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1973 ANNUAL CUMULATIVE ARTICLE INDEX

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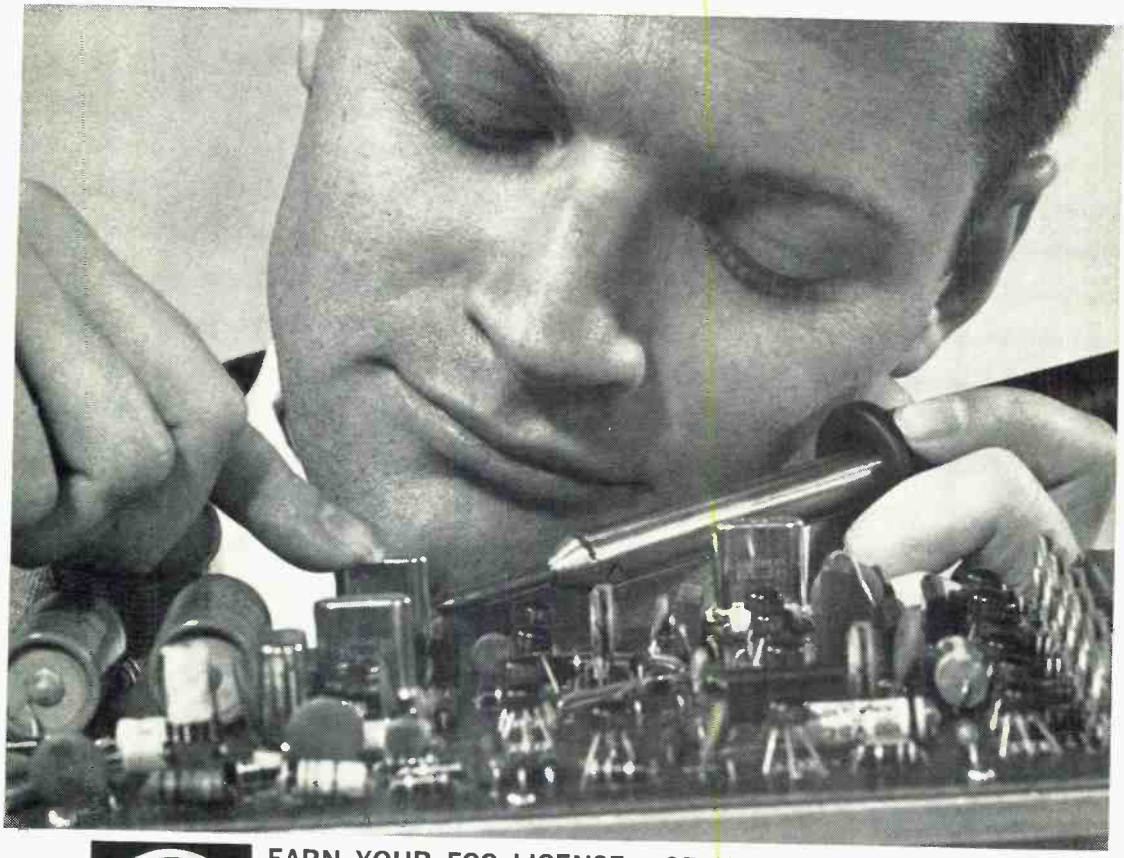

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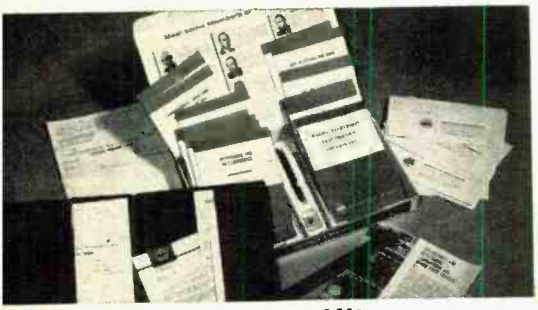

