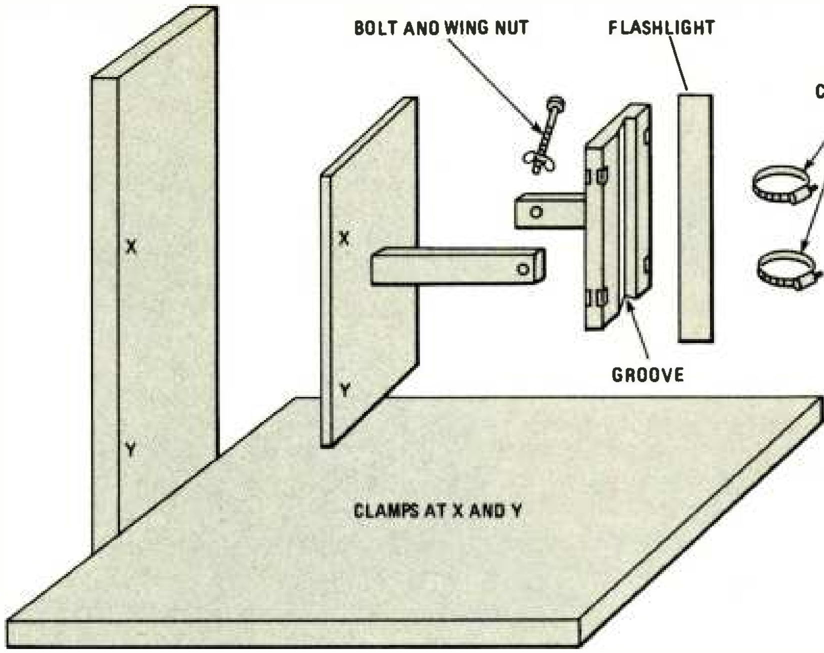


Fig. 5. Shown here are construction details for a typical experimental mount for a flashlight. Such an arrangement allows a flashlight to be used with either a projection unit or a video camera.

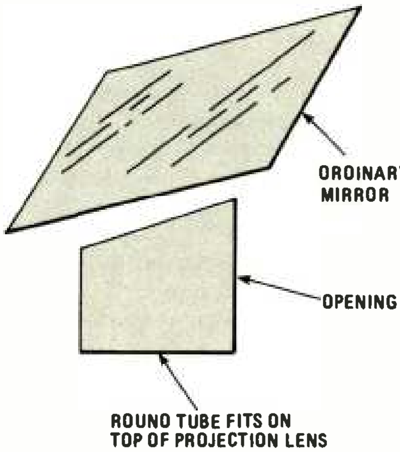


Fig. 6. When projecting the image onto a wall screen, the tube is used to hold a mirror at a 45-degree angle.

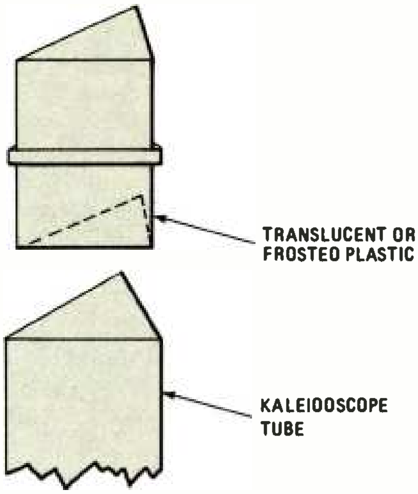


Fig. 7. When video taping, only a relatively small amount of light is required. The light should be diffused. That can be accomplished by placing a piece of frosted plastic between the flashlight and the particles in the tube.

Details of the best way to hold the panel above the kaleidoscope are difficult to give. I frequently use corrugated cardboard for the box. Try using a small slide projector as the light source. The slide projector is mounted on a rack, as shown in Fig. 4, so that the light is emitted at a 45 degree angle into the apex of the kaleidoscope.

Trial and error with the lens at several positions and angles may be needed to optimize the conditions. For short projection distances, I have used a flashlight containing a high-intensity halogen bulb with satisfactory results. A typical experimental mount is shown in Fig. 5. That mount or a similar arrangement of your own design allows the flashlight to be used with either the projection unit or for video taping.

If you wish to project the image onto a wall screen (see Fig. 6), the tube is used to hold a simple mirror (taken from an old purse) at a 45 degree angle. When video taping, only a relatively small amount of light is needed. It

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Salvaging An Autotransformer

BY JULIAN SIENKIEWICZ

On the project bench or under your Christmas tree, this troubleshooting device from the vacuum-tube era is just as important today.

An adventure inside a flea market in the next state uncovered an item that will be very useful at home this Christmas. I was on the trail for a few table-top antique radios, *circa* 1940's, when I came upon an old autotransformer—commonly called a *Variac*, which is a trade name. An autotransformer can take line voltage and vary it at its output from zero to 140-volts AC. The unit I found was an import that was sold by Radio Shack in the late 1950's; it had been dropped and slightly damaged. The deep dust and dirt covering parts of it did not bother me—that's the easiest thing to take care of. I bought the gadget for three dollars (the seller drove a hard bargain), and I took my prize home.

The Story Deepens. The following weekend I had a chance to scrutinize the autotransformer. I removed the large control knob from the top, and a few screws, and then gently slid the metal protective shell off. After cleaning the case I found repainting was not necessary.

Inspection revealed that some plastic parts were broken, and some of the Bakelite pieces were still inside the unit. One of the leads to the transformer coil was yanked a bit, and the copper wire that was wound on the toroidal core was stretched. That caused the wiper contact at the top of the unit (where the selected AC voltage is tapped) to ride roughly over the top of the coil. Also the power cord had been cut off near its entry point to the unit.

Everything else looked very good. Even the 5-ampere fuse was in good shape. There appeared to be no short cuts in the manufacturer's construction techniques. The unit was rigidly built with solid Bakelite parts.

I hooked up a power cord and gave the autotransformer the acid test—AC power. Without a load connected, the autotransformer took the voltage without any smoke. In fact, almost no heat was detected; so far, so good. A voltmeter connected to the autotransformer's output jack showed that the output could be varied from 0- to 140.4-volts when the input was rated at 115.1 volts AC (the AC power line was low that day). Next, I added a two-photoflood bank of lights and the autotransformer worked well with a 300-watt load. The variable-voltage tap worked well throughout most of the

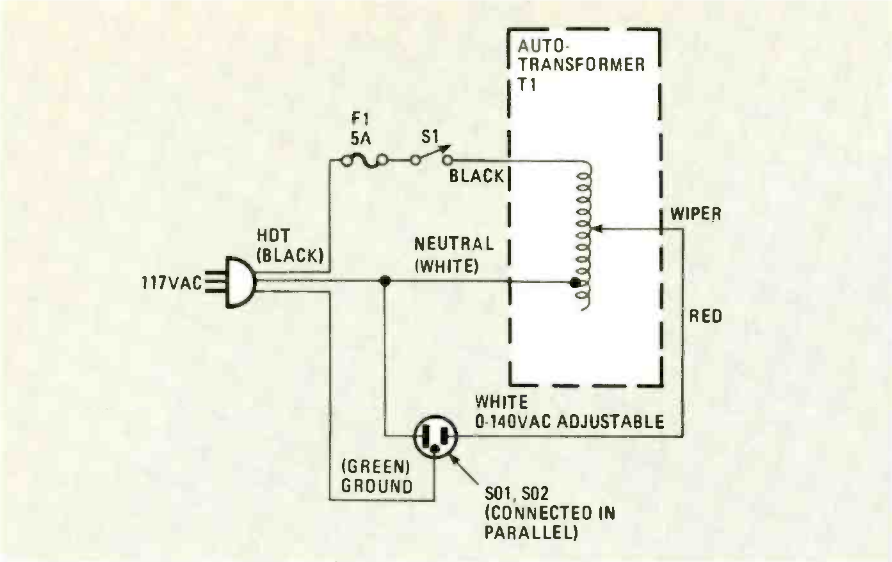


Fig. 1. Here is the wiring diagram for the modified autotransformer. The original fuse holder was reused. The power switch and two-terminal outlet were discarded. Colored insulated wires (black-hot, red-variable AC, and white-neutral) were attached to the short leads on the stripped autotransformer to assist in goof-proofing the final wiring.

range. I was too chicken to take the flood lamps above 130 volts. The results of the tests convinced me that the autotransformer was worth sprucing up and using.

Fixing Up. I began by fixing a *bump* on the tapped coil where the 117-volt AC power line is connected. That was easy to do. Every time I tried to push it down and glue it in place, the turns popped back up again. That technique was not working so I tied a thin leather shoelace to the tap point, and added some weights until the weight was heavy enough to hold the bump down. I applied some epoxy to the sides of the turns so that when the weight was removed, the turns remained in place. Do not ever put glue or cement on the contact surface; the wiper will fail to make electrical contact, and the unit will not work properly. The epoxy set in 24 hours, and the bump was gone.

The next consideration was the broken Bakelite parts. One mounting leg of the autotransformer was gone; broken off and lost forever. However, the rest of the base was good, so I decided that the remaining two legs were sufficient to hold the autotransformer to a breadboard. If necessary, I could have used epoxy to cement the entire base to the board. A plastic tab that was used to secure the cover to the base was floating around inside the case, so I affixed it with some epoxy.

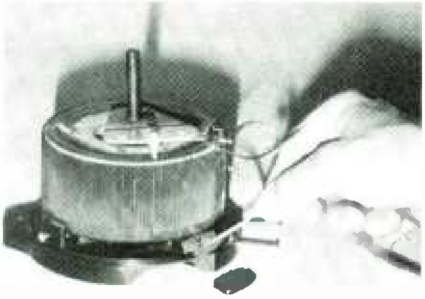
Here's the autotransformer ripe for repair. With a little effort, it turned out to be a worthwhile test-bench tool.

The plastic piece that housed the fuse holder and AC outlet, and passed the line cord to the outside, was broken beyond repair. That was not a total loss, because I was not satisfied with the two-terminal AC outlet used in the original unit. I wanted a three-terminal outlet, and a strong contact surface in the outlet to grab the prongs of the AC plug. So I discarded the plastic piece and covered the opening in the cylindrical housing with a piece of sheet metal cut from a 2-pound coffee can. The price of the can was certainly right. The section I had cut from it had almost the same radius as the metal shield, and its indented ribs (common to coffee cans) made it very rigid. I drilled a hole through it and inserted a grommet in it to protect the insulation of the wires to be passed through it. The metal was painted black before installation, and, when finished, the fabricated cover looked as if it was installed by the manufacturer.

The interconnecting leads from the autotransformer were too short to reach an external electrical box, so they were extended using color-coded stranded wire. The splices were soldered and electrically insulated with black plastic tape.

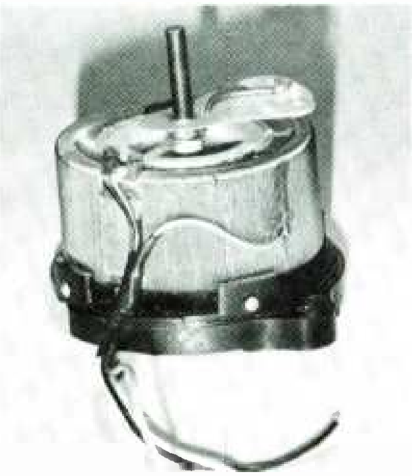
The rest was easy to do. A 6 × 12- × ½-in. hardboard (veneered on both surfaces) was cut and the edges sanded smooth. Any ½- to 1-in. board cut to a convenient size will do. One idea is to purchase a cutting board in a housewares store should you dislike woodworking.

The autotransformer is a one-coil device wound on a cylindrical iron form with the AC line connected across the bottom of the coil and to a tap on a copper turn about 85% of the distance from the first tap. A sliding contact selects one of the coils to pick off an AC voltage. The plastic piece hanging from the leads of the winding was discarded because it was damaged and the single outlet was neither polarized nor of the three-terminal type.



A broken-off part was joined to the base with epoxy. The piece, which was found inside the unit, contains an embedded nut used to secure the unit's shield.

A piece of a two-pound coffee can was used to close up the hole left in the autotransformer's safety shield. The can had an almost perfect curve and indented ribs for reinforcement. A hole was drilled through it. Once the shield was complete, it was sprayed with a flat black paint. After drying, a grommet was installed.



The leads of the cylindrical winding were too short. Colored leads (a red, a black, and a white) were added to make wiring easy and goof-proof. The splices were soldered, and black plastic tape was used to insulate the splices.

Here's the autotransformer mounted on the board with the electrical box mounted and wired. Note that the fuse holder is easy to reach for fuse replacement.

Electrical Work. The autotransformer was secured to the board with wood screws. A 4-in. square electrical box and a face plate for one duplex outlet with toggle switch, was installed on the
I installed a new three-wire power

board about one inch away. Two of the box's circular knockouts were removed and cable clamps were installed. A third knockout was removed and the original fuse holder was installed. The knockout hole was too large for the fuse holder, so an oversized washer was placed on each side of the hole and the fuse holder was installed through them. Should you wish to do that, do not over-tighten the nut because the plastic fuse holder breaks easily. If you can't find washers of the right size, cut out two squares of aluminum and drill a hole in the center of each. One of them should be sized to fit neatly on the inside and one on the outside of the electrical box.
cord and clamped it to the electrical box. The wires from the autotransformer were passed into the box to begin the wiring of the box. In Fig. 1, as in all electrical circuits, the white wires are ground and connect to the silvered screw terminals on the AC outlet. The black wire (it's electrically hot) from the autotransformer goes to the fuse. The red wire from the wiper terminal is also hot and connects to the brass-screw terminal on the outlet.

The Juice is On. I powered up the autotransformer assembly after the fuse was installed. The original unit called for a 5-ampere fuse, so I used a fuse rated at 5 amperes, however, a fuse that has a lower current rating can be used. A voltage check at the AC outlet indicated an output 0 to 140 volts AC as the control knob was moved through its range.

More than just a Christmas-tree bulb saver, the autotransformer is used here to uncover a failing part in an old relic—a Hallicrafters SX-38B shortwave receiver.

The first task I designated to the autotransformer was to discover a fault in an antique tube-design *Hallicrafters SX-38-B* shortwave receiver. The receiver operation was intermittent, but the trouble never lasted long enough to locate the fault. Voltage was applied and I cranked the autotransformer up to 127-volts AC, when the fault occurred and held. The problem was then traced to a defective wax-paper capacitor.

A used autotransformer may be hard to find when you are looking for one. Mouser Electronics sells them in different sizes and configurations. One unit listed in their catalog is a Staco Variable Transformer, catalog No. 563-3PN501 which sells for $125.98; it is comparable to the unit I found.

In a few weeks Christmas will be here and the autotransformer will be put to work on the Christmas tree's lights. Those miniature-bulb sets last much longer when the voltage is down to about 105-volts. ■

E-Z MATH

BOOLEAN ALGEBRA and LOGIC CIRCUITS

BY LOUIS E. FRENZEL, JR.

