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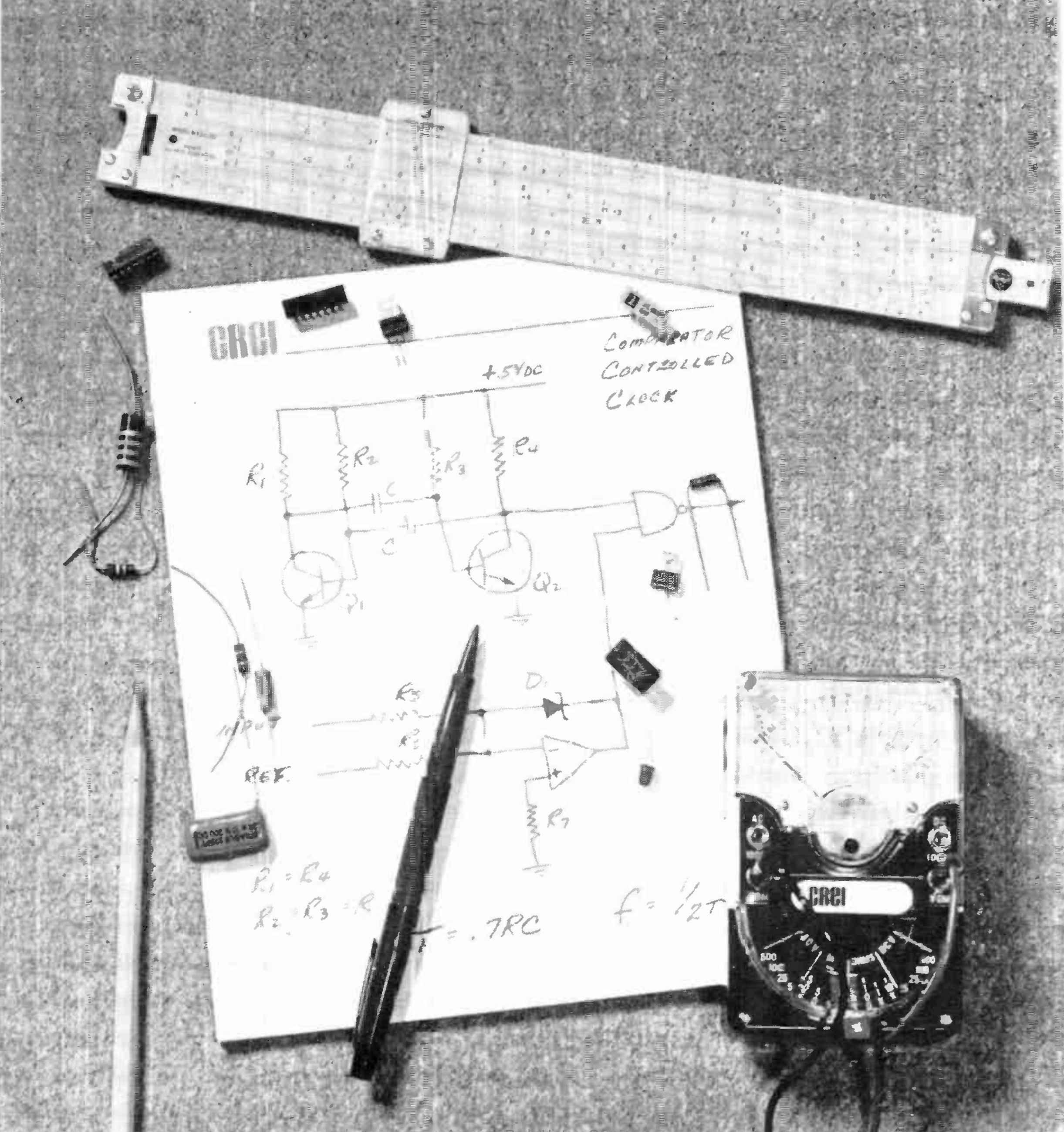

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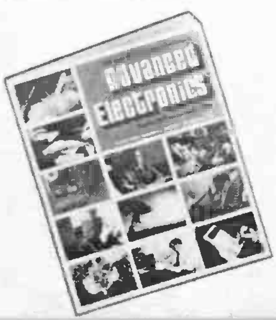

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Editorial

By Milton S. Snitzer, Editor

COMMUNICATIONS FOR THE BOAT OWNER

In 1973, there were an estimated 9½ million recreational boats in use on the waterways and along the shorelines of the United States. A substantial percentage need some means of communicating with each other, with bases on land, and with the Coast Guard. Sometimes a life depends on it!

Boaters often ponder over the choice of which communications rig to buy. Should it be a CB transceiver, a vhf FM marine radio, an AM marine radio or an SSB AM marine radio? The decision isn't all that difficult if needs, regulations, and available dollars are considered.

For example, over 300,000 boats are said to be equipped with CB radios. Though CB is not a direct link with the Coast Guard, in some areas it is monitored by local or state police or the sheriff's office. Also, there are many inland lake and river areas where the Coast Guard cannot be reached by short-range radio; even if they could, the CG might not have rescue facilities. So check your local boating vicinity. REACT, the CB emergency association, can be a vital center in emergencies, also.

Marine radio, on the other hand, provides a direct link for help with the Coast Guard, as well as weather information. Whereas channel 9 is the emergency channel for CB, channel 16 (156.8 MHz) is the distress channel and initial calling channel for vhf FM marine radio. It is monitored 24 hours a day by the Coast Guard. Another CG link on vhf FM is for nondistress calls on channel 22 (157.1 MHz). Cost of a vhf FM marine radio is higher than CB, though relatively low-priced units are now available.

For greater transmission punch, there's a temptation to consider the 2-to-4-MHz AM marine radio, where up to 150 watts of output is permitted (contrasted to vhf FM's 25-watt limit). Resist the temptation, though. New FCC rules will ban double-sideband AM by 1977. Furthermore, new licenses for this type of gear are no longer being issued. So, even if one buys a boat that has DSB AM, it won't be possible to get a license. Of course, SSB AM is available. But such rigs are very expensive and FCC rules requires that they be supplemented by a vhf FM set. Besides, unless your boating takes place in blue water, you don't want long-distance communications.

Should you opt for a marine radio rig, you must observe some special rules: no frivolous chatter, maintenance of a logbook, obtaining a restricted radiotelephone operator's permit (no test), and lowering output power when making nearby contacts. You might also consider having the best of both worlds—CB and vhf FM.

Though pleasure boats are not required to carry a radiotelephone, the ability to communicate when boating is convenient and sometimes essential. That "Mayday" distress call wasn't designed just for fun.

****

News Flash: Starting with the next issue, POPULAR ELECTRONICS will appear in a new, large (8½" x 11") format.

Letters

LOCAL GROUPS COULD HELP CB

My compliments on your April editorial, "The CB Pleasure Seekers."

I was away from CB for four years. When I turned on my rig again some six months ago, I was amazed at how slack the FCC had gotten in controlling the band. This brings to mind a question that I know has come up before: Why can't the FCC designate such groups as REACT and ALERT and other recognized organizations to help clean up the air in their own areas? With thousands of REACT and ALERT "ears" across the country, it would be quite easy for the FCC to be informed of the locations of violators.

KENNETH B. ROTHMAN, KBY0535
Warrensville Heights, Ohio

HIGH-POWER AMPLIFIER TESTS

On reading Ralph Hodges's comments on high-power requirements ("Stereo Scene," May 1974), I recalled some experiments that Bud Fried (IMF Products) and I made on this subject back in 1956. We wanted to find out how much power was required to reproduce a piano using an AR-JansZen speaker combination. We recorded a selection on the piano. Then, in the same room, we played it back and set the amplifier level to match the original moderate sound levels.

We found that it required 250 watts of monophonic power to reproduce a piano at its normal living room level.

DAVID HAFLER
Merion, Pa.

HOW TO "CUT" A RESISTOR

In "How To Make Custom Meters From Salvaged Parts" (April 1974), it was stated that a standard resistor can be "cut" to a custom value by notching it with a triangular file. This is true, but a few words of caution are in order. First, unless a very light cut is made, the desired value can be easily passed. Second, the file produces a high stress concentration at the apex of the cut that can lead to mechanical failure of the resistor. The first danger can be obviated by exercising care, while the second can be dealt with by strengthening the cut resistor. After cutting the notch, clean the resistor with alcohol; then add strength by filling the void with epoxy.

Some people reading the article might form the opinion that notching a resistor is an almost perfect method of obtaining a custom-value resistor. However, we suggest that, before proceeding with the filing, they select a resistor of the next higher wattage rating.

WILLIAM E. PIERCE
V. P., Engineering
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Huntsville, Ala.

CERTIFICATION FOR TV SERVICING

We read with interest your May editorial and must take issue with your recommendations on CET as a proper test to determine a technician's qualifications. . . . (This test) will not meet the criteria of the National Business Council for Consumers Affairs. NATESA (National Alliance of Television & Electronic Service Associations) cannot permit CET to be used as a criteria for any license.

The NATESA Certification program, based upon EIA's "TV Symptom Diagnosis" study course, we believe employers will agree, is far more effective. . . .

FRANK J. MOCH
Executive Director, NATESA

In our editorial, we did not recommend the CET program. It was mentioned as one of the "good starts" toward a better image of servicing for the public.

KUDOS FOR CAPACITANCE METER

Thanks for the "IC Capacitance Meter" (February 1974). It is a perfect, foolproof project. My unit was designed on a printed circuit board and used a 100-microampere meter. None of the ranges needed trimming and accuracy is excellent. However, I would like to see a modification that would add a full-scale range of 100 pF.

JOSEPH F. DINEEN
Westwood, Mass.

The "IC Capacitance Meter" is one of my most-used pieces of test equipment. I have one note to pass on to other experimenters. The schematic and photograph do not seem to match with respect to the range switch. I suggest that the connections be reversed on *S1A* and *S1B* during assembly so that, when tests are being conducted, one can start with the highest range and work down.

One small disadvantage of the meter is that, with larger capacitances (0.5 to 1 microfarad), the lower frequency causes the meter's pointer to oscillate, providing an *average* reading.

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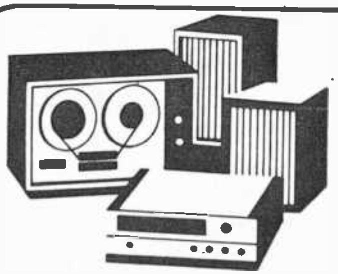

Stereo Scene

Matching Tonearms and Cartridges

By Ralph Hodges

WHEN the assembling of a hi-fi system by purchasing individual components first became popular, the problem of matching components caused many a headache for the audiophile. The tape recorder enthusiast, for example, was often forced to buy a mechanical tape deck from one supplier, record/playback preamplifiers from a second source, and sometimes separate tape heads from still another. Fortunately, those days are past—at least for the tape recordist. He can now buy the whole integrated package from the manufacturer of his choice. The picture is not so bright, however, when it comes to record players. There, the component business still operates just as it did with tape recorders 25 years ago!

What does this mean to the consumer? As a rule, he must shop for a turntable with an integrated tonearm and try to match it to a phono cartridge. Further, he will be plugging the cartridge into a preamp that was probably not developed with that specific cartridge in mind. Aside from creating buying frustrations, the matchmaking process offers plenty of opportunities for the consumer to go astray.

Minor mismatches of equipment are actually common in home music systems. Fortunately, the audible effects tend to be negligible; but every once in a while, some hapless individual makes a big mistake. It may be in pairing a cartridge and phono preamplifier that combine to produce a significant high-frequency rolloff in response (a fairly remote but still definite possibility). More often, it involves a cartridge and tonearm combination whose mass-compliance interaction affects the system's ability to cope with ordinary record warping.

Warps and Record Players. Shure Brothers gave a seminar on phono cartridges last year that included a presentation by Frank Karlov (now head of cartridge development at Shure) on the specific subject of record warps. He reported that, in a study of 67 randomly selected records, 210 warp characteristics were classified—an average of three per record—on the basis of frequency and amplitude. The frequencies ranged from 0.55 Hz (the rotational rate of a 33⅓-rpm record) to well beyond 10 Hz. Some amplitudes exceeded ten times the recorded levels cut into the discs, with the greatest amplitudes tending to occur at the lower frequencies. Not all of the warps were the result of bent or twisted records. Some seemed to be "profile deformations"—irregularities in the thickness of the vinyl material. Figure 1 shows the results of the Shure study.

Ideally, the negotiating of all the material on a phonograph record—warps as well as recorded information—should involve a cooperative effort between cartridge and tonearm. The stylus should respond only to the recorded undulations of the groove. The tonearm should absorb the grosser up-and-down movements of the record surface, leaving the stylus undisturbed. This is evidently a realizable goal, as long as both arm and cartridge are designed to be used together as a team.

The stylus has compliance ("springy" flexibility) and the tonearm has mass. Together,

they constitute a simple spring-and-weight system that, like any such system, has a natural frequency at which it prefers to vibrate—its frequency of resonance. Speaking very simplistically, what generally happens is that, above the resonant frequency, only the spring (stylus) moves in response to any excitation. Below resonance, only the mass (tonearm) moves. Directly at the resonant frequency, both the spring and the mass move, usually rather energetically and, more often than not, out of phase.

Knowing this, it becomes a theoretically simple matter to "tune" the stylus to groove modulations and the tonearm to warps. Mass and compliance are merely adjusted so that the resonance is located between the frequency ranges of the two conditions. (Reducing compliance and/or mass raises resonance, increasing either or both lowers resonance.) Fortunately, the Shure study shows that there is a band of frequencies between about 8 and 20 Hz where there is a region of relative tranquility on most discs. The serious warp activity has died out, and the lowest frequencies of recorded music haven't yet begun. This is an ideal spot in which to tuck the resonant frequency of the cartridge/tonearm combination. Since resonance is a highly unstable condition in this case, it is wise to have it where it will receive as little stimulation as possible.

Enter the Consumer. So far, all well and good. But who does the matching of mass and compliance to ensure the proper performance of the combination? Not, I'm afraid, the cartridge and tonearm manufacturers if they have no knowledge of the devices with which their respective products are to be used. At present, this is the consumer's problem; and he, as a rule, has little information on which to formulate a solution.

Where record warp is concerned, both mass and compliance are frequency-dependent quantities, so the "static-compliance" specifications provided by cartridge manufacturers are not guaranteed to be of any help. (These specifications are simply an indication of how far a unit force can push the stylus to one side or the other.) As for the tonearm, its mass is neither its weight when put on a scale or the gram or so of tracking force it exerts on a stationary record. The mass is actually the inertia the arm presents when you try to wiggle it around by pushing on the stylus tip. As far as I know, there are no recognized standards for specifying this. It depends, to a significant extent, on the mass of the cartridge installed,

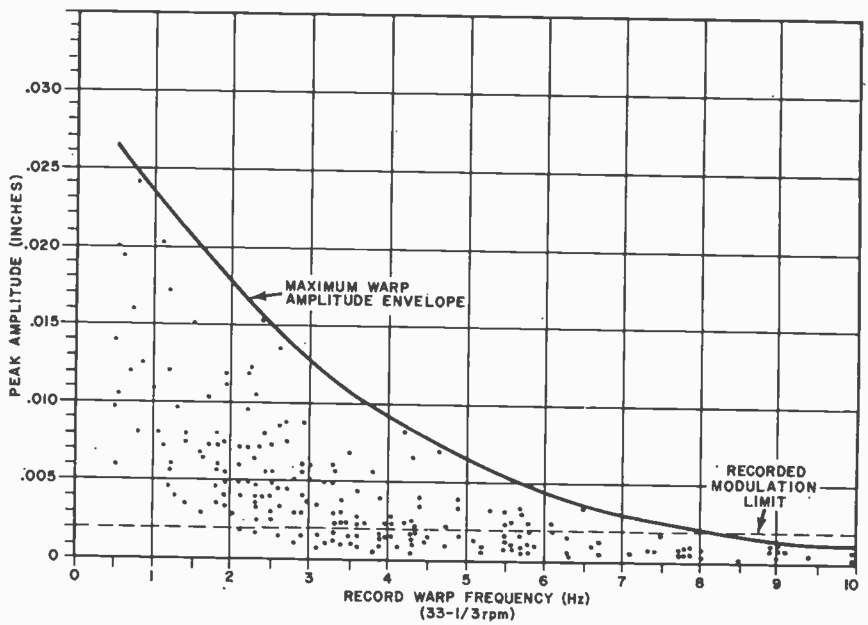

Fig. 1. The distribution of the warps measured by Shure on 67 LP records. Each dot indicates the amplitude and frequency of one of the warps that was found. The dashed line indicates typical maximum recorded amplitudes (about 2 mils).

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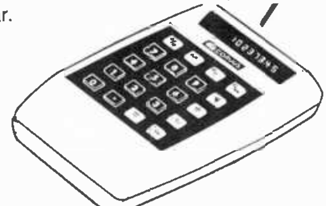

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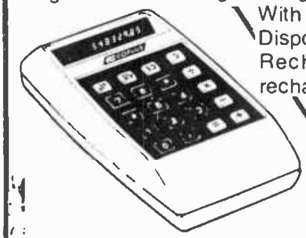

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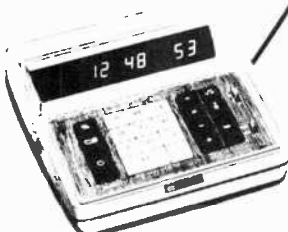

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which the tonearm designer cannot predict.

Some people are reasonably successful in picking a workable combination of arm and cartridge. Others, and I include myself, have not always been so blessed. The symptoms of a mismatch can be surprisingly varied; they almost have to be described one by one.

A combination with too high a resonance (the result of a very light tonearm or a very stiff stylus) would tend to get involved with the audio frequencies, causing aberrations in the deep bass response of the system. Probably, there would be a severe peak in the response, with a sharp rolloff below. I can't say from experience since I've never come across such a combination.

The majority of tonearms tend to be too massy for the compliance of many cartridges. This includes a few of the beautifully machined arms from abroad, which often exact a certain price in performance for their cosmetic appeal. A massive arm tends to force the frequency of resonance down into the warp region, with sundry effects. The warps occurring above resonance have to be managed by the flexing of the stylus. This causes heavy pulses of subsonic energy from the cartridge and can possibly overload the amplifier and speakers. (Even if the latter are not audibly bothered by these throbs, a tape recorder or the tape you are using to dub a record may be affected. They are also subject to overload.)

Warps above resonance can also cause the cartridge to exhibit what is known as "warp wow." The stylus, in flexing up and down, is also thrust forward and back along the length of the record groove, which imposes a low-frequency "wow" modulation on the music (see Fig. 2).

All this might seem like trouble enough, but it is nothing compared to what happens when the warps occur near or at resonance.

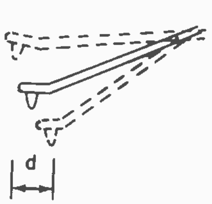

Fig. 2. Warp problems can produce severe vertical deflections of stylus assemblies, causing the tip to move forward and back in the groove over distance *d*. This imposes a "wow" modulation on music. Tone arms, especially shorter ones, are also subject to the effect.

Due to the extreme agitation of both stylus and tonearm, the tracking force may vary, moment to moment, from extremely heavy to nothing—or even less. When it becomes less than nothing, the stylus leaves the record surface, usually jumping a groove or two. As the tracking force approaches nothing, the cartridge goes into mistracking distortion on the recorded material. The possibility of having overload problems is usually great at resonance because of the vigorous stylus motion. Warp wow also occurs, but it may go unnoticed amid all the other audible activity. (It may be some comfort to know that performance is usually adequate when warp frequencies are below resonance.)

I always try to look for tonearms that have very low rotational mass. This would seem to make good sense because, with today's high-compliance cartridges, there is no readily available tonearm light enough to drive resonance up into the audio-frequency range. But does this approach keep me out of trouble? Definitely not. The least massive of modern tonearms, paired with modern cartridges, seem to produce a resonance somewhere above 6 or 7 Hz, which is near the top of the warp frequency range. Generally this is fine, but some cartridges mated with light arms have ocasionally been prone to certain kinds of instability. Sometimes, when high-frequency warps do crop up, they produce (because of their higher rate) warp *flutter* instead of warp wow. Or an unstable arm/cartridge combination can apparently suffer from flutter and other effects even when no obvious cause (such as a warp) is present.

Subtle amounts of flutter can masquerade as distortion quite successfully, which can get you very involved with troubleshooting your amplifier when you should be paying attention to the record player. The worst case of flutter I have ever experienced was when I managed to select a tonearm/cartridge combination that apparently coincided with the resonance of the spring-mounted turntable motorboard. Fortunately, the flutter was quite audible as such, so I didn't rush out to have my amplifier checked. But I was fascinated by some of the side effects that came along with the flutter. First of all, the quality of the stereo was definitely affected. I don't really know the reason for this, but I tentatively attributed it to phase irregularities caused by the disturbance of the stylus-groove relation-

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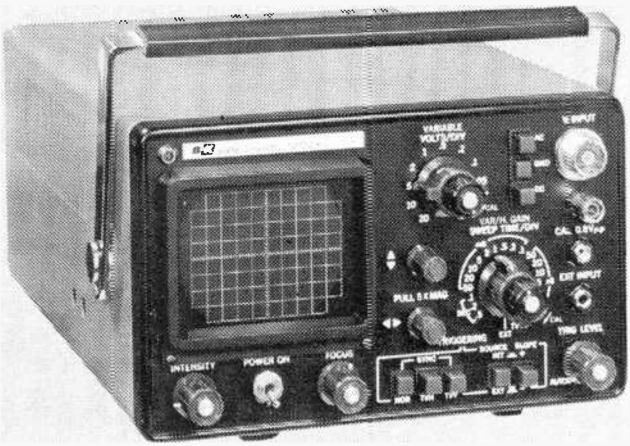

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ship. (An oscilloscope check suggested that the tonearm was moving not just up and down, but also from side to side in a sort of shimmy.) Subtle cartridge mistracking could also have been responsible.

In addition, there seemed to be an increase in the amount of high-frequency record noise. Perhaps this was a type of modulation noise imposed on the recorded signal, or on the noise in the signal. Again, I don't really know; but I do know that this particular arm/cartridge/turntable combination was useless except as a curiosity.

Some Tentative Advice. Despite what I said above, a low-mass (low-inertia) tonearm still seems to be the best answer. What are the identifiable characteristics of a low-mass arm? The rotational inertia of a tonearm increases only linearly with an increase in mass, while it increases according to the *square* of the distance the mass is located from the pivot assembly. This indicates that a large counterweight located close to the pivot is better than a small one that rides well back toward the rear of the turntable.

Short arms tend to exhibit less inertia than longer ones. Among the best arms for dealing with warps seem to be short designs that have their principal masses located very close to the pivot points. However, short arms describe a tighter arc in negotiating up-and-down warps and therefore, like styli, are susceptible to warp wow. However, unless the wow tendency is severe on many records, the improved tracking ability afforded the cartridge by a short, light arm may prove to be worthwhile.

Probably the best and easiest way to evaluate the inertia of an arm is to use and observe it for a while. I generally find that an excessively massy arm can be detected just by hefting it around a bit by hand, watching how it responds to the movements of your finger and wrist. You can see how much agility it displays when it is lowered to the record surface. Surprisingly, some very good arms can occasionally be reluctant in letting the stylus "find" the groove when first set down. They are perfectly capable of playing the "land" area of the record between the grooves; and a slight jog may be necessary to locate the stylus properly.

When playing a record, a tonearm is best judged by the amount of gyration it *doesn't* require the stylus to perform in negotiating warps. If you get your eyes on a level with the turntable, you can observe the stylus pretty closely. It should appear to remain almost perfectly stationary, with the tonearm absorbing all the vertical jolts of the record surface. Small, abrupt warps are frequently more revealing in this test than large, leisurely ones.

An oscilloscope is the best tool for discovering whether or not a record player is having serious problems with mechanical instability. Use a record with a simple recorded signal, such as a sine or square wave. Usually, the trace will display a small amount of vertical "jitter." If the jitter is excessive, and if the switching in of the amplifier's rumble filter virtually cures the jitter, then there is reason to be suspicious. Severe cases of instability will cause the trace to "bowstring" or form shuddery, multiple images. Gross problems will break up parts of the trace because of cartridge mistracking.

Unfortunately, once you detect signs of tonearm difficulties, there is usually very little you can do to alleviate them without replacing some component in the record-playing system. More effective remedies await cooperation between tonearm and cartridge manufacturers. ◈

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News Highlights

Columbia Records and Fairchild Embark on SQ IC Program

Columbia Records has announced that Fairchild Semiconductor will produce the full range of SQ integrated circuits for world-wide distribution to manufacturers of SQ audio equipment. The IC's are expected to make their debut commercially this year. At its highest level of quadraphonic performance, the SQ system consists of three low-cost chips—the matrix IC, in conjunction with a logic-control IC and a voltage-control amplifier IC. The matrix IC by itself can be used in less-expensive audio equipment to achieve decoding but it is not as effective as the "full SQ" system. Motorola and Sony have also developed IC chips for the SQ system.

Optical Supermarket Checkout System

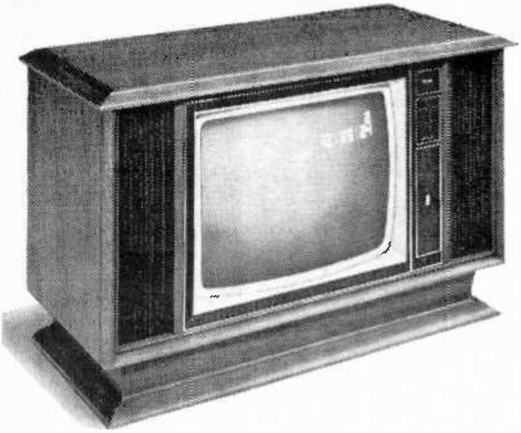
If you've ever done supermarket shopping for yourself or your wife, you know the long delays required for the checker to locate the price of each item and ring it up on the register. Sperry Univac's supermarket checkout system should speed things up. It is the first optical scanning system fully tested in a large supermarket, where it read symbols marked on more than eight million items during 5135 hours of operation over a 15-month interval. The system uses a fixed laser beam optical reader at the end of the checkstand to detect, read, and decode symbols on product containers or labels. A specially designed minicomputer retrieves the price of the item, based on the code number, for visual display and printing on a customer receipt tape.

REACT Helps Save Fuel

REACT teams everywhere are participating in a special effort to aid motorists equipped with CB radios during the energy crisis. With over 4-million such radios in use in the U.S.A., and most of them installed in vehicles, REACT members are receiving many calls on Channel 9 from motorists seeking assistance. The members are prepared to supply route information that can save mileage and fuel during the current shortage. They can also direct the motorist around traffic jams caused by accidents or road repairs.

Voice Encoding System for Automatic Baggage Handling

All outgoing baggage routing at TWA's JFK Airport in New York City will be handled by a new voice-encoded system. Customers check baggage either at curbside or at the ticket counter. The baggage is labeled in the usual fashion with a tag containing an identification number, flight and destination. It is then conveyed to TWA's central automated sorting system where it first reaches an "induction station." Here an operator speaks the flight number and destination for each bag into a microphone while simultaneously placing the bag on the central sorting conveyor. The system recognizes and responds to the spoken words by the operator and sends the baggage to the appropriate loading area for its flight. When the flight is fully ready to be loaded, the system prints out a list of the number of bags on that particular flight by destination.



The editors' choice: Heathkit Digital Design Color TV!

"At **ELEMENTARY ELECTRONICS** they said: "The fact is, today's Heathkit GR-2000 is the color TV the rest of the industry will be making tomorrow...there is no other TV available at any price which incorporates what Heath has built into their latest color TV."

The **FAMILY HANDYMAN** reviewer put it this way: "The picture quality of the GR-2000 is flawless, natural tints, excellent definition, and pictures are steady as a rock. It's better than any this writer has ever seen."

POPULAR SCIENCE pointed out "more linear IC's, improved vertical sweep, regulators that prevent power supply shorts, and an industry first: the permanently tuned I.F. filter."

The **RADIO-ELECTRONICS** editors said the Heathkit Digital TV has "features that are not to be found in any other production color TV being sold in the U.S.:

"*On-screen electronic digital channel readout*...numbers appear each time you switch channels or touch the RECALL button...*On-screen electronic digital clock*...an optional low cost feature...will display in 12- or 24-hour format...*Silent all-electronic tuning*. It's done with uhf and vhf varactor diode tuners...*Touch-to-tune, reprogrammable, digital channel selection*...up to 16 channels, uhf or vhf...in whatever order you wish...there's no need to ever tune to an unused channel. *LC IF amplifier* with fixed ten-section *LC IF bandpass filter* in the IF strip...eliminates the need for critically adjusted traps for eliminating adjacent-channel and in-channel carrier beats. No IF alignment is needed ever. *Touch volume control*... when the remote control is used...touch switches raise or lower the volume in small steps."

POPULAR ELECTRONICS took a look at the 25-in. (diagonal) picture and said it "can only be described as superb. The Black (Negative) Matrix CRT, the tuner and IF strip, and the video amplifier provide a picture equal to that of many studio monitors..."

Furthermore, the Heathkit GR-2000 is an easier kit-form TV to build. **POPULAR ELECTRONICS** pointed out that "Each semiconductor has its own socket and there are 12 factory-fabricated interconnecting cables...The complete color adjustments can be performed in less than an hour."

To sum up, **POPULAR ELECTRONICS** concluded its study by stating, "In our view, the color TV of the future is here—and Heath's GR-2000 is it!"

Why not see what the experts have seen? The Heathkit Digital Design Color TV—without question the most remarkable TV available today.