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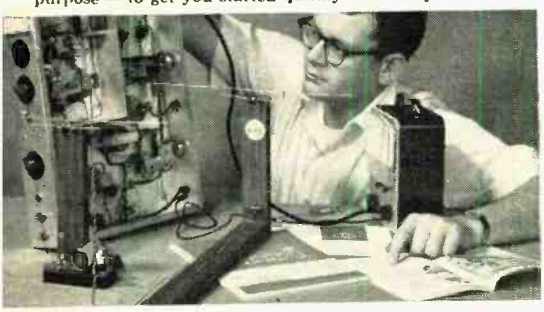

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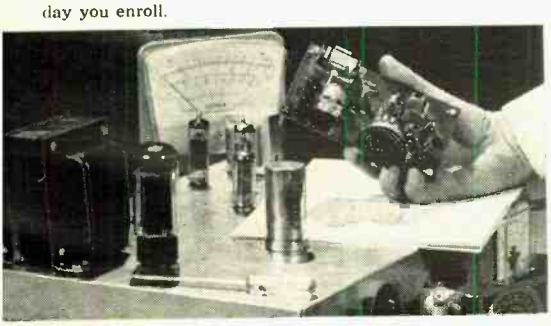

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VOLUME 4 NUMBER 6 DECEMBER 1973

Popular Electronics

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Editorial

By Milton S. Snitzer, Editor

THE ELECTRONICS SEER

As 1973 closes, we look ahead to the new year. What will it bring in consumer electronic products and devices? How will it affect the editorial content of POPULAR ELECTRONICS?

With a report in our hands predicting that 4.78 million solid-state *digital* watches will be sold in 1980, you can be sure that PE will cover this exciting new product. In our next issue, in fact, we will feature a do-it-yourself electronic digital wristwatch!

The "mini" electronic calculator market, which took the U.S. public by storm in 1973, will doubtlessly follow its upward thrust in '74. Thanks to MOS chips and high production, prices will be driven lower than ever. More and more companies will enter the field. For example, National Semiconductor is marketing its own $39.95 six-digit calculator; others are shooting for 8-digit, four-function "teaching machine" calculators at under $30 by next fall. With MOS metric conversion chips already on the market, metrication calculators will surely exhibit substantial growth in '74.

Slow-scan TV now has a foothold with radio amateurs (August 1973, POPULAR ELECTRONICS). Sight with sound promises to grow as additional manufacturers enter the field. Watch PE in '74 for an exciting SSTV "first."

Automotive electronics will display a sharp increase in '74 A potpourri of automotive electronics applications you can try out for yourself will be presented shortly in PE so that your older car can be modernized.

Integrated circuits in the four-channel hi-fi field will be very much in evidence in '74 for SQ, CD-4 and QS. One-chip decoders are not yet in the cards, though. Seems that manufacturers are opting for three-chip designs which are, at this time, more economical than the single-chip approach. More on this in later issues.

Test instruments, too, will be the beneficiary of new devices, as illustrated by our "Super Audio Sweeper" published last October. Price barriers are being broken by instrument manufacturers who were formerly targeting only the professional market. Witness Hewlett Packard's jazzy digital VOM in last month's PE test report; Ballantine and Weston have also broken the price curtain for the non-professional electronic test instrument user. And wait 'til you see what we have for you in the 1974 construction project hopper!

Electronic music is gathering a large following. The growing field will expand in '74 and PE will be right on top of it with Don Lancaster's articles, as well as others.

As a final sign of the times and the future, consider this: a shortage of the lowly 0.1-μF capacitor is holding up present production of calculators.

Best Wishes for a Joyous Holiday Season and a Happy New Year

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BOSE 901 SERIES II

The original BOSE 901 was the product of a twelve year research program on acoustics.* The large sales that have grown from the worldwide acceptance of the 901 now support what we believe is the industry's most sophisticated team of researchers, dedicated to improving home music systems. All forms of loudspeakers, new and old, are studied.