Don't let logic gates bar your ability to experiment with circuits

If you have followed this math series, you know that we've spent a lot of time covering the math related to basic electrical principles and electronic fundamentals. In this month's installment, we'll head out in another direction for a change of pace. We will discuss a type of math used with digital-logic circuits. That math is known as *Boolean algebra.*

What's Boolean for? Boolean algebra is a collection of simple mathematical procedures used to represent and express the logical operations that go on in a digital circuit. Boolean algebra is very similar to standard algebra. The primary difference is that unlike standard algebra, in which variables can be any value, in Boolean algebra only the values 0 and 1 are recognized. Besides that, most of the basic rules of working with algebraic expressions apply.

The big benefit of Boolean algebra is that it provides a way to express digital-logic operations mathematically. Boolean equations can be written to precisely describe how a logic circuit operates, which can help you to design such circuits. Boolean algebra also provides a way to minimize the number of gates needed in a logic circuit to simplify circuit design. That lowers overall cost, and can help reduce power consumption.

Also, the equations can show at a glance what is going on in a logic circuit to aid you in troubleshooting.

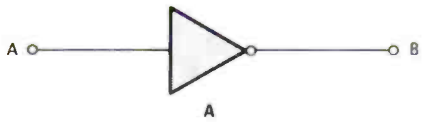
As I've said in previous articles, don't let terms like "Boolean," "equation," "mathematical expression," or "algebra" scare you. Once you learn the jargon and the few simple fundamentals presented here, even complex circuits will be easy for you. So, get ready for a digital-logic refresher, then we will have some fun writing the Boolean equations of a circuit and creating a circuit from the equations.

Review of Digital-Logic Circuits. At one time or another, you probably learned how basic logic circuits work. If not, the following brief summary will bring you up-to-date. The review is also for those of you who need a refresher.

The three basic logic gates are the inverter, AND gate, and OR gate. Two other widely used gates—the NAND and the NOR—are often derived from those basic gate circuits. All of the gate circuits process binary numbers made up of 0's and 1's. Binary 0 and binary 1 are represented by voltage levels. For example, a binary 0 may be indicated with zero volts (ground), while a binary 1 may be indicated by +5 volts.

The Inverter. An inverter is a logic element with a single input and a single output. As its name implies, it inverts an input signal. A binary-0 input produces a 1 output. A 1 input generates a 0 output. The inverter always produces an output that is the complement of the input. Complement here means opposite or reverse. You will also hear the inverter referred to as a NOT gate.

The logic symbol for an inverter is shown in Fig. 1. The triangle represents



A

INPUT	OUTPUT
A	B
0	1
1	0

B

Fig. 1. The simple inverter, A, is shown here with its little four-entry truth table.

a buffer—a circuit that directly passes a binary digit onto the next circuit without changing the value. The circle at the output indicates inversion. So the digit passes through the buffer and is inverted at the gate's output. Note that the input and output are labelled with letters. All logic signals are given a name or designation. Here A is the input and B is the output.

Also shown in Fig. 1 is a table that shows all possible combinations of inputs and outputs. The input, A, can be either a 0 or 1. The table shows the state of the output, B, for each input state. Such a table is called a truth table. Truth tables are used to show what's going on inside a logic circuit.

AND Gate. An AND gate is a logic circuit with two or more inputs and a single output. The output is a binary 1 if all inputs are binary 1. Otherwise, the output is binary 0. The AND gate is often called a coincidence circuit because the output will be binary 1 only when all inputs are simultaneously all binary 1.

The logic symbol for a two-input AND

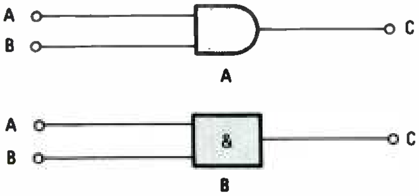
gate is shown in Fig. 2A. The inputs are A and B; the output is C. The shape of the symbol designates its function. An alternate symbol is given in Fig. 2B. The box designates the circuit while the ampersand (&) indicates the gate's function.

The truth table for a two-input AND gate is shown in Fig. 2C. There are always 2^N possible input combinations, where N is the number of inputs. With two inputs, there are:

$$2^2 = 4$$

different combinations. They are listed in the truth table along with the resulting outputs. Note that the only time the output (C) is 1, is when both inputs are 1.

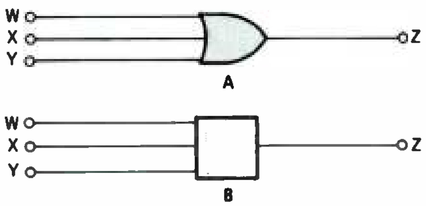
Keep in mind that an AND gate may



INPUTS		OUTPUT
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

C

Fig. 2. This two-input AND gate, A, can be drawn as shown in B. The truth table for all its possible states is shown in C.



INPUTS			OUTPUT
W	X	Y	Z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

C

Fig. 3. For a change, this OR gate, A, is shown with three inputs instead of two. An alternative symbol is shown in B, while the elements truth table is shown in C.

have more than two inputs. Integrated-circuit AND gates typically have 2, 3, 4, 5, 8, or 13 inputs.

OR Gate. An OR gate is also a logic circuit with two or more inputs and a single output. Its output is a binary 1 if at least one of its inputs is binary 1. Otherwise, the output is binary 0.

The logic symbols and truth table for an OR gate are given in Fig. 3. Note that the "equal to or greater than 1" designation means the OR function. The truth table shows the output Z with the inputs W, X, and Y. With three inputs, there are:

$$2^N = 2^3 = 8$$

possible input combinations. As with AND gates, IC OR gates typically come with 2, 3, 4, 5, 8, or 13 inputs.

A NAND Gate. A NAND gate is the combination of an AND gate and an inverter. It is often referred to as a NOT-AND circuit, and thus its name N-AND. The output is binary 0 only when all inputs are binary 1. For other input conditions, the output is binary 1.

A NAND can be drawn as an AND with an inverter (NOT) circuit, as Fig. 4A shows. However, the special symbol in Fig. 4B is normally used. The circle at the output indicates inversion. An alternate symbol is given in Fig. 4C. Here the triangle or half arrow on the output indicates inversion. The truth table indicates all possible inputs and the corresponding output states. Looking back at the truth table for the AND gate, you can see that a NAND output is its complement. NAND gates with 2, 3, 4, 5, 8, and 13 inputs are available in IC form.

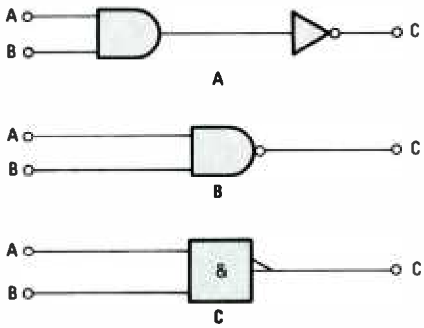
NOR Gate. The NOR gate or NOT-OR circuit is an OR gate followed by an inverter. The output is binary 0 if at least one of the inputs is binary 1. Otherwise, the output is binary 1.

The NOT-OR circuit, shown in Fig. 5A, clearly illustrates the circuit's function, but usually one of the symbols in Fig. 5B or 5C is more often used. The truth table shows the possible input and output states. IC NOR gates are available with 2, 3, 4, 5, 8, and 13 inputs.

Expressing Logic Mathematically. To begin using Boolean algebra, we need to find some way to express the basic logic operations using mathematical expressions. Let's take a look at ways of expressing inversion, AND, OR , NAND, and NOR operations.

As you learn the basic rules, keep in mind that the binary signals to be processed by the logic circuits are known as variables. Variables are signals that can change value. Binary variables can have one of two values; those values are 0 and 1.

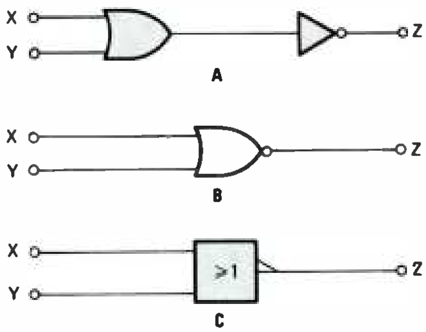
Variables are usually given names to distinguish them from one another. Letters of the alphabet are the most common, although numerous other alpha or alphanumeric names are also used. Usually signals are given some variable name (mnemonic) that is simply a shorthand way of referring to the



INPUTS		OUTPUT
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

D

Fig. 4. A NAND gate is nothing more than an inverted AND (B). Its output is the compliment of an AND gate's (C).



INPUTS		OUTPUT
X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

D

Fig. 5. A NOR gate is nothing more than an inverted OR (B). Its output is the compliment of an OR gate's (C).

signal. An example is a binary signal called "clear," which might be represented by the mnemonic CLR. Many times binary signals are grouped together and related as in a binary number. For example, the bits in an 8-bit word might be given the names A0 through A7. In any case, you will see many different variations.

Inversion. Inversion is expressed mathematically by placing a bar over the variable. In Fig. 6, the input of the inverter is A while the output is B. Note that B is expressed in terms of A. That

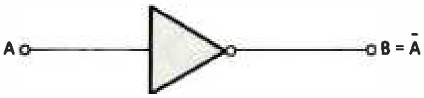


Fig. 6. The complement of a variable can be represented by placing a bar over that variable as shown here.

expression is read B is equal to NOT A. The NOT bar indicates that signal A has been inverted. Remember that A can be either a binary 0 or a binary 1. NOT A, of course, is the opposite, or complement.

Since it is difficult to type a bar over a letter as shown in Fig. 6, other simpler methods have been devised for representing inversion. Sometimes the inverted variable is indicated by an asterisk or a prime (similar to an accent). Using the variables in Fig. 6:

$$B = A^* \text{ or } B = A'$$

AND Function. The logical AND operation is indicated by placing a dot between the two variables to be ANDed. That is illustrated in Fig. 7. The two inputs to the AND gate are A and B

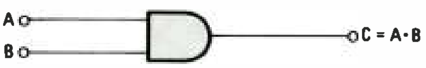


Fig. 7. ANDing of variables is indicated by using a dot between them.

while the output is designated C. Look at this expression for the output:

$$C = AB$$

In regular algebra AB would mean multiply A and B together. That's why the output of an AND gate is often called the product of the inputs. As in regular algebra, it is not necessary to show any symbol between the two variables (although sometimes a dot is used). Instead, they are simply just written adjacent to one another.

Figure 8 shows a four-input AND gate with different input variables. Many times you will see the output expression written with some variables separated by parentheses. Each input term appears within a set of parentheses to keep them visually separated to avoid confusion. But since each expression is written directly adjacent to the next, it

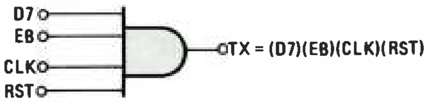


Fig. 8. The variables in Boolean algebra need not be one letter in length, but for clarity, separating them with parentheses becomes necessary.

means that the variables are ANDed together. In Fig. 8, we say that the output product is:

$$TX = (D7)(EB)(CLK)(RST)$$

OR Function. The logical OR is indicated by placing a plus sign between the variables. That is illustrated with the three-input OR gate shown in Fig. 9.

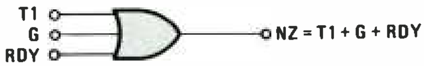


Fig. 9. ORing of variables is indicated with plus signs. Note the three inputs.

Often you will hear the output of an OR gate referred to as the sum of the input variables.

NAND Function. The NAND or NOT-AND function is simply the inverted product of the input variables. An example is shown in Fig. 10. The output expression is written just as it would be for an AND gate, but with a NOT indication given to the entire expression. That can be done by putting a bar over the entire expression as shown in Fig. 10. Alternately, the ANDed input terms can be put into parentheses and an asterisk or

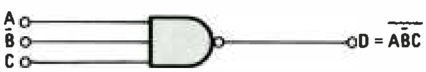


Fig. 10. In a NAND expression, the result of all ANDing is simply inverted.

apostrophe used to indicate the NOT of the function. Note that the B term has a NOT bar over it.

The NOR Function. To produce the NOR function, we simply invert a basic OR output. Figure 11 shows a four-input NOR gate. The output expression is formed by simply writing the input variables separated by plus signs. Then, a bar is placed over the entire expression to invert it. Again note that one term, DZ, is inverted at the input.

Fig. 11. Multiple-input NANDs do not need to have their variables separated by parentheses for clarity.

Now using those basic (Boolean) expressions for each of the logic gates, more complex circuits can be easily represented.

Deriving Boolean Expressions. Knowing the basic rules outlined in the previous section, you can now derive a complete Boolean expression for any larger, more complex logic circuit. The process is simply to work your way through the various logic gates starting with the inputs and building the equation a step at a time. A couple of examples will illustrate the process.

Refer to the circuit in Fig. 12. Note that the input variables are labelled. The output is designated G. Our job is to write the expression for G in terms of the input variables. It's really not as complicated as it sounds.

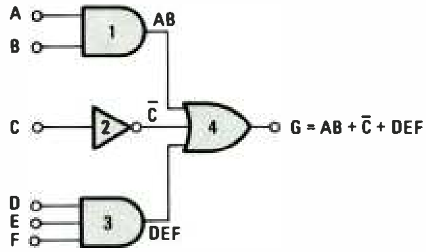


Fig. 12. You end up with a sum of products expression for this circuit after analysis.

To begin, you start with the variables at the inputs to each of the circuits on the left. Write the expression for the output of each circuit. For example, the output of AND-gate 1 is simply AB. The output of the inverter 2 is NOT C. The output of AND-gate 3 is DEF.

The outputs of gates 1 and 3, and inverter 2, form the inputs to OR-gate 4. To complete the expression, simply OR together each of the inputs to gate 4. The output expression G then becomes:

$$AB+\overline{C}+DEF$$

Take a look at the expression we just derived. You often hear an expression like that referred to as a sum of products. In this case, the products are the ANDed variables AB and DEF. The sum, of course, refers to the ORing together of each of the products.

A slightly more complex circuit is shown in Fig. 13. Still the evaluation process is the same. Work your way through the circuit from left to right writing the output expression for each gate. The output of gate 1 is A1(K) as shown. We use parentheses in this case to show the separation between the

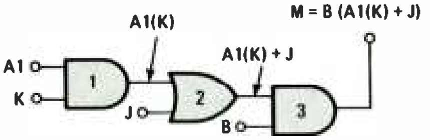


Fig. 13. The output of one gate becomes the input of the next in this circuit.

two variables, yet they are written adjacent to one another to indicate a product or AND function.

Next, the output of gate 1 is ORed with the input of J. The resulting output from gate 2 is:

$$A1(K)+J$$

That becomes one of the inputs to AND-gate 3. That expression is ANDed with input B to produce the final output expression:

$$M=B(A1(K)+J)$$

Again parentheses are used to keep the variables separated and to ensure the correct logical operation is expressed.