Mail order price for chassis and tube, $659.95. Remote Control, $89.95 mail order. Clock, $29.95 mail order. Cabinets start at $139.95. (Retail prices slightly higher)."

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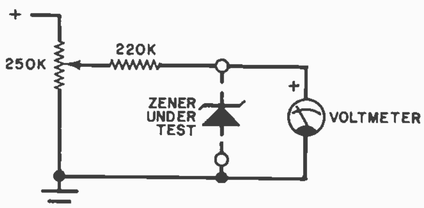
CIRCLE NO. 5 ON READER SERVICE CARD

Hobby Scene

Checking Zener Diodes

Q. *I have a number of unmarked zener diodes. How can I determine their voltage ratings?*

A. In the circuit shown here, a high-voltage, external dc power supply is used. The maximum voltage would depend on what you think will be the highest rating of the zeners you have. A 100-volt supply should cover most contingencies. Now, adjust the potentiometer until the indication on the meter comes to a stop. The reading on the meter is the zener's breakdown voltage.



A "Turn-Off-The-Lights" Reminder

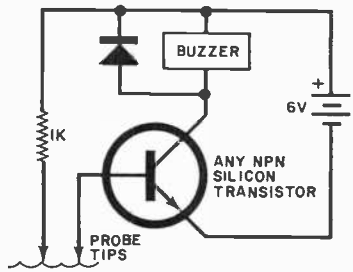
Q. *I have a bad habit of leaving the car lights on after I have removed the ignition key and left the car. The next morning, of course, there is trouble. Do you have a very simple circuit that would alert me when I do this stupid thing?*

A. Try the circuit shown here. Use any silicon rectifier diode and any kind of 10-to-12-volt buzzer, bell, or tone alert module. The alarm will sound if you leave the lights on after the ignition is turned off.

How to Detect Water in the Basement

Q. *With all of the rain we've had this spring, I keep getting flooding in the basement. Could I rig up some sort of simple system that would let me know when to go down and turn on the sump pump? I'm not really very experienced electronically.*

A. The circuit here is about the simplest you could build to do the job. You can use some

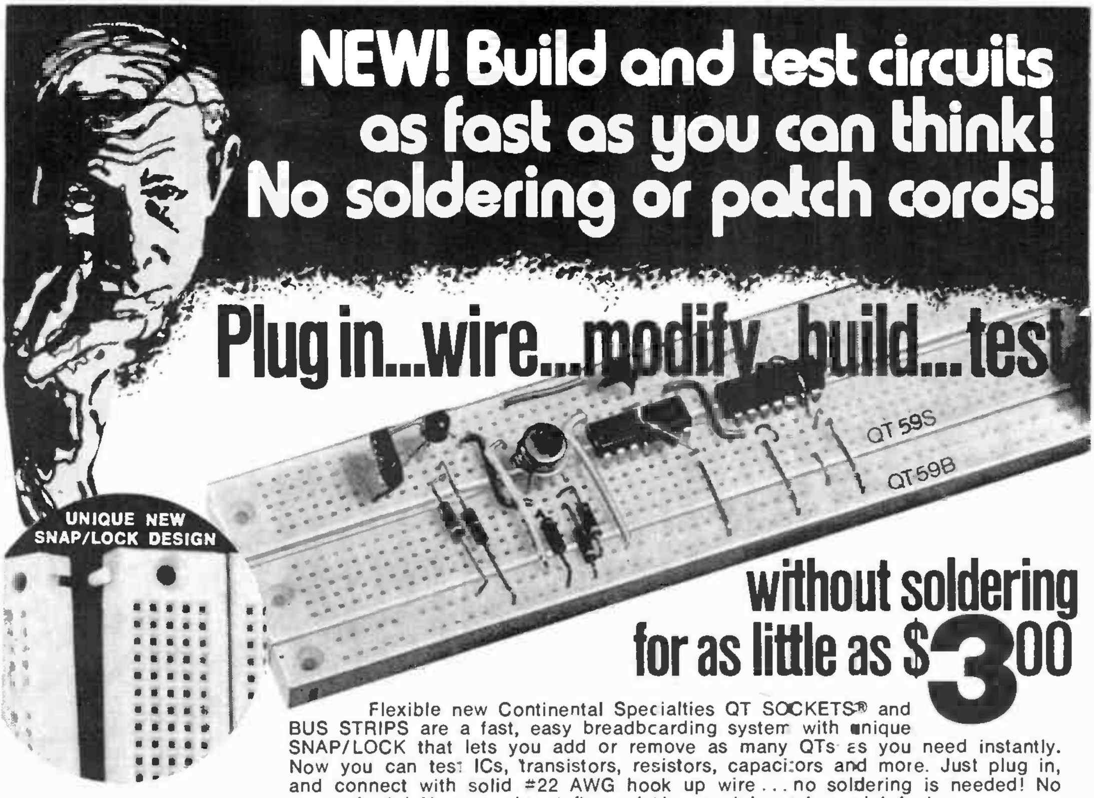


ordinary D cells for the power and any type of warning device that will operate on 6 volts. The circuit draws very little current on standby, but when water touches the probe tips, the alarm will sound off.

Getting Semiconductor Information

We get a lot of mail asking where certain semiconductors and other special parts can be obtained. Most of the parts used in construction projects can be found in the catalogs of our advertisers. Of course, they can't show everything in their ads, so please write to them for their catalogs. You will find a goldmine of useful information in them.

Have a problem or question on circuitry, components, parts availability, etc.? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.



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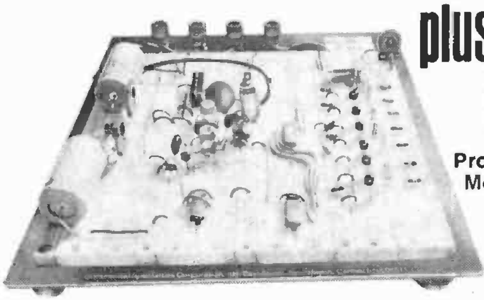
PAT. PENDING



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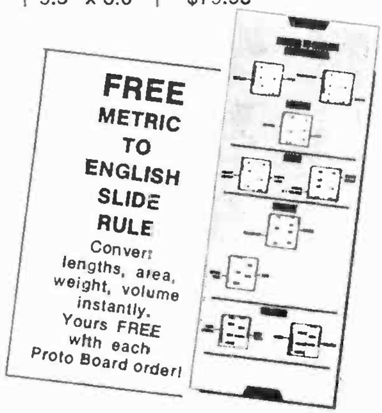

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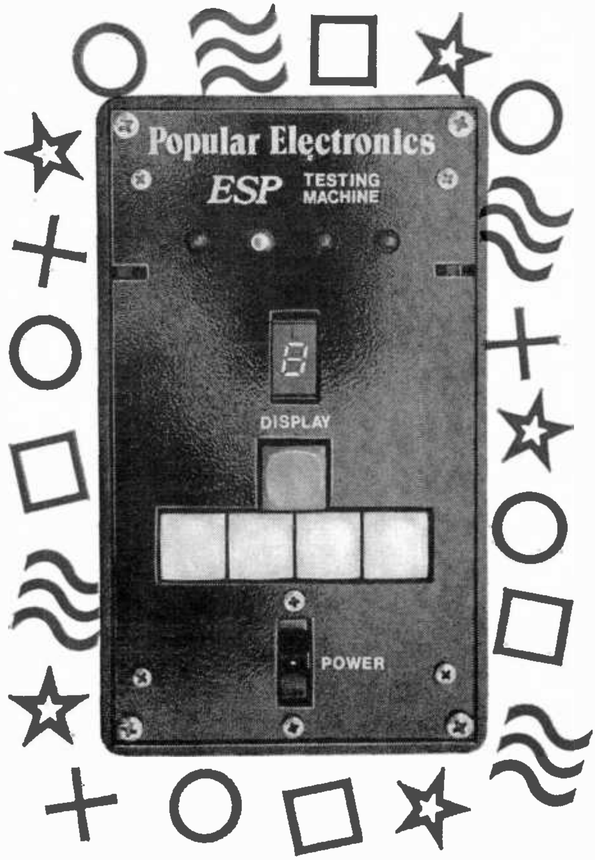


BUILD AN

ESP TESTING MACHINE

PE TESTED

Experiment with a young science and provide entertainment too!

BY IRA H. SPECTOR

OVER forty years ago, Dr. J. B. Rhine, of the Duke University Parapsychology Laboratory, began the first thorough scientific research into extrasensory perception (ESP). In those days, testing for ESP consisted of thousands of card-guessing experiments in which subjects would try to pick the exact order of a deck of cards to see how close they could come. Since a certain amount of "hits" were expected by chance, Dr. Rhine and his associates were only interested in those individuals who could consistently achieve scores that were significantly above chance. Those persons provided the experimenters with overwhelming evidence of the existence of ESP.

For today's advanced parapsychological research projects, the trend is away from card guessing. Recent ESP testing machines provide a test, automatically keep score, and can be interfaced with other instruments for determining physiological and psychological correlates of extrasensory perception.

The ESP Testing Machine described here incorporates many of these features. It is a portable, battery-operated device that allows the experimenter to test for all three types of ESP—telepathy, clairvoyance, and precognition,. Additionally, it's a fun game for entertainment purposes.

General Description. The ESP Test Machine consists of four light-emitting diodes (LED's) which serve as ESP "targets." There are four corresponding target-select pushbuttons. An internal random-number generator selects one of the LED's for illumination behind a small partition so that the target is not visible to the subject.

Although the procedure varies according to the type of ESP under investigation, the general objective is for the subject to achieve a "hit" by pressing the pushbutton corresponding to the hidden target. After each

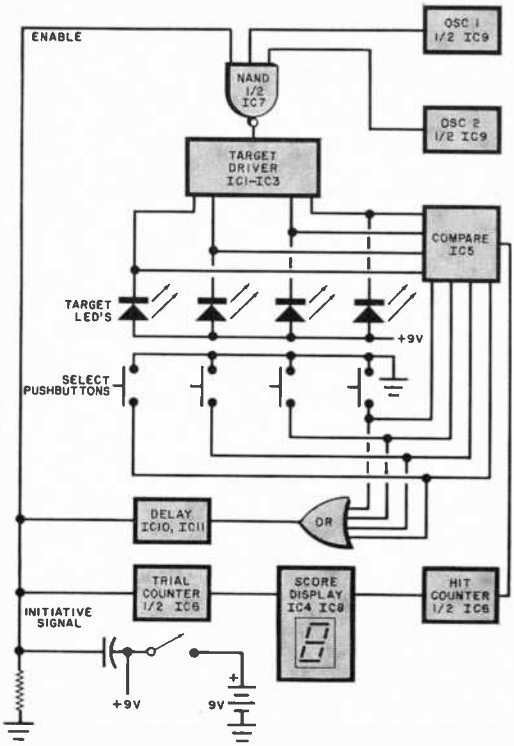


Fig. 1. Logic diagram of the Testing Machine. Two oscillators are gated to turn on one LED at random. When switch for lighted LED is pressed, a hit is shown on display.

trial, the random-number generator automatically selects the next target. When ten trials are completed, the number of hits is automatically displayed by a numeric indicator. A manual-display pushbutton is also provided to allow immediate feedback of the score anytime during the test run.

Since there are four equally probable target choices, the probability of a hit during any trial is 25%. Therefore, in ten runs (100 trials), the chance score is 25 hits. Tests scores which regularly deviate significantly from chance are considered evidence of ESP.

Circuit Operation. The basic logic circuit is shown in Fig. 1. When power is first turned on, an initiating signal generated by an RC circuit turns on a single, randomly selected LED.

When one of the four pushbuttons is depressed, an enable signal is generated. This goes through a delay to a three-input NAND gate formed by half of *IC7*. The other two inputs to the NAND gate come from a pair of non-synchronized pulse-generator oscillators (*IC9*). When the NAND gate is enabled, it allows two non-synchronized pulse trains to clock the target driver made up of *IC1, IC2, IC3*. This causes the LED's to illuminate in a 1-2-3-4 sequence at a random rate. At this speed of operation, the four LED's will all glow weakly. When the selected pushbutton is released, the enable signal is removed from the NAND gate (after a random delay), and only one of the LED's will remain lit.

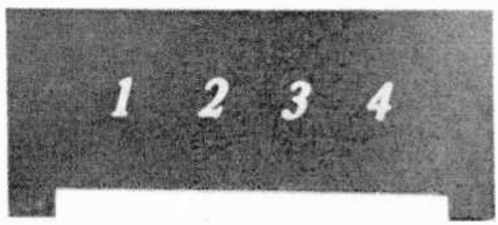
Each time the enable signal is generated, it also clocks the trial counter (*IC6*). After counting up to 10 trials, this counter generates a stop signal which turns on the seven-segment readout to display the number of "hits." It simultaneously turns off all four LED's. In the case of 10 consecutive hits, the logic produces a capital letter "H" on the seven-segment readout. To start a new test run, the power is turned off and then on again.

If the operated pushbutton corresponds to the illuminated LED, a comparator (*IC5*) generates a signal which is counted by the hit counter to form the display on the readout.

The length of the enable signal is a function of the time that one of the selection pushbuttons is held down. The delay in the circuit depends on the amount of bounce that occurs when the switch is operated. This adds human and mechanical randomizing elements to the target selection.

The actual circuit of the machine is shown in Fig. 2.

Construction. The ESP Testing Machine uses a double-sided pc board. Due to the large size of the foil patterns, they cannot be reproduced here. **However, you can obtain them, free of charge, by writing (enclosing a self-addressed, stamped envelop for return) to Editorial Dept., POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016.** The layout of components is shown in Fig. 3.



Piece of opaque plastic is cut to fit on top of chassis to form the vision barrier.

In working with the CMOS IC's, be sure that they do not come in contact with anything that can build up a static charge. Keep them in their conducting foam until ready for installation and handle them only by their non-pin edges. Use a small, low-wattage soldering iron with a grounded tip and observe the notch index for proper positioning.

Install the four white (*S2* through *S5*) and one red (*S1*) pushbutton switches on the Display Side of the board, along with the seven-segment readout. Mount the four LED's so that their bases are about ⅛" above the board. Use short lengths of bare wire, soldered on both sides of the board, for the test points.

Mark the cover of the plastic box so that it can be drilled and cut to allow the six switches, *RO1*, and LED's to protrude. The pc board is mounted on the front panel using 3/16" spacers. The power switch (*S6*) is

ESP TESTING PROCEDURES

General Principles. It is desirable to experiment in a quiet, comfortable room with subdued lighting. Take the test slowly, allowing enough time during each trial to develop a "feel" for the correct target. Use the DISPLAY pushbutton for immediate feedback when you think you are performing well.

Try to correlate any psychological factors (mood, approach, etc.) or physiological factors (tiredness, physical comfort, etc.) with test scores to see if patterns emerge. Use the figures in the Performance Chart to evaluate your scores.

Always keep the target partition in place during tests and always press the target select button for at least ½ second to ensure the registering of your trial and to provide extensive randomizing of the targets.

Testing for Telepathy. Mental telepathy is the transferring of information from one individual to another without the use of the five senses. The procedure for conducting a telepathy test is as follows:

1. Place the ESP Testing Machine on a table between the subject (receiver) and the sender. Make sure that the machine is oriented so that the targets are visible only to the sender.
2. When the power is turned on and the initial target is illuminated, the sender concentrates on the *number* on the target partition that corresponds to the target selected by the machine.
3. The subject should then try to get a mental image of the correct number and press the corresponding target select pushbutton. The subject should never look at the sender during the test to avoid "sensory leakage."
4. Repeat this procedure until ten trials are complete and the score is displayed.

Note: You may want to substitute other target material for the numbers on the partition to see how scores are affected. Use letters, colors, pictures—anything that you feel will enhance the visualization process.

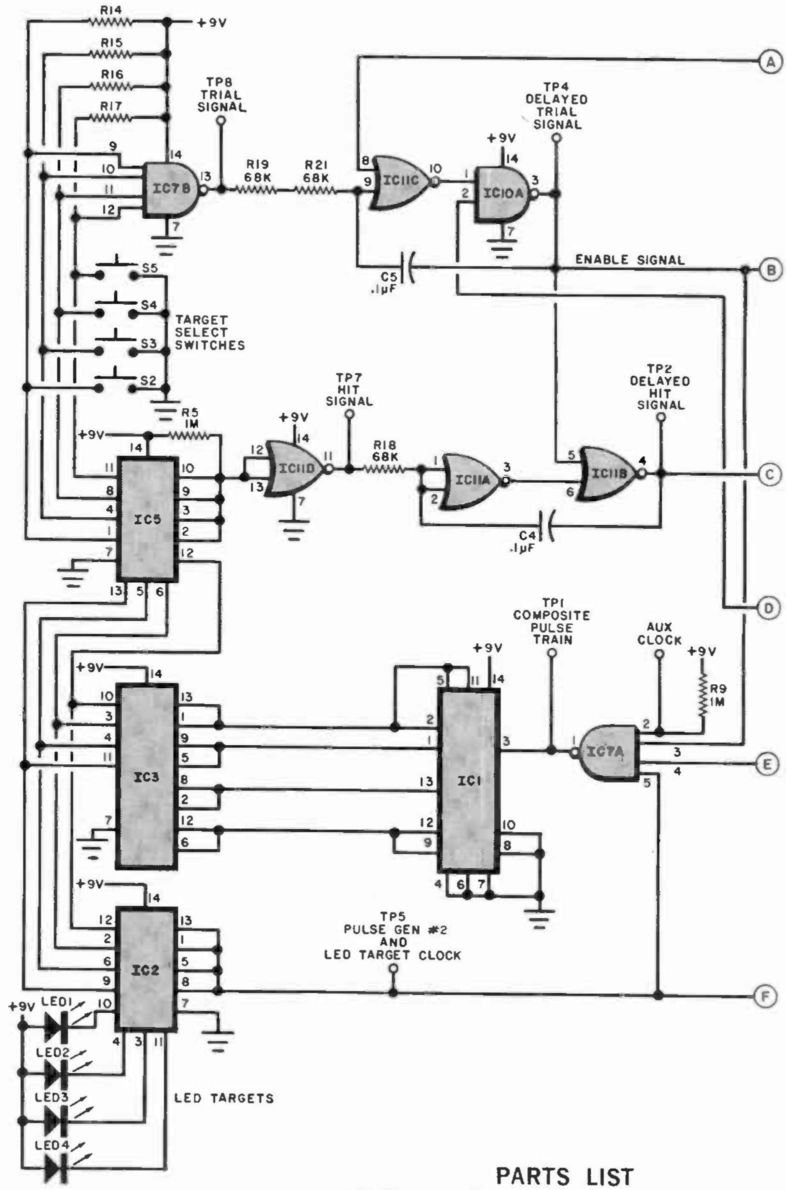
Testing for Clairvoyance. Clairvoyance is the perception of objects without the use of the five senses. The procedure is as follows:

1. Position the ESP Testing Machine so that the targets are not visible to anyone. This precaution avoids the possibility of "telepathic leakage."
2. Turn on the power and try to visualize which target is illuminated. Then press the appropriate pushbutton.
3. Continue this procedure until the run is complete and the score is displayed.

Testing for Precognition. Precognition is the prediction of future events that cannot be inferred from present knowledge. The procedure is:

1. Write down a list of ten numbers from among the target integers 1, 2, 3, and 4. Use any sequence which you "feel" will be selected by the machine when you actually perform the test.
2. Turn on the power and press the target select pushbuttons in accordance with the chosen sequence. When the last number is entered, your score will automatically be displayed.

Other Tests. The use of the ESP Testing Machine with other electronic equipment will permit a more detailed investigation of the nature of ESP. For example, if ham radio equipment is available, telepathy-over-distance tests can be performed either to verify or challenge previous results indicating that telepathy performance is unaffected by distance. If high scores are achieved, it would be an indication that the telepathy signal was not appreciably affected by distance.



PARTS LIST

B1,B2—9-volt battery
C1,C2—0.001-µF, 20% mica, Mylar, or ceramic capacitor
C3-C5—0.1-µF, 20% Mylar or ceramic capacitor
IC1—4013 CMOS dual-D flip-flop
IC2,IC8-IC10—4011 CMOS quad 2-input NAND
IC3,IC11—4001 CMOS quad 2-input NOR
IC4—4055 CMOS 7-segment decoder/driver
IC5—4016 CMOS quad bilateral switch
IC6—MC14520CP CMOS dual binary up-counter
IC7—4012 CMOS dual 4-input NAND
LED1-LED4—Light-emitting diode (Monsanto MV-5024 or similar)

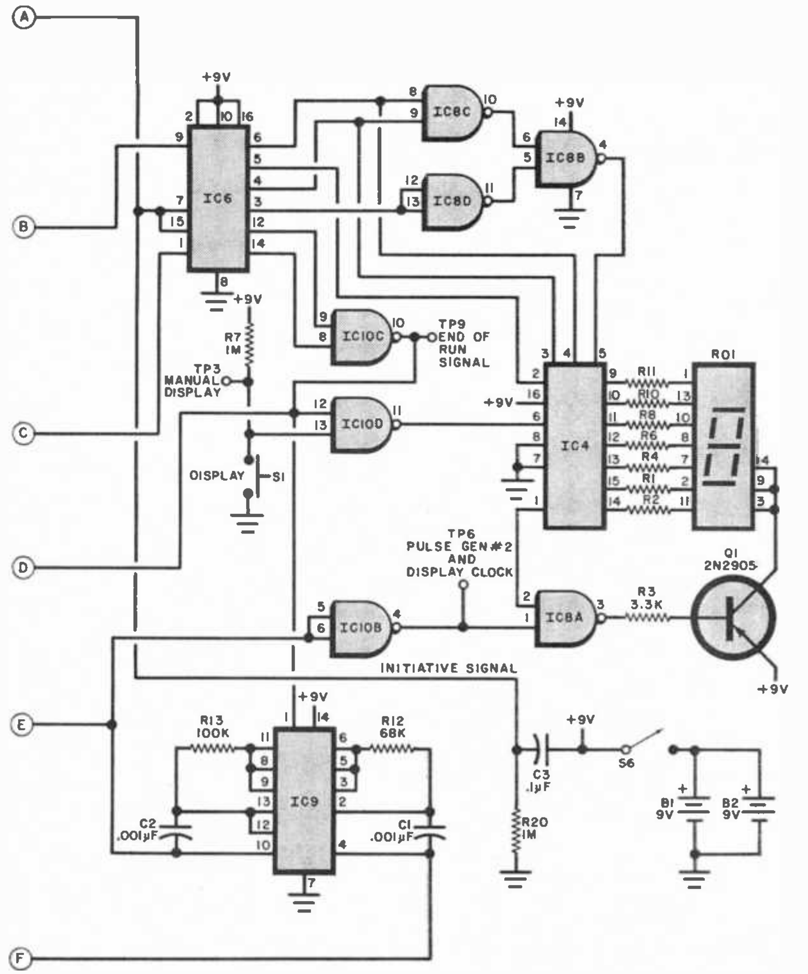


Fig. 2. The complete schematic for the ESP Testing Machine is shown above and on the opposite page. The circuit is powered by two 9-volt batteries. CMOS logic units are used to reduce drain on the batteries.

Q1—2N2905 transistor
R1,R2,R4,R6,R8,R10,R11—560-ohm, ¼-watt, 10% resistor
R3—3300-ohm, ¼-watt, 10% resistor
R5,R7,R9,R14-R17,R20—1-megohm, ¼-watt, 10% resistor
R12,R18,R19,R21—68,000-ohm, ¼-watt, 10% resistor
R13—100,000-ohm, ¼-watt, 10% resistor
RO1—7-segment LED readout (Litronix DL-707 or similar)
S1—Spst momentary pushbutton switch (red) (Oak 415-399592-LP or similar)
S2-S5—Spst momentary pushbutton switch (white) (Oak 415-399596-LP or similar)
S6—Spst alternate-action rocker switch (Chicago 26-220-100 or similar)
Misc.—Case (H. H. Smith 2255), cover (H. H. Smith 2256), plastic for target partition, battery holders (2), battery connectors (2), mounting hardware, etc.
Note 1—The following are available from Paratronics, 150 Tait Ave., Los Gatos, CA 95030: etched and drilled pc board (ESP-1PC) at $7.00; finished and labelled panel, case, and target partition (ESP-1PP) at $5.50; complete kit of parts (less batteries) (ESP-1KN) at $69.00; assembled and tested unit (ESP-1AT) at $86.00. All items postpaid. California residents please add 6% sales tax.
Note 2—Foil patterns for the double-sided pc board can be obtained free of charge by writing (enclosing a self-addressed, stamped envelope) to Editorial Department, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016.

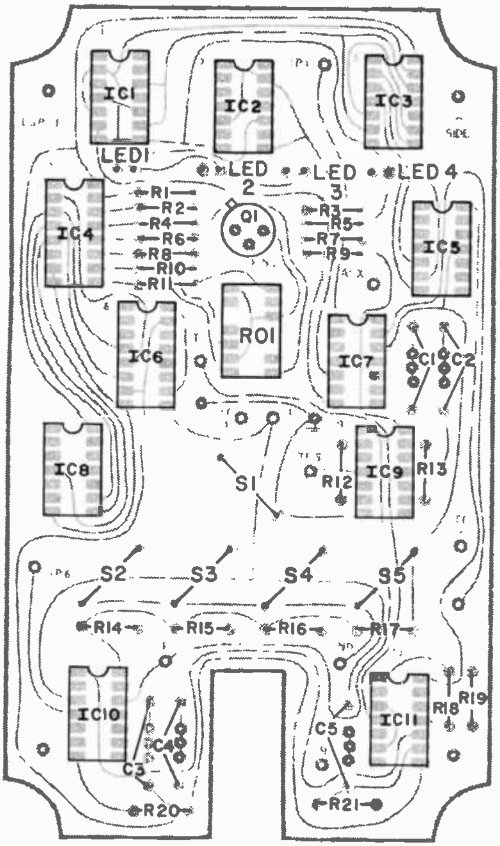


Fig. 3. Component layout for the pc board.

mounted directly to the front panel and fits into the cutout on the board.

The chassis cover should also have two slots, one on each side, between the LED's and the readout. A piece of opaque plastic should be cut so that it will fit into the slots on each side. This forms a vision barrier so that the person operating the pushbuttons cannot see the LED's. Mark the barrier with the numbers 1, 2, 3, and 4 on each side, keeping in mind that on one side the numbers must read from left to right, and right to left on the other.

PERFORMANCE CHART

No. of Runs*	Chance Score	Good Score (Odds 20:1)	Excellent Score (Odds 100:1)
10	25	34	36
20	50	62	66
30	75	90	94

*10 trials in each run.

Complete the wiring in accordance with Fig. 2.

Checkout. Turn on the power and observe that only one of the four LED targets is illuminated. Press the DISPLAY button and note that the numeral "0" appears on the readout. Then press the target select pushbutton opposite the illuminated LED and notice an immediate mixing of the targets. Upon release of the pushbutton, one of the four LED's will be lighted for the next target. Press the DISPLAY button again and note that the numeral "1" appears on the readout. Continue this procedure until numerals "1" through "9" have been checked out. On the tenth hit, the letter "H" should automatically appear and further trials should be inhibited.

If trouble occurs, first be sure that the batteries are fresh. Further trouble-shooting will be aided by the use of the test points labeled on the pc board and shown in Fig. 2.

One Final Note. In the event that some readers view the subject of ESP incredulously, consider the following. The prestigious IEEE (Institute of Electrical and Electronics Engineers) at its recent annual convention, held a seminar at which researchers presented professional papers outlining their work in ESP and related subjects. The session was attended by several hundred enthusiastic electronics engineers. ◈

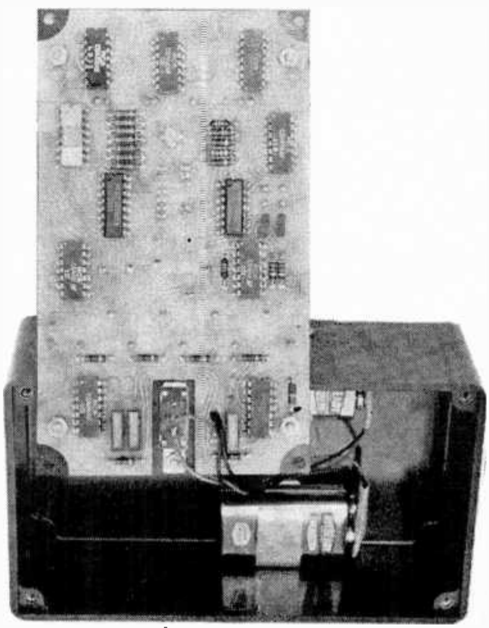
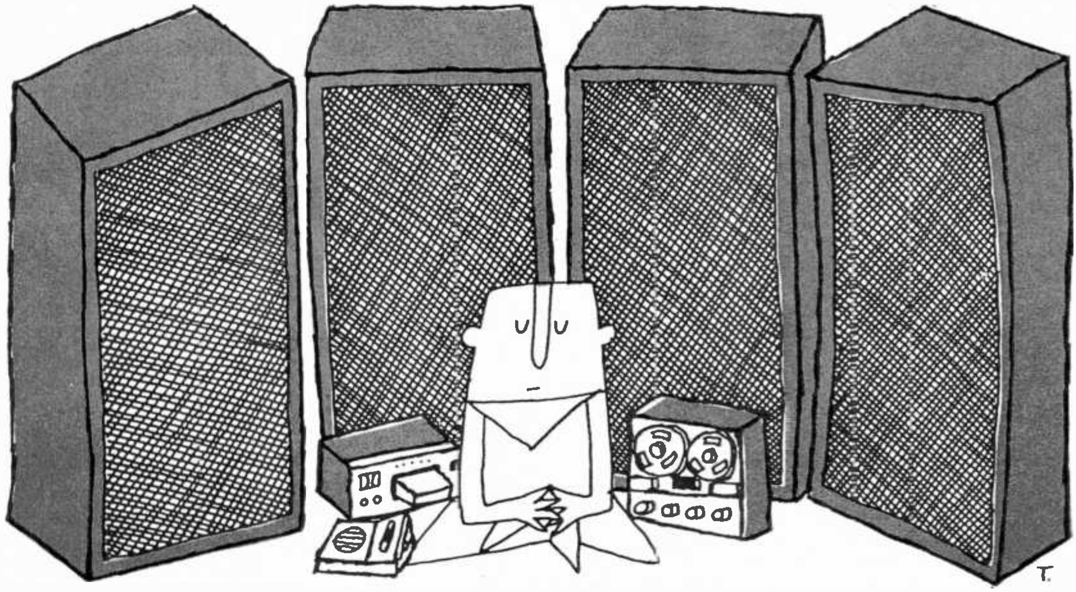


Photo shows pc board and the enclosure.