The concepts of direct and reflected sound, acoustically-coupled full-range speakers, active equalization, and flat power radiation have emerged from the research as fundamental for optimum music reproduction. We doubt that these will change.

However, what is changing is the accuracy with which we can realize these concepts in a producible speaker design and the adaptability of the design to a wider range of home environments. The 901 SERIES II represents the combination of all the technological advances that have emerged from our research department over the past five years.

The 901 SERIES II features a completely new equalizer design. It provides a type of equalization for program source variations not available on other speakers. The new equalizer also enables the 901 SERIES II to adapt to a much wider range of room environments. The 901 SERIES II can even be played in front of drapes and still reproduce music with the proper frequency balance.

The new cone formulation in the 901 drivers provides an unprecedented uniformity of response. BOSE now employs a blue coloring and the BOSE logo to distinguish the basic cone material for special quality control measures, starting right with the manufacture of the cone material.

The 901 SERIES II carries a FIVE-YEAR warranty covering parts and labor on both the electronic active equalizer and on the speakers.

BOSE 501 SERIES II

The Design Goals of the new 501 SERIES II:
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*If you would like to know about the research that developed the 901, and about the state-of-the-art of sound recording and reproduction, you will want to read Dr. Bose's articles in the June and July '73 issues of TECHNOLOGY REVIEW. A 20 page combined reprint of these articles is available from BOSE for $.50. Also we'll send you a complimentary copy of the 16 page, full-color 1801 amplifier brochure and information on the new BOSE 901 and 501 SERIES II speakers. Write Dept. EP, and request the "complete literature package."

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ELECTRONIC MUSIC IC

The article on electronic music in your October issue was just fine. I hope there will be more on this same topic in later issues. I am having some trouble with the construction of one of the pitch generators shown on page 37 however. I simply cannot locate a source for the Intersil 8038 IC that is specified. Any ideas?

STEPHEN MILLS
Brooklyn, N.Y.

The 8038 shouldn't be all that hard to find. For example, you might try Photolume, 118 East 28th St., New York, N.Y. 10016. Price of the IC is $5.75 postpaid in U.S. only. N.Y. residents add 7% sales tax.

MONUMENTAL GOOF

In the August 1973 Stereo Scene, Mr. Holt has pulled off what is probably the most monumental goof in history. In answering a question about bias compensation, he states . . . "more distortion in the right channel indicates excessive bias compensation, which is what you will always get if you try to adjust it using one of those ungrooved 'test' bands." Everything in this sentence is a falsehood. The truth is that more distortion in the *left* channel indicates excessive compensation. Furthermore, if you adjust the compensation using an ungrooved test band, you will get *inadequate* compensation.

Mr. Holt continues to make a fool of himself by stating that the forces acting on a stylus riding on an un-cut disc will cause considerably more skating force than when it is tracing a normal groove. Just the opposite is true.

ROBERT V. HOOKER
Los Angeles, Calif.

Mr. Holt replies: I apologize for writing "right" when I should have written "left". (My adjustment suggestions later in that column were correct.) Mr. Hooker seems to agree with me (and everyone else in the pickup business) that the ungrooved disc will yield a false bias indication. The error, it seems, can go either way for several reasons. Some pickup styli are polished only at the contact points—not at the tip —so their friction on a flat surface can be several times greater than when riding groove walls.

The cartridge mounting angle and position in different tonearms can tend to offset this condition. It appears that there is also a relationship between tracking force and the resulting differences in stylus friction against a flat vinyl surface versus a groove. My observations were stacked by variables of which I was unaware and, in the majority of cases, were found to yield bias figures in excess of that actually needed.

A NEW ALIGNMENT TAPE

In Mr. Holt's "from-the-mail-bag" section of the August 1973 Stereo Scene an answer was given with reference to the availability and sources of magnetic alignment tapes. I would like to inform readers of POPULAR ELECTRONICS that a new source is in the offing. The Magnetic Division of National Intertel has started producing tapes with frequency response tones out to 20,000 Hz on all tapes down to 3¾ ips speed. With this tape, the speed of a tape deck can be determined to 0.50 percent accuracy by one of two systems designed into each tape.