Take a look at the example in Fig. 14. Again, the procedure is to develop the output expressions of the input gates,

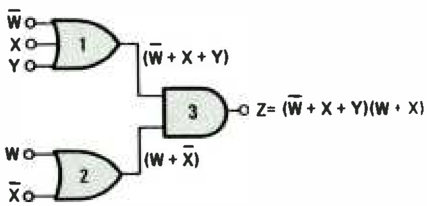


Fig. 14. You end up with a product of sums expression for this circuit after analysis.

then work your way from left to right to create the output. The output from gate 1 is:

$$(\overline{W}+X+Y)$$

The output of gate 2 is:

$$(W+\overline{X})$$

Those two outputs become the inputs to AND-gate 3. We create the final output expression, Z, by simply ANDing together the two expressions. The result is:

$$Z=(\overline{W}+X+Y)(W+\overline{X})$$

You might hear that kind of expression called a product of sums.

Generating a Circuit From Equations. Now let's consider the process of drawing the logic circuit corresponding to a given Boolean expression. Let's start with the simple expression below:

$$W=XY+\overline{Z}$$

The various logic functions implied by the equation are pretty easy to spot. The X and Y are written adjacent to one another indicating that the two signals are ANDed. Simply draw an AND gate with X and Y as the input. The output of that AND gate XY is then going to be ORed with another input called $\overline{Z}$. The plus sign tells us we need an OR gate to do that. If only the variable Z is available, an inverter is needed to produce $\overline{Z}$. The resulting circuit is shown in Fig. 15.

A slightly more complex example is given below:

$$X=(A+B+\overline{C})(\overline{D}+E)(F)$$

The parentheses tell you that you have three different groups of variables ANDed together to form the output, X. The variables in the groups are ORed

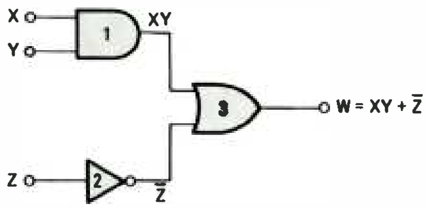


Fig. 15. By drawing the logic symbols that correspond to the Boolean expressions you'll arrive at the correct circuit.

together. You can start by creating the circuits for each group of variables. The plus signs inside the parentheses indicate an OR gate should be drawn. To start you can draw an OR gate with inputs A, B, and $\overline{C}$. Another expression is derived by ORing the input variables $\overline{D}$ and E. Simply draw an OR gate with the two variables as the inputs. The variable F inside parenthesis will be ANDed together with the other two expressions. Finally, to complete the circuit simply draw an AND gate with three inputs and connect them to the outputs of the two OR gates and a source of signal F. See Fig. 16.

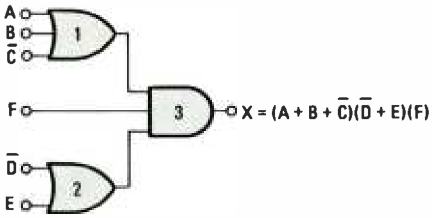


Fig. 16. The product of sums expression shown was used to generate this circuit.

Exercise problems. Here are a couple of problems for you to practice on.

1. Write the output expression of the circuit shown in Fig. 17.

2. Draw the logic diagram corresponding to the expression:

$$M=(\overline{F}+G+H)(J+\overline{K}+L)$$

Assume no inverted signals are available.

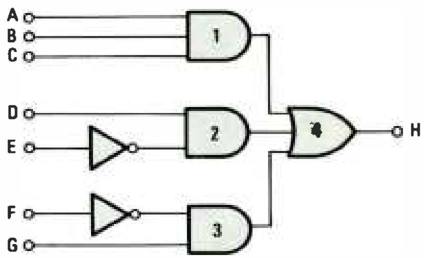
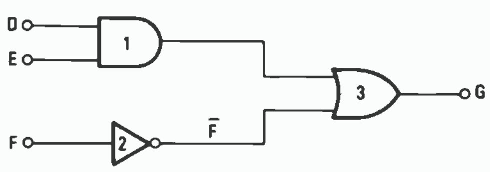


Fig. 17. Write the equation for the circuit.

Truth Tables. You have already seen how truth tables are used to define all possible combinations of inputs and outputs for the various logic elements. Truth tables, however, can also be used to describe larger, more complex logic circuits. The nice thing about a truth table is that it gives you a complete picture of what's going on in the circuit for any set of input states.

Developing a truth table for any logic circuit is relatively easy. All you have to do is write out all the possible input states, and for each one compute the output state for every gate in the circuit until the final output is derived. Let's take a couple of simple examples to show how you can evaluate the output state for a given set of inputs.

Take a look at the circuit shown in Fig. 18A. Where N is the number of in-



INPUTS			OUTPUTS		
D	E	F	GATE 1 DE	INVERTER 2 $\overline{F}$	GATE 3 G
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	0	0
1	0	0	0	1	1
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	1

B

Fig. 18. The possible outputs for circuit A can be displayed in a truth table like B.

puts, the total number of different input states is 2^N. The circuit shown has three inputs, so with three inputs, there are:

$$8 = 2^3$$

Those eight possible combinations are the binary numbers 000 (decimal 0) through 111 (decimal 7). Therefore, we will make a truth table with eight possible input states as shown in Fig. 18B.

The remainder of the truth table will contain the outputs at each element in the circuit. For example, note that we have the output of AND gate 1, the output from inverter 2, and the output from OR gate 3. Knowing how each of the logic gates work, you can then determine the output of each gate given the various combinations of inputs, and record those values in the table. For example, the input to gate 1 is D and E. Since it is an AND gate, the only time it will produce a binary-1 output is when both D and E are binary 1's. Simply locate those states in the inputs and record binary 1's beside them. All of the other entries in the DE column will be binary 0. The $\overline{F}$ column is created by simply inverting the F column.

You now know both inputs to OR-gate 3. The DE and $\overline{F}$ columns can then be ORed together to produce the final output, G. Again, remembering that an OR gate produces a binary-1 output if either or both of its inputs are binary 1, you can complete the G column.

Be sure you go through the circuit and the truth table carefully so that you understand exactly what is going on in each column.

Let's take one more example to be sure you know how to develop the truth table from a given logic circuit. Refer to Fig. 19A. That circuit has four different inputs, therefore, it will have:

$$2^4 = 16$$

possible input combinations. Those are the four-bit binary numbers 0000 (decimal 0) through 1111 (decimal 15). They are illustrated in the truth table shown in Fig. 19B.

The remaining columns in the truth table are the output of gate 1 (A + B); the output of gate 2 (C + D); and the final output, F. Again, using the input states, develop the output for gate 1 and then gate 2. Those are OR gates, and so produce a binary-1 output when either or both inputs are binary 1. For gates 1 and 2 simply search through the table for those rows where binary 1's occur at the inputs of the gates and record binary 1's in the corresponding output column. Once you have done that for both gates, you will have the inputs to gate 3. Gate 3 is an AND gate, so its output is 1 when the output columns for gates 1 and 2 are both binary 1. Again look through all of the columns in the truth table to be sure you understand how they apply to the circuit.

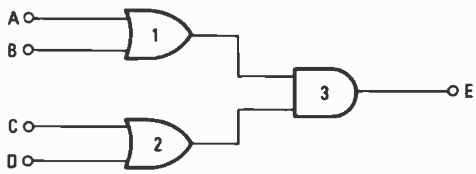
Exercise Problem. To see if you can do this yourself, try the following problem.

3. Draw the circuit for the Boolean expression:

$$Z = Y(VW + \overline{X} + \overline{V}X)$$

Assume only the inputs V, W, X and Y are available. Develop the truth table showing the outputs for all inverters and gates.

Writing from a Truth Table. In many cases, you will start with a truth table and develop the Boolean expression from it. That is what usually happens when you are designing a digital circuit. Typically, you will define a desired



INPUTS				OUTPUTS		
A	B	C	D	GATE 1 (A + B)	GATE 2 (C + D)	GATE 3 (E)
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	1	0	0
0	1	0	1	1	1	1
0	1	1	0	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	0
1	0	0	1	1	1	1
1	0	1	0	1	1	1
1	0	1	1	1	1	1
1	1	0	0	1	0	0
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

B

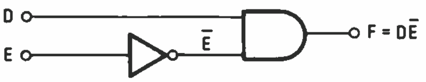
Fig. 19. You must use all possible input combinations for the circuit A for the table, B.

output condition that is generated when specific input states occur. To develop your design, you build a truth table filling in the columns with the desired output states for the given inputs. Then, the truth table can be used to help write the Boolean equation, and the logic circuit itself, can be deduced from the equation. Once the logic circuit is drawn, it can be implemented with ICs or other components.

A simple example of that is a design where we have two inputs and want a specific output to occur. For example, perhaps you want the output F to be binary 1 when input D is equal to 1 and input E is equal to 0. For all other input states, we want the output to be binary 0. That set of conditions can be drawn in a truth table as shown in Fig. 20A. With two inputs, there are four possible input combinations. We want the output to be a binary 1 when D is equal to 1

INPUTS		OUTPUT
D	E	F
0	0	0
0	1	0
1	0	1
1	1	0

A



B

Fig. 20. A truth table (A) must be generated from a circuit (B) before deriving the Boolean equation.

and E is equal to 0. All other input states produce a binary 0 output. The truth table shows that set of conditions.

Now to derive the Boolean expression from the truth table, we look at the output column F and note where binary 1's occur. Next, we look at the input states that produce that output. Then we write an expression that is the product of the input variables. For example, in the truth table of Fig. 20A, the equation becomes:

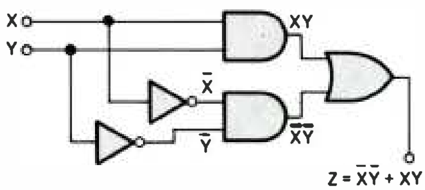
$$F = D\overline{E}$$

We write the D because a binary 1 appears in the D column. We write $\overline{E}$ because a zero exists in the E column. That simple equation, of course, can be implemented with a single two input AND gate. An inverter is be needed to produce $\overline{E}$ if only the E input is available. The resulting circuit appears in Fig. 20B.

Now let's take a more complex example. Suppose that we want to develop a simple circuit for comparing two bits. We would like the output of the circuit to be binary 1 when the two bits are equal, and binary 0 when they are different. That is described in the truth table shown in Fig. 21A. The two inputs are X and Y, therefore, the four possible input combinations are listed. We want the output Z to be binary 1 when the bits are alike. So we write a binary 1 when both bits are 0 and when both bits are 1. The remaining input states produce a binary 0 output.

INPUTS		OUTPUT	
X	Y	Z	
0	0	1	← $\overline{X}\overline{Y}$
0	1	0	
1	0	0	
1	1	1	← XY

A



B

Fig. 21. The truth table, A, generates a sum of products equation for circuit B.

Now we can write the equation for the circuit. We look at the output column and note the places where the binary 1's occur. Then we write an AND ed expression using the inputs. The first binary 1 output occurs if X = 0 and Y = 0. Therefore, the equation for that state is:

$$Z = \overline{X}\overline{Y}$$

The other binary 1 output occurs when X = 1 and Y = 1. Therefore, the input expression is:

$$Z = XY$$

To complete the Boolean expression, we simply OR the two AND expressions together. That is because the output becomes binary 1 under either condition. The resulting output expression:

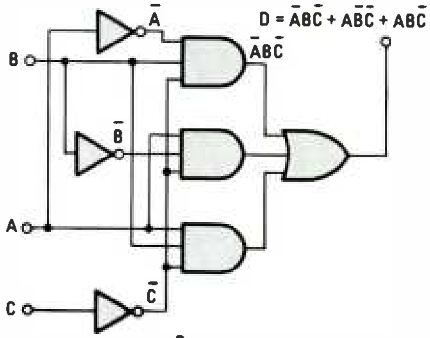
$$Z = \overline{X}\overline{Y} + XY$$

The resulting circuit is illustrated in Fig. 21B.

Let's take it one step further, and develop a more complex circuit. Suppose we have three inputs and the desired outputs are indicated by the binary 1's in the truth table of Fig. 22A. To develop the output expression for

INPUTS			OUTPUT	
A	B	C	D	
0	0	0	0	
0	0	1	0	
0	1	0	1	← $\overline{A}B\overline{C}$
0	1	1	0	
1	0	0	1	← $A\overline{B}\overline{C}$
1	0	1	0	
1	1	0	1	← $AB\overline{C}$
1	1	1	0	

A



B

Fig. 22. The conditions for a binary 1 output (A) must be ORed together to produce the Boolean equation (B).

the truth table, write an AND expression using the input variable for each place where a binary 1 appears in the output. The first AND expression is $\overline{A}B\overline{C}$. The variable with the NOT sign is used when a binary 0 appears at the input, and the variable itself is used when a binary-1 state occurs.

The other two conditions that produce a binary-1 output are $A\overline{B}\overline{C}$ and $AB\overline{C}$. Finally the output expression is built by ORing together the three input conditions that cause a binary 1 to appear:

$$D = \overline{A}B\overline{C} + A\overline{B}\overline{C} + AB\overline{C}$$

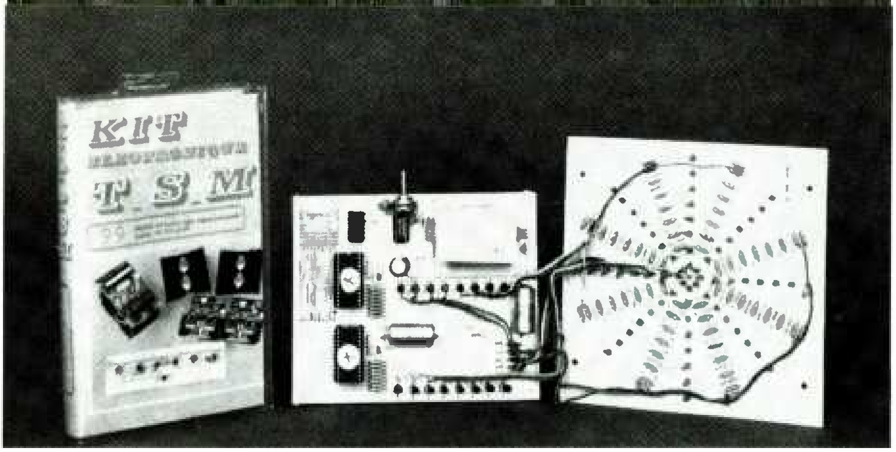
The corresponding circuit is shown in Fig. 22B.

That procedure works regardless of the number of inputs used. As the number of inputs increases, the Boolean expressions become far more complex. As it turns out, most of the larger more complex networks can be simplified by the use of Boolean rules. In the next installment, we will introduce the Boolean rules and show you ways to turn complex circuits into simpler ones.