Status Report: 4-CHANNEL TAPE MACHINES

Here are the latest developments on quadraphonic open-reel, 8-track and cassette tape recorders

BY LEONARD FELDMAN

THE 4-channel tape medium has, for some time, lagged behind the quadraphonic disc format—although that situation is changing. (Equipment manufacturers are designing new lines of quadraphonic open-reel and 8-track cartridge recorders; and there is the promise of 4-channel cassette decks on the horizon.) Here is a status report on quadraphonic tape machines.

Open-Reel Four-Channel Tape. No real problem was posed in translating open-reel tape formats to quadraphonics. For years, stereo open-reel tape machines had four-*track* capability, as shown in Fig. 1. One stereo program was recorded and played back on tracks 1 and 3, while a second stereo program was recorded and played in the reverse direction, using tracks 2 and 4. To get four-channel recordings on open-reel tapes, it was only necessary to devise new tape record and play heads which incorporated four magnetic gap circuits instead of two, as shown in Fig. 2. Driven by additional

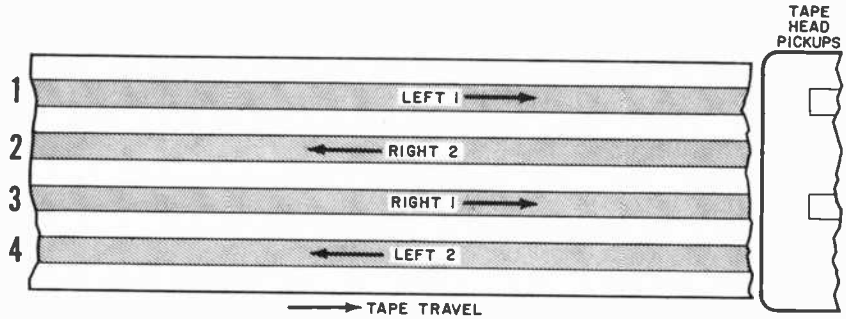


Fig. 1. Arrangement of two stereo programs on open-reel 4-track tapes.

record and playback preamplifiers, each gap magnetized one of the available four tracks during record; on playback, each recorded track was picked up by a separate section of the playback head and suitable playback preamplifying circuits.

The only element of the system that is altered is the available length of recording time in a given length of tape. (Obviously, with full tape width used for the four channels of recording, playing time is cut in half for any tape speed.) This open-reel tape format inherently offers best fidelity and the most "discrete" four-channel sound of all. Separation in excess of 40 or 50 dB between channels is easy to achieve, compared with the 20 or 25 dB of separation offered by even the most carefully recorded (and played back) CD-4 "discrete" phono discs. Why, then has the open-reel four-channel machine become the preferred "pet" of only a limited number of dedicated audiophiles?

If you thumb through any hi-fi equipment catalogue you will be surprised to learn that open-reel machines, stereo or quadraphonic, carry very high price tags. Unlike a decade ago, when good stereo decks could be bought for $200 or $300, components of this type are now largely confined to the over-$500 category and, in the case of good quadraphonic decks, they approach the "$1000 and up" bracket.

Cassette Four-Channel Tape. Track layout of a standard cassette differs from that used in open-reel tapes. Here, related stereo tracks are placed side by side, as diagrammed in Fig. 3. Thus, one stereo program is heard when the cassette is played in one direction; when it is inverted and played in the other direction, a second full program is heard. This format was decided upon by Philips Company of Holland, licensors of the cassette principle to all other manufacturers. This arrangement makes cassettes fully compatible. That is, a stereo cassette played on a mono machine has its two channels picked up simultaneously by a wide playback head gap, while a mono cassette played on a stereo machine induces the same magnetic information in both stereo head gaps (and hence both speakers).

At first glance, the simplest transition to quadraphonic cassettes might be made by using all four available tracks, recorded in the same direction, much as is being done for open-reel pre-recorded

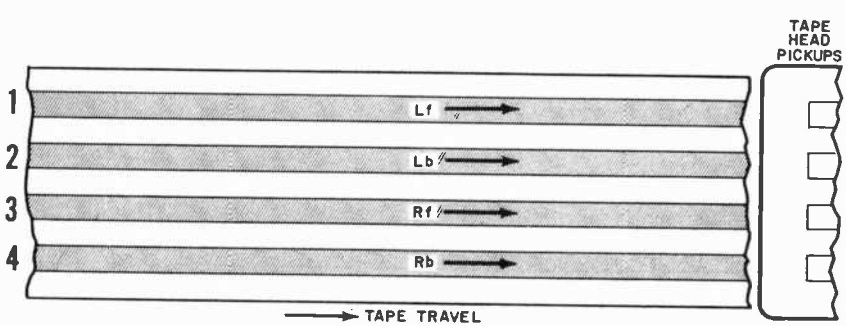


Fig. 2. In 4-channel open-reel, all four tracks are played at once.

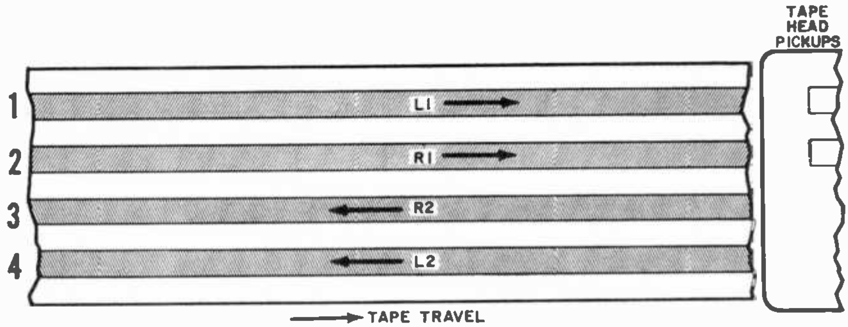


Fig. 3. Cassette track utilization for stereo differs from open-reel.

tapes. The track arrangement would be that shown in Fig. 4. New record and play heads would have to be engineered, but this would be no more difficult than the transition in open-reel machines. The problem lies with the compatibility of cassettes. Since Philips decrees that all cassettes must be compatible with all machines, the solution using the track layout of Fig. 4 would not fill the bill. A listener playing a quadraphonic cassette on a stereo machine would hear, first, the two front channels (with no contribution from the two rear channels). Upon inverting the cassette, he would not only be treated to the back channels *only*, but would hear their content played *backwards*.

Accordingly, Philips has repeatedly suggested that the way to four-channel cassettes must involve a further reduction of track width. Specifically, this is eight *very* narrow tracks all within the width of a little more than ⅛ inch, as shown in Fig. 5. Each track would be just a few thousandths of an inch wide and, while manufacturers might be able to keep their record/play heads in reasonable alignment so as to prevent crosstalk and poor frequency response, signal-to-noise ratios would take a "step backwards," negating some of the improvement brought about by the Dolby system. An even more severe problem would be faced by cassette duplicating firms (who "dub" pre-recorded music onto cassettes at much higher speeds for reasons of economy). Cassette tapes, moving at high speeds, have a tendency to wobble up and down. Therefore, with decreased track widths proposed by Philips, alignment problems in duplicating could become horrendous.

Despite the problems envisaged, at least one company has announced production plans for a quadraphonic cassette tape deck following the Philips 8-track proposals. But, seeing is believing. It has also been suggested that "matrix" encoding from four channels to two channels might be the best solution for cassettes. Indeed, the two encoded channels of a matrix system could be recorded onto cassettes without any change of parameters, format, frequency response, or signal-to-noise specifications, much as is done with matrix-encoded records. It would seem a pity to have to go this route with any tape format, however, since tape, of all storage media, seems so right

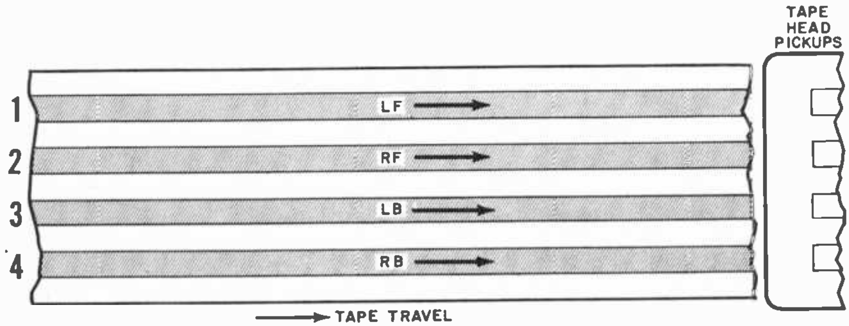


Fig. 4. The simplest transition to 4-channel cassettes can't be used.

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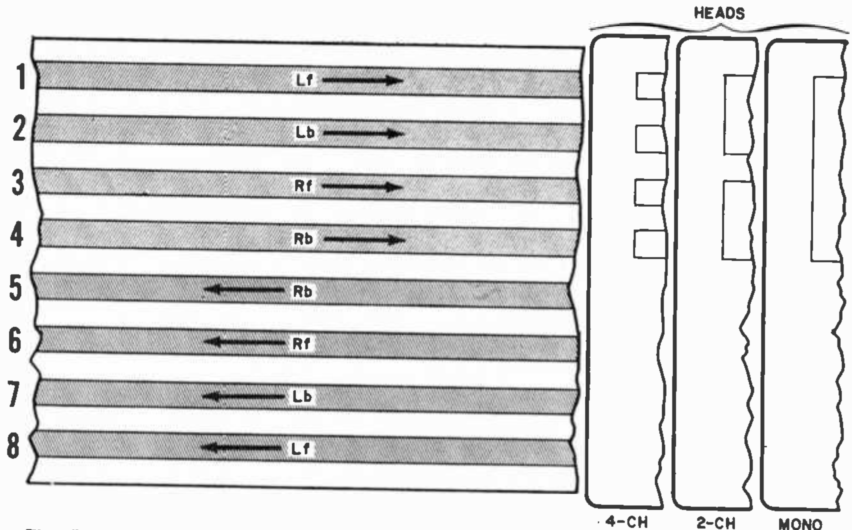


Fig. 5. Further division of cassette tracks to 8 maintains quad-stereo-mono compatibility and playing time while reducing the track width.

for discrete approaches to multi-track recording.

Cartridge Four-Channel Tape. The last of the tape formats to be considered in terms of its four-channel applicability is the 8-track cartridge. First dubbed "Quad-8" cartridges, and later Q-8 by RCA, four-channel sound on cartridges appeared very early in the quadraphonic era. Stereo 8-track cartridges of the "endless loop" variety had been introduced years before, primarily as a background music program source for automobile use. The track arrangement of stereo 8-track cartridges is shown in Fig. 6. Four full programs of two tracks each is standard. As each program is completed, a metal foil strip bonded to the tape itself actuates a switch and solenoid which moves the tape playback head downward (or upward) an appropriate distance so that the succeeding program can be played. Play is continuous, of course, and in most machines the cartridge will repeat playings of its various

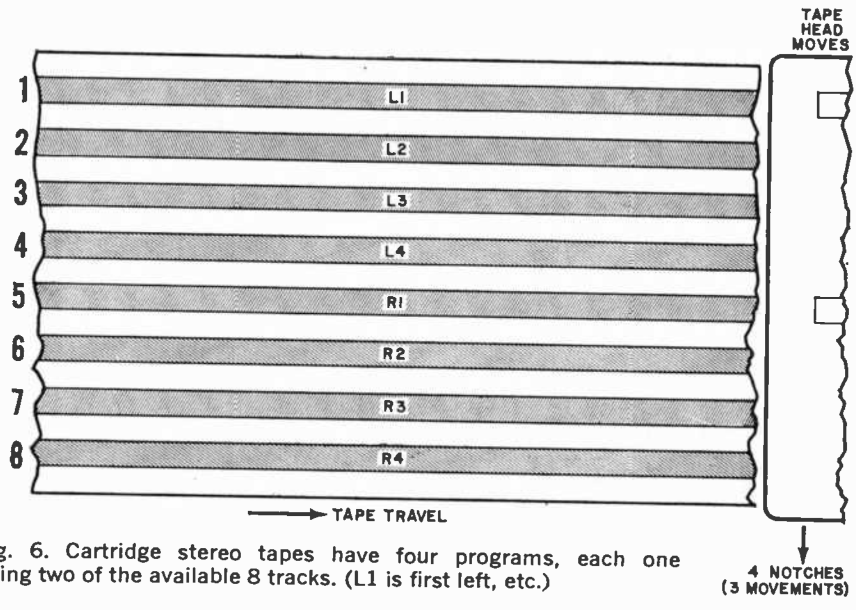


Fig. 6. Cartridge stereo tapes have four programs, each one using two of the available 8 tracks. (L1 is first left, etc.)

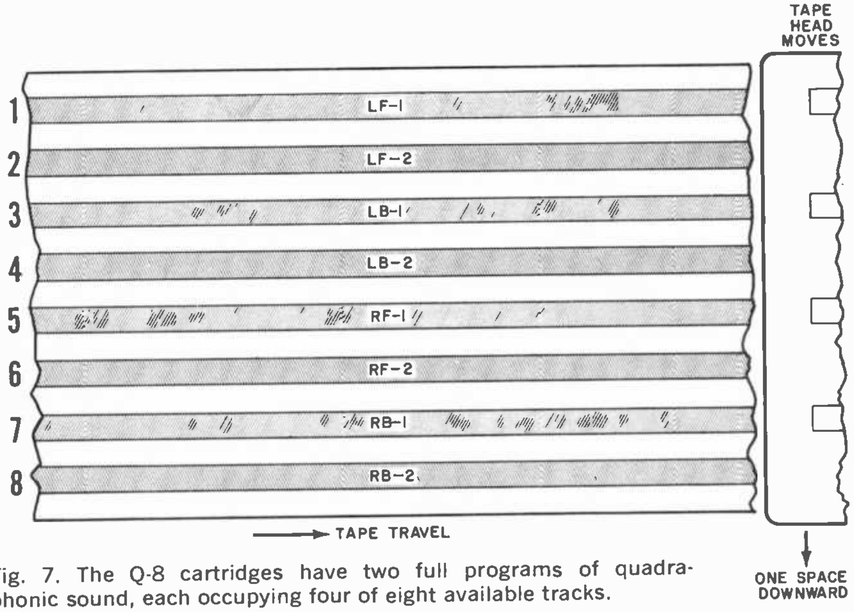


Fig. 7. The Q-8 cartridges have two full programs of quadraphonic sound, each occupying four of eight available tracks.

programs until it is physically extracted from its slot.

In Q-8 cartridges, only two program loops are possible, since each uses four of the eight available tracks, arranged as shown in Fig. 7. New machines designed to play these cartridges have a built-in measure of compatibility. That is, a stereo cartridge inserted in the slot of such a machine will have all its four programs played in sequence, while a Q-8 quadraphonic cartridge, equipped with a special slot in its plastic housing, will cause the head to move only once when switching from the first quadraphonic program to the second. On the other hand, a quadraphonic cartridge inserted in a stereo cartridge player will first play the front channels of program "A," followed by the back channels of program "A," the front channels of program "B" and, finally, the back channels of program "B."

Even though 8-track cartridges operate at higher speeds than cassettes (3¾ ips) and one would expect the fidelity and S/N ratio to be better than that obtained in slower-speed cassettes, the reverse is true. The fact that the head itself is required to move from program to program makes permanent, precision head alignment almost impossible. The endless-loop principle in which tape is drawn from the inside of the wound tape and returned to the outer diameter involves a tricky drive system which does not lend itself to the extremely low wow and flutter figures possible with either open-reel or cassette mechanisms.

The closed-loop tape also makes it impossible to have a "fast rewind" feature on these machines. (There is no rewind of any kind possible, since it is not possible to squeeze the tape back into the center of the roll.) Though some late-model machines do feature a somewhat faster-than-play "fast forward" mode. Signal-to-noise ratios (tape hiss) are generally poorer than those found in better cassette machines, even before Dolby is applied. Not surprisingly, Dolby noise reduction has not been applied to either pre-recorded 8-track cartridges or to the playback machines with which they are used. A few machines now have record as well as playback facilities, but the vast majority are built for playback of pre-recorded music only. In short, the 8-track format just has not caught on with the true audio buff. That is not to say that these mechanisms could not be built for improved specifications—they simply have not been up to now. Some of these shortcomings are masked by road and engine noise, of course. And it's in automobiles where cartridges made their mark. Also, 8-track offers a much greater pre-recorded library than other formats. ◈

HOW TO SELECT

EM KEYBOARDS & CONTROLLERS

Types and availability for electronic music synthesizers

BY DON LANCASTER

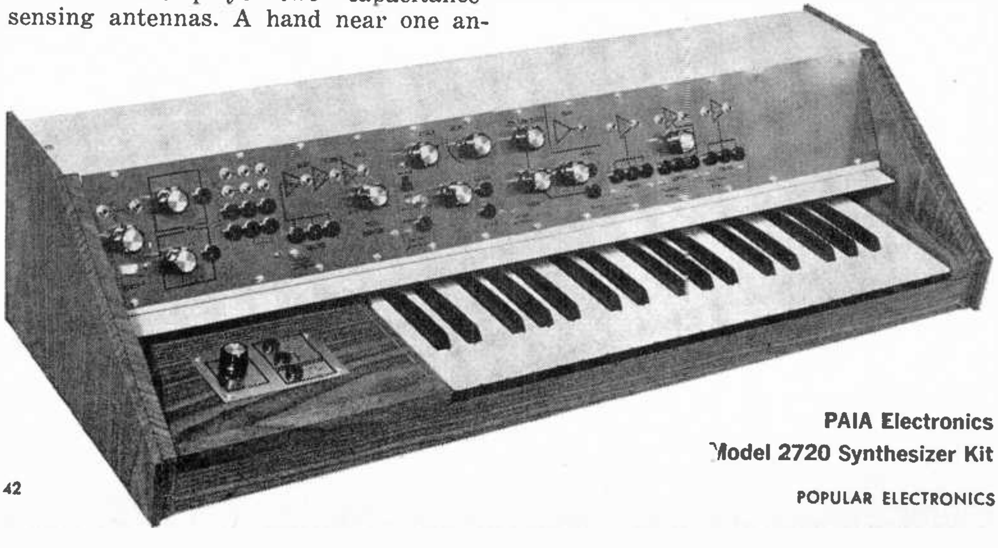
WE HAVE received a number of inquiries from readers about the types and availability of keyboards for use with music synthesizers. We have also gotten quite a bit of manufacturers' literature on the subject. We'll try, here, to answer some of the questions and also pass along information we have received.

Controllers. A controller is a device that provides some means of deciding when and in what sequence the notes are going to occur. It can also simultaneously set the frequency, duration, envelope, volume, and special effects. The most common—and obvious—controller is the keyboard, usually based on the traditional type used on pianos and organs with seven white and five black keys per octave. (The preferred size, shape, and locations of the keys are illustrated in the drawing on the next page.)

There are many other controller possibilities. For example, the theremin, dating back to the 1920's, was one of the earliest of electronic musical instruments. It employs two capacitance-sensing antennas. A hand near one antenna sets the pitch, while a hand near the other controls volume. The instrument is literally played in mid-air. The theremin was extremely popular in providing eerie background sounds on radio programs and in motion pictures.

A computer or a digital sequencer can also be used to set the sequencing, duration, beginning, and ending of a note. One obvious example was the "Psych-Tone" (February 1971) in which a pseudo-random sequence generator set the frequency and duration of each note. Other special sequence generators can be used for rhythm and accompaniment, forming a sideman or bandbox. Usually, a group of counters is suitably decoded to provide the desired rhythm pattern.

Some digital sequencers are mechanically or electronically programmable. The earliest example of this was the player piano, but today's minicomputers provide tremendous control possibilities, far beyond those offered by the player piano. Tape cassettes, too, offer all sorts of stor-



PAIA Electronics
Model 2720 Synthesizer Kit

age and control possibilities for electronic music.

Digital sequencers can be too regular or too random. Much of what we call music can be described as a sequence of expected surprises, regular sequences dominating, with changes and randomness essential but in a minority. Most of our music, consequently, consists of a 65 to 95 percent redundancy.

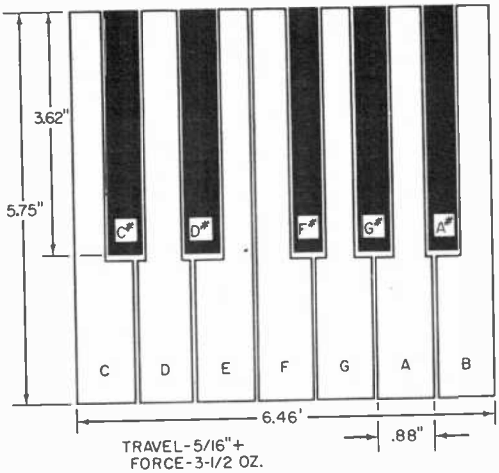
If everything is redundant, the sound is boring—a sideman that never changes or misses. Make it all random, and somehow it is not music. Any good digital sequencer must play the middle ground, perhaps by adding slight randomness to break up an "exactitude," or by having alternate sequences so elaborate that they do not bore.

It can be argued that traditional keyboards limit the flexibility of musical composition, making many effects (particularly loudness control) and glides and trombone slides difficult to obtain. But the piano keyboard is a product of hundreds of years of adaptation to the human mechanism. It has been so highly optimized that no other traditional instrument can come even remotely near it for range and flexibility of expression.

In the studio, we are free to custom-build each note and use multiple recording techniques and individual sequencers to build up a final sound image without a keyboard. To this end, we use patchboards, switches, punched or magnetic tapes or cards, scissors, etc. Interestingly, though, whenever an attempt is made to turn this into a real-time process, all patches and switches turn into stop tablets and the result is a keyboard.

Commercial Keyboards. There are two basic keying systems in current use. In *direct* keying, all notes go through the keyboard; this is the traditional electronic route, but it limits what can be done with attack and decay and contains cross-talk problems.

Most synthesizers and many newer organ circuits employ an *indirect* system in which only control voltages are routed through the keyboard. For example, the keyboard can send the supply voltage to an oscillator or keyer in the separate-voicing pitch-generation method. It can select a division ratio or route a command to an envelope generator or a digital pitch generator. On the other hand, it can select a fixed precision resistor for the vco method of pitch generation, or it can route a frequency reference to a phase-locked loop tracker pitch generator.



One octave of traditional piano or organ keyboard. White keys are different shapes in order to get a "piano" spacing in the front and even mechanical spacing at back.

Almost always, the equivalent of multiple contacts on the keyboard is desired. In a synthesizer, you might select a pitch resistor with one contact and at the same time generate a common command: "A note has been played in octave #3." In traditional electronic organs, you might sum up pipe voices onto 2', 4', 8', and 16' buses and provide for manual-to-manual coupling.

Perhaps, in your system, you might like to move up a fifth without changing key positions (done in groups for automatic chording) or be able to switch keys for transposition without moving all over the keyboard. To do this, the equivalent of a new set of contacts is needed for each desired effect.

As you can probably imagine, multiple contacts can become a headache. Commercial keyboards are available with up to eight contacts per key; but two, three, and five contacts are more common. A better route today is the use of electronic expansion or contact multiplication, using diodes or digital-logic gates to provide virtually any number of contacts per key. CMOS logic is ideal for this and can handle both digital and analog signals. Check out the CD4016 in particular.

Two general classes of keyboard systems are "regular" and "touch-sensitive." In the first system, the contacts simply close when a key is pressed. The closure is independent of the speed and force at which the key is closed. Loudness of the note or other special effects must be controlled by some other means. How fast the key is pressed in a velocity-sensitive keyboard or how hard it is pressed in a pressure-sensitive keyboard also initiates a separate electrical control-signal output.

An ideal velocity-sensitive setup would have some mechanism similar to that of a piano on each key. Its final velocity would be converted into an electronic signal and used for control. More reasonable methods can be imagined by using optical couplers or by using the fixed charge on a capacitor whose plates move together as the key is pressed. Alternatively, key motion or displacement can be sensed and used to establish velocity. Both velocity and pressure could be sensed in this manner.

In single-voiced instruments, one common velocity generator can be used for velocity or pressure sensing to eliminate key-to-key variations. An obvious way to sense pressure is to use conductive foam under each key, but the big problems include obtaining key-to-key uniformity and good wear properties combined with long-term stability.

Selecting a Keyboard. If you are an experimenter, chances are that you are considering making your own keyboard. You might save some money going this route, but be prepared to run into numerous obstacles. On the other hand, if you are serious about music and have the money to spend, a commercial keyboard may be more to your liking.

Commercial keyboards run from a minimum of $1.60 to more than $3.00 *per key*. At first glance, this might seem extravagantly expensive, but bear in mind that these keyboards represent a good deal of research, have a great deal of integrity, and are characterized by uniformity. In the long run, a commercial keyboard is the only possibility for the serious musician.

SUPPLIERS OF COMMERCIAL AGO KEYBOARDS

Devtronix Organ Products
5872 Amapola Dr.
San Jose, CA 95129

Eμ Systems
3455 Homestead Road
Santa Clara, CA 95051

Newport Organs
846 Production Place
Newport Beach, CA 92660

PAIA Electronics
Box 14359
Oklahoma City, OK 73114

Schober Organ Company
43 W. 61st ST.
New York, NY 10023

Many commercial keyboards are made by the 176-year-old Pratt & Reed Co. to the high standards set by the American Guild of Organists. They are professional units, custom designed for specific users; so, do not expect to find them as "off-the-shelf" items and at bargain prices. There are, however, other sources of supply to which you can turn as shown in the table below.

When last we checked, PAIA Electronics had the lowest price per key for a 37-note system. Even so, an AGO keyboard *without* velocity or pressure sensing is going to cost a minimum of $1.60 per key.

You might try to build up a simpler keying system for experimental use or initial setups. For the keyboard, you might want to use a surplus calculator or computer keyboard as is or rearrange it into a more "playable" setup. This approach will get your system operating for only a few dollars—even if it is essentially unplayable. If you plan on imitating the traditional key shapes, you can get keytops and sharps from Tuners Supply Co. (94 Wheatland St., Somerville, MA 02145); the white ones #531A sell for $7.20 for a set of 52, and the black #523L are $6.50 per set of 36.

Touch-sensitive foams and vinyls are available from Emerson and Cuming (604 West 182 St., Gardena, CA 90247). Their Eccoshield CLV vinyl and MOSFET foams might prove of interest. Another good conductive foam is #7611 Vellofoam available from Custom Materials Inc. (Alpha Industrial Park, Chelmsford, MA 01824). While the price per square inch of these materials is very low, the normal minimum order seems to run about $25, which will buy a large sheet.

Sealed key switches with integral return springs are available from Southwest Technical Products Corp. (219 West Rhapsody, San Antonio, TX 78216) at $4 per octave. They are single-contact high-quality reed switches with the normal range of travel and force.

Designing and building your own keyboard may be difficult, but it isn't impossible—else how could the commercial units have evolved? If you come up with something that is inexpensive, reliable, and suitable for professional use, let us know about it. ◈

BUILD A

GUITAR SOUND INTENSIFIER

IMPROVES FREQUENCY RESPONSE, GIVES COMPLETE TONE CONTROL

BY KEN LANG

THERE are few families with youngsters (or young-at-heart oldsters) that don't have guitars these days. The instrument may be the familiar acoustic type, whose shape and size have not changed much during its long history, or it may be a solid-body electric type. With a smaller body, the electric guitar relies entirely on electronic amplification for its sound—and it is probably today's largest selling electronic instrument.

The solid-body electric guitar has a thick wooden section instead of a resonant box. Magnetic pickups are mounted inside the body under the metal strings. Without the nuances of body size and shape to provide differences in tone, most solid-body guitars sound pretty much alike. The combination of pickup, strings and electronic resonance provides a pure inductance, which contributes little to sound character and causes peak emphasis at one particular frequency (with attendant ringing and hangover). The subtle string overtones get lost because they can't compete with the sound output at circuit resonance.

Of course, special effects can be added to electric guitars, but a means of really changing the coloration of the sound is more desirable. Such a change can be achieved by adding this Guitar Intensifier. It has its own volume, bass, and treble controls and can be mounted in the cavity of many solid-body electric guitars. Having independent tone-control arrangements, this approach gives the user a variety of tonal colorations and produces a wide frequency response. There is no loss of high-frequency overtones at low volume settings, but the GI provides the instrument with more "punch."

Circuit Operation. The signal induced in the guitar pickup (Fig. 1) is coupled through *S1* and *C1* to the base of *Q1*, a preamplifier. Potentiometer *R12* is a volume control, while *R13* and *R14* provide bass and treble control.

The complete bass cut-and-boost circuit is composed of *R5*, *R13*, *R6*, *C3*, and *C4*. The treble cut-and-boost consists of *C5*, *R14*, and *C7*. The contoured signal is then applied to output amplifier *Q2*, which is coupled to *J1* through *C8*.