DUANE S. MCQUEEN
Chief Engineer, Magnetic Div.
National Intertel
3225 Interchange St.
Riverside, CA 92501

Interested readers can write directly to National Intertel at the address given above.

WANTS TO START A REACT PROGRAM

Several CB'ers in this area have expressed interest in starting up a REACT program. We have been unsuccessful in finding an address for REACT. Can you help us?

GRETCHEN M. RICE
Petrolia, Pa.

Write to Mr. Peter Kreer, REACT, 111 E. Wacker Drive, Chicago, IL 60601.

ANOTHER ELECTRONIC MUSIC MANUFACTURER

We were very interested in Don Lancaster's October 1973 article on electronic music. It is our belief that modern-day electronics experimenters are into electronic music in a manner similar to that of creative experimenters years ago in radio.

The list of electronic music manufacturers that accompanied Mr. Lancaster's article was incomplete in that it did not mention Electronic Music Associates. We are making a new ring modulator module and custom sequencers, the latter designed to complement large music synthesizers.

HOWARD MOSKOVITZ
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B) Heathkit AA-2005 4-Channel Amplifier . . . 179.95*

For the 4-channel purist, the 100-watt amplifier section from the AR-2020 with integrated pre-amp and complete control package. The AA-2005 also gives you built-in encoder circuitry to handle all the matrixed 4-channel material currently available. The sophisticated front-panel control section provides access to 25 watts of music power per channel in just about any combination you can imagine, including stereo and mono modes. Individual level controls, plus a master volume, further enhance the flexibility of the AA-2005. Modular solid-state design with plug-in circuit boards simplifies assembly and makes trouble-shooting a breeze. And the slim-line cabinet is part of the bargain. Mailing weight, 28 lbs.

C) Heathkit GR-104C 12V black & white TV . . . 129.95*

One of the most popular kit-form TVs ever — now with total detent tuning on all UHF and VHF channels so you lock-in on each station the first time, every time. Plus the 104C retains all the great features that make it the number-one kit-builder's portable. All solid-state circuitry with "up-front" speaker and secondary controls. Go-anywhere capability lets you use it in the home, on the road with the 12-volt adapter supplied, or outdoors with optional rechargeable battery pack. The high-impact beige and black cabinet has built-in carrying handle, UHF and VHF antennas. But best of all it's a TV you can build — in six enjoyable evenings — so you know how it works and how to keep it working for years. Mailing weight, 35 lbs. Optional battery pack and sun shield, Kit GRA-104-3, 9 lbs., 42.95.*

D) Heathkit GD-1150 Ultrasonic Cleaner . . . 54.95*

This newest idea in labor-saving electronics makes quick work of items you hate to clean. Art and decorator paint brushes, intricate jewelry, watches, glasses and contact lenses, dentures — just about anything except pearls and plastic. Just fill the tank with a safe detergent or solvent, set the 0-5-min. timer and switch the unit on. Ultrasonic waves generate millions of tiny cleansing bubbles in the solution and force them into every little corner . . . Uniquely gentle, you can use it for all those delicate valuables. And in Heathkit-form, Ultrasonic cleaning is a great buy, too. Build your GD-1150 in one or two easy evenings. All components mount on just one board. Mailing weight, 5 lbs.

E) Heathkit/Thomas Organs . . . 995 and 1045*

The most beautiful organ kits we have ever offered. And they sound as magnificent as they look. The TO-1260 series takes the successful Heathkit/Thomas collaboration to a new musical high. Features include two 44-note over hanging keyboards, and a 13-note Radial Arc pedal board. Behind the soaring stereo sound are two powerful 35-watt rms solid-state amplifiers and two specially designed wide-range 12-inch heavy duty speakers. Also, there is a convenient accessory panel for quick installation of cassette recorder, earphones and external tone cabinet. Cabinets come preassembled and finished. Contemporary model, TO-1260W, (not shown) $995. Mediterranean, TO-1260M, (shown) $1045. Express freight, 203 lbs. Optional Rhythm Section, TOA-60-1, 5 lbs., 249.95*.