But first, another exercise problem can be found on page 94. Why not turn there now to check your understanding. The answers to all of problems in this month's installment can be found there. ■

(Continued on page 94)

Popular Electronics HANDS-ON REPORT



CIRCLE 35 ON FREE INFORMATION CARD

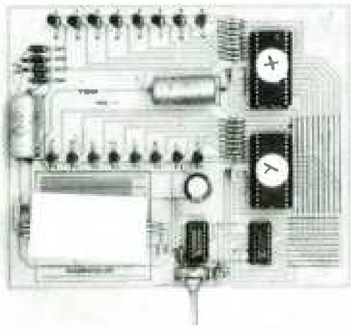
TSM VEGAS KIT

It's a star burst, cartwheel, chase light... it's everything 64 LEDs can do to entertain!

The TSM Vegas Kit (TSM-99) is a festive light display. When assembled, the Vegas Kit is a fascinating hypnotic lighting device which can be both relaxing and amusing. A long sequence of changing light patterns gives the display a dancing quality that appears to have motion and depth. A speed control can be set to suit the mood of the observer.

The two-board kit holds the light-emitting diodes on one board—eight radials of red and green LEDs (eight LEDs per radial)—and all the electronics on the other board. The circuit board contains a diode bridge for rectifying 9-volts AC. Its output is passed through two 5-volt regulators. Two pre-programmed ROMs contain the lighting sequences and are used to control 16 switching transistors.

Construction. The light display goes together with a minimum of trouble. By following the simple instructions, the two boards can be wired quickly. Connecting the LEDs may take some effort because there are 64 of them—that's 132 solder connections. Each LED has a series current-limiting resistor which means an additional 132 solder connections. Get past that phase and the rest is a piece of cake.

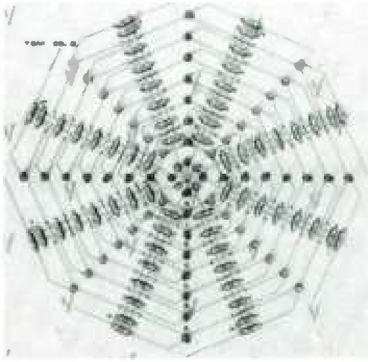


This is the circuit board that contains the "brains" for the Vegas Kit. Two pre-programmed ROMs (marked X and Y) provide almost 800 different patterns.

A ribbon cable is supplied with the kit to use as long jumpers and for interconnecting the two boards. Unfortunately, the individual wires were stranded. I discarded the cable and used one from my junk box that was a bit more colorful and had solid wire. The solid wire would help me avoid twisting and pre-soldering of the wire ends and the trouble of fitting the processed ends into the small drilled holes in the printed-circuit board.

Power-Supply Confusion. There was some confusion generated by the kit instructions in regards to the power supply required to operate the Vegas Kit. On the first page of the instructions it was indicated that a 12-volt DC, 1-ampere power supply (not included) was required to power the unit. The circuit board, however, indicated that a 9/12-volt AC, 1-ampere power source was required. That made more sense since a diode-bridge circuit was included on the circuit board. Somewhat later in the instructions two sentences cleared up the confusion. Yes, a 12-volt, AC supply was required; however, in its place a 12-volt DC supply can be used, provided it is connected across filter capacitor C2 on the circuit board. No further mention was made about 9-volt sources.

With those options open, a telephone step-down transformer, normally used to power the lights in a home phone, was used to provide the AC power. The transformer was rated at 8.5-volts AC and most probably rated less than 1 ampere, but I decided to use it anyway. It did do the job, although it was warm to the touch after one-hour's use. Once the power was applied to the Vegas Kit, the LED display started and amazed those who saw it.



The LEDs are arranged in a cartwheel fashion with four radii of red LEDs and four radii of green LEDs. The colors of the radii alternate.

Looks Great. The assembled Vegas Kit found its place in a Christmas-decorated window in a home. Next to a moving mechanical Santa Clause, the LED display was the most stared-at item in the window. Children and adults were fascinated by the varying light-patterns presented by the 64 LEDs.

The display can find its place anywhere inside the house too. It'll perk up a child's room. Set between parallel mirrors it has an Infinity-Mirror effect that makes it suitable in any room.

The Vegas Kit is a project for beginners and gadgeteers who like novel and unusual items to assemble and use. The actual number of applications is unlimited. You can purchase the Vegas Kit (Order No. TSM-99) for $130.00. You can contact the TSM headquarters, at 2065 Boston Post Road, Larchmont, NY 10538 for the TSM distributor nearest you. ■

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So don't blow a fuse . . . take it easy and enjoy the holidays. Give Christmas gifts of Hands-On Electronics!

Antique Radio

By Marc Ellis

CABINET REFINISHING

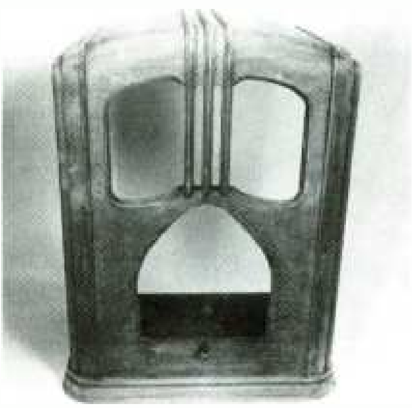
Last month, we completed the restoration of a Zenith Model 7S232 "shutter-dial" chassis that was begun in the August issue. I certainly enjoyed doing the work, and I hope that you all enjoyed reading about it. Unfortunately, the set's cabinet also requires quite a bit of attention. (And cabinet refinishing is my least favorite radio-restoration activity.) The radio was damaged in a small, but violent, gas-furnace explosion while it was possessed by its previous owner—which is the only reason he was willing to sell it!

Besides blowing out the speaker cone (which has since been repaired) and charring the grille cloth, the explosion also completely ruined the finish on the 7S232's cabinet. It looked as if it had been almost vaporized, exposing a rough, light-colored, wood surface. The wood seemed virtually grainless, suggesting that the grain had been a photographic one—as was common in sets of that era—and was lost along with the finish.

Down to Basics. That was discouraging, but obviously the only thing to do was to strip off the remains of the old finish and reassess the situation. I hoped that, once cleaned up, the cabinet would take stain nicely so that a presentable replacement finish could be applied. Being grainless, it would lack the beauty of the old one. But it would at least be fresh and new, providing an attractive setting in which to install the restored chassis.

I used a methylene-chloride-based chemical stripper—the kind that applies as a heavy gel so that it will stick to the wood surface and do its work without dripping off. That stuff takes off old paint or varnish coatings as quickly as anything I know. And it's pretty nasty if you get it on your hands. It's not caustic like lye or acid, but will definitely sting, burn, and redden the skin.

I find it difficult to strip furniture while wearing gloves, so I try to work near a water tap. By rinsing my hands frequently, I can avoid most of the ill effects. It's also wise to use that type of stripper outside or in a well-ventilated area. While not noxious, the fumes are definitely not good for you—and can leave you with an unpleasant, hang-over-like feeling the next morning.



Shown here is the 7S232 now stripped of its finish. Much to my surprise and delight, the grain was not photographic, but really in the wood—just waiting to be brought out by an application of stain.

Under the Sludge. That type of chemical stripper turns the old finish to a kind of gummy sludge. The idea is to remove as much as possible with a broad putty knife, being careful not to scratch the wood surface as you work. The remains of the sludge are then mopped up with a cloth moistened in solvent—leaving behind a clean-as-a-whistle surface.

As soon as I began the first mop-up operation, I received a very pleasant surprise. A beautiful wood-grain pattern was being exposed; the grain was real after all! What had looked—prior to stripping—like an almost-bare grainless, wood surface was really a layer of old varnish, decomposed and whitened in some way by the effects of the explosion.

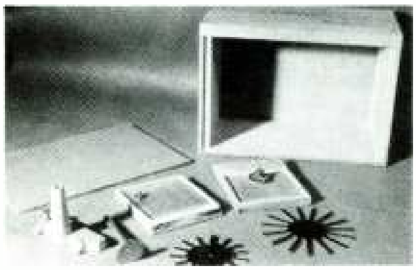
Working a little more enthusiastically, now, I quickly removed the rest of the old finish. Stripping may be a smelly, messy job, but it really doesn't take long to complete even for a large cabinet like this one.

I had noticed too late, by the way, that the recommended "mop-up" solvent for the particular stripper I was using was lacquer thinner. I didn't have any handy, but made do with mineral spirits instead. That worked fairly well, but tended to leave behind little grains of solid sludge. Those remaining grains were easily brushed off once the cabinet had dried, but I assume that they would have been dissolved and removed during mop-up had I used the correct solvent.

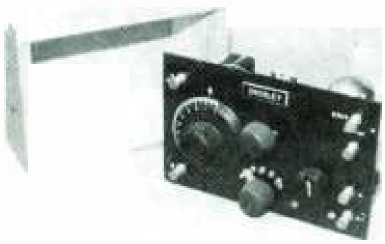
When I had finished, with the cabinet still damp from stripper and solvent, it looked almost as if I could apply the new finish without re-staining. But after overnight drying, the picture looked quite a bit different. The stripper had definitely removed quite a bit of the old stain, resulting in a pale, splotchy appearance. A new coat of stain would definitely be required, possibly with a preliminary bleach to even out the variations in color intensity. I'll report on my progress next month.

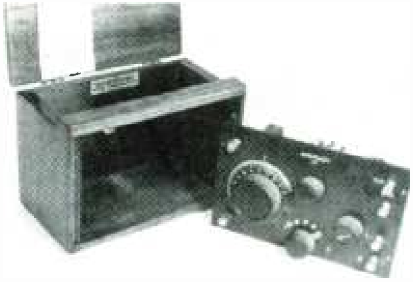
Several readers have written me interesting letters during the course of the Zenith restoration, and this seems like a good time to catch up with them. So let's open the mailbag!

7S232 Clones. One of the first communications I received was from John W. White, II, who says he has a Zenith 6S233 set that's very similar to my 7S232. The cabinet on his was warped, so he had to discard most of it. But he enjoys the set so much that he keeps the bare chassis on a bedside table for evening listening. John doesn't miss the cabinet too much, because he likes to



This is the preliminary stage in the construction of Dan Damrow's Crosley 50 replica. The fabricated parts for the coils and "book" condenser are in the foreground.





Compare the front of Dan's replica (left) with a similar shot of an actual Crosley 50 (right). Note the remarkable resemblance between the two!

watch the glow of the tubes at night.

Can anyone help John with a schematic for a "National Dobro Amplifier Model 6107A?" It was built by Webster Electric of Racine, WI and uses the following tubes: one 5Z3, two 2A3's, a 79, and a 56. He'd probably also be interested in a cabinet for his Zenith. Contact him at RD 3 Box 217, Claysville, PA 15323.

Frank De Stasi has another set very similar to mine, a Zenith 9S262. By a strange coincidence, his is also a bare chassis job. Like John, he doesn't allow the lack of a cabinet to keep him from enjoying the radio. But if you can supply a cabinet for Frank's set, write him at 769 Sybil Ave., San Leandro, CA 94577.

Frank enclosed a schematic of the set, which has a larger speaker than mine and a couple of extra tubes. Frank's set also boasts a motor tuning drive that allows him to go from one end of the dial to the other in seconds. And since the tuning dials on those radios are geared way down for good vernier action, I imagine that the motor drive comes in very handy.

Frank tells me that he purchased the 9S262 schematic, and many others, from Howard W. Sams & Co. Photofact Tech Services, PO Box 7092, Indianapolis, IN 46206. He reports that they can come up with schematics for many antique radios for a price of $1.00 per copy and a $2.50 handling charge (I assume the latter is a "per order" rather than "per copy" fee).

Helping Hands. John Fitzgerald (Middleton, WI) informed me that a copy of the 7S232's schematic can be found in Supreme Publications' *Most Often Needed 1926-1938 Radio Diagrams* on page 228. That useful book, as well as many of the other Supreme publications, is available as a reprint. Write ARS Enterprises, PO Box 997, Mercer Island, WA for a free catalogue. Here's another tip from John: He's found that Omnitron Electronics, 770 Amsterdam Ave., New York, NY 10025 is a good source of hard-to-find tubes and other parts.

Keenan Whitley joins the growing group of people (see last month's column) who have written to say that the Zenith dial glass and dial belt that I was looking for could be obtained at Antique Electronic Supply, 688 W. First St., Tempe, AZ 85281. And he took the trouble to photocopy the entire A.E.S. catalogue for me.

Keenan went on to say that those with cabinet restoration problems might like to read *The Complete Manual of Wood Finishing* by Frederick Dieghton. He says that it's an excellent book, and even contains a chapter on faking woodgrain finishes (in case you've lost a photographic one, as I suspected that I had before stripping my Zenith cabinet). It's published by Stein and Day, Scarborough House, Briarcliff Manor, NY 10510.

It's even more impressive to compare the rear view of the replica (top) to the actual set's (bottom). Except for the tube, Dan made every one of his parts from scratch.

Finally, Keenan suggested that I restore a really impossible set in the column, perhaps one with extensive lightning damage. Having just devoted several months worth of columns to a restoration, I'd like to deal with some other kinds of subjects for a while. But Keenan's suggestion did give me a terrific idea.

How about a contest where you readers submit photos and descriptions of your most messed-up radios? The one judged to be the best (worst, that is) would be restored in the column and then returned to the owner. Let me know what you think, but hold your entries. It will be several months before I'd consider doing that.

Mike Schulsinger (Springfield, OH) wrote to correct a boo-boo I made in the September column. I referred to the broadcast band dial of the 7S232 as covering a range of 55-170 kilohertz; the range is really 550-1700 kilohertz. Thanks for the correction, Mike!

Waltons Reruns. I finally received the 7S232 comment that I was hoping someone would send! It comes from Bill Morris (13901 Oakridge Dr., Carmel, IN 46032). Some years ago, I had seen a Zenith set that looked very much like mine used as a recurring prop in a TV situation comedy series. I wanted to mention it in the column, but couldn't quite remember the series name. Bill writes that the series was *The Waltons*, so keep an eye open for reruns in your area. You may be lucky enough to spot the Zenith, too.

Bill included quite a want list of sets and parts, and I'll see if I can fit them all in. Please contact him if you can help! He'd like to locate a Zenith Transoceanic Model 7G605 (1942 model); servicing information, an owner's manual, door assembly, and AM wave magnet for a Transoceanic Model 1000 (1957 model); Fisher 800B receiver; antenna coils for an Echophone EC-2; any Zenith shortwave receiver of the 1960's; and he wouldn't mind locating a 7S232, either!

Criticism Accepted. George Bidwell (La Jolla, CA) wrote to remind me that I still haven't discussed the reader comments received in response to the columns on the Crosley 50 (January and February 1988 issues). At the time, I postponed the discussion on that one-tube regenerative receiver; there was such a backlog of reader mail that the

(Continued on page 102)

Circuit Circus

By Charles D. Rakes

UNUSUAL USES FOR TRANSDUCERS

This month's Circus starts the new year off with a number of solid-state piezo-transducer circuits. Those critters can be heard chirping their little hearts out in just about every kind of equipment that uses an electronic sounder.

We wake up to the beep-beep sound of our digital clock. Then as we get into our automobile, a beep reminds us to buckle up. And on through the day we hear a beep here, a chirp there, directing our attention from one place to another. With all of the racket created by the piezo sounders, you'd think there's nothing else they can do. Well, it's just not so!