When S2 is placed in the bypass position, the transistor amplifier is turned off and the input signal goes through only the volume, bass, and treble controls.

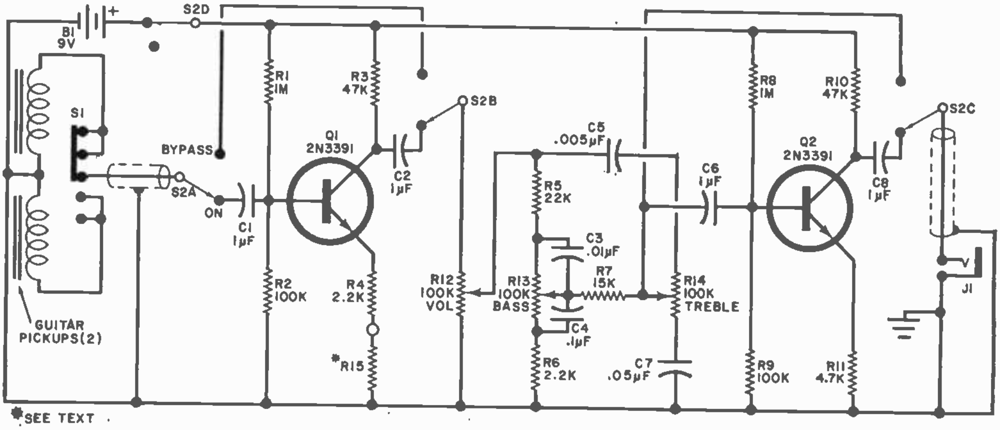


Fig. 1. Spectracom IGI™ circuit (patent applied for) is similar to discrete model.

Construction. The complete circuit can be assembled on a small pc board as shown in Fig. 2. If the unit is to be mounted in the cavity of a solid-body guitar, be sure all components are mounted so that they take up a minimum of height.

The value of *R15* must be selected so that it prevents distortion due to overloading of the first stage. Because of variations among guitar pickups, this resistor can be any value from zero to 10,000 ohms.

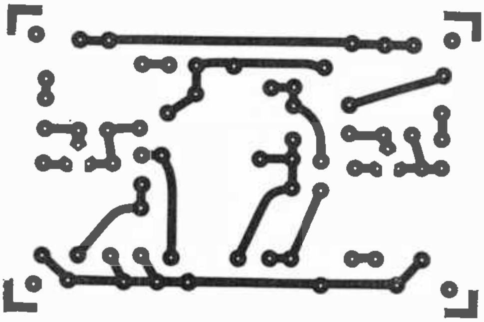
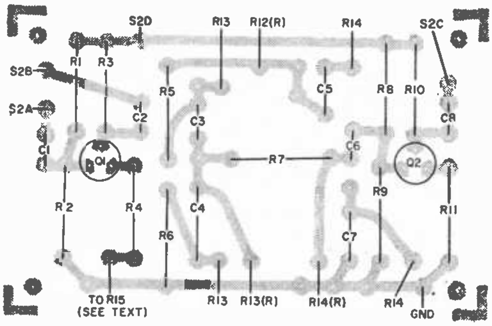


Fig. 2. Actual-size foil pattern for intensifier is above; component layout below.



PARTS LIST

B1—9-volt battery
C1,C2,C6,C8—1-μF tantalum capacitor
C3—0.01-μF, 20-volt, ceramic disc capacitor
C4—0.1-μF, 20-volt, ceramic disc capacitor
C5—0.005-μF, 20-volt, ceramic disc capacitor
C7—0.05-μF, 20-volt, ceramic disc capacitor
J1—Phone jack
Q1,Q2—2N3391A transistor
R1,R8—1-megohm, ¼-watt resistor
R2,R9—100,000-ohm, ¼-watt resistor
R3,R10—47,000-ohm, ¼-watt resistor
R4,R6—2200-ohm, ¼-watt resistor
R5—22,000-ohm, ¼-watt resistor
R7—15,000-ohm, ¼-watt resistor
R11—4700-ohm, ¼-watt resistor
R12-R14—100,000-ohm potentiometer
R15—See text
S1—On guitar
S2—4-pole, 2-position rotary switch
Misc.—Suitable chassis (if not put in guitar), knobs (3), battery holder, battery connector, mounting hardware.
Note—A kit (in hybrid IC form rather than discrete components) of the circuit described here is available from Spectracom Corp., Box 307, 1101 State Rd., Princeton, NJ 08540, for $49.50, including installation instructions and switch.

After determining that the amplifier operates with *S2* in the bypass position, connect the loose end of *R4* to ground and place *S2* in the on position. If you get distortion, start by using 2200 ohms for *R15*. If the distortion continues, try 4700 ohms. Continue to increase the resistance if necessary.

Set the amplifier volume and tone controls as you normally do. Then play the guitar and test the operation of volume control *R12*, bass control *R13*, and treble control *R14*. The results should be very noticeable. Tone response is tailored by adjusting the bass and treble controls for a broad range of coloration. The wider frequency response gives both slashing chords and softly picked solo notes. The attack is fast and the sound is clean. Chord sustain is excellent. ◈

LOW-COST METAL LOCATOR

An easy-to-build locator that detects buried metal objects at depths of 6 inches

BY JOE A. ROLF

MOST inexpensive metal locators are "heterodyne" types where the output frequencies of a fixed and variable oscillator "beat." The fixed-frequency oscillator serves as a reference, while the other oscillator has a sensing loop that changes its frequency when brought near metal. The resulting heterodyne (difference frequency between the two oscillator signals) is amplified and fed to a speaker or meter.

The low-cost metal locator described here is a heterodyne unit. But it is less expensive and easier to build than most because it can be used with an ordinary portable AM broadcast-band receiver. The radio already contains everything but the sensing-oscillator circuit. The necessary oscillator and sensing loop are easily added.

How It Works. The schematic diagram for the sensing oscillator is shown in Fig. 1. Essentially, it is a tuned-gate, field-effect transistor (*Q1*) oscillator. Variable capacitor *C2* permits the circuit to be tuned across the middle frequencies of the AM band.

The sensing oscillator is first tuned exactly to a broadcast station (which must be done far away from any metal objects). Subsequently, any metal in the vicinity of the sensing loop (*L1*) will change the oscillator's frequency to produce a beat note at the receiver's speaker. Moving the loop away from the metal will cause the beat note to cease.

Construction. The oscillator circuit can be built into any 3¼-in. by 2⅛-in. by 1⅝-in. metal utility box. To simplify assembly, use a piece of perforated phenolic board and solder clips to mount the oscillator components as shown in Fig. 2. Referring to Fig. 3, machine the top half of the utility box and mount on it *B1* (in a battery holder), *C2*, *J1*, and *S1*. Then mount the board assembly with #6 machine hardware and ⅜-in. metal spacers. Refer back to Fig. 2 and interconnect the chassis-mounted and on-the-board components.

Drill two ⅛-in.-diameter holes and mount the bottom half of the utility box to the handle you plan to use for your metal locator. For the handle, you can use either ¾-in.-outer-diameter aluminum tubing or an old broom handle. Whichever you choose, cut it to a length of 36 in. and wrap the top with several layers of electrical tape

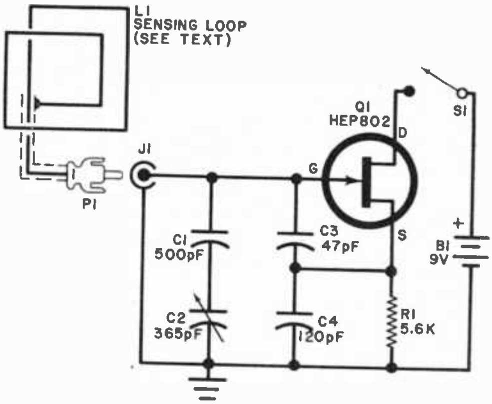


Fig. 1. Schematic of sensing oscillator that beats against any BCB receiver.

PARTS LIST

B1—9-volt transistor battery
C1—500-pF ceramic capacitor
C2—365-pF miniature variable capacitor
C3—47-pF ceramic capacitor
C4—120-pF ceramic capacitor
J1—Phono jack
L1—See text
P1—Phono plug
Q1—2N3819 or HEP-802 (Motorola) field-effect transistor
S1—Spst slide or toggle switch
Misc.—3¼" x 2⅛" x 1⅝" utility box; perforated phenolic board and solder clips; No. 32 enameled wire for L1; ¾" outer-diameter aluminum tubing or broom handle, cut to 36" length; coil form for L1 (see text); 36" Belden No. 8411 microphone cable; control knob; #6 machine hardware; spacers; battery holder; phono jack and plug for sensing coil cable (optional); solder; solder lug; etc.

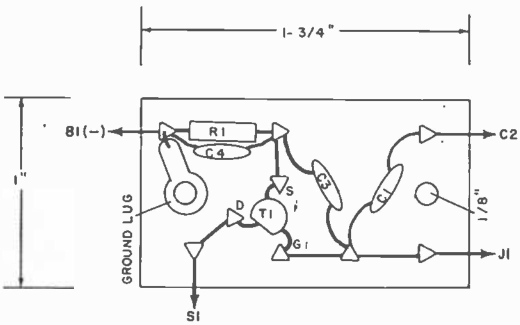


Fig. 2. Diagram shows how components are laid out on a perforated phenolic board.

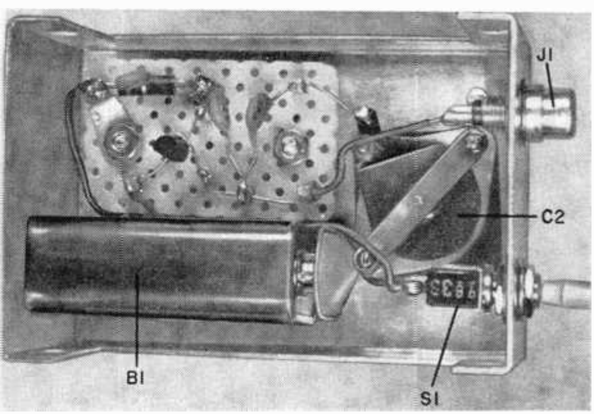


Fig. 3. Photo of prototype showing how the board and components go into chassis.

to provide a comfortable grip. Then mount the bottom half of the utility box to the aluminum tubing with sheet metal screws (wood screws if you are using a broom handle) as shown in Fig. 4.

An 8-in. by 6-in. lid for a plastic freezer container makes an ideal form for winding sensing coil *L1*. For durability, however, it should be made rigid by adding a 6-in. by 3-in. piece of ⅛-in. Bakelite or phenolic board as shown in Fig. 5. The board that adds rigidity can be fastened with three sets of #6 machine hardware, one set of which also anchors into place the U bracket required for fastening the sensing loop assembly to the handle of the metal locator.

Sensing loop *L1* consists of 20 tightly wrapped turns of No. 32 enameled wire around the rim of the freezer container lid. Secure the turns with coil dope and a turn or two of electrical tape. You can either bring the ends of *L1* out to a phono jack mounted on the freezer container lid, or solder the cable that interconnects loop and oscillator directly to the loop's leads. The connecting cable itself should not exceed 36 in. in length and should be a low-capacitance variety like the Belden No. 8411 used for lapel microphone cables.

In Use. To operate the metal locator, tune your transistor receiver to a strong station in the middle of the AM band and slowly tune *C2* back and forth. A beat note will be heard when you cross the station tuned on the receiver. Carefully adjust *C2*

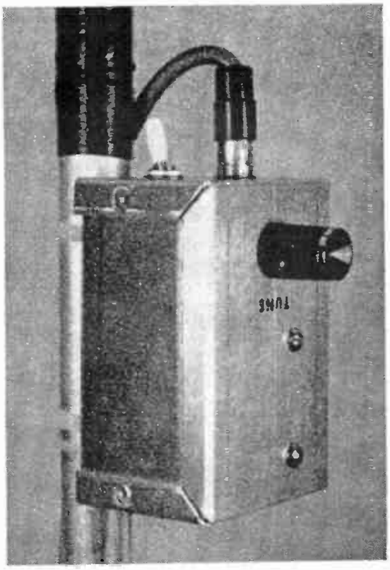


Fig. 4. Attach bottom half of box to handle and mount top half as shown.

until the beat note disappears, or is as low as possible. (Do not forget to do this with the sensing loop far away from any metal objects.) Now, sweep the sensing loop near to a metal object; the tone should re-occur.

The sensing loop described above is most useful for general-purpose work, but other sensing-coil configurations can be built for specific applications. A round (6-in.-diameter) plastic container lid with 25 turns of enameled wire can be used for exploring smaller areas, while a ferrite antenna coil (designed for use in transistor radios) inside a length of plastic tubing will provide a wand-type sensor that is useful for locating ducts, studs, and pipes in walls. Whichever sensor you plan to use, it is important that the cable between loop and utility box be less than 36 in. long.

While using the metal locator, you will discover that the audible indication you get is proportional to the size of the object being sensed, its depth below the surface of the soil, and soil condition. An object the size of a soup can at a depth of 6 in. is easily detected in dry soil, but at a lesser depth in wet soil. With practice, it is possible to determine the size and depth of an object—a good thing to know before you begin digging. ◈

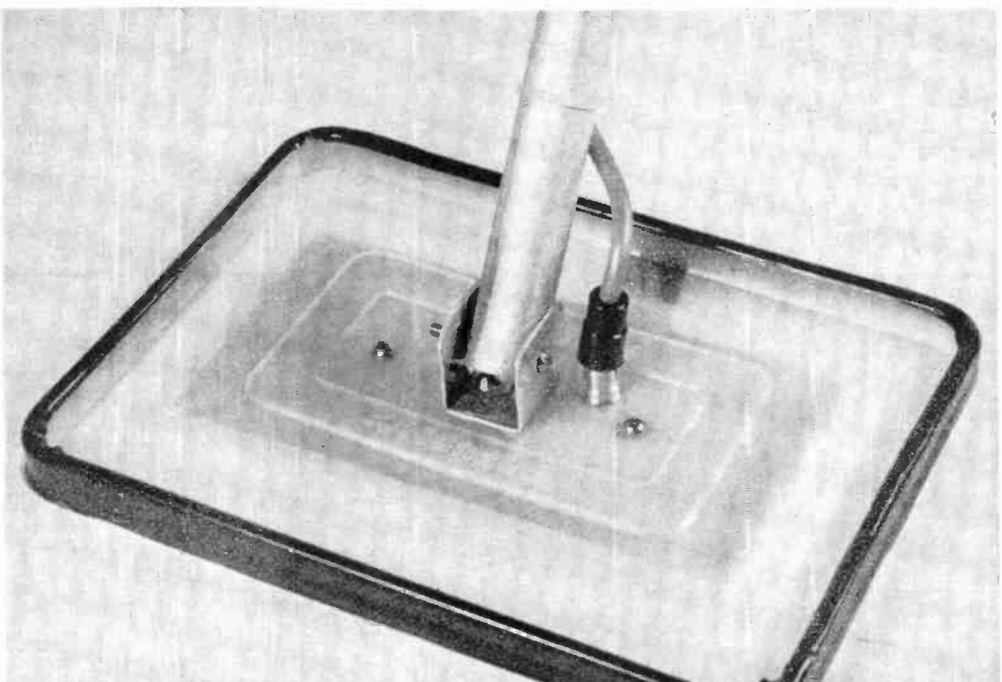


Fig. 5. The sensing coil is wound on a plastic freezer container lid that is stiffened with Bakelite or phenolic. A phono jack is used to connect loop to oscillator cable.

Making Noises with the 555 IC Timer

One popular chip can be the heart of a variety of circuits

BY MICHAEL S. ROBBINS

THE 555 IC timer can be used to generate a wide variety of tones and noises. Some have been described in these pages before. Here are other applications for this versatile, easily obtainable IC, whose output is a harmonic-rich square wave. As shown in the sketches, very few components external to the IC are required. (For a complete discussion of how the 555 works, see "The IC Time Machine," POPULAR ELECTRONICS, November 1973.)

Basic Tone Generator. The circuit for a basic variable-frequency tone generator using a small permanent-magnet speaker is shown at (A). The volume can be controlled by using the 20-ohm potentiometer in the speaker circuit. With the values shown, the output frequency is continuously variable over an approximate range of 76 Hz to 22 kHz.

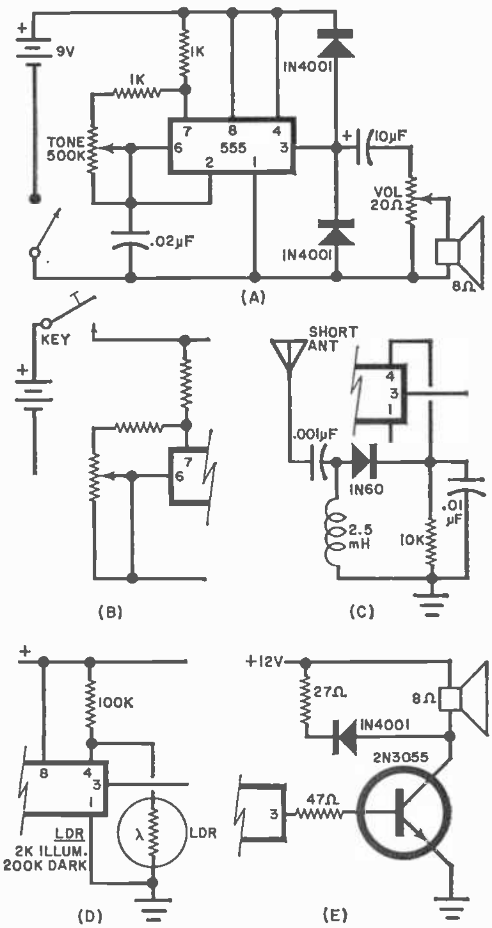
Code Practice Oscillator. The circuit shown at (B) is a CPO with adjustable tone and volume controls. The rest of the circuit is the same as that in (A). The speaker can be replaced with headphones if desired.

CW Monitor. The CW amateur radio operator often finds that having an audio signal to go with his code transmission is very helpful. A circuit to do this is shown at (C). The r-f signal on the short antenna is rectified and applied to pin 4 of the IC. When the positive pulse appears at pin 4, the tone generator turns on. The circuit should be as-

Suppressing Transients in Solid-State Equipment

VOLTAGE transients can prove to be destructive to some solid-state electronic equipment, particularly the new "super-power" hi-fi amplifiers. There are any numbers of ways by which voltage transients can be developed, but the biggest culprit in hi-fi amplifiers is the transient (surge) that results whenever the equipment is turned on or off. You can often hear this surge as a "thump" coming from your speakers when the power switch of the amplifier is turned on or off.

There is a rather effective way of coping with transients and voltage surges; and it can save a lot of expensive repairs. All you need is a simple device made by General Electric and costing $1.13. It



Some circuits based on the 555 timer chip.

sembled in a small shielded enclosure with only the short antenna protruding.

Electric-Eye Annunciator. A compact doorway alarm for stores and other applications can be built around the 555. It eliminates the need for the usual relays and chimes. In the circuit shown at (D), a cadmium-sulfide LDR and a light source (such as a flashlight powered by an ac supply) will bias the reset transistor within the IC. With the LDR illuminated, there is a very low voltage at pin 4. When the light beam is interrupted, the resistance of the LDR rises rapidly, placing the positive voltage on pin 4. When this happens, the 555 breaks into oscillation and provides a "screaming" tone to the speaker.

Louder Noises. Though the 555 is capable of driving a small speaker at high volume, louder noises are possible. In the circuit shown at (E), the output circuit on pin 3 is replaced with a switching amplifier. With a 12-volt battery (lantern or vehicle type), the output is an ear-piercing (approximately 10 watts) square wave into the 8-ohm trumpet speaker.

Construction. Any of the circuits described here can be assembled on perf board or on a small pc board. No special precautions are required if the supply is kept within 12 volts and the resistor between the positive supply and pin 7 of the 555 is 1000 ohms or more. ◈

is a GE No. 6RS20-SP4B4 Thyrector. (It should be available at your local electronics store or they can order it for you.)

The Thyrector is a selenium rectifier designed for intermittent operation in its reverse direction. It was developed primarily to protect other semiconductors from high-voltage reverse transient spikes. Since it has a relatively high power-dissipation capability under transient conditions, it is very useful for surge voltage protection as well.

Thyrectors are commonly connected directly across the primary winding of the amplifier's power transformer, immediately after the power switch and pilot lamp, if any. In operation, the Thyrector diode begins to suppress transients at about 150 percent of its peak rated voltage.

In a modest test, a Thyrector was installed in a breakdown-prone hi-fi amplifier that had made several trips back to the factory for repairs. The last time the amplifier was repaired and returned, a note accompanied it. The note mentioned on/off transients and made the suggestion that the amplifier be left with the power on at all times. This was not necessary, however, because after two years of operation with Thyrector protection, not once has the problem returned. What is more, the characteristic on/off thump has been eliminated. ◈

3-WAY (SOUND LIGHT MANUAL) PHOTO FLASH TRIPPER

FOR NOVEL STOP-ACTION EFFECTS

BY JOHN F. HOLLABAUGH

SOME exciting and different photographic effects can be obtained with a strobe flash rigged to trigger from stimuli independent of the normal shutter switch. The photoflash tripper described here can initiate and delay the flash cycle with a sound or light stimulus or by completing an electrical circuit. For example, after the tripper receives a sound stimulus, a delay starts. Then, after a preset time, the flash fires and exposes the picture.

About The Circuit. The common part of the flash timer is the delay circuit consisting of *SCR1*, *SCR2*, and *Q4* (see schematic). The cycle is begun by firing *SCR1* via a sound input at *SPKR*, light at *LDR1*, or mechanical trip wires connected to terminal strip *TS1*.

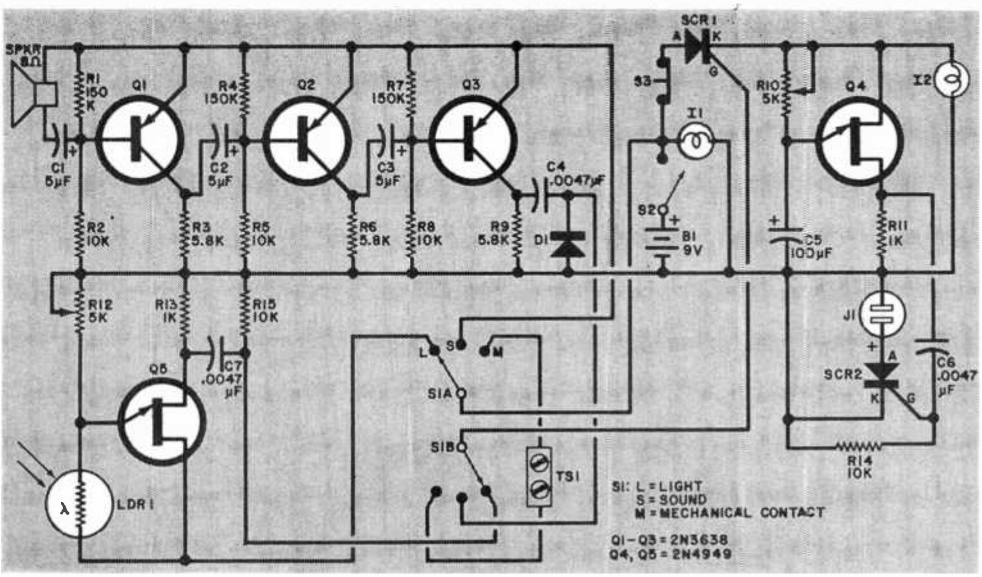
When *SCR1* fires, it applies voltage from battery *B1* to the *R10/C5* circuit, and *C5* begins to charge through *R10* at a rate determined by the value of the resistor. (The lower the value of *R10*, the shorter the charging time.) When *C5* has charged sufficiently to forward bias the emitter junction of *Q4*, a rapid rise in the current between the *B1* and *B2* terminals of *Q4* generates a positive pulse across *R11*.

This positive pulse is applied to the gate of *SCR2*, causing it to conduct current (from inside the flash unit connected to the tripper via *SO1*) and fire the electronic flash. After the cycle is complete, the circuit is reset to its initial conditions by momentarily depressing and releasing pushbutton switch *S3*.

Placing *S1* in position L (light) powers the *Q5* circuit and sets the system up for light tripping. Light falling on light-dependent resistor *LDR1* causes the circuit to trip. Potentiometer *R12* serves as a sensitivity control.

When *S1* is placed in position S (sound), power is applied to the audio amplifier circuit consisting of *Q1* through *Q3*. The speaker (*SPKR*) at the input of *Q1* is used here as a microphone. When a popping or other sharp sound is picked up by this microphone, a pulse is produced which is amplified sufficiently to trigger *SCR1* into conduction and start the timing cycle which, ultimately, fires the flash unit.

The final position of *S1* is marked M for mechanical contact. In this position, neither the light nor the sound circuits is powered. A pair of wires, terminated in a switch or left bare, is connected to terminal strip *TS1*. To start the timing cycle, the switch at the end of the wires need only be mo-



PARTS LIST

B1—Six 1.5-volt AA cells in series
C1-C3—5-µF, 15-volt electrolytic capacitor
C4,C6—0.0047-µF ceramic capacitor
C5—100-µF, 25-volt electrolytic capacitor
D1—1N4001 silicon diode
I1,I2—Miniature 10-volt panel lamp
J1—Camera shutter jack (includes length of cable)
LDR1—Light-dependent resistor (Clairex No. CL704 or similar)
Q1-Q3—2N3638 transistor
Q4,Q5—2N4949 unijunction transistor
R1,R4,R7—150,000-ohm, ½-watt resistor
R2,R5,R8,R14,R15—10,000-ohm, ½-watt resistor
R3,R6,R9—5800-ohm, ½-watt resistor
R10,R12—5000-ohm linear-taper potentiometer
R11,R13—1000-ohm, ½-watt resistor
S1—Double-pole/3-throw non-shorting rotary switch
S2—Spst switch (part of R10)
S3—Normally-closed pushbutton switch
SCR1,SCR2—Silicon controlled rectifier (1 ampere, 200 volts)
SPKR—8-ohm, 2¾-in. diameter speaker
TS1—Two-lug, screw-type terminal strip
Misc.—Bakelite or metal utility box; perforated board and solder clips; battery holder; pointer knobs (2); rubber grommet (for J1 cable exit hole); hookup wire; solder; hardware; etc.

The delay circuit, composed of two SCR's and Q4 is triggered by signals from either the audible input through speaker, light striking LDR1, or a switch action at TB1.

mentarily closed or the bare wires momentarily touched together.

The time lag between the firing of *SCR1* and the completion of the cycle with the firing of *SCR2* can be varied by adjusting potentiometer *R10*.

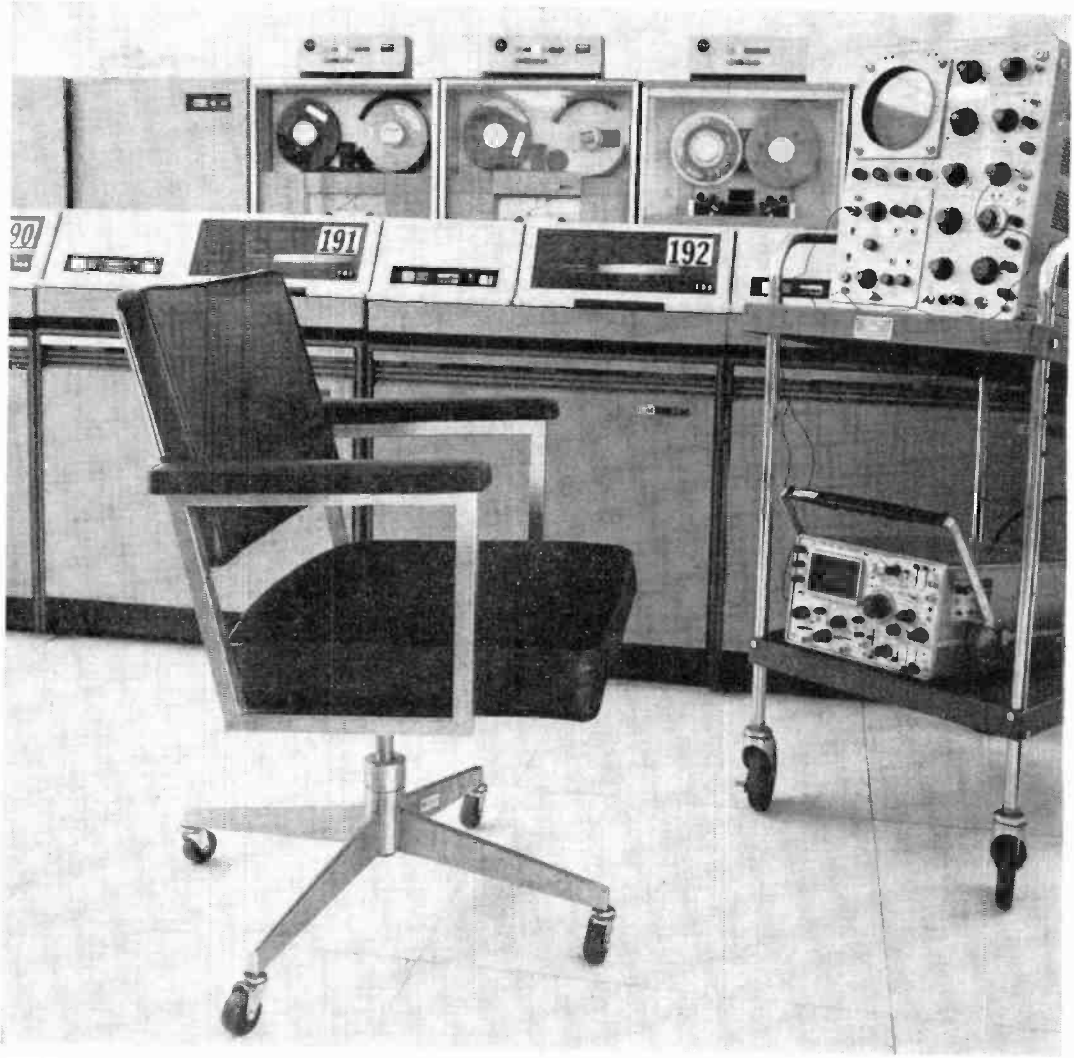
Construction. The circuit of the photoflash tripper is very simple, lending itself nicely to almost any type of chassis assembly. Just be sure that you observe proper polarity and basing connections.