F) Heathkit ID-1390 Digital Thermometer . . . 59.95*

Now digital electronics can tell you the temperature indoors and out—accurately, unmistakably. The new ID-1390 continuously monitors two different temperatures at sensors placed inside and outside your home. A rear-panel switch lets you set the bright digital readout to alternately display indoor and outdoor temperatures at four second intervals, or to continuously show just one temperature. A second switch sets your electronic thermometer for Fahrenheit or Centigrade readings. Display includes plus and minus and indoor/outdoor indicators. Includes 85 feet of cable and two sensors. (Styled to match Heathkit Digital Clock $54.95). Mailing weight, 5 lbs.

G) Heathkit ID-1290 Home Weather Station . . . 89.95*

Now you can build your own professional-type home weather station — at kit-form savings! The new ID-1290 features 5 functions, solid-state circuitry, plus weatherized wind-cup & wind vane that mount in minutes to your TV mast or anywhere handy. Barometer has special movement with 2½ times greater pointer deflection — shows as little as .02 in. of change without squinting. 8 compass points light up on the wind direction indicator to give you 16-point resolution. Wind speed indicator has switch-selected 0-30 and 0-90 mph ranges for more accurate readings. And the thermometer gives you the temperature indoors or outdoors at the flip of a switch. Handsome simulated walnut housing with black & gold instrument cluster mounts either vertically or horizontally on wall, or sits on desk with end panels provided. Kit includes informative weather book — goes together in just a few evenings. Mailing wt., 9 lbs. 50 ft. cable, 5.95*, 2 lbs.; 100′, 9.95*, 4 lbs.; 150′, 14.95*, 6 lbs.

H) Heathkit IC-2006 Pocket Calculator . . . 69.95*

This battery-powered beauty is less than one inch thick yet performs all mathematical functions with results up to eight digits. A constant (K) switch permits fast repetitive work when multiplying or dividing. ⅛" LED display reads-through bright and clear with no distorting magnifier. Uses readily available 9-volt battery or optional AC converter for desk-top operation. It's a rewarding stocking stuffer for businessman, housewife or student. Mailing weight, 2 lbs. GRA-43-1, AC converter, 1 lb., 3.95*.

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CIRCLE NO. 19 ON READER SERVICE CARD

Stereo Scene

By J. Gordon Holt

Record Player Trouble-Shooting

THE AVERAGE non-audiophile is often taken aback by the audiophile's constant state of frustration with his hi-fi system. "Why," the former asks, "would anyone pay $800 or more for a music system and then moan about its imperfections?" Said non-audiophile doesn't know the rules of the game. High fidelity *is* frequently a state of dissatisfaction. It was (and is) a pursuit of reproduced perfection; and, with some people, it doesn't exist without dissatisfaction about the state of the art or the state of one's own hi-fi rig.

For example, state-of-the-art disc reproduction is extraordinarily good—the next best thing, according to some perfectionists, to hearing an original master tape. But most of us own phono units which display some shortcomings. This is often the result of fairly simple malfunctions which can be remedied at little or no cost. Here's a listing of some of the problems, and what you can do about them.

Wow. Wow is defined as "cyclical speed variation occurring at a slow repetition rate." One thing on a turntable that can cause slow-speed variations is the platter bearing. Wow is not, however, as widespread a problem as many think, for there is a common belief that you can *see* turntable wow as shifting bars on a strobe disc pattern. However, you frequently can't. What *looks* like wow on a strobe pattern may be due, not to turntable irregularities, but to imperfections and imperfect centering of the strobe pattern itself. The illuminated strobe patterns on some turntables, and the strobe discs sold by accessory manufacturers, like Robins and Audiotex, are for determining whether the *average* platter speed is correct. They are not intended for any other purpose and should not be so used.