Fixed-Frequency Generator. The circuit shown in Fig. 1 is self-oscillating; in it, a piezo element is used as the frequency-determining component. The circuit produces a tone output that can be used as an encoding signal for remote control or any other application where a fixed-frequency tone signal is required.

An unusual function of that tone-encoding generator is that both an audible tone and a signal are generated at the same time. The circuit's operation is simple. A single op-amp (one fourth of an LM324 quad op-amp) is configured as a standard inverting amplifier.

At power-up, a positive voltage is applied to the non-inverting input of U1 (via R3), forcing its output high. That high travels along three paths. The first path is the tone output. Along the second path, by way of R5, that high is used as the drive signal for BZ1.

In the third path, the high output of U1 is fed back, via R4, to the inverting input of U1. That forces the output of U1 to go low. And that low, when fed back to the inverting input of U1, causes the op-amp output to again go high, and the cycle repeats itself. As configured, U1 provides a voltage gain of 4.7 (gain = R4/R1).

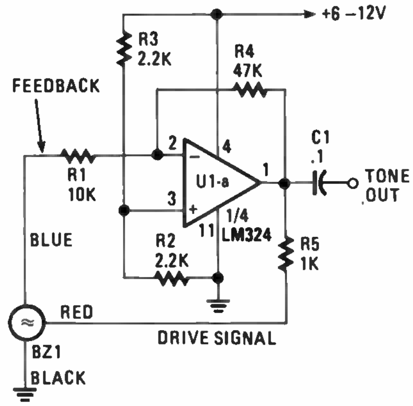


Fig. 1. This self-oscillating circuit uses a three-terminal piezo transducer as the frequency-determining component.

There are a number of "orphan" piezo transducers available on the surplus market. Several three-terminal piezo transducer elements were tried in the circuit and all performed well. The transducer specified in the Parts List comes with three short colored-coded (red, blue, and black) lead wires as indicated in Fig. 1. With the aid of the piezo-transducer pinout shown in Fig. 2, you should have little trouble in connecting any transducer to the circuit.

The outer ring of the piezo element is usually connected to circuit ground. The large, inner circle serves as the driven area, and the small, elongated

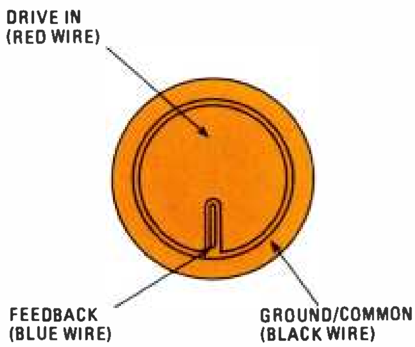


Fig. 2. Here is the pinout diagram for the three-terminal piezo transducer. The outer ring is usually connected to ground; the large inner circle is the driven area, and the elongated section is the feedback.

PARTS LIST FOR THE FIXED-FREQUENCY GENERATOR

U1—LM324 quad op-amp, integrated circuit
R1—10,000-ohm, ¼-watt, 5% resistor
R2, R3—2200-ohm, ¼-watt, 5% resistor
R4—47 000-ohm, ¼-watt, 5% resistor
R5—1000-ohm, ¼-watt, 5% resistor
C1—0.1-µF, ceramic disc capacitor
BZ1—Piezo fixed-frequency transducer, Radio Shack 273-064 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

section supplies the feedback signal. Resistor R5 sets BZ1's output-volume level. That level can be increased by decreasing R5 (say, to 470 ohms). To decrease the volume, increase R5 to about 2.2K, or so.

Resistors R2 and R3 set the bias for op-amp U1's positive input (pin 3) to half of the supply-voltage level. That allows for a maximum voltage swing at U1's output. Although a quad op-amp is specified in the Parts List, almost any similar low-cost single or dual op-amp will work for U1-a.

Sound-Activated Decoder. Turning our attention to Fig. 3, we see a piezo transducer performing double duty in that it operates as a sound-pickup device as well as a frequency-selective filter. Transducer BZ1, is connected to op-amp U1-a just as in the previous circuit, but with one notable exception—a gain control, potentiometer R3, has been added.

By controlling the gain of the op-amps, the oscillator circuit can be transformed into a sensitive and frequency-selective tone-decoder circuit. With the gain of U1-a set just below the point of self oscillation, the transducer becomes sensitive to acoustically coupled audio tones that occur at (or near) its resonant frequency.

The circuit's operation is comparable to an early and popular type of radio receiver in which regeneration was used to achieve super-high gains using relatively low-gain amplifying vacuum tubes. Regeneration is obtained by adding a controllable positive-feedback path between the receiver's input and output circuitry. And it was the gain obtained via regeneration in receivers of the 1920s that turned a simple one-tube set into a world-wide receiving station.

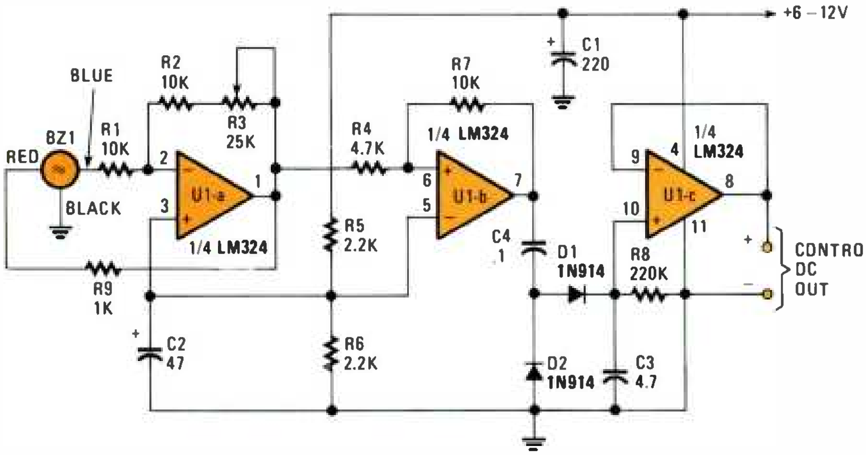


Fig. 3. In the Sound-Activated Decoder, the piezo transducer performs double duty, in that it operates as a sound-pickup device and a frequency-selective filter.

PARTS LIST FOR THE LOW-FREQUENCY CRYSTAL FILTER

U1—LM324 quad op-amp, integrated circuit
R1—47,000-ohm, ¼-watt, 5% resistor
R2-R5—10,000-ohm, ¼-watt, 5% resistor
R6, R7—2200-ohm, ¼-watt, 5% resistor
R8—100,000-ohm, ¼-watt, 5% resistor
C1, C2—0.1-µF ceramic-disc capacitor
C3—47-µF 16-WVDC electrolytic capacitor
C_X—See text
BZ1—Piezo transducer, Radio Shack #273-073 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

PARTS LIST FOR THE SOUND-ACTIVATED DECODER

U1—LM324 quad op-amp, integrated circuit
D1, D2—1N914 general-purpose small-signal diode
R1, R2, R7—10,000-ohm, ¼-watt, 5% resistor
R3—25,000-ohm potentiometer
R4—4700-ohm, ¼-watt, 5% resistor
R5, R6—2200-ohm, ¼-watt, 5% resistor
R8—220,000-ohm, ¼-watt, 5% resistor
C1—220-µF, 25-WVDC electrolytic capacitor
C2—47-µF, 25-WVDC electrolytic capacitor
C3—4.7-µF, 25-WVDC electrolytic capacitor
C4—0.1-µF, ceramic-disc capacitor
BZ1—Piezo fixed-frequency transducer, Radio Shack #273-064 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

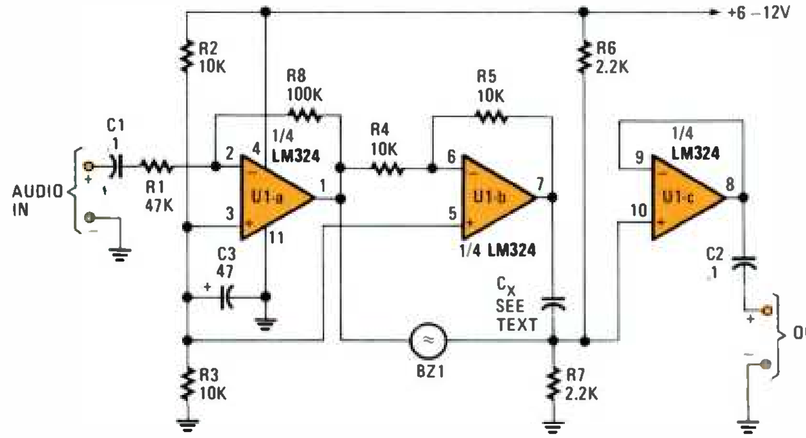


Fig. 4. In this circuit, the piezo transducer functions like a low-frequency, quartz crystal in a narrow band, crystal-filter circuit.

In-band audible tones reaching the transducer's surface cause the transducer to vibrate in step with the incoming sound wave. The regenerative action of the circuit then causes the signal to be amplified to a 1½- to 2-volt level. The output of U1-a is fed to U1-b, where the signal is doubled. The boosted signal is then fed across a dual-diode rectifier circuit to the input of a voltage follower, consisting of U1-c only.

The circuit's output can be used to activate optocouplers, drive relay circuits, or to control almost any DC-operated circuit. The DC signal at the output of U1-c varies from zero to over six volts, depending on the input-signal level. One unusual application for the Sound-Activated Decoder would be in extremely high-noise environments, where normal broadband microphone pickup would be useless. Because piezo transducers respond *only* to frequencies within a very narrow bandwidth, little if any of the noise would get through the transducer

Low-Frequency Crystal Filter. Another interesting job that the piezo transducer can perform is to function like a super low-frequency, quartz crystal in a narrow-band crystal-filter circuit. The circuit shown in Fig. 4 is the piezo equivalent of a super-selective crystal filter.

In a typical crystal-filter circuit, the crystal's internal capacitance is electronically canceled to keep unwanted and out-of-band signals from getting through and showing up at the filter's output. Internal capacitance normally runs in the low picofarad range for crystals and in the 20- to 30,000-pF range for the piezo transducers.

In a quartz circuit, a small trimmer capacitor is used to tweak out the capacitance effect, but to use the same approach for the piezo filter, you'd need to gang at least 100 broadcast-band tuning capacitors together to achieve the same effect.

With our piezo-transducer circuit, op-amp U1-a doubles the level of the input signal. That magnified signal is fed to one leg of BZ1, while at the same time being fed to the inverting input of U1-b. Op-amp U1-b, with a voltage gain of one, inverts the signal's waveform, which is next fed through capacitor C_x and then to the other side of the piezo element.

If the value of C_x equals the internal capacitance of the piezo element, the transducer's capacitance effect is canceled out. Several piezo transducers come with a list of their electrical characteristics, including their internal-capacitance figure. If the information isn't available, it can be determined with the aid of a capacitance decade-box or a capacitance meter.

(Continued on page 97)

Computer Bits

By Herb Friedman

AN ELECTRONIC ROSETTA STONE

For many hundreds of years, the language of ancient Egypt had been a riddle to scholars. But in 1799, a French officer discovered a stone carved with a decree of Ptolemy V, the king of Egypt from 203 to 181 B.C.. The decree was carved in three languages: ancient hieroglyphics, Demotic—the popular language of Egypt at that time, and Greek. A scholar was able to translate the Demotic from the Greek, which then permitted translation from Demotic to hieroglyphics. The door to ancient Egypt was literally thrown wide, and scholars could now read the literature of ancient Egypt.

Now what has all that got to do with computers? Simple. At last count there were more than 1500 word-processing programs for personal computers. Of them all, about two dozen are *biggies*; and of the biggies, virtually none are interchangeable. That means that if you started out in personal computing back in the pioneer days you might be using *WordStar*—20% of the word-processing programs sold are WordStar; but your office might be using *Multimate*, your college probably uses *WordPerfect*, your child's high school might use *PFS: Write* or *IBM Writing Assistant*, and your lab-partner might be using *Volkswriter*.

A Tall Tower. Basically, what we have is a word-processing Tower of Babel, because the most popular, most frequently used word-processing programs can't read the text files of the other programs.

For example, I use XyWrite, the word-processor of choice for magazine editors. Why is it the word-processor of choice for editors? Because its text files are *pure* ASCII. They are read directly by our typesetting computer, and its files can be read by any program that reads pure ASCII files—and that's a very large list of software.

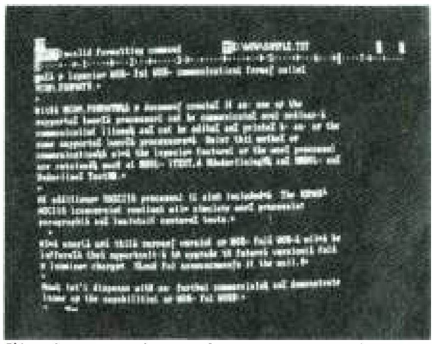


Fig. 1. A WordStar file read on a different word-processor will produce a screen of what resembles hieroglyphics, as will most documents that were prepared on non-ASCII word-processors.

But if I try to read an author's disk that was written in WordStar, I get the "hieroglyphics" shown in Fig. 1, which is caused by WordStar having the high bit set.

While there are several programs that "strip" the high bit to create readable text from WordStar files, a "stripper" doesn't untangle WordStar's formatting codes for such things as boldface, indent, underline, etc. Just as with virtually any other word-processor, I would still have to muck my way through to change all the page-formatting commands to the commands of my word-processor—and on a large document, that might take an hour or more.

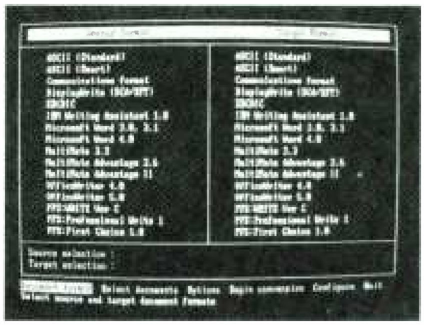


Fig. 2. Word For Word can be command-line or menu-driven. This is the opening menu. You page down for more formats.

The Electronic Rosetta. What was needed to untangle the incompatibilities of word-processors was an Electronic Rosetta Stone, something that could translate one word-processed document—including the page-formatting commands—into the format used by another word-processor. That meant, for example, that if I were translating a Multimate text file into a XyWrite file, the Multimate page-formatting commands would automatically be converted to XyWrite commands; thereby saving me an hour or so of dull, boring, manual format conversions.

Well, we now have an Electronic Rosetta Stone. It's called *Word For Word* (Design Software, Inc., 1275 West Roosevelt Rd., West Chicago, IL 60185), and it translates both the text and the major formatting features—such as line spacing, tabs, boldface, underline, etc.—of the most-popular word-processors. When Word For Word cannot make a format translation, it will print out a list of the non-translatable locations so that the user can step right to the problem(s) and key in the correct format command(s).