When you mount *LDR1* in the chassis box you have chosen for your project, make certain that there is an access hole for the light to fall on the active element of this component. A good mounting method is to use an ordinary plastic pill container, its inside surfaces painted flat black, to hold the LDR.

When you wire the shutter cord into the tripper (this cord is terminated in *J1*), make certain that it is properly polarized. If it is improperly wired, the photoflash will not trigger because current flow through *SCR2* is unidirectional.

How To Use. Photography with the tripper requires the use of "red blind" ortho film. This permits the setup to be made in an area illuminated by only a dark red safe light.

Immediately before action begins, open the camera's shutter and leave it open until after the flash has fired. Setting the amount of delay required for any given filming sequence will have to be determined by trial and error. You can estimate how much delay is required by observing the event in total darkness. ◈



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CONSTRUCTION

IN-CIRCUIT/OUT-OF-CIRCUIT SEMICONDUCTOR JUNCTION TESTER

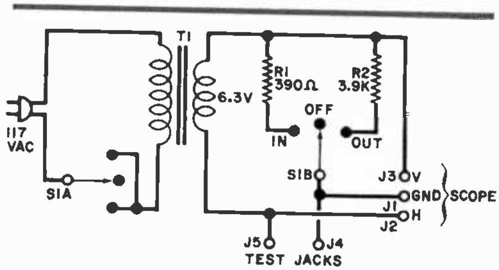
Checks bipolar transistors and diodes with scope display

BY MYLES H. MARKS

HERE is a transistor tester you can build yourself—easily and inexpensively. Though it does not display any parameters, it will tell you whether or not a junction is still operable. The tester can be used either in or out of a circuit and the only other equipment needed to use with it is an oscilloscope to display the results.

The circuit is shown in Fig. 1. When the test leads are open, the scope displays a horizontal line as shown in Fig. 2A. When the leads are shorted, a vertical line is displayed. The output of the transformer is a 60-Hz signal, and a good diode junction connected to the test leads will conduct on every other half cycle. It remains off during the other half cycle. This is indicated in Fig. 2A by the sharp, L-shaped display. If the device has leakage, the display will be curved, as shown in the diagram.

Resistors *R1* and *R2* are used to limit the current through the junction and avoid damaging it. The lower resistance is used for in-circuit testing, the higher for individual junctions.



PARTS LIST

J1-J5—Five-way binding post
R1—390-ohm, ½-watt resistor
R2—3900-ohm, ½-watt resistor
S1—Dpdt center-off switch
T1—6.3-volt filament transformer
Misc.—Suitable chassis, terminal strip, line cord, mounting hardware, etc.
Note—A complete kit of parts is available for $12.00, postpaid, from Marks, 315 Thornberry Ct. Dr., Pittsburgh, PA 15237

Fig. 1. Tester is a simple resistor circuit.

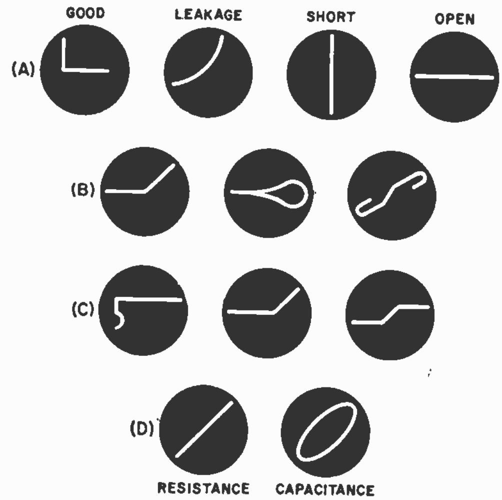


Fig. 2. Idealized scope display patterns show what to expect for different conditions.

Use. With the tester connected to the scope, set the scope's horizontal gain to approximately two-thirds of the scale. Short the test leads together, and set the scope's vertical gain also for two-thirds of the scale.

To check a transistor, three tests are required: base-to-collector, base-to-emitter, and collector-to-emitter. The polarities of the test leads are unimportant. For out-of-circuit tests, set *S1* to OUT and look for a sharp break in the waveform, indicating a good junction.

When checking a device in a circuit, place *S1* on the IN position and note the display. Due to the shunting effects of passive components that may be connected to the transistor, some confusing displays may be observed as shown in Fig. 2B. These displays all indicate a good junction.

Because of the intrinsic properties of the transistor, some emitter-to-collector waveforms of a good transistor will appear as shown in Fig. 2C.

You can also check standard resistors and capacitors with the tester. Waveforms for non-faulty devices should be as shown in Fig. 2D. ◈

ELECTRONIC *Sensory Aids for the Blind*

LASER CANES, OPTICAL SCANNERS, AUDIBLE COMPASSES, AND BRAILLE-MARKED TESTERS ARE SOME OF THE DEVICES TO HELP THE SIGHTLESS

BY FORREST MIMS

A FEW years ago at the MIT Sensory Aids Evaluation & Development Center in Cambridge, Mass., a strange contrivance about the size and shape of a flashlight was demonstrated. To it was attached a small earphone from which emerged strange and complex sounds as the "flashlight" was scanned around the room. Even a coat rack some 10 feet away came in loud and clear as a *whoosh . . . WHEEP . . . whoosh* as it was scanned.

Surely, this was no ordinary flashlight. In fact, it was a radar-like ultrasonic mobility aid for the blind, developed by Dr. Leslie Kay in England. At the time, it was undergoing tests at the Center.

After demonstrating the Kay device, Center director Vito Proscia strapped a small box-like object around his neck and proceeded to give a demonstration of another ultrasonic mobility aid. Though himself blind, he always managed to stop short of any obstacle in his path.

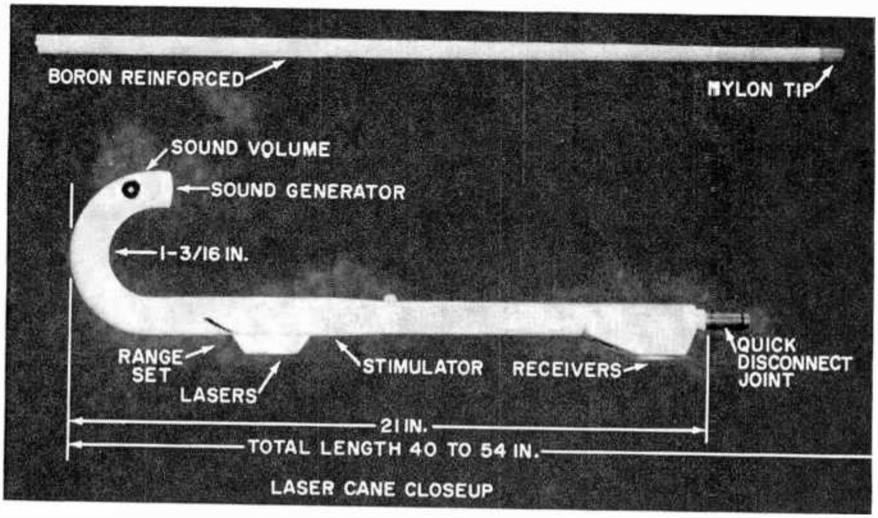
As an object was approached, a ticking sound came from two small speakers inconspicuously mounted on the device's neck strap. As the object came within one pace's distance, the ticking became a tone, a warning to change course or reach out to investigate. The simple but efficient aid was developed by Lindsay Russell, a Cambridge engineer, and was called the "Travel Path Sounder."

In general, there are two major classes of mobility aids under development: passive and active. Passive devices sense objects in the manner the human eye does. Active devices, such as the two ultrasonic aids just described, transmit a beam of light, sound, or radio waves and then receive reflections from obstacles that are in the path of the beam.

Active & Passive Aids. While only active devices have so far proved practical, passive aids have several advantages to recommend them: They are sometimes much smaller than their active counterparts; they usually require far less operating power; they have the potential for providing far more information; and they are considerably lower in cost.

One of the most interesting passive devices to come along was the "Optar," developed more than 15 years ago by H. E. Kallman. It was able to measure the range to objects by means of a slight adjustment required to bring the object into sharp focus on a photocell. An earphone provided the focussing information in the form of an audible tone.

Unfortunately, the Optar's audio tones were complex and difficult to interpret. The project was abandoned but later expanded upon by J. C. Bliss at Stanford University. Bliss modified the basic Optar concept by adding a vibrating device to the photocell and using signal-processing circuitry to simplify the device's output. The resultant signal was fed into an earphone or to an electro-



Laser Cane, developed by Bionic Instruments, uses three lasers and receivers to detect obstacles by triangulation. Tactile stimulator warns user about obstacles.

mechanical tactile stimulator. Even so, this device suffered from too many limitations for it to be a practical mobility aid.

The problems of the passive sensor are in large part eliminated by active devices that carry an energy source that makes them independent of the uncertainties of natural illumination. Some mobility aids use radio or microwaves, but most current research centers around a few devices using infrared light and ultrasonics.

The operating principles of an ultrasonic aid can be likened to those of sonar. A transducer in the device projects a narrow beam of ultrasonic sound, some of which is reflected by nearby obstacles and returned like an echo to a second transducer on the mobility aid. Since sound travels at a rather slow velocity of about 1100 ft/s, it is easy to electronically measure the time of the round-trip circuit of the beam. This "range" information is then presented to the blind user as a tone or tactile stimulation.

The output of the Kay aid presents a great deal of unprocessed information. Since each burst of sound emitted by the device is swept through a wide frequency range, the signal is in the form of a series of strange-sounding "rushes" that are interrupted by music-like tones when an object is detected. Smooth surfaces like glass and wood yield a steady tone; contoured surfaces like draperies and clothing give complex tonal patterns.

The output of the Travel Path Sounder is much less complex. Processing circuitry absorbs the information received and merely informs the user by clicks and a single tone, when he is near an obstacle. While this technique provides significantly less information than the Kay device does, it requires much less concentration and is easier to use.

Though the signals from the Kay device are sometimes difficult to interpret, Dr. Kay feels that the approach warrants additional study. He has developed an ultrasonic aid that has transducers and earphones mounted in a modified pair of spectacles and a small external case for the electronics and battery. About 200 of the aids are currently being evaluated in several countries.

Infrared Aids. A number of active mobility aids that use infrared light have been developed. Early versions used inefficient incandescent and gas-discharge lamps. But modern devices employ light-emitting diodes (LED's) and semiconductor lasers. (For discussions of LED's and semiconductor lasers see POPULAR ELECTRONICS Nov. 1970 and Oct. 1971, respectively.)

One of the most advanced infrared mobility aids available is the "Laser Typhlocane" developed by Bionic Instruments, Inc. This laser cane consists of three pairs of tiny lasers and receivers mounted on a conventional long cane. The lasers are housed in a nacelle near the cane's crook, and the receiver photodiodes are located in another nacelle about 12 in. below the first. Rechargeable batteries and all electronics are housed in the cane itself.

The laser cane determines the presence and approximate range of obstacles by triangulation. Each laser/photodiode pair is optically aligned so that objects coming within their mutual field of illumination and view are detected when light from the laser strikes the object and is reflected directly back to the photodiode. When an object is detected, a tactile stimulator in the cane's handle comes alive. Also, one of the channels uses a warning tone from a tiny speaker in the end of the cane's handle to signal the presence of certain obstacles.

With a range of more than 20 ft, the laser cane is remarkably sensitive. Futhermore, the cane performs the important—and difficult—function of detecting obstacles such as low curbs, drop offs, and glass. Unfortunately, the system is rather costly, but results with test subjects are encouraging, and it is expected that costs will decline when and if the cane goes into commercial production.

A less costly infrared aid, the "Seeing Aid," uses a single LED. It provides far less information than the laser cane, but its low cost makes it a good candidate as a supplemental mobility aid. A series of tests with blind children in Saigon revealed that the Seeing Aid is easy to operate and detects most common obstacles at a range of several paces. Work with the device continues with the addition of a more sensitive receiver and a triangulation feature. The unit has also been built into a pair of eyeglasses.

Reading Machines. While mobility aids may one day give their blind users improved travel ability, reading machines will enable them to move beyond Braille and "Talking Books." Surprisingly, the first crude reading machine—the "Exploring Octophone"—was invented by British scientist Fournier d'Albe in 1912. It employed a selenium cell in a Wheatstone bridge to signal about light intensity variations with a musical tone. Originally intended for environmental exploring, the Octophone was soon equipped with an adjustable aperture and used in experiments to read print. In 1923, blind Mary Jameson was able to read several words per minute with the device. Mary's continued interest in reading machines and her comments and evaluation have played important roles in the development of more sophisticated devices in recent years.

After the Octophone, Batelle Memorial Institute developed a reading machine with advanced electronics and other improvements. A more recent device, the "Visotoner," was developed by Mauch Laboratories. Like the original Octophone, these devices presented information about printed letters in the form of complex tone patterns that require long training to properly interpret.

Reading machines that stimulate the fingertips with the actual shape of the printed characters may hold more promise than those with complex audio outputs. Mauch Labs has converted its Visotoner to this type of operation, dubbing it "Visotactor." In operation, the scanning head is moved along a

Le Que Manh learned to use infrared mobility aid quickly, even though he spoke no English. Developed by the author, this prototype aid was tested by blind children in Vietnam.

line of print as small tactile stimulators signal each of four fingers on one hand about the shape of a letter.

In a more sophisticated tactile stimulation machine that actually displays each letter in a raised relief with an array of stimulators has been developed at Stanford University. One of the machine's chief developers is the same James Bliss who developed one of the passive aids described earlier. Called the "Optacon," it uses a sensing head containing an array of 144 integrated phototransistors. As the sensing head is moved along a line of

Shari Gabrielson, Berkeley High School student, reads bulletin board with an Optacon reading machine developed at Stanford Univ. While scanning with probe in right hand, her left hand makes contact with an array of tiny tactile stimulators which form outline of each scanned letter. Single finger tip can be employed to read the letters.

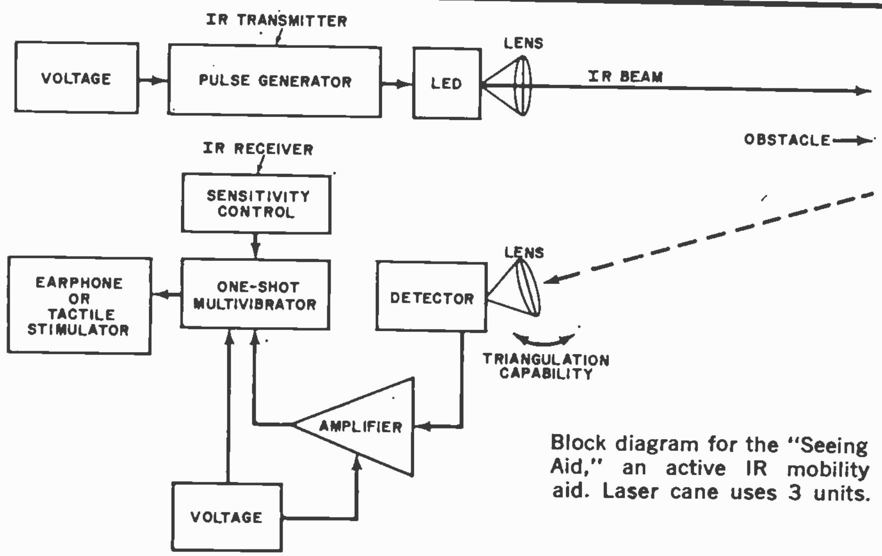
print, each letter, number, and symbol is indicated in outline form on a 24 X 6 array of tactile stimulators that a single finger can "read."

Battery powered and weighing only about 8 lb, the Optacon is sufficiently portable for use in a variety of locations. Several test subjects who have used Optacons for quite some time all report that the aid is extremely useful in performing many tasks heretofore impossible for them.

The reading machines described thus far are limited to a maximum speed of less than 100 words per minute in the majority of cases. A much more efficient approach is a computer-assisted technique developed at MIT. In this method, a mini-computer performs complex analysis of each letter as it is scanned and then selects a prerecorded *spoken* letter.

Mauch Labs has also developed a reading machine with a voice output. Their "Cognodictor" uses photodetectors in a hand-operated scanning probe that reads up to 31 different letters and numbers. The machine is capable of storing up to eight letters at a time while it searches its optically recorded vocabulary for the proper letter. A reading speed of up to 90 wpm is hoped for with the Cognodictor.

Perhaps the most advanced reading machine of all has been developed by Haskins Laboratory. Other machines read but one letter at a time. The Haskins machine has a spoken *vocabulary* of 7200 of the most often

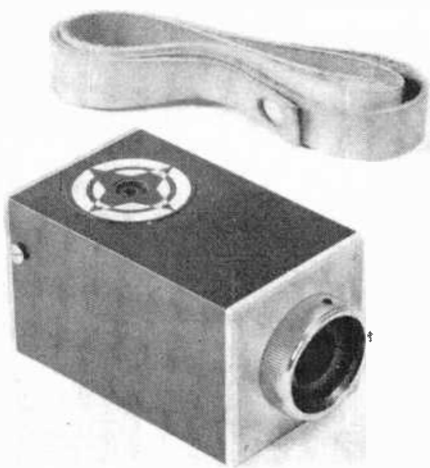


Block diagram for the "Seeing Aid," an active IR mobility aid. Laser cane uses 3 units.

used *words* and the entire alphabet. The alphabet permits words not in the machine's vocabulary to be spelled out.

Owing to cost, if either the MIT or Haskins machines can be developed so that they prove practical, a good likelihood, their high costs will probably limit their use to reading rooms, libraries, and other public places frequented by the blind.

Meanwhile, the development of less costly devices continues. The Optacon developed at Stanford University is currently commercially available, and Mauch Labs continues to make significant improvements in their machines. Advanced versions, for

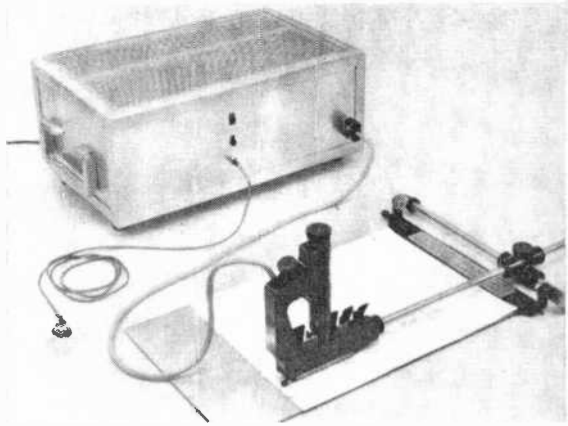


A compass, photocell, and Mallory Sonalert combine to produce electronic compass with audible output. Device uses a penlite cell.

example, will be able to read spoken letters at rates up to 200-300 wpm. Since the Cognodictor employs a Visotactor as a scanner, the Visotactor can be disconnected from the spoken-letter output and used independently.

A variety of simple, important sensory aids have also been fabricated. There is the "beeping ball" that enables blind children to play games normally restricted to sighted children. The beeping ball was developed by Telephone Pioneers, a Bell Telephone Company employee organization.

Still other aids include electronic compasses and directional radio receivers designed to help the blind traveler to navigate from one place to another without becoming lost. For the blind electronics technician or hobbyist, there are several types of test equipment made especially for the sightless;



The Mauch Laboratories Cognodictor reading machine. Device produces spoken letters one at a time as detected by scanning probe.

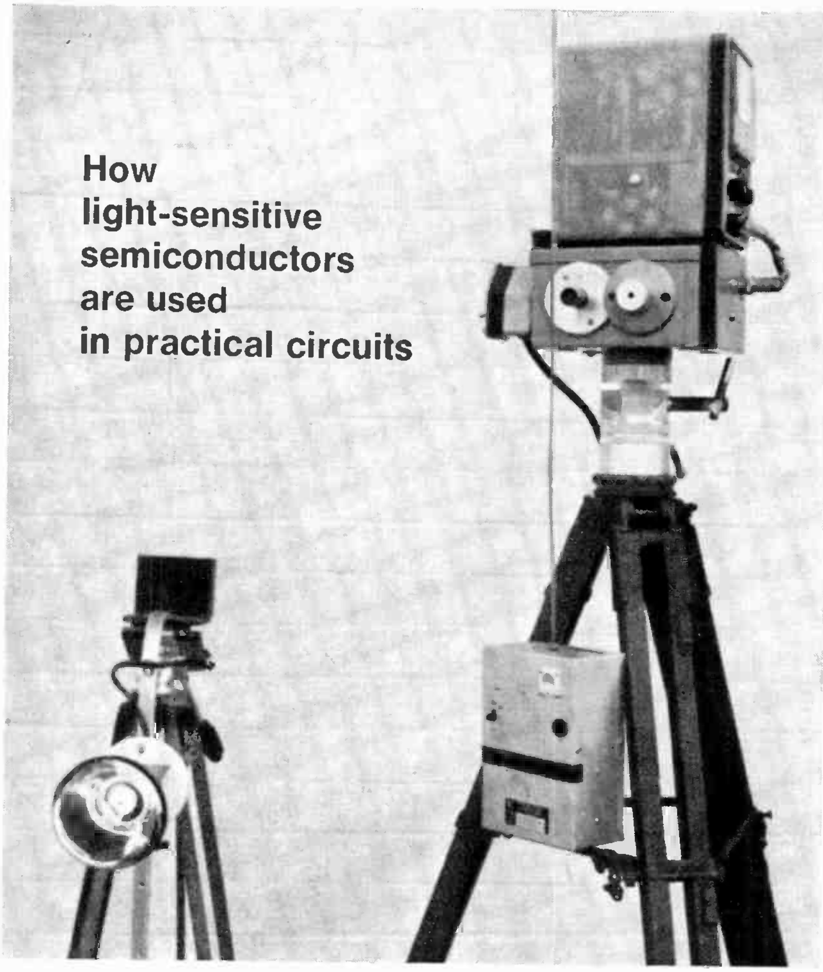
multimeters that produce a tone instead of a meter reading are just one example.

One ingenious aid has been developed to warn deaf-blind employees at a New York establishment in the event of a fire. Each employee carries a small receiver that is capable of detecting signals from a master loop antenna. When the receiver is triggered, a motor rotates and an eccentric wheel causes the entire assembly to vibrate.

At present, most of the advanced electronic sensory aids described in this article are still laboratory devices. But many of them are undergoing trial use with blind test subjects, and a few are on the commercial market. Thanks to recent significant advances in semiconductor technology, the long awaited development of a range of sensory aids for the blind that can be put to practical use is almost here. ◈

This American Foundation for Blind instrument provides tactile readings of voltage, resistance, and current. Earphones supply signal which is nulled to obtain reading.

Author's practical embodiment of electromechanical light chopper shown in Fig. 3. Calibration lamp is at left. An r-f transmitter triggers lamp.



How light-sensitive semiconductors are used in practical circuits

Solid-State PHOTOCELLS FOR HOBBYISTS Part 2

BY L. GEORGE LAWRENCE

LAST month, different types of photocells and their general characteristics were discussed. Now we will illustrate how photocells are used in actual applications.

In some of the circuits described here, we use an NSL-446 (National Semiconductors Ltd., 331 Cornelia St., Plattsburgh, NY 12901). It has a light-to-dark resistance ratio of about 1:1000 (11,400 ohms in light to 12,000,000 ohms in darkness). Maximum peak voltage is 420 V at peak power of 1 watt. These specifications make it suitable for a wide range of sensing and control functions and are typical of many high-power photoconductive cells. Low-power photocells, such as the P-41,108 from Edmund Scientific Corp. (300 Edscorp Bldg., Barrington, NJ 08007), can also be used in similar circuits. For example, it can be used to control a relay with a 0.2-watt coil rating, as opposed to 1 watt for the 446.

A good way to experiment with photocells without damaging them is to use alligator clips for temporary connections. Many cells with pin-type leads are heat sensitive. Thus, both substrates and light-sensitive materials can be damaged by frequent soldering. To be on the safe side, use a simple heat-sink tool (Miller No. 80, for example) or long-nose pliers when soldering.

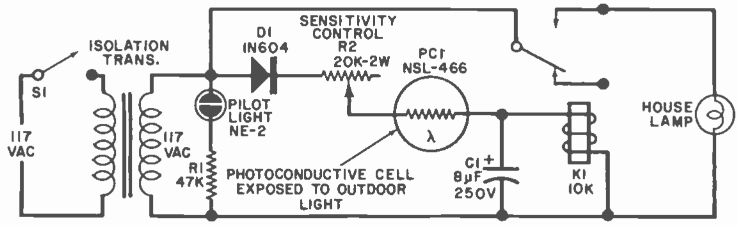


Fig. 1 Simplicity of application of photoconductive cells is demonstrated in this construction project. House Sitter stops conducting at night, making relay drop out and turn on lamp.

Daylight-Operated Controller. A basic application for the NSL-446 is the "house sitter" shown in Fig. 1. The photocell is exposed to outdoor light and it automatically turns on a lamp circuit when the sun goes down. Potentiometer *R2* and relay *K1* provide current limiting for the photocell. Half-wave rectification is provided by *D1*, and *C1* prevents relay chatter. During daylight hours, the photocell's resistance is low, and

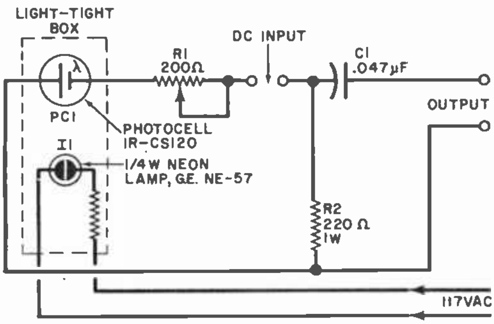


Fig. 2 Photoelectric chopper for converting dc to amplitude-variable ac for oscilloscope.

the relay is kept energized. The lamp circuit is thus turned off. When the resistance of the photocell rises with waning light, the relay drops out and the lamp circuit is energized. The neon pilot light indicates that the unit is on and ready to operate.

Choppers. When the circuit shown in Fig. 2 (called a photoelectric chopper) is used with a conventional ac-type oscilloscope, the latter can be used to display dc signals. The photocell, *PC1*, is optically coupled to a ¼-watt neon lamp, *I1*. Since the cell is gated on and off by the neon lamp's flicker frequency of 60 Hz, a dc signal applied to the input of the circuit is chopped and appears as ac across R2. High dc input provides an analog increase in the amplitude of the ac output. This arrangement works well in many non-critical applications. The excitation current can be derived from the scope's power supply.

The ac processing of a photocell's dc signal is desirable in many applications where the inherent drift of "straight" dc amplifiers (including low-cost IC's) cannot be condoned. In the setup shown in Fig. 3, for instance, a motor-driven wheel "chops" the light to the photocell. The frequency of the electromechanical chopper is determined by the number of apertures in the wheel and the speed of rotation. If, for example, the wheel is driven by a synchronous motor at 1800 rpm and has 4 holes, the effective chopping frequency is $(1800/60) \times 4 = 120$ Hz. The chopped dc (actually a square-wave signal) across *R1* is amplified and applied to a meter readout through a full-wave rectifier.

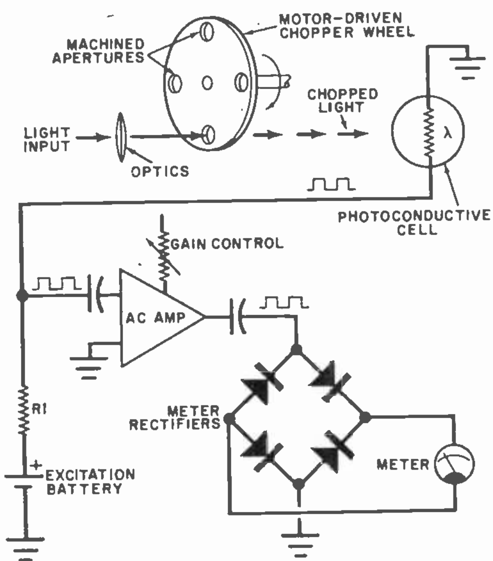


Fig. 3. Electromechanical light chopper has rotating aperture wheel, amplifier, meter.

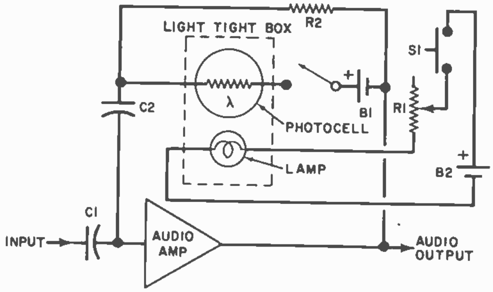


Fig. 4 Photocell feedback for audio effects.

Audio Use. Photoconductive cells can be used in many fascinating experiments and money-saving conveniences in audio work.

The circuit shown in Fig. 4, for example, provides light-controlled feedback of an audio amplifier. If the intensity of the lamp (controlled by *S1*) is sufficient to lower the resistance of the photocell, part of the amplifier's output signal is fed back to the input. Depending on the lamp's brightness, which is set by potentiometer *R1*, powerful feedback oscillations of variable intensity can be obtained. Thus, the amplifier can be converted into a single-frequency "cue" generator, an aid in cutting master tapes.

If desired, the amplifier can trigger a special-effects instrument. The photocell can be activated by the dominant light of a color organ during original deep bass sequences, with the photocell's output triggering a solenoid-operated drum.

In the circuit shown in Fig. 4, *R2* provides a "keep-alive" current path for the cell. Since its own resistance is high, no feedback will ensue unless resistive circuit values are lowered by the activated photocell. Best results can be obtained by actual experimentation.

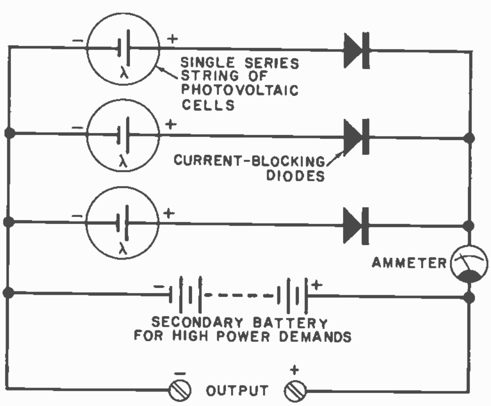


Fig. 5 Solar cells in series-parallel array.

Power Generators. Photovoltaic cells are used primarily as sources of dc power. An excellent application is in the generation of power for emergencies. As shown in Fig. 5, silicon or selenium cells in series can furnish charging currents to a secondary battery, with current-blocking diodes to protect the cells from reverse current. The ammeter (optional) indicates the total amount of charge.

Since the output of the cells is governed by the amount of ambient sunlight, special allowances must be made in computing charging rates and effective load resistances. An excellent guide for this purpose is International Rectifier's handbook, *Solar Cells and Photocells* (HB-30), which is available for $2.00 from most electronics distributors.

In typical applications, solar batteries act as trickle chargers for conventional batteries that furnish high dc power (100 A or more) for a few minutes at a time. This concept is used in satellite applications, with silicon photocells assembled in arrays on the satellite.

An excellent hobby project is the sun-powered emergency radio receiver shown in Fig. 6. It is simple and reliable, with a 3-volt standby battery (two C or D cells in series) for sunless days. For use on land or at sea, the receiver works best with a true earth ground and a long antenna. The ground can be a metal frame or a submerged metal plate in the case of a boat. A small transistor amplifier can be added to improve the power output. Wiring and layout are not critical, but the electronic components should be housed in a sturdy metal container. ◈

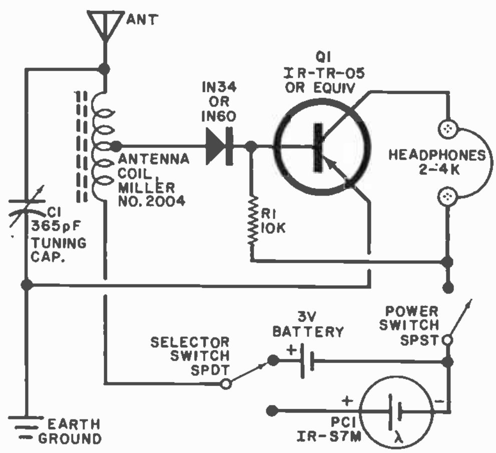
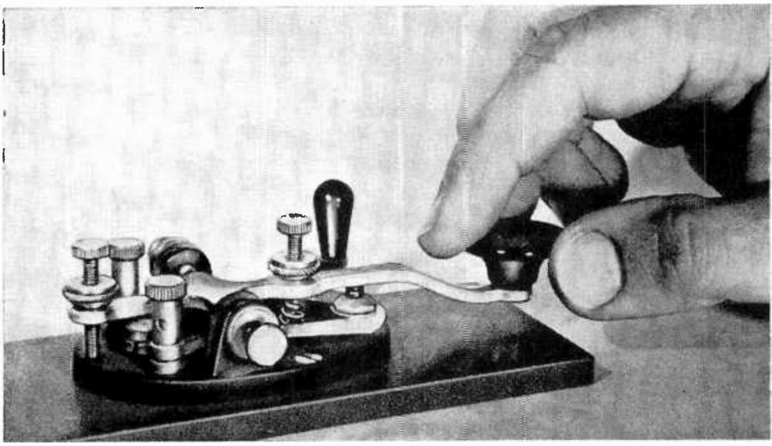


Fig. 6. Sun-powered emergency radio receiver.

How to break the 10-words-per-minute CODE BARRIER

BY RICHARD HUMPHREY



LUCKY is the radio amateur who doesn't "plateau out" somewhere around ten words-per-minute when he's learning code. There may be a fortunate few who march right up to 20 or 30 wpm without a break, but most of us make it to 10 wpm literally in a matter of days, then struggle for many months to get up to 15 wpm solid copy so we can be sure of hacking 13 wpm when we go up for our General. Once definitely past the 10 wpm "hump," progress is seldom a problem.

Hams aren't the only ones bothered by the CW plateau. The Navy, Army, Coast Guard, and Air Force all have their difficulties in getting their radio-operator trainees off the 10 wpm dime. When asked if the Army had a problem, Colonel A.J. Sullivan in Washington said:

"Yes we do. Approximately 60% of trainees reach a hump somewhere between 10 and 13 words-a-minute. Our goal is to raise them to 15," he said, "and often we're able to get them to go as high as 25 and 30 words-a-minute." Col. Sullivan went on to explain how the Army did it. "The first way is to have the student and instructor analyze error patterns and then determine remedial patterns to correct them in the student.

"The second way," he continued, "is to analyze individual rhythm patterns and make recommendations to improve these. The third thing is to try and get these students to copy 'behind' one or two characters so that they might be able to comprehend a whole word instead of a letter at a time."

A spokesman for the U.S. Navy, Lt. Tim Mennuti, echoed Col. Sullivan. "It takes three weeks to peak out," he said, "at which point the average person has reached 12 to 14 words-per-minute." Mennuti added, "The problem is that over 14 words-per-minute there are no breaks between letters." It appears the Navy considers the "hump" serious since we understand the training program is undergoing considerable revision.

Everyone interviewed agreed on one of two positions: either (a) the plateau was caused by reaching a speed where you had to stop copying *letters* and start copying *words* or (b) the "letter-to-word" transition was a coincidence and the reason for the "hump" had to be found elsewhere. The Navy seems to favor the latter view. "Apparently," said Mennuti, "there's some psychology connected with this thing that we didn't have before. What we're finding out," he explained, "is there may be a certain type of individual who can copy fast code and a certain type who can't.

Strangely, two things which might be expected to have had an effect on an almost auditory process such as learning CW seem not to have affected it at all: the increasing use of audio-visual aids in teaching and the tremendous impact of television on those who have been coming into the military. The generation which has been studying code for the past several years are, say the experts, "picture" oriented rather than "word" oriented. One might expect that hams and others cramming code today would be having more trouble. But Col. Sullivan says the percent of those hitting the "hump" hasn't changed "in the last 20 years."

Psychologists and authorities in the business of teaching brought up the point when they were interviewed that getting past the 10 wpm plateau wasn't a "learning" problem but a "fluency" problem. Obviously, they said, if you can copy and send ten words-a-minute, you *know* the code. The point was also made that gaining fluency in code might be similar to gaining fluency in a foreign language. If you learn a foreign language by "reading" it—in high school or college, for instance—you will usually have tremendous difficulty in *speaking* (or understanding) the language fluently. You will find that you translate from the foreign tongue into your own language, absorb the information, form an answer, in your own language, translate the answer into the foreign language, and then say it. To gain any fluency whatsoever you must *think* in the foreign language.

But how do you "think in code?"

Here, the experts and authorities as well as military instructors and radio amateurs are more-or-less in agreement. Number one on everyone's bugaboo list: *don't* sit down and learn the code before you start listening to it! Many hams fall into this bottomless pit. The CW trainee in the military has usually been sitting there for three hours with the cans on his head listening to taped copy before someone tells him what it is he's doing. Even so, six out of ten plateau out somewhere around 10 wpm, according to the Army. The attrition rate among radio amateurs must be tremendous. One instructor put the problem this way:

"When you find yourself hearing *dah-dit-dah-dit* and saying 'Aha, that's a C' and then writing it down, you're in big trouble. It's got to be instantaneous," he said. "You hear it, you write it. No translating!"

The way you transcribe CW may also have a direct bearing on the 10 wpm hump. Without exception, everybody agrees that the best way is to use a typewriter. For two reasons. First, the mental attitude you have when you learn to touch type is quite similar to what it should be in learning code. You're not translating. You learn by rote that the right forefinger goes *there* and the left forefinger goes *here* for this letter or that letter. You're not falling into the bad habit of reading a letter, looking for it on the keyboard, then hitting it.

Second, copying by hand in capitals will limit your speed to around 15 wpm. Longhand script will only take you to 25 wpm or so. The only thing limiting your code speed when using touch typing is your typing speed. A 40-wpm typing speed in only fair. A 40-wpm speed in copying code is very good. (It's undoubtedly no coincidence that of the Air Force's 630 hour CW course, 435 hours are devoted to "touch typing and transcribing International Morse code with a typewriter.")

The various tapes and records on the market to teach you the code undoubtedly have some value. The unanimous comment from radio amateurs is that they'll memorize each tape or record after a few playings and once this has happened the recording is useless. Tapes work out fine for the military because they can afford thousands-of-hours of it so there's little chance of copy memorization. Hams usually aren't so affluent.

What to do if you "studied" the code before you began listening to it? You can try the Army's recommendation of "copying behind" to try to progress from *letter* copying to *word* copying. Or you can try the method used by a former Navy Chief Radio Electrician.

"My hump was around nine-a-minute," he says. "It made me mad. I just kept at it. I copied until my eyes fell out. I even copied Russian and Spanish code, though I didn't understand it. Later, aboard ship, they tested me on taped copy, and I made 9 words-a-minute."

To many would-be hams, all this insistence on an "antiquated" form of communications is ridiculous. With FM, SSB, facsimile, and other things to come in the future, they may be right. But CW is still the simplest form of long-range communications. Because when you are using CW, you can cut through QRM with modest power, a minimum number of components with simple antenna, and troubleshooting and repairs can be made with almost no training. CW is a unique case of the Old Gray Mare being just as good as she "used to be." ◈

Product Test Reports

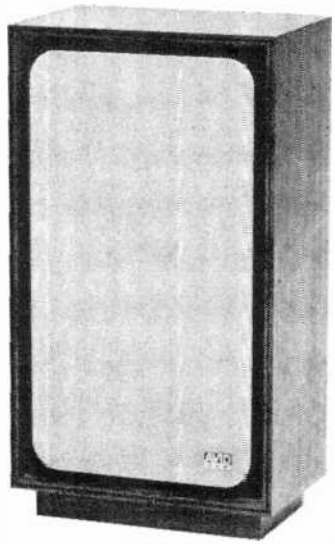
AVID MODEL 103 SPEAKER SYSTEM
(A Hirsch-Houck Labs Report)

THE Avid Model 103 acoustic suspension speaker system employs a three-way design. Its 10-in. woofer crosses over at 500 Hz to a 4½-in. cone-type midrange driver. Then at 3500 Hz, a second crossover to a 1-in. dome tweeter takes place.

Behind the system's snap-out grille is a five-position switch for adjusting the middle- and high-frequency levels over a moderate range. Nominally an 8-ohm system, the Model 103 can handle up to 150 watts of program power. An amplifier of at least 20 watts (per channel) output is recommended for driving the system. The midrange driver and tweeter are protected by a fast-acting 2-ampere fuse, access to which is provided behind the grille.

This is a compact system. Its cabinet measures 25 in. by 15 in. by only 9⅝ in. deep. Although the system can be placed vertically or horizontally on a floor, its shallow depth makes it especially suited to shelf mounting. Overall weight is 38 pounds.

The retail price of the Avid Model 103 speaker system, including matching floor stand, is $144.50.

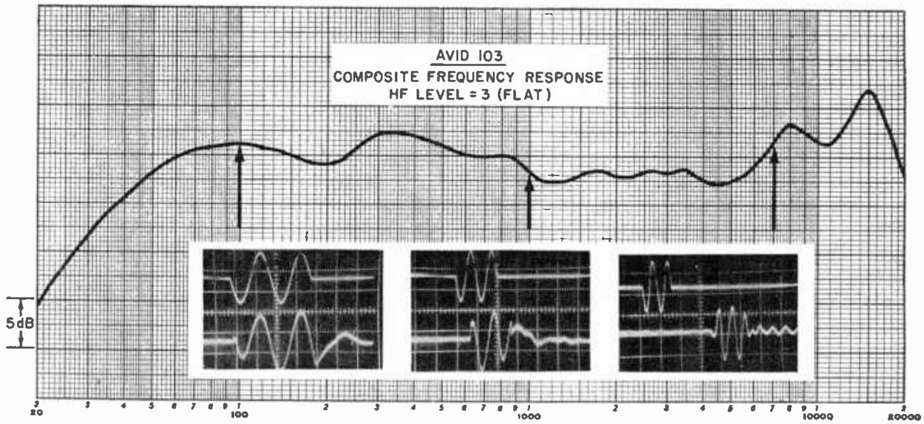


Laboratory Measurements. The smoothed and averaged frequency response of the speaker system was within ±3 dB from 47 Hz to 13,500 Hz. Its output increased at the highest frequencies (with the level switch set to position 3, nominally the flattest). It reached a maximum of +6 dB at 15,000 Hz, relative to the midrange level, and was still a strong −3 dB at our upper test limit of 20,000 Hz. The level switch could raise or lower the output at most frequencies above about 1000 Hz by 2 to 3 dB at its extreme settings.

Like other fine acoustic-suspension speaker systems, the Model 103 had very low bass distortion. With a 1-watt drive level, distortion was only 3 percent at 30 Hz and 8.5 percent at 20 Hz. Even with a 10-watt drive level, distortion remained moderate, measuring 3 percent at 45 Hz and only 7 percent at 30 Hz.

This is a relatively inefficient speaker system. It required just over 1 watt of drive power in the midrange to produce a sound pressure level of 90 dB at a distance of 1 meter from the grille. The system's impedance characteristic was unusually uniform, measuring between 8 and 12 ohms from 200 Hz to 20,000 Hz. It dropped to 7 ohms at 120 Hz, and with a well-damped resonance, it rose to 10 ohms at 45 Hz. The minimum impedance of 6 ohms was at 20 Hz.

The tone-burst response of the system was uniformly excellent over the full frequency range. Less than 1 cycle was required to



reach the full burst amplitude, without overshoot, ringing, or spurious responses.

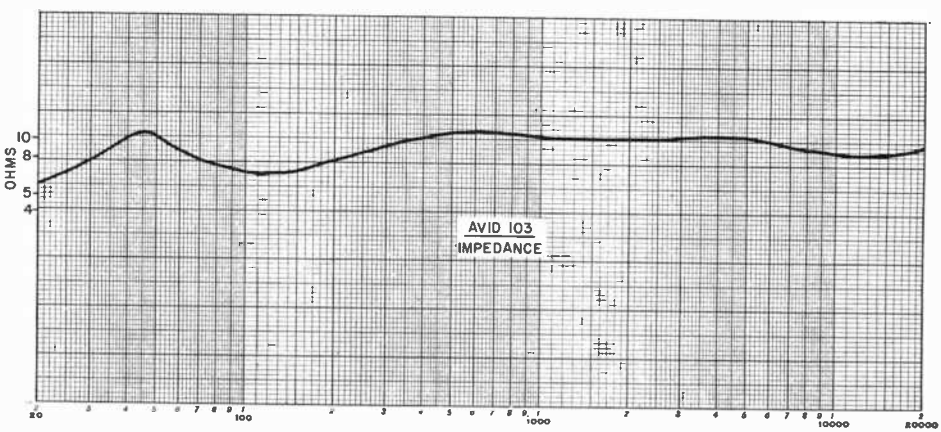
User Comment. The sound of the Avid Model 103 speaker system can best be described as smooth, easy, and free from emphasis or coloration in any portion of the frequency spectrum.

As expected, the "live-versus-recorded" test revealed the effect of the rising high-end response in the form of a slight prominence of the uppermost frequencies and harmonics in such sounds as wire brushes and triangles. Reducing the setting of the level switch by one step produced a near-perfect response. The only difference between the original sound and its reproduction through the Model 103 was in the midrange. A boost of about 2 dB between 1200 and 5000 Hz with an octave-band equalizer nearly eliminated even this slight effect.

The high-frequency dispersion of the speaker system was as good as we have heard from a single-dome, 1-in. radiator, although we could of course detect some loss of extreme highs in off-axis listening positions.

The very low distortion of the Avid speaker system encouraged us to try it out with a high-power amplifier with 200 watts/channel. The system was able to absorb the full output of the amplifier with musical program material without damage, strain, or objectionable distortion of any kind. This is unusual for speaker systems in the $145 price range.

In every respect, the Avid Model 103 proved to be one of the best moderately priced speaker systems we have heard. It should be able to compete effectively with many speaker systems costing as much as $200 or more.



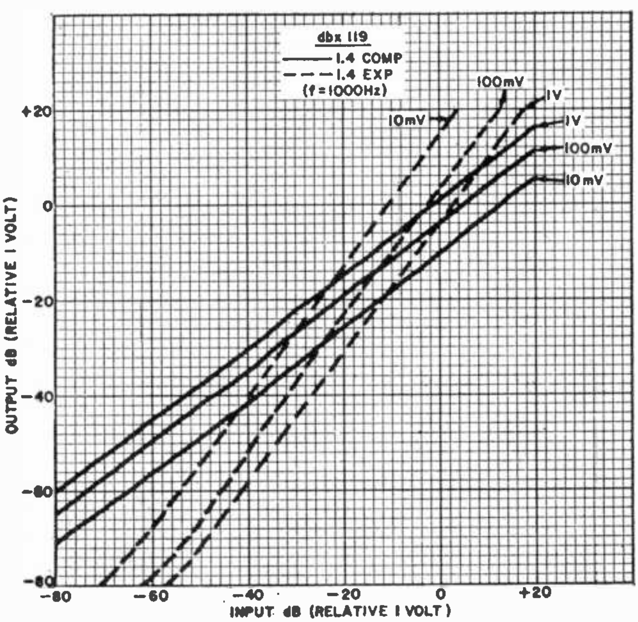
dbx MODEL 119 DYNAMIC RANGE ENHANCER
(A Hirsch-Houck Labs Report)

THE dbx Model 119 "dynamic range enhancer" audio compressor/expander employs a true rms detector and two (for stereo) low-noise, variable-gain elements. The input/output characteristic can be continuously adjusted to obtain a positive slope greater than unity for expansion, through unity, to a slope less than unity for compression. It is even possible to set the slope to zero for infinite compression so that the output level remains essentially constant over an input range of greater than 100 dB. At all times, the relationship between input and output levels, expressed in dB, is linear, which dbx calls "decilinear" operation.

General Description. The range enhancer has at least three distinctly different modes of operation. As a compressor, the output change is less than the input change. As an expander, the output change is greater than the input change. Finally, by making recordings in the compressor mode and playing them back with the complementary degree of expansion, the unit can serve as an effective tape noise reduction system.

On the front panel of the range enhancer is a SLOPE control knob backed by a calibrated scale that goes from 2.0 maximum expansion through 0 to infinite compression. A THRESHOLD control shifts the level at which the unit has unity gain. Hence, the first control changes the slope of the input/output characteristic, while the latter shifts the entire characteristic over a wide range of voltage levels. The only other control is the MODE switch. In its LINEAR position, operation is as described above. In the ABOVE THRESHOLD position, expansion or compression occurs only when the signal level exceeds the threshold setting, at which time a LED lights up.

Since the unit contains only a single pair of control elements, it must be switched between a tape deck's input and output circuits when going from record to playback, and the slope must be changed from compression to expansion. Because it is not possible to operate the unit simultaneously



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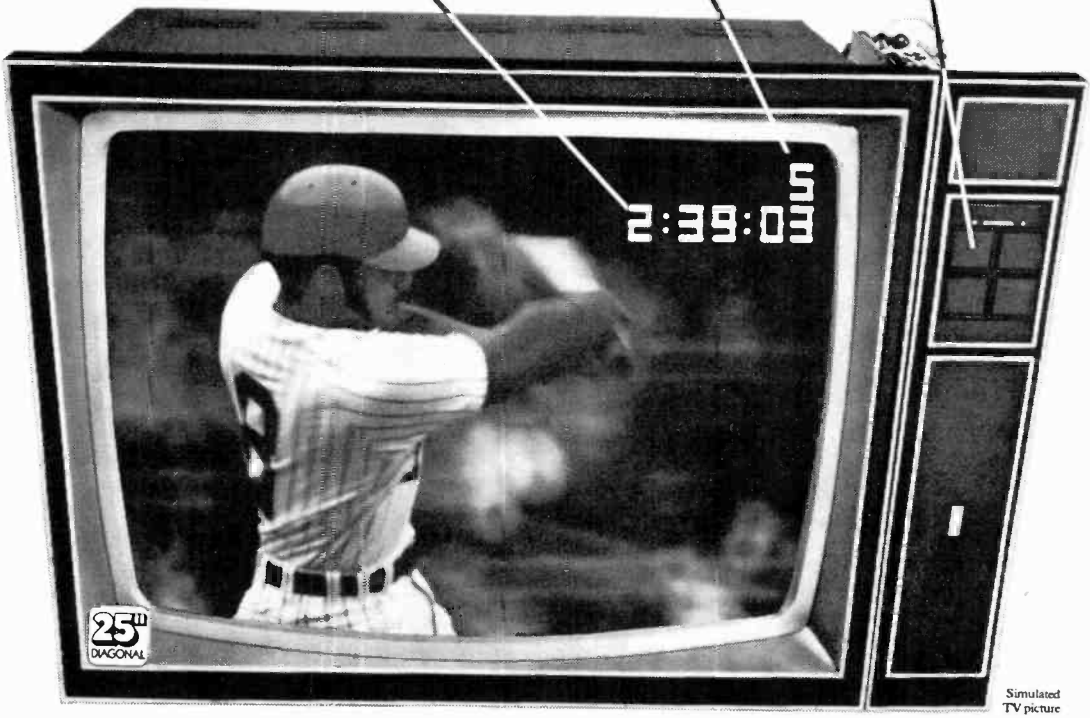

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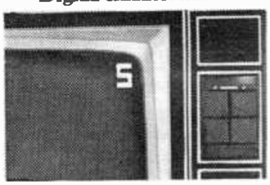

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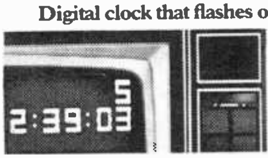

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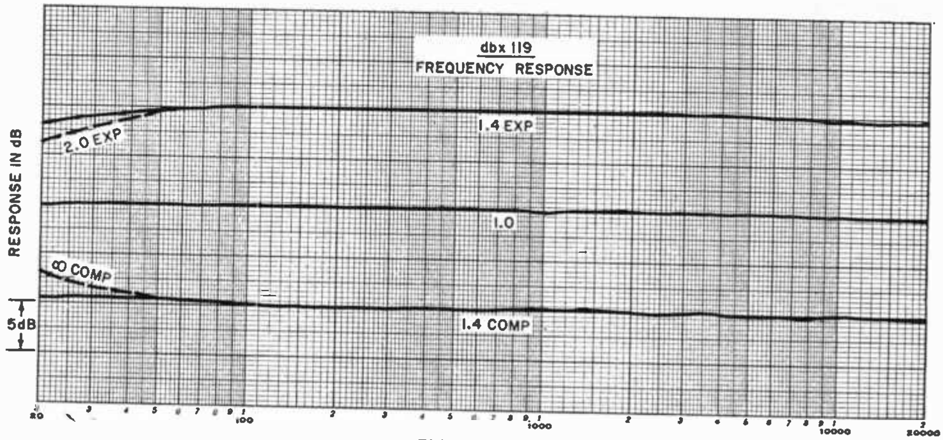


in both the compression and expansion modes, the tape recorder's playback must go to the amplifier's AUX inputs instead of the usual tape inputs.

Operated as a tape noise reduction system, the range enhancer can provide about 10 dB of noise reduction with recordings that have poor S/N ratios. Noise reduction of up to 20 dB can be obtained with the best recorders. Unlike the Dolby system in which only the higher frequencies are affected, the range enhancer reduces noise over the entire 20-20,000-Hz range. Its sensing circuits respond to the sum of the two channel levels with its effects applied equally to both channels, while the Dolby system operates as two independent channels.

The retail price of the dbx Model 119 dynamic range enhancer is $189.

Laboratory Measurements. We measured the input/output transfer characteristic of the system with several degrees of expansion and compression and over the full threshold range. In every case, the slopes agreed almost exactly with the calibration marks on the front panel.

The frequency response was within 1 dB overall from 40 to 20,000 Hz at any slope setting. At lower frequencies, there was a slight variation in response with different slopes: a maximum drop of 3.5 dB at 20 Hz with a 2.0 expansion, and a 3-dB boost with infinite compression.

The output at the clipping level was 10 volts. The 1000-Hz THD was between 0.04 and 0.07 percent for outputs of up to 3 volts and expansions up to 1.4. At 20,000 Hz, distortion was less than 0.1 percent at 1 volt (with a compression or expansion slope of 1.4). Maximum distortion, at 20 Hz with a 1.4 expansion and 1-volt output, was 0.63 percent.

Using tone bursts, we were able to estimate the dynamic properties of the range enhancer. With not more than a 1.4 compression or expansion slope, the action appeared to be 90 percent complete in about 20 ms. Greater expansion slopes required more time (about 100 ms) to reach final levels, but most of the change occurred in the first 20 ms.

User Comment. To avoid unnatural effects, the instruction manual suggests using no more expansion or compression than necessary. Slopes exceeding 1.4 are not recommended for noise reduction or expanding the range of typical musical programs.

When the threshold is correctly set, introducing expansion has little effect on the maximum program level. But during pauses or drops in average level, background noise rose perceptibly—especially with slope settings exceeding 1.4. Similarly, in expansion, the background noise dropped markedly during program pauses. With slopes exceeding 1.4, the noise level shifts could be heard as "swishes".

As a tape noise reduction system, the unit's chief limitation is the need for precise matching of the compression and expansion slopes. Threshold levels are not critical, since the 120-dB dynamic range of the system leaves plenty of room for a 60- or 70-dB program range without exceeding the unit's capabilities.

Attempting to obtain greater noise reduction with slopes of 2.0, we found the fluctuation of the background noise was more noticeable during the attack and release times, although the average noise level certainly was much lower. We suspect that this was due as much to the differences between attack times in the two modes as to any slope errors.

In our opinion, the dbx Model 119 dynamic range enhancer is an exceptionally useful adjunct to a music system whether it has a tape deck or not.

Circle No. 66 on Reader Service Card

BROWNING LTD AM/SSB MOBILE CB TRANSCEIVER

THE Browning Labs LTD mobile CB transceiver provides 23 channels of operation in each of its AM and SSB modes. The transceiver offers the customary features of r-f and a-f gain controls, AM/LSB/USB selector, Delta tune, adjustable squelch, switchable r-f noise blanker, alc for SSB and amc (automatic modulation compression) for AM, agc, PA or CB operation with external speakers, and transmit indication. It also has a 13.8-volt dc negative- or positive-ground system with reverse-polarity protection, line filter, and electronic voltage regulation. An illuminated channel-selector dial and an edgewise S-unit/relative-power meter is easier to read than on some rigs.

Retail price of the LTD is $360, which includes the transceiver, microphone, and anti-theft mobile mounting bracket.

SSB Operation. The basic circuit configuration of the LTD is similar to some other transceivers now making their appearance on the market. The frequency synthesizer, employing 14 crystals, provides outputs in the 22-MHz range (as needed for each channel). When combined with a 12.8-MHz crystal-controlled signal, a nominal 34.8-MHz heterodyning signal results, producing a 7.8-MHz i-f. Single conversion to this i-f in conjunction with a crystal-lattice sideband filter is thus employed for SSB operation.

This setup provides an unwanted-sideband rejection of 60 dB at 1000 Hz. Together with the product detector circuit and the characteristics of the a-f amplifier, the overall a-f response was found to be nominally 300-2700 Hz at 6 dB. Sidebands are changed by shifting the bfo about 3000 Hz, using one of two crystals and similarly "rubbering" the 12.8-MHz crystal to maintain operation on exactly the same channel frequency of either sideband.

The r-f amplifier is built around a field-effect transistor which, along with a low-noise bipolar transistor mixer, provides an excellent 0.1 μV for 10 dB (S + N)/N SSB sensitivity.

The SSB transmitting signal is generated in the conventional way, through the sideband filter and several r-f stages, ending up with the power-amplifier stage that is then set up for linear operation. Included in the power-output stage is a matching and filtering network that provides a high order of spurious-signal attentuation.

The SSB power input was originally rated at 15 watts pep with 8 watts pep output. However, under the recently amended FCC regulations, a somewhat higher input is permissible as long as the pep output does not exceed 12 watts. Our unit, therefore, was factory adjusted for 12 watts pep output with a 13.8-volt dc source. At this level and at the alc threshold, third-order intermodulation distortion products were 26 dB below the maximum output, while all higher-order products were down 40 or more dB. The fundamental a-f output response was nominally 500 to 2750 Hz at 6 dB, while carrier suppression was 50 dB.

AM Operation. Double conversion is used in the LTD for AM operation, with the 7.8-MHz i-f combined with a 7.345-MHz crystal signal to provide a 455-kHz second i-f where selectivity is obtained with two ceramic filters. The overall 6-dB a-f response with this arrangement was nominally 200 to 2200 Hz, and adjacent-channel rejection was 45 to 50 dB. A full-time a-f noise limiter is used for AM. The AM sensitivity was 0.3 μV for 10 dB (S + N)/N with 30 percent modulation at 1000 Hz.