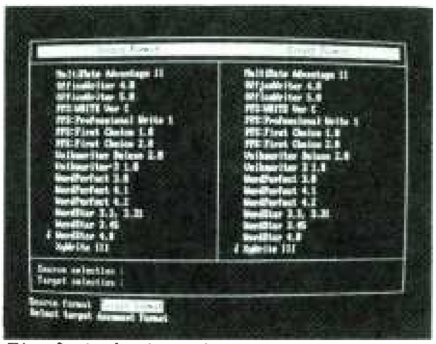


Fig. 3. A check mark appears adjacent to the selected source and target formats.

Word For Word can be either command-line or menu driven. Command-line is what is usually called the "expert mode," meaning a single line of commands gets the computer to do a series of steps. For example, with Word For Word, the command-line WFW WS XY3 SAMPLE.TST SAMPLE.TXT is all that it takes to convert a WordStar file called SAMPLE.TXT to a XyWrite file called SAMPLE.TXT.

But you can also use menu-driven commands until you become an expert, or if you use the program so infrequently that you can't remember the translation commands.

The program comes up with the menu shown in Fig. 2. Both sides of the screen are identical, listing those

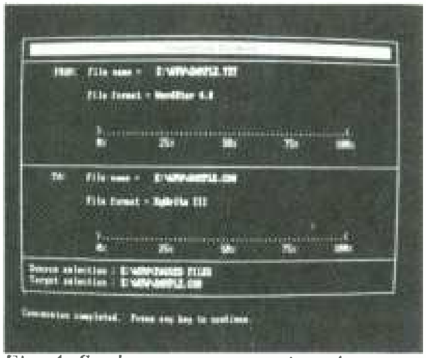


Fig. 4. So that you don't get bored, or think something's gone wrong if the translation takes several seconds, Word For Word keeps you entertained with a screen display of the translator's progress.

word-processors that you selected during the initial installation. (Figure 2 shows only part of the total.)

As shown in Fig. 3, checkmarks indicate the source and target formats. You then select the source file, enter the name you want to use for the target file, and you end up with the screen display shown in Fig. 4.

Basically, Fig. 4 is entertainment to keep you amused as the translation takes place. A series of travelling dots tells you what percentage of the source was "read in," and a similar series of dots tell you what percentage of the translation was written to disk.

Figure 5 is the translation of the hieroglyphics shown in Fig. 1. Notice that Fig. 5 is now in pure XyWrite format, right down to the on-screen displays for boldface and underline. But there is a problem. Because of the original WordStar file's line formatting, the inter-word spacing varies between one and two spaces. But no problem. A quick automatic search/and replace of one space for two (CIA / / /) gives us the almost-perfect screen display

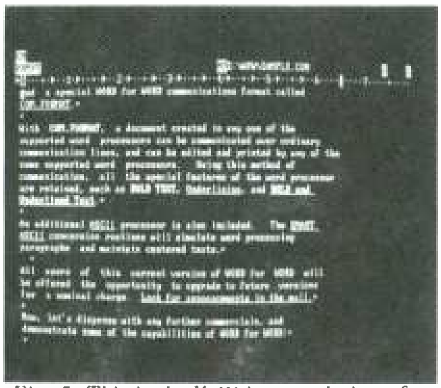


Fig. 5. This is the XyWrite translation of the WordStar file shown in Fig. 1. All formatting is correct, but there are single and double spaces between the words.

shown in Fig. 6. The only manual clean-up that's necessary is to remove the extra space between the second and third paragraph (the space in front of the left-pointing arrow that signifies a line space).

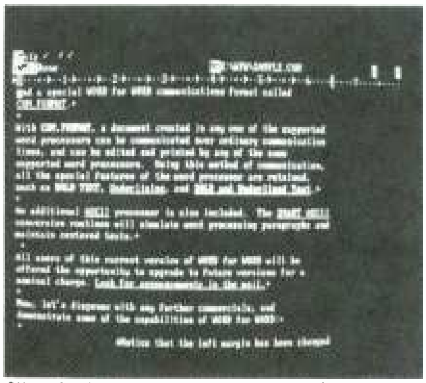


Fig. 6. An automatic search-and-replace eliminates the extra spaces between the words. In less time than it takes to read this caption, the "Electronic Rosetta Stone" has given us a perfect translation of the WordStar file shown in Fig. 1.

Smart ASCII. Now if you're up on software you know that many word-processors save, or can save their files in ASCII format, which is transportable to other word-processors. The problem, however, is that either all page-formatting is stripped off, or the target computer hasn't the vaguest idea what the page formatting commands mean. Either way, the translation is neither complete nor accurate, and translations can prove to be a real time-waster. For example you could probably make lunch in the time it would take some programs to page-format a 2000-word ASCII document.

Word For Word gets around the problem by having both ASCII and Smart-ASCII translations. Generally, conventional ASCII contains no page formatting of any kind; the file contains only text characters. Smart-ASCII contains ASCII text characters and the page-formatting commands. However, keep in mind that a non-word-processed document—such as a spreadsheet—should be converted in conventional ASCII. ■

DX Listening

GLASNOST AND DX'ING

By Don Jensen

DX'ers here often tune in *Radio Moscow*, or other Soviet shortwave broadcasters like *Radio Kiev* or *Radio Yerevan*. But what about the reverse? Can SWL's in the Soviet Union listen to broadcasts from the west?

Yes, indeed, according to a Soviet listener writing in the Danish Shortwave Clubs International's "Short Wave News." Listening to foreign stations has not been a crime since the death of Joseph Stalin, says Igor Sannikov, but neither was SWL'ing encouraged because some western stations engage in what he calls ideological warfare.

In 1982, some Russian SW enthusiasts sought to have DX'ing recognized by the Radio Sport Federation as a part of the amateur-radio hobby, but the request was rejected. However, with today's official policies of *"peristroika"* and *"glasnost,"* more Soviet citizens are discovering SWL'ing.

Still, Sannikov estimates, there are only your 100 active SWL's in the entire USSR, with its population of 280 million. That's mostly due to a previous lack of publicity about DX'ing as a hobby.

That, too, is changing. Sannikov says that in Lithuania, for example, there already have been two articles published on the listening hobby. Soviet SWL's also have been asked to participate in DX'ing programs aired by *Radio Tashkent* and *Radio Vilnius*.

Most Soviet listeners belong to the "Radio Budapest SW Club" (Hungary), he notes, but that there are some local clubs developing within Russia. As early as the 1970's, club bulletins were published by two small organizations known as "Baltika DX Club" and "DX-Club 77." There also was an English-language publication called the "Ukrainian DX Review Summary" in 1982.

The problem for small Soviet clubs is the lack of copying equipment. Xerox-type machines are not for public use. Most bulletins are simply typed in limited numbers, although computer printers are becoming available. Some active listener clubs are the "DX Circle Leningrad" (founded over two years ago by three SWL's from that city) and a newer organization, the "Soviet DX Club," which has published a bulletin called "World DX News" since mid-1987.

While those bulletins surely would be of interest to U.S. and Canadian SWL's, so far, they are intended for Soviet listeners and are written entirely in Russian. In the future, though, look for greater contacts between DX hobbyists in the USSR and the West.

A Fine Romansch. On shortwave, one can hear all sorts of obscure languages and dialects, from the Eskimo Inukitut (Canadian Broadcasting Commission's Northern Quebec Service) to Pidgin (the National Broadcasting Commission of Papua, New Guinea).

It is interesting to note, as you tune the SW bands, the many different and varied *lingos* of the world. Consider Romansch, for instance. Along with French, Italian, and Swiss-German, it is one of the four official languages of Switzerland.

This gentleman is not only a shortwave listener and a licensed ham-radio operator—9IMC—but is also the chief engineer for Radio Nepal. Readers who have received QSL's from this exotic Asian station have Krishna B. Khatry to thank for those replies.

You won't find it among the 200-name list of principal languages of the world—languages spoken by more than a million persons. There are more people in West Africa (some 2 million) who speak Ijaw than there are Swiss (about 50,000) who consider Romansch their mother tongue. And each census shows that the number of Romansch-speaking persons is decreasing.

In the eastern canton of Graubunden, less than half of the population now can speak the language. Few visitors to the ski resorts of St. Moritz even realize that the native language of the region is Romansch, not the commonly heard Swiss-German.

Romansch, linguists say, is probably the closest living language to the ancient Latin vernacular spoken during the time of the Roman Empire. Clearly, Switzerland's curious "fourth" language is dying!

Curious SWL's can get a brief sample of Romansch on *Swiss Radio International* (SRI), notes Harold Sellers, writing in the Ontario DX Association's bulletin, "DX Ontario," on Tuesdays and Fridays, at 0315 UTC on 6.135, 9.725, 9.885 and 12.035 kHz.

Feedback. Your letters are always welcome. Send details of your SWL'ing, your comments, or questions to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmindgale, NY 11735.

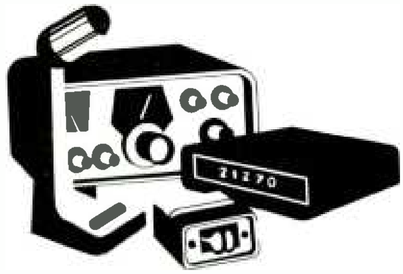
Donald Callahan, Gray, ME, writes to say that he's very new to DX'ing and uses an older Lafayette shortwave receiver. "I hear quite a bit," he says, "but I am particularly interested in a signal I'm hearing from the Yukon." Donald says he'd like to eliminate interference from Latin America and wonders if a dipole antenna will do the trick.

First, Don, I think you must be listening to a ham on one of the amateur-radio bands. There are no shortwave broadcasting stations—that is, stations that broadcast programs—in the Yukon Territory, although there are hams operating from the Canadian far north.

One of the commercial amateur-radio beam antennas on a rotor could

(Continued on page 95)

*Credits: Harold Sellers, ONT; Jack Jones, MS; Alan Laves, TX; Ivan Grishin, ONT; Paul Buer, FL; Ed LeBlanc, ONT; Henry Loewer, OH; Tom Manley, ONT; Paul Brouilette, IL; Tom Laskowski, IN; Richard Eckman, CA; Ontario DX Association, PO Box 161, Station A. Willowdale, ONT, Canada M2N 5S8; North American SW Association, 45 Wildflower Rd. Levittown, PA 19057.



Ham Radio

By Joseph J. Carr, K4IPV

MYTHS AND MISINTERPRETATIONS

We radio amateurs sometimes toss around facts, figures, numbers, and parameters without giving much thought to what they mean. As a result, some plain old-fashioned nonsense creeps into our daily language. This month we will devote this column to looking at a couple of myths, or semi-myths, frequently found in amateur-radio (as well as CB) circles.

Signal Strength Reports. Most of our receivers are equipped with S meters to indicate the strength of the received signal. The S meter (Fig. 1) allegedly measures input-signal strength in a rigorously defined manner. The truth, however, is that receiver manufacturers can't even decide on what constitutes the correct definition of an "S unit." Note how the S meter is calibrated. The lower two-thirds or so of the meter is calibrated in the nearly arbitrary "S units." The S scale is logarithmic. The upper one-third of the meter face is calibrated in decibels (dB), so it, too, is logarithmic.

Now let's consider what some of those S units are supposed to mean. Table 1 shows the subjective meanings given to the signal-strength portion in the standard amateur-radio RST (readability, strength, tone) scale for CW, or RS system in voice modes. Note that "S9" corresponds to a subjective determination of an *extremely strong signal.* Hold that thought for a moment (S9 = extremely strong).

Recently I heard a guy on 20 meters tell a DX station that he was "60 dB over S9." Wonderful report (most amateur receivers only go up to +40 dB/S9). If you work out the arithmetic for voltage decibels—dB = 20 log (V1/V2)—we find that 60 dB is a ratio of 1000:1. In other words, a report of 60 dB over S9 means that other station was one-thousand times louder than an extremely strong signal!

Perhaps what he really meant was power decibels...which means that the other guy was a real "blazing blowtorch:" 60 dB over S9 means 1,000,000 times as much signal power at the receiver's antenna terminals as an S9 signal. Surely, such a signal qualifies as a long-range death ray! The Pentagon should take note.

So what is an S9 signal? According to some manufacturers, an S9 signal is a 50-μV signal across the 50-ohm input. Others require a 100-μV signal across a 50-ohm input to make the meter deflect to S9. In other words, there is at least a 2:1 ratio between voltage levels that supposedly qualify as S9.

The S unit is traditionally given the subjective definition of being the minimum signal-level change that an appreciable number of standard, grade-A average listeners can perceive...whatever that means, or whoever that person is. As a result, the usual definition makes each S unit worth a 6-dB change in voltage level, or a 3-dB change in power level (which is the same thing mathematically). A 3-dB power change has a ratio of 2:1. In other words, if you double the RF-output power from your rig, the S meter at a distant station will increase one S unit.

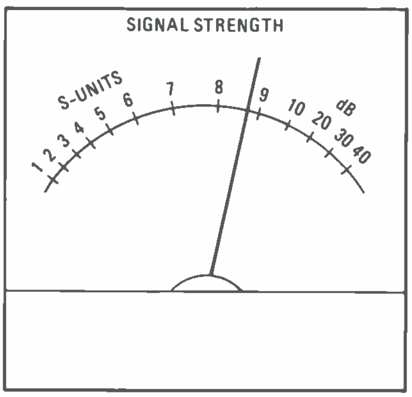


Fig. 1. Most receivers are equipped with S meters to indicate the strength of the received signal.

So, why is that important? What difference does it make to know what it takes to blast an S meter one digit higher? The answer is simple: it tells us what to expect if we increase power.

How Much Station Power? Most of us are enamored of high-power linear amplifiers for boosting our signal. In nearly 30 years of hamming, I've owned a one-kilowatt linear amplifier only in the last five or so years. Yet I only occasionally suffered from power levels that were too low. Even today I run "barefoot" more often than not, which is in accordance with the FCC requirement to use the minimum power required to do the job.

High power brings problems that must be considered. For example, you can expect an increased probability of TVI (television-interference) and BCI (broadcast-interference) problems. Antenna tuners must be the more costly heavy-duty types. Also, little annoying anomalies, such as RF "bites" on the microphone due to poor grounding or "RF in the shack," are more severe with a kilowatt. So where's the benefit?

TABLE 1—DEFINITIONS OF S-UNITS

S1	Faint signals, barely perceptible
S2	Very weak signals
S3	Weak signals
S4	Fair signals
S5	Fairly good signals
S6	Good signals
S7	Moderately strong signals
S8	Strong signals
S9	Extremely strong signals

Linear amplifiers come in three basic power levels (all of which are called "kilowatt" in advertisements): 600-watt CW, 1000 watts, and 1500 watts. Let's see if running a power amplifier is worth it in your case, and which power level is best for you.

Assume that you have a 250-watt HF transceiver. A 600-watt linear (also called "1200-watts PEP") is little more than 2:1 increase, so it is about 3 dB. That means that a station at the other end will just about hear an S-unit change. If you were S6 before, you might be S7 now. But if you bought a 1000-watt linear, then there would be a two S unit change. And that begins to be worthwhile.