The carrier for the AM transmitter is developed by the synthesis system, while the r-f driver and power amplifier are collector-modulated, as usual, by the a-f power-output amplifier of the receiver (with automatic modulation compression included). The power amplifier parameters are altered for optimizing AM operation.

A carrier output of 4 watts was measured with operation from a 13.8-volt dc source. Full modulation was attainable with good waveform, exhibiting only 5 percent distortion when complete modulation was first reached. Although the amc held the positive peaks properly to 100 percent with increased speech-input levels, it did not prevent overmodulation and carrier breakup at the negative peaks—a condition common to most CB rigs. Nevertheless, with 10 dB of compression, the modulation splatter with a test tone was down 40 dB at the adjacent channel. (Under normal voice operation, the attenuation will actually be greater.) Otherwise, a-f response was 550-3600 Hz.

Other Test Results. With either mode of operation, the squelch threshold range was 0.3-1000 μV. The S meter registered S9 with about a 100-μV signal. Image rejection was 68 dB, and i-f signal rejection was 80 dB. The agc held the a-f output to within 2 dB on SSB and 4 dB on AM with a 60-dB r-f input change (10-10,000 μV).

The noise blanker is an r-f parallel-gate type that can be used on either AM or SSB. Its effectiveness hinges on the type of noise to be suppressed, according to the pulse width, rise time, repetition rate, amplitude, etc. Thus, the blanker can attenuate certain noise pulses by 20 to 40 dB and yet be relatively ineffective with others. In addition, its use is more beneficial with SSB reception than with AM reception.

For PA operation, the class-B output amplifier put out 4.5 watts with 6 percent distortion at the start of clipping, and 5 watts at 7.5 percent distortion with very slight clipping at 1000 Hz into 8 ohms. On receive, the distortion was slightly higher.

The Delta tune circuit varies that frequency on SSB and AM transmit and on SSB receive by ±800 Hz. At maximum deviation, the frequency held to within a tolerance of 0.0035 percent. On AM receive, the tuning range was about ±1500 Hz.

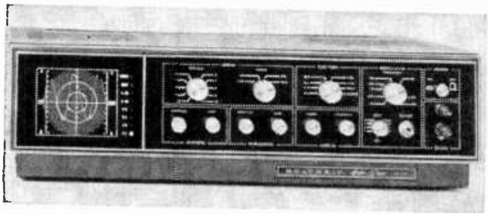
The r-f gain is usually referred to as a means for reducing receiver overload, but it should be noted that reduction of r-f gain can also minimize adjacent-channel interference. In addition, it can improve unwanted-sideband suppression under dynamic operating conditions.

HEATHKIT MODEL AD-1013 AUDIO OSCILLOSCOPE
(A Hirsch-Houck Labs Report)

AN AUDIO oscilloscope can be a very useful addition to an advanced hi-fi setup, especially in a 4-channel sound system. Such a scope should have a 4-channel matrix for displaying the directional properties of quadraphonic programs and direct-coupled vertical and horizontal amplifiers for monitoring multipath distortion.

Although there are a few specialized audio scopes available, most are rather expensive. One sophisticated instrument is the Heath Company's Model AD-1013 scope that sells for $200 in kit form (plus $25 for optional walnut cabinet). It is intended for the advanced audiophile who wants to check out the performance of 2- and 4-channel systems.

The AD-1013 is actually two instruments in one. It is primarily an audio oscilloscope



with a 3-in. CRT display. However, it also has a built-in audio signal generator that comes in handy for tests, setting levels, and balancing channels.

General Description. The scope's horizontal sweep is set by a range switch and a continuously variable control. The sweep is triggered by the input signal and is automatically synchronized to it. In the absence of a signal, the sweep is free-running with a line always visible on the CRT screen.

The FUNCTION switch connects the vertical amplifier to any of the four input channels, or to a pair of binding posts on the instrument's front panel for use as a conventional oscilloscope. In the 2 CH mode, the scope provides an X-Y display of the stereo channels, with the right channel producing a horizontal deflection and the left channel a vertical deflection.

A mono program appears as a 45° line, and stereo can be identified by a broadening of the line, which can take on an amorphous, fuzzy shape.

In the 4 CH mode, an internal matrix combines the channel outputs to move the spot radially from the center of the screen in proportion to the instantaneous channel levels. A front-right (FR) signal produces a 45° line, while a back-right (BR) signal appears at 135°, BL at 225°, and FL at 315°. (Hence, the top of the screen corresponds to the front spread and the bottom to the rear spread in a 4-channel display.) Intermediate directions are seen as dimly filled areas of light on the screen.

Finally, in the MULT mode, the instrument becomes an accurate FM tuning indicator that displays the instantaneous signal deviation and the amount of multipath distortion on the received signal. A suitably equipped tuner or receiver is required to take advantage of this function.

Many audio system checks require a test signal that can be varied in frequency and level. The AD-1013 provides such a signal through its built-in oscillator. Coverage is from 20 Hz to 20,000 Hz in the audio band, continuously variable with a single turn of the instrument's FREQUENCY control knob. The continuously variable LEVEL control has a CAL position that provides an accurate 1-volt peak-to-peak, 60-Hz signal at the osc output. With the aid of this signal, the vertical sensitivity of the scope can be calibrated so that approximate peak power levels at the outputs of the amplifier under test can be determined. The oscillator waveform has less than 1 percent distortion, and its level is constant over the full frequency range.

A row of neon lamps near the scope's CRT screen shows the operating mode selected by the FUNCTION switch. Power to the instrument is controlled by a pushbutton switch. The rear apron contains jacks for the audio and H and V multipath inputs. There is also an osc jack that parallels the one on the front panel. A switch is provided to permit phase reversal in the back channels to provide a correct 4-channel display when the front and back channels of the amplifier being monitored are out of phase.

The built-in oscillator is actually a square-wave generator whose output is integrated to form a triangle wave. This is then shaped by a diode/resistor network to create a low-distortion sine-wave signal.

The AD-1013's styling complements the company's Model AR-1500 receiver and AJ-1510 tuner that already have built into them the H and V outputs for the necessary multipath display. It should be noted that the instrument can be used with any tuner or receiver so equipped. For those people who have the Heath Model AR-15 receiver and AJ-15 tuner that do not have the H and V outputs, there is available for $25 the Model ARA-15-1 conversion kit.

Laboratory Measurements. The scope in the AD-1013 met or surpassed all of its published specifications. The vertical sensitivity was 25 mV/cm, while input impedance was 100,000 ohms. The frequency response was flat from 5 Hz (our lowest measurement limit) to beyond 30,000 Hz. It was down 3 dB at 250,000 Hz. The triggered sweep generator operated from less than 5 Hz to beyond 300,000 Hz.

The audio oscillator had a range of from 5 Hz to just beyond 21,000 Hz. Its frequency calibrations are very approximate (within 30 percent according to Heath and confirmed by us). The output level range of 2 mV to 3 V was measured by us as 3.8 mV to 4.2 V. The variation in output level, rated at less than 0.25 dB, proved to be an almost unmeasurable 0.1 dB. The CAL voltage was within 1 percent of the specified 1.0-V p-p value.

The distortion in the audio oscillator is critically dependent on two adjustments in the shaping network. The visual method, in which the controls are set for the best approximation of a sine wave seen on the CRT screen, cannot be expected to result in the rated 1-percent THD. Our best efforts produced about 5 to 6 percent distortion, although the waveform appeared to be quite sinusoidal and would probably be satisfactory in most cases. To optimize distortion (which varies a bit with frequency), we used a distortion analyzer and obtained a 0.75-percent figure at 20 Hz, 1.5 percent at 1000 Hz, and 1.0 percent at 20,000 Hz.

Comment. The construction of the kit was straightforward and uncomplicated even though the finished instrument is a fairly complicated unit. It took us about 14 hours for assembly and checkout.

We used the instrument with several 4-channel receivers. It provided a welcome insight into the effectiveness of the demodulators and decoders in the receivers, and it simplified the balancing of channels. (Final balancing should always be done by ear.)

Perhaps the greatest value of the AD-1013 in everday operation is as a multipath indicator for FM reception. Owners of suitably equipped tuners and receivers will find this feature extremely helpful in properly orienting antennas and for explaining away the distorted signals sometimes heard over the air on FM signals.

Although there are a few models of commercial scopes intended for applications similar to that of the AD-1013, we know of only one with comparable versatility—and it sells for about $600.

Solid State

By Lou Garner

Designing With Ingenuity

INGENUITY—that happy blend of imagination, knowledge, intelligence and skill—can be the most valuable talent which an experimenter, hobbyist or project builder can possess. Properly applied, it can change the routine to the rare, the commonplace to the curious, the mundane to the marvelous, accident to advantage, and problems to progress.

One person may look at an amplifier circuit and see just that—an amplifier. An ingenious person, on the other hand, may look at the same circuit and envision a whole spectrum of exciting projects: controls, alarm systems, musical instruments, test equipment, intercoms, paging systems, or electronic games and toys.

There are many who feel that a project *has* to be complex to be useful. Some, experienced engineers included, will even lift their noses in disdain at simple circuits, considering any design requiring less than, say, a half-dozen IC's beneath their talent and dignity.

In the final analysis, however, it's really no trick to find complex solutions to complex problems or, for that matter, even to simple problems. All that is required is technical knowledge, routine design procedures, and hard work. The real trick is to find simple solutions to complex problems . . . to find the simplest circuit or design that will solve the problem or accomplish the desired result. And that's where ingenuity can play a role.

A good example is the pnp Darlington amplifier illustrated in Fig. 1A. Two direct-coupled transistors in this configuration are equivalent in performance to a single very-high-gain transistor and, in practice, may be used as such. Although the circuit can be assembled from discrete devices, several semiconductor manufacturers offer fabricated Darlington transistor assemblies in low, medium and high power versions in both pnp and npn types. Typical commercial units are Motorola's low power HEP types S9100 (npn) and S9120 (pnp) and high power types S9140 (npn) and S9141 (pnp). Where npn devices are used, circuit dc polarities are reversed.

As in a conventional single-transistor, common-emitter amplifier, dc is supplied by power source *B1*, with base bias applied through current limiting resistor *Rb*. The input signal is applied between the base (B) terminal and either circuit ground or the emitter (E). Any of a variety of input arrangements and output loads may be used, depending on the circuit's application.

Now let's add a bit of ingenuity and consider a *few* of the many possible applications for this one simple circuit.

METER AMPLIFIER. Use a low-power Darlington and a D'Arsonval meter as the collector load, applying the dc input signal between the base (B) and emitter (E) terminals. Resistor *Rb* is not used. This arrangement can increase the meter's effective sensitivity by factors ranging from 100 to 1000 or more, depending on the components used.

SENSITIVE RELAY. Use a low-to-medium-power Darlington and an electromagnetic relay as the collector load, applying the input dc control signal between the base and emitter electrodes. Resistor *Rb* is not used, but a current limiting resistor in series

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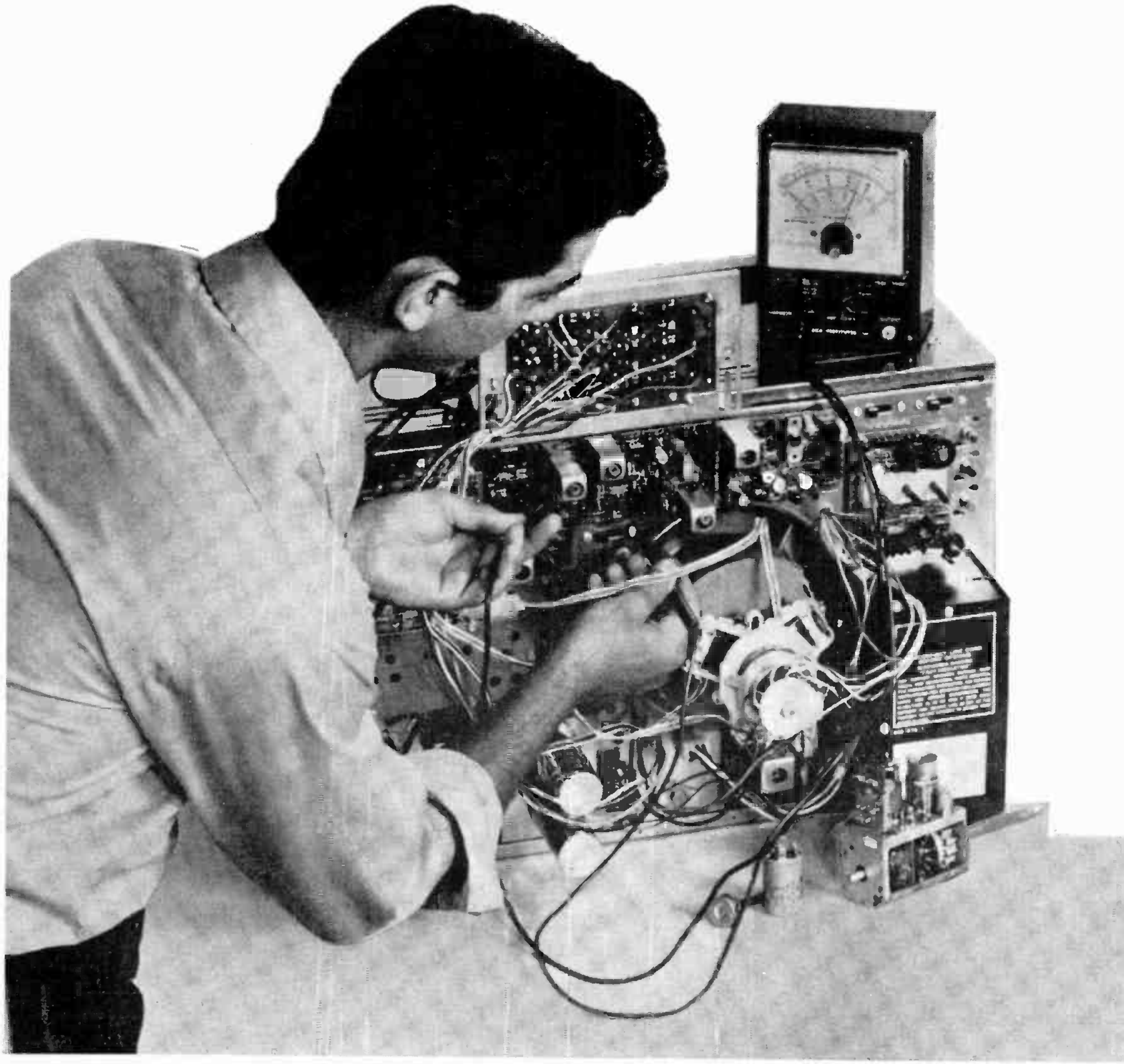


In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

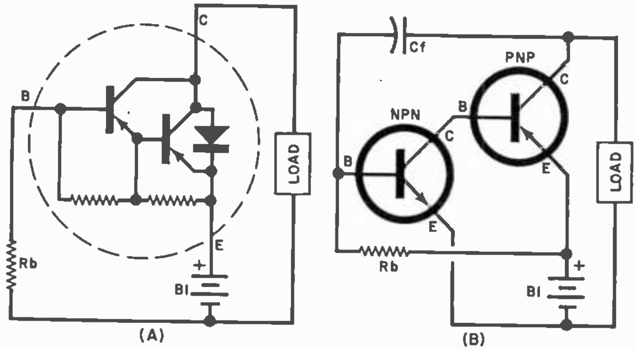


Fig. 1. The Darlington amplifier (A) and complementary relaxation oscillator (B) are simple circuits; but, with ingenuity, can be used in many diverse types of applications.

with the base is advisable. Would you believe a *10 microampere* relay?

PHOTOMETER. Use a low-power Darlington and a D'Arsonval meter as the collector load. Connect a photovoltaic or photoresistive cell in series with *Rb*, adjusting its value accordingly.

PHOTORELAY. Replace the meter in the previous circuit with a suitable electromagnetic relay. This arrangement can be used for burglar alarms, doorway annunciators, slave photoflash, and equipment control applications.

TEMPERATURE CONTROL. Use a low-to-medium-power Darlington and a relay as the collector load. Replace *Rb* with a thermistor bridge circuit. Use the relay contacts to switch external heating or cooling equipment.

ELECTRONIC THERMOMETER. Replace the relay in the previous circuit with a D'Arsonval meter. Calibrate the meter's scale in degrees C or F.

BURGLAR ALARM. Use a low-power Darlington with a relay as the collector load and connect window foil and closed-circuit door switches *in series* with *Rb*. The relay contacts are used to switch an external alarm bell or horn. The value of *Rb* is adjusted so that the relay is closed. Opening the base circuit at any point, as by breaking a foil protected window or opening a door, will cause the relay to drop out, sounding the alarm.

BOOSTER AMPLIFIER. Use a medium-power Darlington with an output transformer driving a PM loudspeaker as the collector load. The input signal is applied to the base (B) through a dc blocking capacitor and may be obtained, say, from the earphone jack of a small transistor radio or similar source.

POWER MEGAPHONE. Replace the PM loudspeaker in the previous circuit with a horn-type paging speaker and connect a carbon microphone in series with *Rb*, readjusting the value if necessary.

AUDIO SIGNAL TRACER. Use a low-power Darlington and an earphone as the collector load. Add a potentiometer gain control ahead of the base, coupling to the base through a dc blocking capacitor. Assemble in a probe body with self-contained battery.

R-F SIGNAL TRACER. Add a simple diode detector and r-f bypass capacitor ahead of the gain control in the previous circuit. In both, a suitable dc blocking capacitor should be connected in series with the input lead or probe terminal.

Another simple but, with a touch of ingenuity, extremely versatile circuit is illustrated in Fig. 1B. Here, npn and pnp transistors are direct-coupled as a complementary relaxation oscillator powered by *B1*. The two devices may be interchanged if dc polarities are reversed. Feedback is provided by *Cf*.

In operation, the circuit develops a pulse-like harmonic-rich signal at a repetition rate determined by the *Cf-Rb* time constant, by the transistors' characteristics, and by the supply voltage. Depending on one's choice of components, the circuit can be operated at rates from less than 1 Hz to the upper kHz or lower MHz values. It can be used with small-signal or medium-power devices, or even with a combination of a small-signal transistor driving a power type. A number of different load devices can be used in the design.

To some, this would be "just an oscillator." To the ingenious, however, this circuit could become one of these:

POCKET METRONOME. A potentiometer is connected in series with *Rb*, a moderately large value is used for *Cf*, and an earphone is used as an output load.

STANDARD METRONOME. The previous circuit is modified by using a power transistor for the output stage and replacing the earphone with a PM loudspeaker.

CODE PRACTICE OSCILLATOR. The value of *Cf* is reduced in the previous circuit and a handkey is connected in series with *B1*.

TOY ELECTRONIC ORGAN. A number of different capacitors are used for *Cf*, selected by separate momentary contact key or pushbutton switches to provide different frequencies (tones).

SIGNAL INJECTOR. Small signal transistors are used with an inductive load (such as a small iron-core choke) and the instrument is packaged in a probe body.

AUDIO PHOTOMETER. A photovoltaic or photoresistive cell is connected in series with *Rb* in the CPO circuit. Here, the circuit's output frequency will vary with the light falling on the photocell.

LIGHT FLASHER. An incandescent lamp or LED load is used and a moderately large value is chosen for *Cf*.

CYCLIC PULSE TIMER. An electromagnetic relay is used as the output load.

ELECTRONIC CRICKET. A thermistor is substituted for the photocell in the photometer circuit.

Reader Circuits. Reader John Lord (16 N 4th Ave., Clayton, NM 88415), who works for a cable system firm, wanted to switch moderately low-level audio and r-f (4.5 MHz) signals without using electromechanical relays. He decided to use diodes as switching elements and devised the circuits shown in Figs. 2A and 2B.

Both circuits utilize an externally applied 12-volt dc signal to achieve switching action. Depending on the control voltage polarity, the switching diodes are biased in either a forward (conducting) or reverse (high-resistance) direction. In both circuits, a positive control voltage transfers input signal 1 to the common output terminal, while a negative voltage switches input 2 to the output.

John used standard components in his designs. The input and output terminals are conventional coaxial connectors. All diodes are type 1N914 silicon devices and the resistors are half-watt types. Capacitor *C1*, Fig. 2B, is a disc ceramic capacitor.

Suggesting that other readers may find applications for his electronic switching circuits, John writes that his models have given excellent service for over a year without problems.

Device/Product News. Recognizing that a constant motor speed is essential for optimum performance in tape recorders, cartridge players, phonographs, and similar types of equipment, the SGS-ATES Semiconductor Corporation (435 Newtonville Ave., Newtonville, MA 02160) is offering a pair of linear IC dc motor speed-control regulators, types TCA 900 and TCA 910. Both devices are housed in standard TO-126 three-lead packages, with the TCA 900 designed primarily for use in battery-operated portable equipment, while the TCA 910 is intended for applications at the higher voltages found in automotive and line operated equipment. The maximum source

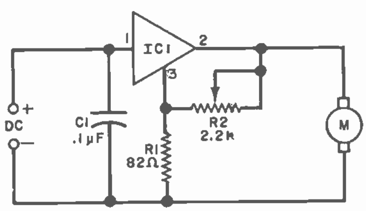
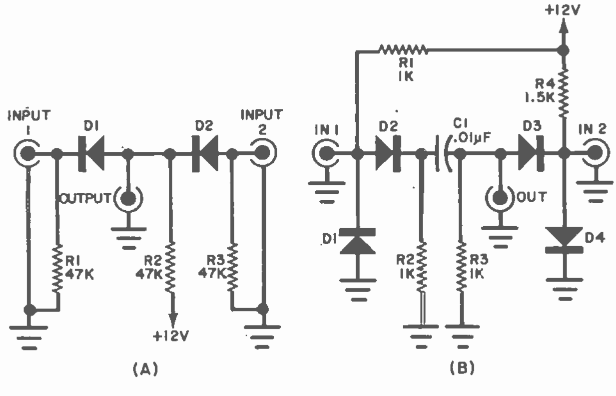


Fig. 3. The SGS-ATES circuit for motor regulation uses one IC.

Fig. 2. Two different circuits for switching moderately low-level audio and r-f signals, without using standard relays.



voltage ratings are 14 volts for the TCA 900, 20 volts for the TCA 910.

Requiring only two external components for operation, as illustrated in Fig. 3, the new SGS-ATES devices are designed to maintain a virtually constant motor speed despite variations in supply voltage, ambient temperature, or load.

The National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051) has introduced several new devices of potential interest to serious hobbyists, including two digital alarm clock IC's, a two-wire transmitter, and what is termed a "second generation" phase-locked loop (PLL) FM stereo demodulator.

Intended for use with seven-segment gas discharge displays, National's new digital alarm clock circuits are low-threshold p-channel MOS devices containing all of the logic needed to build several types of clocks and timers. Identified as types MM5370 (for 60-Hz operation) and MM5371 (for 50-Hz applications), the two IC's can provide three displays modes: time, alarm set, and sleep time. The display format may be either 12 hours with leading-zero blanking and a.m./p.m. indication, or 24 hours. Operating over a wide power supply range of from 8 to 29 volts, and with an integral power failure indicator, the MM5370 and MM5371 are available in either 28-pin Epoxy-B or ceramic DIP's.

Suitable for use with various sensors, including thermocouples, strain gauges, and thermistors, National's two-wire transmitter, type LH0045, is designed to convert a voltage signal from the sensor into a current and to transmit the current down a simple twisted-pair line to a receiver. The same twisted pair can serve to supply the device with its dc operating voltage, permitting the IC's use in remote sensing applications. Comprising a sensitive input amplifier, an output current source, and a reference designed to power the sensor bridge, the LH0045 is offered in both 12-pin TO-8 and 8-pin TO-3 packages.

Designated type LM1800, National's new PLL FM stereo demodulator features automatic stereo/monaural switching, a built-in stereo indicator lamp driver, an improved output decoder circuit, an on-chip voltage regulator, and a wide operating supply range of from 10 to 24 volts. Its design permits the use of a single, inexpensive potentiometer, rather than a coil, for all tuning functions. With a typical channel separation of 45 dB, the LM1800 is supplied in a 16-pin Epoxy-B DIP.

Both Motorola Semiconductor Products, Inc. (P. O. Box 20924, Phoenix, AZ 85036) and RCA's Solid State Division (Box 3200, Somerville, NJ 08876) have introduced new devices which should be of interest to hams, advanced experimenters, or students working with uhf and microwave circuits.

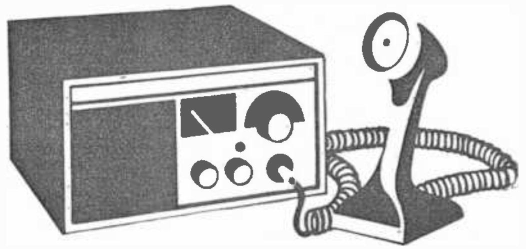
Motorola's 3N209 and 3N210 dual-gate MOSFETs are diode protected n-channel silicon-nitride passivated devices developed for use through the 500-MHz band. Featuring designed-in agc capability, low feedback capacitance, and very low intermodulation distortion, they offer a common-source power gain of 13 dB at 500 MHz, with a 4.5-dB noise figure.

Assembled in tiny ceramic "pills," Motorola's new vhf/microwave diodes are identified as types MV205 and MV206 hyper-abrupt tuning diodes, MBD103 silicon hot-carrier mixer (Schottky) diode, and the MPN3601 PIN microwave switching diode.

Supplied in HF-46 style flanged ceramic-metal packages, RCA's new microwave power transistors are designated types RCA2001 and RCA2310. Of these, the RCA2001 is intended for applications in the 500-MHz to 2-GHz range and, used with a 28-volt supply, can yield 1 watt output power with 7 dB gain at 2 GHz. The RCA2310 is rated to supply 10 watts CW at 2.3 GHz with a 24-volt dc source and is designed especially for telemetry service.

With a maximum turn-off time of 8 μs, RCA's first SCR family consists of 10-amp devices, types S5210B, S5210D and S5210M, rated at 200, 400 and 600 volts, respectively. The second family includes 35-amp devices with a maximum turn-off time of 10 μs, types 2N3654, 2N3655, 2N3656, 2N3657, 2N3658 and S7432M, with voltage ratings from 50 volts for the 2N3654 to 600 volts for the S7432M. Both SCR families are suited to a broad range of applications.

Consisting of a gallium-arsenide infrared emitting diode and a silicon npn phototransistor supplied in a modified hermetically-sealed TO-5 package, RCA's new optically-coupled isolator type C30111, can be used for data processing, control, alarm, instrumentation, and power-supply regulation applications. The device features a maximum isolation voltage rating of ±1000 volts and a minimum dc current transfer ratio of 20 percent. ◈



CB Scene

By Len Buckwalter, KQA5012

Antennas for Cars

ASK any antenna engineer where the best place to mount a mobile CB whip is, and he'll probably say the center of the car roof. From a technical point of view, this is sound reasoning, primarily because the location usually provides a more symmetrical pattern than any other. The mass of the car's metal, which acts as a ground plane, is most equally distributed about the antenna and encourages signal radiation in all directions.

By comparison, if an antenna is located on the left rear fender, then most of the metal is toward the front right of the car, so that would be the direction of the strongest signal. (This condition can be exploited, of course, by turning the car so that the strongest lobe is pointed toward the station you want to contact.)

Another engineering reason for the rooftopper is that the antenna is on the highest part of the vehicle. The loftier location thrusts the radiation slightly farther over the horizon and provides a little more range. Also, it helps the signal clear the car itself—as well as nearby objects.

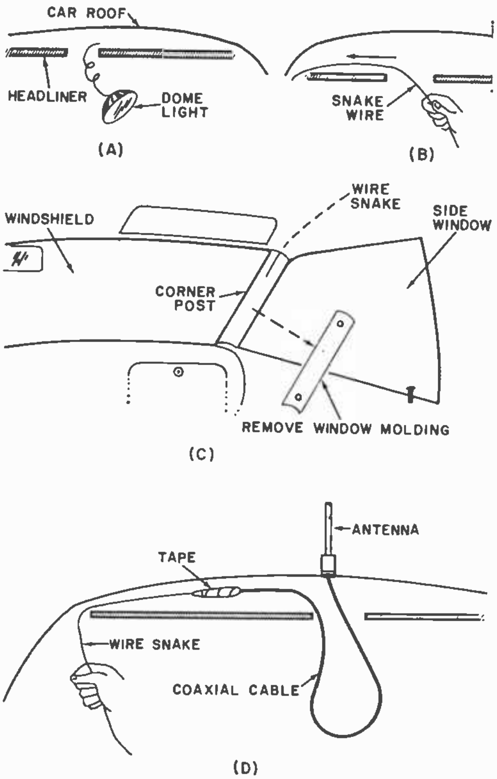
Why, then, don't all CB'ers center their whips on the car roof to obtain maximum communications? Since estimates from the industry put the percentage of such whips at considerably less than half of all mobiles, there must be a reason—or two. Of course, there is the problem of installing the antenna in the first place. And then there is the matter of what to do with the hole when you sell the car and remove the antenna.

To deal with the latter problem first, there are about five ways to take care of the rooftop mounting when the car is offered for resale. The easiest is to remove the whip and cover the hole with a rubber plug. Antenna Specialists sells plugs in a variety of sizes for this purpose.

Another possibility is to leave the antenna, or at least the rooftop fitting, in place at the time of sale. Maybe this was objectionable ten years ago, but about one out of every 60 cars on the road now has CB radio. Like an automatic transmission or air conditioner, a CB antenna installation might even increase a car's resale value.

Another option is to have the hole repaired by a professional body-and-fender shop. Since this work commands about the same fees as for brain surgery, however, you might try your own hand at covering the hole. It is, after all, only about ⅜ to ¾ of an inch in diameter. Western Auto offers a body patch kit with all the ingredients necessary to seal 136 square inches for only $2.39. They also sell spray enamel paint to match the color of almost any car.

Mounting Problems. If the hole is no threat to you or your car, then you have to consider probing the inner mysteries of the car roof to make the installation. In some automobiles there are major barriers here and you should know about them in advance. But thanks to the car's dome light, you can discover the pitfalls before doing any irreversible damage. By lowering the domelight assembly (see illustrations), you can look into and explore a section of the car roof that is very close to where the antenna will mount. This gives an idea of whether



For rooftop installation lower dome light (A), feed snake wire through light hole to corner post (B) and (C), drill hole, attach antenna and pull coax through with snake.

any obstacles will interfere with the cabling or antenna mounting hardware. First, check whether the roof has a double thickness—a type of construction found in late-model cars. If so, much of the antenna mounting hardware now on the market may be difficult or impossible to install. (Even the antenna designers are wrestling with this one!). But in a huge number of autos and pickups you'll find a single sheet of metal that accepts the popular fittings.

Also from the vantage point of the dome-light hole, you can make a trial run at snaking a wire through the headliner (the decorative covering over your head) to a window post on either side of the windshield. If you can fish a stiff wire through that area without hitting solid barriers, you've solved the next most difficult phase of the job. Sometimes it takes a couple of trials with the wire to work your way through. If you can't find a clear patch, you might have to lower part of the headliner, but this is a job that may be difficult unless you're familiar with how it's done.

But let us say these early steps present no problem and you're ready to cut metal. The first precaution when working on a car roof is to avoid denting the sheet metal. If you step on the roof with all your weight on one shoe, friends and family seeing the dents will wonder if you were in a roll-over accident or hit by a low-flying airplane. By carefully distributing your weight on knees and shoes (preferably sneakers) you won't mar the surface.

Next for the hole itself. The antenna manufacturer tells you the diameter, often ⅜ inch, but it may be as wide as ¾ inch. If you can manage a tube-socket punch to cut the hole (meaning you must be able to install the punch from the bottom, through the dome light hole) you can make a perfect circle. Alternatively, drill a pilot hole and widen it to size with a reamer or round file.

No matter what the method, beware of drilling that first hole. The slope of an average car roof encourages the drill bit to skitter across the surface, exposing a jagged streak of bare steel that will succumb to rusting in a few days. You can avoid the runaway drill with a hammer and nail or center punch to drive a starting dimple at the center, or with a variable-speed drill turning at its lowest speed. Never press down hard on the drill or you might break through the ceiling and ruin the headliner. You merely want to cut through the sheet metal layer.

With the antenna finally in place, the coaxial cable is taped to the snake wire and pulled through the headliner. The rest of the path to the transceiver is usually easy.

Some Typical Antennas. There is a good variety of rooftoppers from which to choose. Here's a sampling: Lafayette's "Auto-Top" is a 39-inch base-loaded stainless steel whip that mounts in a ¾-inch hole. Price is $8.95 less the cable. Antenna Specialists' M-125 is a 40-incher that snaps into a ⅜-inch hole and has a solderless connector with 17 feet of cable for $18.59. Hy-Gain offers the Hellcat 3, a 35-inch model with a magnetic mount which eliminates holes entirely and withstands winds up to 100 mph. (Note, though, that the coaxial cable must run outside the roof and enter the car through a window). Radio Shack offers a 42-inch roof mount of stainless steel with a chromeplated shock spring and 16 feet of cable for $17.95. The durability of the rooftop models in the marketplace seems to indicate they're doing something right.

CB Items. *F.C.F., the Fraternal Communications Foundation, is looking for new members to help "clean the airways." Now incorporated in six states—Utah, Nevada, Colorado, Wyoming, Michigan and Texas—the organization hopes to build a national headquarters in Utah within ten years, get the names and address of all "bootleggers, power pushers, and troublemakers" and forward them to the FCC. They'll also send a man to Washington to fight for better laws and lower license fees. It costs $6 to join F.C.F. with $10 per year dues. A package on the organization is $2 from: F.C.F., 444 Erie Street, Salt Lake City, UT 84116.*

North Jersey REACT (P.O. Box 1330, Secaucus, NJ 07094) is looking for new members, or anyone wanting more information about how CB radio improves the safety and convenience of anyone's daily affairs. . . Arnie Timm, of Electronic Avocations, writes that one solution to the problem of unlicensed stations is to require a buyer to show his license to a dealer, distributor or technician before he can obtain equipment. . . The "Quit Skip QSL Club" is circulating a questionnaire with queries on most major CB issues: e.g. should antennas be higher, linears be necessary, rules be freer? To get one write: George Capps, Rt. 2, Box 174, Rolla, MO 65401. ◈

PORTABLE TIME BASE for DIGITAL CLOCKS

BY PAUL MICHAEL, Signetics Corp.

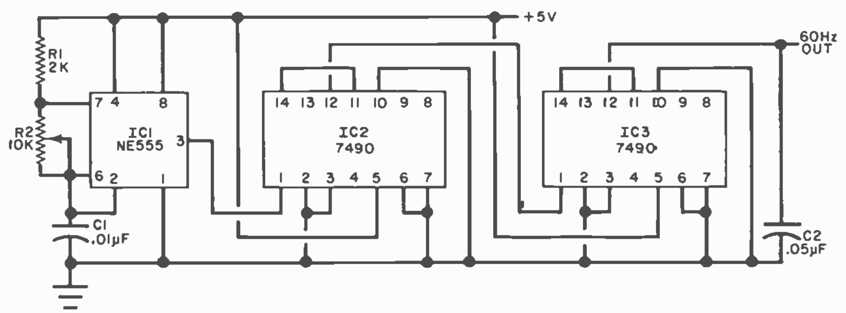
IF YOU have a camper, recreation vehicle or boat, you know that you can't use a digital clock because you don't have a source of 60 Hz for the timing. This problem can be solved easily by using one of the new 555 timers in the circuit shown below.

Essentially, the circuit consists of a Signetics NE555 timer operating at a stable rate of 6 kHz and driving a pair of 7490 TTL's in a divide-by-100 configuration. Although the 555 can operate as a 60-Hz source directly, it is more stable operating at 6 kHz.

Trimmer potentiometer *R2* is adjusted for an exact 60-Hz square-wave output. The timing error of the circuit was found to be less than two seconds every 10 hours. The output voltage is 3.8 volts when a 5-volt supply is used.

The 5-volt supply can be obtained easily by using a regulator such as the Signetics LM309 operating off the vehicle's regular 12-volt supply.

In constructing the circuit, the IC's and four other components can be mounted on a small piece of perf board or a pc board can be made. Once the correct position for trimmer *R2* is determined, fix its rotor with cement. ◈



Test Equipment Scene

Testing Internal Combustion Engines

By Leslie Solomon, Technical Editor

GETTING the most from our transportation dollar is a major concern these days. With the rising cost of gasoline, it's little wonder that there is a lot of interest in test equipment to use in improving the performance of internal combustion engines (automobile or marine). Let's investigate how we can make use of conventional electronic equipment in tuning up a motor.

Probably the best-known piece of electronic test gear for engines is the tachometer. This is simply a pulse counter. (We'll have a project on this item next month.) The tachometer is useful in measuring and setting engine speed under certain conditions. The thing to remember in using a tachometer is to be sure that it is accurate. To determine whether it is or not, you need a basic audio square-wave generator that can deliver 8 to 12 volts to provide the signal from the "points" and a 12-volt dc power supply.

The test frequency supplied to the tachometer by the signal generator is equal to the desired rpm reading on the tach multiplied by the number of cylinders and divided by 120 for a conventional four-cycle engine. (For a two-cycle engine, divide by 60 instead of 120.) As an example, assume you want to check the 1200-rpm indication on the tachometer and you are working with a six-cylinder, four-cycle car. Then $(1200 \times 6)/120$ is 60, so you would apply a 60-Hz signal to the tachometer to see if it reads 1200. (Incidentally, these values are convenient if you want to use a common filament transformer operating off the commercial power line as a source of 60 Hz.)

One diagnostic use for the tachometer is in checking engine cylinder compression. With the engine and tachometer operating, lift the connection off of one plug and note the drop in rpm. A cylinder with low compression will show only a small drop in rpm. A good cylinder will show a large drop.

Using a Dwell Meter. A dwell meter is simply a special type of ohmmeter. It measures the apparent resistance of the points as they rapidly open and close. Dwell refers to the time that the points are closed.

During the dwell time, battery current flows through the primary of the ignition coil to build up the magnetic field that is then collapsed to produce the high voltage for the spark plugs. We say that the meter measures the apparent resistance because, as the points open and close, the dwell meter receives either full current or none at all. Therefore the current is proportional to the percentage of time that the points are closed. However, don't trust a conventional ohmmeter to make this measurement. In many cases there may be sufficient resistance when the points are closed to produce an offset which will provide the wrong indication of dwell.

A conventional oscilloscope (or ac voltmeter) can be used to check alternator diodes. Simply apply the dc supply in the car to the scope and check for ripple. Under normal conditions, the ripple may be as much as 0.5 volt. If it is greater than that, there is probably a faulty diode.

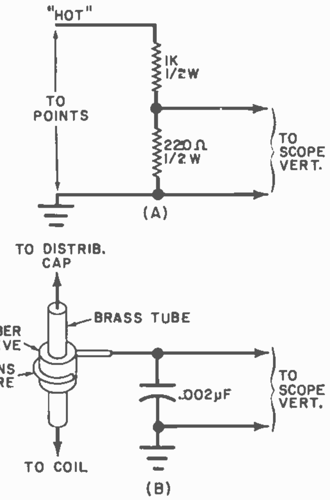
A standard bench power supply can be used to check an engine's condenser. The condenser should allow no appreciable current flow with about 300 volts dc across it. With a resistance of about 5 megohms in the condenser, the current would be only 0.00006 ampere.

Checking Ignition Circuits. One of the best ways to check an ignition circuit is to use an oscilloscope. Professional tune-up experts have a specially designed scope for this purpose but a regular scope can be used by attaching the adapter circuits shown in the sketch. To check the primary waveform use the voltage divider shown at (A).

To check the secondary (high-voltage) waveform, use the arrangement shown at (B). First, a word of caution: in installing and handling the adapter, remember that some very high voltages (about 20 or 30 kV) are present. The adapter is essentially a capacitor divider with one part made up of a brass tube, fiber sleeve and one or two turns of wire and the other part of a 0.002-μF high-voltage (the higher the better) unit.

Suitable thin-wall brass tubing for the adapter can be obtained at almost any hobby shop. It should fit between the top of the ignition coil and the cable going to the distributer cap. The insulator is made of thick fiber sleeving. If the latter is not available, use several layers of good fiberglass insulation. Just be sure to keep the high voltage in mind. It may be necessary to alter the ratio of the capacitors by changing the loop around the fiber sleeve.

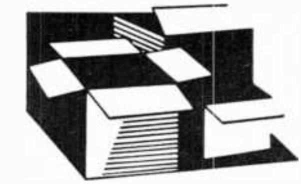
To use the adapter, run the engine at about 1000 rpm and adjust the scope sweep rate to show one waveform for each cylinder in the engine. The waveforms will follow the firing sequence for your engine. Consult the engine manual to determine



Checking ignition with an oscilloscope.

the sequence. The waveforms may be upside down—commercial ignition analyzers usually invert the waveform so that the positive-going elements go toward the top of the CRT display.

When all the waveforms are displayed sequentially, the display is called a parade. If the sweep rate is changed so that all of the waveforms are on top of each other, the display is called superimposed. In the parade mode, you will see the operation of all of the cylinders at once so that you can instantly spot one that is not firing properly. In the superimposed mode, you can check that all waveforms have approximately the same shape. We don't have the space here to analyze all of the waveforms and the conditions that produce them. They are easily checked, however, by using a good manual on electronic diagnostic techniques. ◈



New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer if address is given.

MIDLAND 2-METER MOBILE FM TRANSCEIVER

Midland Electronics Co. has announced availability of the Model 13-505 FM mobile transceiver designed for 2-meter ham work. Separate transmit and receive channel selectors provide simultaneous control of all transmit and receive frequencies in the 144-148-MHz range. The dual-power transmitter delivers 30 or 5 watts of r-f output power and has automatic VSWR protection. The transceiver is equipped with a discriminator meter that registers frequency shift in received signals and can be used to

calibrate both the receiver and the transmitter. Also built in is a S/r-f/SWR meter, squelch control, and double 12-channel selectors. Crystals come installed for 146.16, 146.34, and 146.94 MHz on transmit and 146.76 and 146.94 MHz on receive. Retail price is $299.95.

Circle No. 68 on Reader Service Card

GC DESOLDERING AID

You can desolder any connection quickly and cleanly with Soder-Wick (Cat. No. 684) according to G.C. Electronics. Soder-Wick is designed to absorb molten solder instantly and is said to eliminate component-damaging heat buildup, leaving no residue or flux contamination.

Circle No. 69 on Reader Service Card

JERROLD TUNABLE FM INTERFERENCE TRAP

A tunable trap, designated the Model RFT-300, from Jerrold Electronics is said to eliminate FM interference in TV receivers. Strong local stations can cause interference lines on TV screens, especially when the receiver is tuned to channel 6. The trap connects to the 300-ohm antenna terminals on the back of the TV receiver or indoor amplifier. The user simply watches his TV screen, while turning the trap's knob, until the FM interference disappears. The trap can easily be tuned to any industrial radio (72-76 MHz) or FM broadcast (88-108 MHz) frequency. The tunable notch is 250 kHz wide and 18 dB deep. Retail price is $39.95.

Circle No. 70 on Reader Service Card

ACOUSTIC RESEARCH SPEAKER SYSTEM

The Model LST-2 is the result of Acoustic Research's desire to produce a speaker system employing the same basic design principles used in the LST-1—at a lower cost. The LST-2

represents a blending of drivers. A unique crossover network and spectral balance switch permit three repeatable and accurate spectral energy profiles, allowing the user to select the energy output best suited for room acoustics and program material. The geometric design of the cabinet and the characteristics of the drivers in the three planes are claimed to result in uniform dispersion at all frequencies. The driver complement includes a 10-in. woofer, three 1½-in. hemispherical dome midrange radiators, and three ¾-in. hemispherical dome tweeters. Retail price is $400.

Circle No. 71 on Reader Service Card

SIMPSON GENERAL-PURPOSE OSCILLOSCOPE

The Model 455 oscilloscope introduced by Simpson Electric Co. has a 10-MHz bandwidth and 10-mV/cm vertical sensitivity. The scope accepts camera or light hood and has a low-parallax, high-contrast graticule with both amplitude and vector display indexes. Sweep frequency is adjustable from 1 Hz to 200 kHz in five overlapping ranges. For TV work, there is a special sweep rate for horizontal sync and R–Y/B–Y inputs for vector alignment. Horizontal sensitivity is 300 mV/cm, with a dc-to-500-kHz bandwidth. A 1-kHz, 500-V p-p square-wave signal is provided for external circuit testing and voltage calibration. Retail price is $295.

Circle No. 72 on Reader Service Card

HARMAN/KARDON MULTICHANNEL RECEIVER

The new top-of-the-line product in Harman/Kardon's hi-fi equipment is the Model 900+ multichannel receiver. The amplifiers are designed to drive up to eight speaker systems,

even when high sound levels are desired. When operated in the 2-channel mode, its outputs are rated at 90 watts/channel, while in the 4-channel mode, output power is 32 watts/channel (both driven into 8-ohm loads). The tuner is for AM/stereo FM. The mode switch has positions for SQ matrix, phase-shifted enhanced stereo, and CD-4/discrete, as well as mono and stereo programs. Included in the controls complement are switches for high- and low-cut filters, contour, FM muting, and Dolby noise reduction system. Retail price is $749.95.

Circle No. 73 on Reader Service Card

MARANTZ FLOOR-STANDING SPEAKER SYSTEM

The Marantz Co. recently introduced a new floor-standing speaker system to the Imperial line. The Imperial 8 is designed around a variable-density 12" woofer, three midrange drivers, and two tweeters. The array results in minimal air pressure on the individual speaker cones to provide high efficiency and low distortion. Also, the transducer array can be rotated so that a pair of Imperial 8's can be matched with mirror image. Frequency response is specified at 40 Hz to 18,000 Hz ±2 dB, while power handling capacity is 125 program watts.

Circle No. 74 on Reader Service Card

SBE UHF AND VHF SCANNERS

Linear Systems recently announced the introduction of a complete line of SBE Sentinel

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Series scanning monitors which cover 30 to 470 MHz in six models. The Sentinel package is the smallest eight-channel scanner around. It includes eight channels for scanning, lock-out switches, manual/automatic scan, and operation on ac or dc. An important feature of the Sentinels is the priority channel which assures the reception of the most important user-designated channel.

Circle No. 75 on Reader Service Card

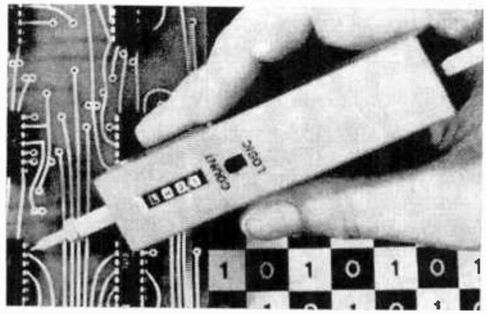
CONTINENTAL SPECIALTIES BREADBOARDING SYSTEM

A new Proto Board #103 has been developed that allows users to build, plug-in, modify, wire, test, add or remove circuits quickly, using as many as 24 14-pin DIP's, without soldering or patch cords. Input/output and processing circuits can be separated easily by using different power buses and separate sockets for every part of the design. Each section of the user's design can be tested independently because he can break up power and ground lines. Further, extra IC's or components can be plugged in and interconnected with #22 AWG solid hookup wire. The entire unit measures 6" x 9" x ⅜".

Circle No. 76 on Reader Service Card

ZI-TECH IC LOGIC PROBE/PULSE COUNTER

A versatile new logic probe (Model DP-6000) from Zi-Tech Division of Aikenwood Co. has the dual capability of displaying logic states



and functioning as a fast-pulse counter. The probe indicates logic states and identifies faults in IC's. When switched to the counting mode, it acts as an indicator for short pulses. The pulse counting circuit requires no accessories or options to detect multiple clock and trigger pulses, and it can indicate the presence of spurious oscillations. Price is $66.

Circle No. 77 on Reader Service Card

KENWOOD 2/4-CHANNEL FM RECEIVER

The newest addition to the Kenwood line of "Two-Four" receivers, the Model KR-5340, provides 2/4-channel compatibility with all program sources. When used in the 4-channel mode, the receiver develops 10 watts rms/channel. Operated in the 2-channel mode, a unique strapping circuit combines the separate 4-chan-

nel amplifier channels to provide 25 watts rms/channel at 8 ohms. The receiver is compatible with all 4-channel program sources. It has built-in SQ and RM decoders and provisions for a 4-channel tape deck. A CD-4 demodulator is available as an optional accessory. The receiver's front-rear, left-right balance and separate bass and treble controls make it possible for the listener to compensate for any room in which the receiver (with four speaker systems) is used.

Circle No. 78 on Reader Service Card

AKAI SOLENOID-OPERATED TAPE DECK

The Model GX-285D is a new solenoid-operated, two-speed reel-to-reel tape deck from Akai America. It features three GX glass and crystal tape heads, a Dolby noise reduction system, and a unique automatic-reverse playback system. The four-track (2-channel stereo/mono) deck employs a servo-controlled capstan motor and two outer rotor motors. It also has sound-on-sound and sound-with-sound mixing; mike and line mixing; universal voltage control; standard/low-noise, high-output tape switching; and a four-digit tape counter. ($750).

Circle No. 79 on Reader Service Card

GOLD LINE MOBILE PHONE PATCH

The Model GLC phone patch from Gold Line allows an operator to expand communications contacts from his car's CB rig. A simple instal-

lation connects the phone to a CB transceiver. The patch can be used with 3- to 16-ohm speakers and high-impedance microphone inputs. The modulation gain control compensates for varying line levels, while an on/off switch disconnects the patch when not in use. Retail price is $15.95.

Circle No. 80 on Reader Service Card

New Literature

IR RECTIFIER PRODUCT LOCATOR

A product locator (No. PL-2.0) for 86 models of silicon rectifiers is available from International Rectifier Corp. The company's broad range of rectifiers is listed according to specific current ratings, surge current ratings, voltage range, case style, and data sheet number. Each series part number is followed by a brief explanation of distinguishing features. Fast-recovery rectifiers are listed separately. Address: Semiconductor Product Div., International Rectifier Corp., 233 Kansas St., El Segundo, CA 90245.

ELECTRONIC DEVICES SOLID-TUBE® DATA BROCHURE

Electronic Devices, Inc., has added a new model to its Solid-Tube line of silicon solid-state plug-in rectifier tube replacements. You can learn more about it (and the other Solid Tubes in EDI's line) by writing for the four-page Form No. C-372-10, which gives the vacuum-tube numbers it replaces. Address: Electronic Devices, Inc., 21 Gray Oaks Ave., Yonkers, NY 10710.

CAMBION COMPONENTS CATALOG

The Cambion XQ Components Catalog (No. 31001) illustrates various Cambion components available through retail outlets. Items listed include terminals, jacks, plugs, knobs, handles, battery holders, IC sockets, IC breadboards, coils, chokes, etc. Most of the items listed are ideal for hobbyist and experimenter prototype project building. For a copy of the catalog, write to: Cambion, Dept. XQ, 145 Concord Ave., Cambridge, MA 02138.

1974 ANSI STANDARDS CATALOG

More than 8600 domestic and international standards for all areas of industry are listed in the new 1974 American National Standards Institute's catalog. This 176-page catalog contains all ANSI-approved standards and such international standards as adopted by the ISO, IEC, and CEE as of the close of 1973. The standards cover almost every area in which standardization must be used, including the electrical and electronics fields. Also listed are special ANSI publications. Address: American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

Electronics Library

PRINCIPLES AND PRACTICE OF ELECTRONIC MUSIC

by Gilbert Trythall

A fundamental approach to understanding the new sound sources, this book starts off with basic acoustics. Then it proceeds to tape techniques and the form and notation used in electronic music. The technical chapters cover basic principles of electronics, circuits used in electronic music, function and operation of EM blocks.

Published by Grosset & Dunlap, 51 Madison Ave., New York, NY 10010. 214 pages. $7.99 hard cover; $6.95 soft cover.

ELECTRICAL TECHNOLOGY

by T. Baitch

This book is written for students in the first year of any course leading to a technician qualification in electrical engineering, electronics, and allied fields. It covers, in particular, direct-current phenomena. The first chapter leads off with fundamental concepts. The next three chapters deal with electromotive force (emf). Then Ohm's Law is introduced, and the text takes off with discussions on resistance, energy and power, network theorems, magnetism and induction.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 502 pages. $18.50.

EXPERIMENTS WITH A HELIUM-NEON LASER, Second Edition

This is a reference manual and experiment guide for use with He-Ne lasers and optics education kits. It begins with the theory of laser operation, then goes on to explain what a laser is. This is followed by 26 experiments that can be performed with the laser and accessories. Among the experiments presented are: an ophthalmology test, polarization effects, measuring the index of refraction of glass, measuring critical angles, Foucault knife-edge test, Lloyd's mirror experiment, the elementary form of the Michelson interferometer, holography, measuring the speed of light, etc.

Published by Metrologic Instruments, Inc., 143 Harding Ave., Bellmawr, NJ 08030. Soft cover. 59 pages. $5.00.

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LOWEST Prices Electronic Parts. Confidential Catalog Free. **KNAPP**, 3174 8TH Ave. S.W., Largo, Fla. 33540.

ELECTRONIC PARTS, semiconductors, kits. **FREE FLYER**. Large catalog $1.00 deposit. **BIGELOW ELECTRONICS**, Bluffton, Ohio 45817.

PYROTECHNICAL chemicals, casings, tools, fuse, literature, supplies. Catalog——50¢, with samples—$1.00. Westech, Box 593, Logan, Utah 84321.

Led Readouts with Internal Logic

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7407 — $ .29	7442 — $ 77	7492 — $ 89	74174 — $1 95
7408 — $ .23	7447 — $ 95	74121 — $ 49	74181 — $3 50
7409 — $ .29	7448 — $ 95	74123 — $ 95	74192 — $1.39
7410 — $ .23	7473 — $ .39	74150 — $1.39	74193 — $1 39
	7474 — $ 39		

IC Breadboard Panel

Removed from computers. Consists of an Augat panel with 210 14 pin wirewrap sockets. Also has 44 — MV-50 Led lamps. Board has also 2 oscillators, one is a CTS — Knights unit at 4 000000 MHZ. and the other is 2,000 HZ ± 1° tuning fork osc. Both are set up to work on 5v DC. There is also a Beckman 10v reg IC. Original cost on these units was $750. Our price is $12 50 ea.

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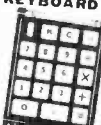

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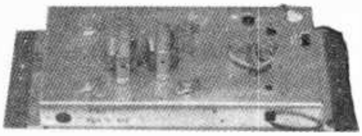

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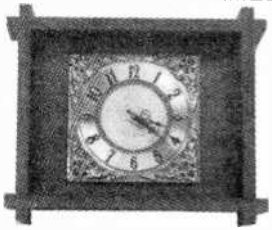

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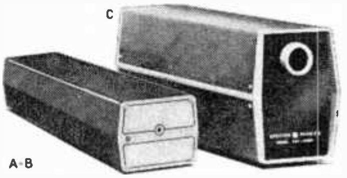

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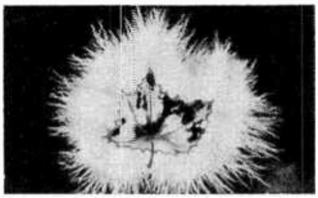

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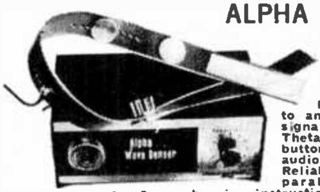

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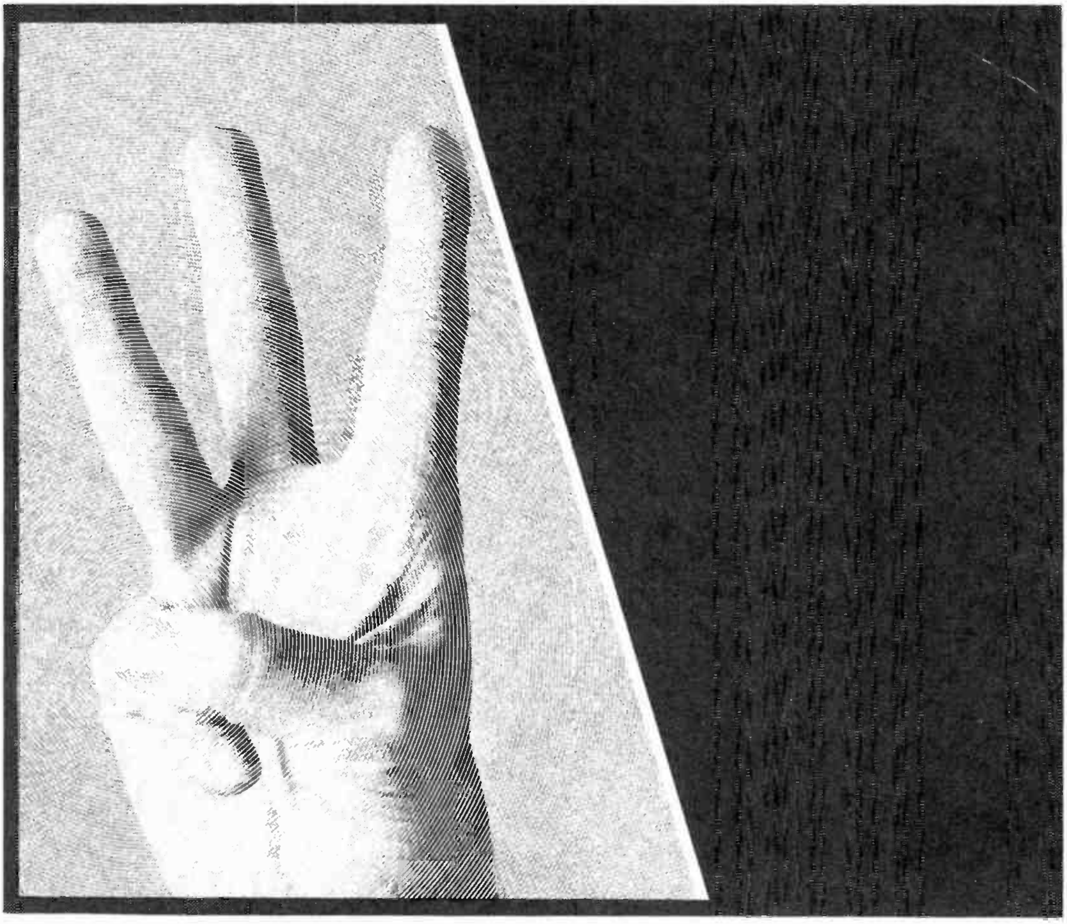

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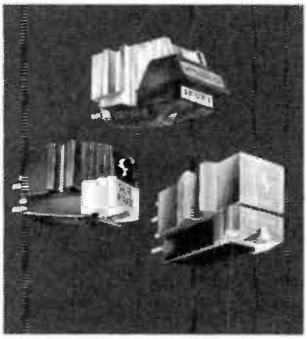

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