Now consider what happens if you own a 100-watt transceiver (or one of

(Continued on page 101)

Scanner Scene

By Marc Saxon

NEW FREQUENCIES?

It looks as though the FCC is responding to frequency congestion in the Business Radio Service by considering the possibilities of adding 12 new channels for use in the VHF "high band" (152 to 162 MHz). Another possibility the FCC is thinking about in order to open up new frequencies in the Business Radio Service (BRS) is to create new channels offset 15 kHz above and below existing Business Radio frequencies in the 152- to 162-MHz portion of the spectrum. BRS channels presently exist on 151.655, 151.685 and 151.715 MHz; under such a new plan (if approved), that portion of the BRS allocations would expand to become: 151.64, 151.655, 151.67, 151.685, 151.70, 151.715, and 151.73 MHz.

Questions to be dealt with relate to the amount of interference that might be expected to BRS and other service licensees, should those new channels be created. The Taxicab Radio Service, in particular, may be on the receiving end of signals that will be flying around from transmitters established on such newly created frequencies.

The FCC may also open up a nationwide Automated Maritime Telecommunication System (AMTS) service in the 216- to 220-MHz band. AMTS has been in use by Mississippi River System tugs and barges since 1981, providing automated voice and data communications similar to a cellular phone system. The FCC had originally been concerned that AMTS might cause interference to Channel 13 TV reception; however there haven't been any complaints along those lines.

If approved on a nationwide basis, licensing of individual coastal transmitters in the service areas of Channel 13 TV stations would probably be subject to anti-interference precautions and restrictions. Just for the record, in case you want to get set for scanning those stations, there are 80 channels. Coast station channels start at 216.0125 MHz and progress upwards, in frequency in steps of 25 kHz, to 217.9875 MHz. The paired ship channels run from 218.0125 through 219.9875 MHz. Individual coastal stations each operate on 20 consecutive channels from the overall allocation, with the channels numbered from 101 to 180.

Scanner Market. AOR scanners got their name after the callsign of the company's founder, JA1AOR. AOR has brought out no less than three new scanners within the past few months, giving it a well-deserved place in the array of monitoring equipment available to monitoring enthusiasts of North America.

The AR-900 handheld scanner offers complete public-service band coverage, and features a priority channel, BNC antenna connector, backlit LCD display; there are lockouts, a scan delay, and other standard features along with rechargeable batteries, an AC adaptor/charger, and two antennas, all for a suggested retail price of $299.

The latest entry from AOR is their AR-900 handheld scanner—a small unit that offers complete public-service band coverage, including 27 to 54 MHz, 208 to 174 MHz, 406 to 512 MHz, and the hot-new, high interest 830- to 950-MHz band. The AR-900 can operate on channels in 12.5-, 25-, and 30-kHz increments.

Twenty-five front-panel keys allow programming of five banks of 20 channels, for a total of 100 channels. All information is retained in three state-of-the-art permanent memories that won't get "amnesia," even if the batteries are removed or become drained.

Other features of the unit include a priority channel, BNC antenna connector, and a backlit LCD display with 22 separate prompts to aid in programming and to show the status of channels. Of course, there are lockouts, a scan delay, and other standard features along with rechargeable batteries, an AC adaptor/charger, and two antennas. The unit has a suggested retail price of $299. For more information, write to the sole American source for those units; Ace Communications (a subsidiary of AOR), 10707 East 196 Street, Indianapolis, IN 46256.

Fishy Business. A newsy note from Alex W. McIlwain, Lakeland, FL clues us into some strange goings-on that are probably nationwide in scope. Alex reports that some of the newer VHF-FM marine-band radios provide their owners with channels designated as 1 to 5 and 60 to 64. The 10 frequencies that correspond to those channel numbers are spaced at 25-kHz increments between 156.025 and 156.25 MHz.

The problem is that even though transceivers using those frequencies are sold for use in the U.S., the 10 channels are for simplex use in overseas areas and aren't permitted for maritime use in American waters.

Alex observes that the temptation to use those "forbidden" frequencies in American waters has apparently proven too much for some boat owners seeking uncrowded yakking frequencies. In fact, he points out that some frequencies among that group are set aside by the FCC for police and other public service purposes.

In Alex's own area, illegal maritime use of those channels hasn't been without strange consequences. The High-

(Continued on page 106)

E-Z MATH

(Continued from page 79)

Exercise Problem. Try this yourself to be sure you understand the concepts presented.

4. A logic circuit has four inputs A, B, C, and D. Binary outputs occur when *any* three inputs are simultaneously binary 1, but not when all inputs are 1. Write the truth table, develop the Boolean output equation F, and draw the resulting circuit.

INPUTS				OUTPUT	
A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	0	
0	0	1	0	0	
0	0	1	1	0	
0	1	0	0	0	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	1	← $\bar{A}BCD$
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	0	
1	0	1	1	1	← $A\bar{B}CD$
1	1	0	0	0	
1	1	0	1	1	← $AB\bar{C}D$
1	1	1	0	1	← $ABC\bar{D}$
1	1	1	1	0	

$$F = \bar{A}BCD + A\bar{B}CD + AB\bar{C}D + ABC\bar{D}$$

A

Answers to Exercise Problems

1. $H = ABC + \bar{D}E + \bar{F}G$
2. See Fig. 23.
3. See Fig. 24.
4. See Fig. 25.

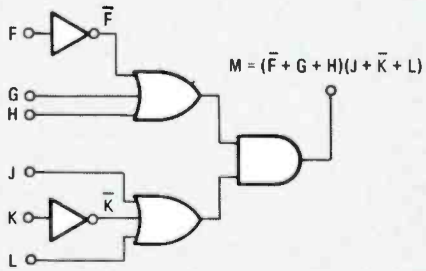


Fig. 23. Your solution to problem 2 should look like this, if not recheck your logic.

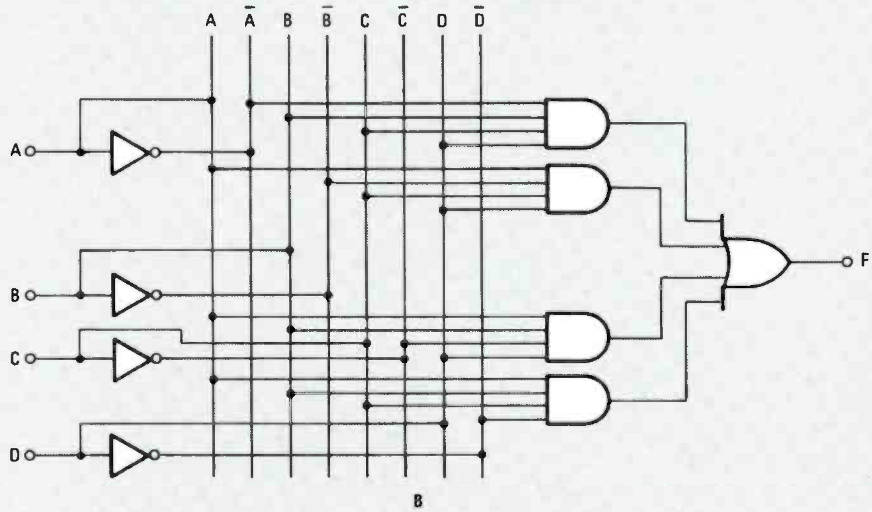
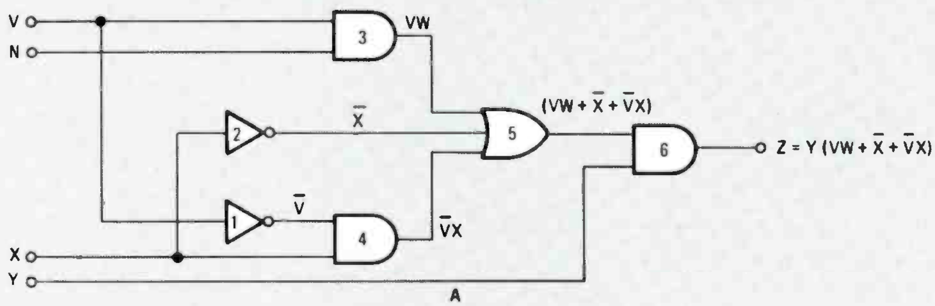


Fig. 25. When solving problem 4, you should've started with a truth table, generated an equation (A), and drawn the final circuit (B) as shown.



INPUTS				OUTPUTS					
V	W	X	Y	INVERTER 1 $\bar{V}$	INVERTER 2 $\bar{X}$	GATE 3 VW	GATE 4 $\bar{V}X$	GATE 5 $(VW + \bar{X} + \bar{V}X)$	GATE 6 Z
0	0	0	0	1	1	0	0	1	0
0	0	0	1	1	1	0	0	1	1
0	0	1	0	1	0	0	1	1	0
0	0	1	1	1	0	0	1	1	1
0	1	0	0	1	1	0	0	1	0
0	1	0	1	1	1	0	0	1	1
0	1	1	0	1	0	0	1	1	0
0	1	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	1	0
1	0	0	1	0	1	0	0	1	1
1	0	1	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0
1	1	0	0	0	1	1	0	1	0
1	1	0	1	0	1	1	0	1	1
1	1	1	0	0	0	1	0	1	0
1	1	1	1	0	0	1	0	1	1

B

Fig. 24. Problem 3 should've tested your ability to generate the circuit in A and the table in B from the equation.

DX LISTENING

(Continued from page 88)

give you what you want (enhanced reception from the Yukon), while attenuating interference from the side or back. But such a setup will be rather costly. A simple dipole might help, but don't expect too much from it in the way of rejecting unwanted signals.

Donald also has a question about converting *E*astern *S*tandard *T*ime (EST) to the worldwide broadcasting standard, Coordinated *U*niversal *T*ime (UTC).

Coordinated Universal Time—which is based on a 24-hour clock system—is five hours ahead of EST (or four hours ahead of Eastern Daylight Time during the summer months). For example, When it's 1 AM EST, it is 6 AM, or 0600 UTC. At 5 AM in Maine, it is 1000 UTC; 12-noon EST equals 1700 UTC, and 2 PM EST is 1900 UTC.

If it is 8 PM EST on a Monday night, for instance, the UTC time is five hours later or 0100 UTC, but remember that conversion has taken it past midnight into the next day. So both time and date can be affected, Don, when you convert to or from UTC.

The easiest way to get used to the time conversion is to keep a separate clock set to UTC, or make a simple reference chart.

Down The Dial. What are you hearing on the SW bands? How about letting the rest of us know. Send your loggings to the above address. Now, here are some of the catches recently reported by other DX'ers.

Alaska—6,150 kHz. *KNL*, a missionary broadcaster, is the only way to hear a shortwave station from Alaska. That station is reported with English programming, religious talk and classical musical, beginning at 0800 UTC.

Canada—6,000 kHz. *CFCX* is the shortwave version of one of the oldest broadcasting stations in North America. The SW outlet relays the medium wave signal, which is why you may hear it announced as "AM radio in Montreal." It has been noted with a call-in program at 0845 UTC.

Costa Rica—13,660 kHz. A curious station with a very serious mission is *Radio for Peace International* (RPI), which transmits from Costa Rica in Central America. It has been logged here at 2200 UTC with a talk in English on U.S. arms spending.

Greece—9,420 kHz. The *Voice of Greece* (VOG) offers some of the best ethnic music on shortwave, to my way of thinking. Tune it in at 0200 UTC. You can't miss it with its haunting and melodic interval signal. Programming in Greek follows.

Israel—12,077 kHz. Here is where you can find *KOL Israel* broadcasting from Jerusalem, with world music and pops, beginning at 2130 UTC.

Mexico—17,765 kHz. The government-operated shortwave station, *Radio Mexico International* (RMI) has been reported on this frequency with Spanish-language programming, including Mexican music and identifications, at around 0415 UTC.

New Guinea—4,890 kHz. The National Broadcasting Commission of Papua, New Guinea's shortwave outlet at Port Moresby has been logged on this frequency at 1000 UTC, first with an English newscast, then the news read in the native language.

Peru—4,9966 kHz. Tuning this 60-meter band frequency during the early morning hours, around 1000 UTC, may turn up *Radio San Miguel* (RSM), transmitting from the ancient Incan city of Cusco in Peru. Radio San Miguel has been heard in the U.S. with Spanish programming and rustic sounding Andean music, called *huaynos*.

Poland—7,270 kHz. *Radio Polonia*, Poland's shortwave service, last May canceled its English programs directed to North America at 0200 and 0300 UTC. That remains the situation as of this writing and future plans are now unclear. ■

ABBREVIATIONS

CKFX	C is prefix for Canadian SW station call signs (CKWX, CKVP, CFRB, CFCX, etc.)
DX	long distance (over 1000 miles)
DX'er	listener to shortwave broadcasts
DX'ing	listening to shortwave broadcasts
EST	Eastern Standard Time
kHz	kilohertz (1000 hertz or cycles per second)
RMI	Radio Mexico International
RPI	Radio for Peace International
RSI	Radio Sweden International
RSM	Radio San Miguel
SRI	Swiss Radio International
SW	shortwave
SWL('s)	shortwave listener('s)
US	United States
USSR	Russia (Union of Soviet Socialist Republics)
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VOG	Voice of Greece

ROCKET STROBE

(Continued from page 33)

does not need any heatsink. Different types of mini transformers and component tolerances may necessitate a small heatsink on Q1 if it gets too hot to comfortably hold. Sometimes, due to winding differences, you will need to increase C4 to 470 µF or 680 µF in order for the PWM circuit to work efficiently. A 16-volt capacitor is satisfactory for use with a 9-volt battery.

Build the PWM part of the circuit first. You should test it before installing the hex FET and T1. That is easily accomplished by using a small speaker with a 10-µF capacitor attached to one lead. Connect the other lead to ground, and the free end of the capacitor to pins 6, 8, 10, and 12 of U1. By adjusting R4, you will be able to hear the volume of the tone getting louder or quieter as R4 varies the pulse width. Once the PWM circuit works, attach the mini transformer, using Figs. 2 and 3 as a guide to polarity. Use proper precautions to minimize static, and install Q1. The +300-volt output may be tested with a neon lamp. Resistor R4 varies the brightness of the lamp somewhat.

Put together the strobe section of the circuit (see Fig. 4) keeping in mind the high-voltage output of T2. Once you have all the parts assembled, it is a good idea to give the finished board and components several light coats of an insulating spray to prevent shorts and high-voltage arcing. A product such as "Acrylic Coating" (which has a dielectric strength of 2,000 volts per .001 inch) or other material for coating printed-circuit boards works well. Don't coat R4, or it won't work anymore! Also, don't spray anything on the flash lamp, although you may insulate the ends to prevent arcing outside the flash tube.

Testing. Before installing the electronics in the rocket, and gluing everything down, check to see that the Strobe is operating correctly. With a 9-volt input and using the parts specified, you should see a flash every 4 seconds on the high setting, and about every 30 seconds on the lowest setting of R4. You'll note the first flash takes quite a while to appear—usually, about 10–15 seconds on high, and a few minutes on low.

The reason for that is that C7, the large electrolytic that stores the energy to light the flash lamp, has to "polarize" if it has been sitting idle for long while. Leakage within the capacitor is maximum when voltage is first applied, and it has to charge and discharge several times before leakage subsides and absorbs less power. If that problem exists, run the Strobe from another 9-volt battery before launch, and wait until the flash rate goes up. Then, you may install your flight battery, and let 'er rip.

If you can get accurate specifications, select C7 for low leakage. Most miniature, recent-style capacitors work fine. In our prototype Strobe, we left out an on/off switch, opting instead to simply install the 9-volt battery when launching. You may install a switch, or leave it out as desired.

Finally, remember to observe sensible practices when flying your rocket. If it gets caught in a power line, or high in a tree, leave it! No project is worth risking one's life! Fly in clear areas, especially for night launches, and observe wind direction, launch angle, expected trajectory, and landing site to optimize your chances of successful recovery. Happy Flying! ■

CIRCUIT CIRCUS

(Continued from page 85)

Either a two- or a three-wire piezo transducer works well with the circuit. If a three-wire transducer is used, connect the driven and common sections to the circuit (see Fig. 2 for pinout), using it as a two-wire device.

The filter's output is coupled to a voltage follower, U1-c, isolating the transducer from the output load. If the capacitance value of the transducer used in the circuit isn't known, substitute a capacitance decade-box in place of C_x and set it to about .015 microfarads to start.

Apply power to the circuit and a signal generator to the input; set the generator's frequency to about 1 kHz above the resonant frequency of the transducer, and its output level at about 500 millivolts. Connect a oscilloscope or an AC voltmeter to the filter's output. Adjust the oscilloscope's gain so that the filter's output signal covers about 70% of the vertical screen.

Adjust the capacitance decade-box for a minimum output signal. Remove the decade box and connect a capacitor of the same value in its place. Slowly sweep the audio generator to the transducer's resonance frequency and observe the output level and the bandwidth of the filter.

The gain of U1-a can be raised or lowered as needed to work with just about any level of input signal: the gain is calculated: gain = R8/R1. Don't change the unity gain of op-amp U1-b because its only function in the circuit is to invert the output of U1-a.

The output of U1-c can be fed to a dual-diode rectifier circuit (as was done in Fig. 3) to provide a DC output to drive a variety of circuits.

Encoder/Decoder. The transducer circuit shown in Fig. 5—consisting of a 567 phase-locked loop (PLL), a piezo transducer, LED, and a few support components—can be operated as either a tone encoder or decoder by changing the position of S1. The operating frequency of that dual-purpose circuit is determined by C3 and R2. Capacitors C1 and C2 are not critical and can be of almost any value between 1 and 5 microfarads. When the circuit is receiving an on-frequency signal, LED1 lights.

Although a two wire-piezo transducer, with a resonance frequency of 2500 Hz, was used in the circuit (see the Parts List) any piezo unit should work as long as the values of C3 and R2 are selected to tune to the transducer's operating frequency.

With power on and S1 in the "B" position, adjust R2 for the loudest tone output. The circuit should be tuned to the resonance frequency of the transducer. In that position, the circuit can be used as an acoustical or tone signal encoder. Next, switch to the "A" position and aim an on-frequency audible tone toward the transducer; the LED should light, indicating a decoded signal.

The LED can be replaced by an optocoupler or relay to control just about anything that's electrically operated. A single op-amp audio amplifier can be added between the transducer and U1 to detect weak audio tones. Use the U1-a amplifier circuit shown in Fig. 4, and select R1 and R8 to set the amp's gain as needed. ■

PARTS LIST FOR THE ENCODER/DECODER

- U1—567 phase-locked loop (PLL), integrated circuit
- LED1—light-emitting diode (any color)
- R1—1000-ohm, ¼-watt, 5% resistor
- R2—25,000-ohm potentiometer
- C1, C2—4.7-µF, 16-WVDC electrolytic capacitor
- C3—0.02-µF ceramic-disc capacitor
- BZ1—Piezo transducer, Radio Shack 273-073 or similar
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

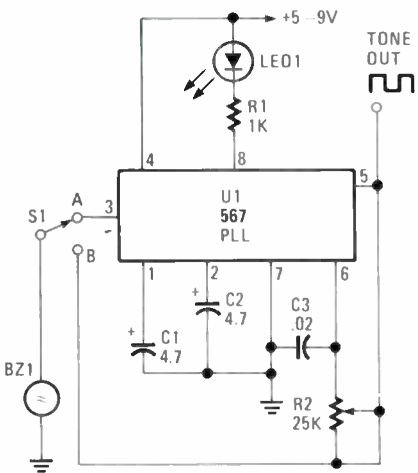


Fig. 5. This transducer circuit—consisting of a 567 phase-locked loop (PLL), a piezo transducer, LED, and assorted components—can be operated as a tone encoder or decoder, depending the position of S1.

SOUND-ACTIVATED KALEIDOSCOPE

(Continued from page 68)

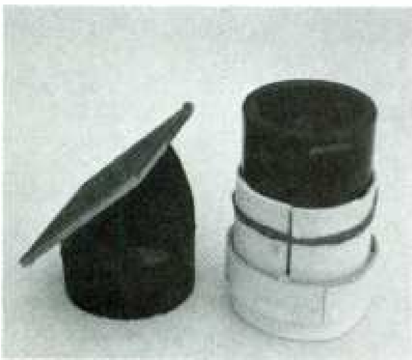
should be somewhat diffused. Diffusion can be accomplished using a small piece of frosted plastic held in the top of the kaleidoscope between the flashlight and the particles in the tube.

If you wish, you can take a small piece of clear plastic and roughen it with fine sandpaper. The diffusion medium is held on a triangular tube that just slips about .4 inch into the top of the kaleidoscope tube. The tube is then held in position with a slightly larger strip of cardboard glued around it. (See Fig. 7.)

You may want to try is to convert the unit for use with a video camera. That requires only a few changes in the unit, but you'll need to do a little engineering to mount the light source for proper illumination. The fleeting images of the kaleidoscope can be captured on video tape and the programs replayed with the assurance that it will be what is planned. For video taping or projecting the image, it is desirable to use two speakers—one speaker is used as the audio source, while the other is used to produce the changing patterns of the kaleidoscope.

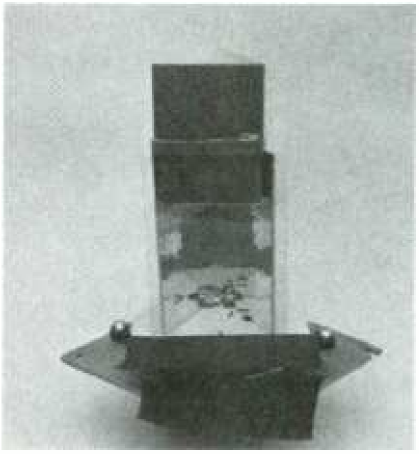
The automatic exposure control of the typical home video camera does not function properly if a black background is used. For video purposes, use either a neutral gray or a pale-blue background. If you have some light-color spray paint available, use it and see for yourself what works to your satisfaction.

For video work, illumination of the particles is done from above, with the camera mounted on a tripod at an angle determined by the optics of the particular video camera. Here again, what you have available dictates what you can do. I have close up lens attachments for my video camera and find that a lens with about a 2-inch focal length is quite satisfactory for use with a kaleidoscope.



A mirror mounted atop the cardboard tube at a 45 degree angle and fitted over the projection lens allows the kaleidoscope images to be projected on a wall screen.

The usual kaleidoscope pattern owes much of its fascination to the completely unpredictable patterns that come and go on the screen. I prefer a variety of patterns that are completely unpredictable for certain applications; but for demonstration purposes, a pre-recorded program is frequently desirable.



For video taping, a defusion panel (consisting of frosted clear plastic) can be fitted over the viewing window of the kaleidoscope.

I am currently building a unit that will project the pattern on the ceiling of a bedroom, which is the easiest mode of projection. Combined with soothing music, it may have some therapeutic value. For either video taping or projection, you will need to hold the speaker invariably level. That can be accomplished by mounting the speaker in a piece of ⅛-inch plywood. The plywood, in turn, has three threaded bolts long enough to serve as feet.

I have built many variations of the unit described in this article since I built the first one in the early 1960's. I am always looking for improvements and would be very pleased to hear from anyone who has improvements or refinements to suggest. (Write to me in care of **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.) The advent of the video camera has given me a renewed interest in building variations to take advantage of this exciting technique. ■

GRAPHER.BAS
(Continued from page 64)

bit), that means that each graph must occupy:

89,600/8 = 11,200 bytes

of the computer's random-access memory.

Based on the above calculations, we see it turns out that the old cliche is wrong. As far as Grapher is concerned, a picture is not worth simply a thousand words; a picture is worth 5,600 *words*!

Printing Graphs. If you would like to send the graphs you generate with the program to your computer's printer, you can do so using the PC's <SHIFT> <PRINT SCREEN> keystroke sequence. However, because the graphs are displayed on the high-resolution screen of the PC, you must execute the Graphics.Com file before you enter BASIC. The graphics program will cause the picture to be rotated by 90 before being sent to the printer to account for the differing aspect ratios.

That file, which can be found on one of the DOS disks that came with your computer, gives the computer the "intelligence" to use <SHIFT> <PRINT SCREEN> for graphics as well as text screens. For more information on using that command, please consult your DOS reference manual. ■

TABLE 1—PROGRAM BREAKDOWN

Line(s)	Functions(s)
1000–1040	Clear variables, set to 80-column text mode, clear screen, and define Pi.
1060–1280	Display instructions.
1300–1320	Wait for key press. If E is pressed, end the program.
1370	Place computer in high-resolution graphics mode and clear screen.
1380–1420	Draw horizontal and vertical axis.
1440	Get graph values from subroutine.
1460–1560	Print graph and axis titles.
1580–1690	Label the axis.
1730	Calculate the horizontal step size.
1750–1830	Graph both functions–one pixel at a time.
1850–2880	Wait for an E to be pressed, then exit the program.

LISTING 2—GRAPHER.BAS MODIFICATION

```
7000 '========== PLACE CONSTANT VALUES HERE ===============
7010 '
7020 YMIN = 0        'minimum y value
7030 YMAX = 10       'maximum y value
7040 'place y-axis title below (18 characters, max.)
7050 YS = "VOLTAGE - Volts"
7060 '
7070 XMIN = 0        'minimum x value
7080 XMAX = 5        'maximum x value
7090 'place x-axis lable below (60 characters, max.)
7100 XS = "TIME (in seconds)"
7110 '
7120 'place two title lines below (60 characters, max.)
7130 T1S = "EXPONENTIAL FUNCTIONS"
7140 T2S = "(For the second example)"
7150 '
7160 RETURN
7170 '
7180 '
8000 '========== PLACE FUNCTION #1 BELOW =================
8010 '
8020 Y = 10 - 10 * EXP(-X)
8030 '
8040 RETURN
8050 '
8060 '
9000 '========== PLACE FUNCTION #2 BELOW =================
9010 '
9020 Y = 10 * EXP(-X)
9030 '
9040 RETURN
```

ANTIQUE RADIO

(Continued from page 83)

entire June and July 1988 columns had been devoted to it—and I still hadn't gotten to the Crosley material. Although they were interesting columns indeed, I felt that I should introduce more new material before discussing the remainder of the letters from the readers.

The Zenith restoration, just being concluded, was begun in August. A couple of months into the restoration—just as I had begun to dissect the dial assembly to make the necessary repairs—George lost his patience. He accused me (writing tongue-in-cheek, I hope) of evading a good subject, the Crosley, in order to make a massive attack on a Zenith dial.

Well, George, I agree with you. The Crosley is a good subject, and the letters I've received about it (including your own long one) were very interesting indeed. And finally their time has come! We'll get started right now, and present a few more of them next month, and go on into the following month if necessary.

Wonderful Re-Creation. I think the best way to get everyone back into a Crosley 50 mood is to show you the pictures Dan Damrow (Burbank, IL) sent me illustrating his incredible re-creation of that little set. And I'm also including matching photos of my own real Crosley 50 so that you can see just how faithful to the original this model is.

Every major component in the reproduction—with the exception of the vacuum tube—was built from scratch. That includes the "book-type" tuning condenser, with its hardwood leaves; the mica-and-bakelite bypass condensers; the grid leak; the tube socket (made of PVC pipe sprayed black); the "spiderweb" coils; and even the filament-control rheostat!

Dan likes building replicas because he feels that they have a clean, neat look that no 60-year-old set could ever attain. And when you realize that he retired after twenty-one years as an electronic technician for Argonne National Laboratories (the well-known atomic research facility), you'll understand that he has plenty of skills to support his hobby.

I've run pictures of Dan's sets in the column before. In fact, he was one of the first readers to respond to the column when I first began writing it a few years ago. And I hope I'll have the opportunity to show you more of his meticulous recreations in the future.

So Long. If you are one of the several people who wrote in response to the two Crosley articles, stay tuned for next month's column. I'll probably be quoting you then! In the meantime, keep those cards and letters coming. Your comments and ideas are always welcome. Write to Marc Ellis, *Antique Radios*, C/O **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

AUDIO COUPLER

(Continued from page 65)

flame. Solder a 10-ohm resistor to one end of the coil. Before soldering, wrap 3 or 4 turns of the burned-enamel wire around the resistor lead. Solder the other end of the resistor to one lead of the wire or cable that will exit the cartridge. It would be a good idea to connect the inner conductor of the cable to the resistor, leaving the shield conductor for the other end of the coil. That will protect your scanner, handi-talkie, etc. in the event that the coil should get scuffed and make contact with grounded metal objects. Solder the other end of the coil to the other wire lead.

Finishing Up. You should now have a coil and resistor connected in series (see Fig. 1). At this point you may want to check your completed circuit with an ohmmeter to be sure all connections are good. Now secure the resistor and wire so that they will not come into contact with the rotating spindles of the tape player. You could just glue them securely or wrap them around some of the tape guide pins located in the corners of most cartridges. Route the wire through the exit hole and carefully re-assemble the cassette cartridge. If the piece of equipment you wish to amplify has an auxiliary-output jack (such as for headphones or earphones), connect the appropriate plug to the end of the wire. If the equipment in question does not have such an output, you will have to connect the wire to the internal speaker terminals of the unit.

Before putting the cartridge into a tape player to test it, carefully examine the newly created coil. In particular, check to be sure that the ends of the coil (or anything else) will not get snagged on any of the mechanisms inside the tape player.

To use the device, simply pop it into a tape player and plug or connect the Audio Coupler to the unit needing amplification. The tape player must be in the play mode, just as if you were ready to listen to a tape. Adjust the volume control of the tape player and the volume control of the signal source to your liking. If you have a 40-watt booster on your tape player, you can really bring that little handheld unit to life! I have made three of these devices and they all work just great. I'm sure your's will too! ■