A strobe must, incidentally, be viewed under illumination that is flickering at the ac line frequency, which means daylight illumination is out. An incandescent lamp will suffice if the strobe is shielded from natural light, but the best viewing source is a fluorescent lamp or one of those little neon lamps sold specifically for the purpose, usually by the same firms that supply strobes.

Okay then, how *do* we test for wow? Since few of us own wow and flutter meters, our best approach is to play a disc with some sustained piano chords, and listen for once-per-revolution pitch changes. Or, we can use an even more critical listening test, a recording of a high-frequency tone. Whatever you use, the grooves *must* be precisely concentric or you'll have the same problem as with a strobe: an indication of wow where none exists.

If the pickup, viewed from directly above, shows *any* visible side-to-side swing, you'll hear wow from even the most constant-speed turntable. Warpage of the test disc can cause audible wow from some tonearm designs, although it generally takes much more warp than eccentricity to be audible. The listening test, in other words, is valid in one direction only. If you hear *no* wow from it, the turntable (and test disc) is perfect; if you *do* hear some wow,

it could be the fault of the table *or* of the test disc.

If you suspect a turntable-wow problem, remove the platter and clean the bearing and its well with a lintless cloth (push it into the well with the eraser end of a pencil), being careful not to lose the ball bearing that some models have at the bottom of the well. Then relubricate as recommended. If you still have wow, let the manufacturer or a service technician cope with it.

Flutter. This is "cyclical pitch variation occurring at a rapid repetition rate." It is best detected by ear via the same signal sources used for checking for wow, but there's no need to worry about record concentricity when listening for flutter. As before, though, the test is valid in one direction only. If no flutter is audible, the turntable is perfect. If some *is* audible, it could be the turntable or it *could* be the disc, since some test discs are cut from a master tape which may introduce more flutter than your turntable. So if your turntable flunks the flutter test, try a sampling of other discs with sustained piano tones on them. If they all flutter, and the flutter always has the same repetition rate, it's the fault of your turntable.

The probable site of the flutter is usually indicated by its repetition rate. Extremely high-speed flutter, with a rate equivalent to the vibrations of a bumblebee's "Zzzzz" sound, may be due to very severe platter spindle problems (in which case it is always accompanied by a bad case of rumble) or to a frayed or stretched drive belt. High-speed flutter, with a repetition rate of a rolled-on-the-tongue "Brrrr," generally indicates dirt or wear on the drive-motor pulley, dry or worn motor bearings, or a bent pulley shaft. Dirt can be seen as black patches, bearing problems can usually be felt as vibration of the motor, and a fingernail placed against the pulley surface (with motor running) will reveal any eccentricity.

Rumble. Most good turntables are so designed that the majority of their rumble occurs at a subsonic frequency, which is a mixed blessing. The good news is that it is rarely audible as rumble. The bad news is that, although generally inaudible, it can cause other system problems which *are* audible but which don't sound like rumble and are thus harder to diagnose. True rumble is more often seen than heard, as fluttery pumping motions of a woofer speaker cone.

If the speaker has pronounced low-frequency distortion, the rumble may be audible as a breathy fluttering sound. More often, though, the only audible effect is a subtle muddying of bass reproduction, plus a failure of the amplifier to put out as much signal power as it *should* be able to (because of the power wasted in driving the woofer at subsonic frequencies). Usually, it takes a spectacularly poor turntable to produce this much rumble, although one thing that can help to magnify the problem is the (mis)mating of an arm and pickup which happen to resonate at the same frequency at which the turntable's rumble occurs. Changing either the arm or the cartridge will usually kill that proclivity.

A pulsating, booming rumble, usually recurring once or twice per platter revolution, is often due to a bad platter bearing or a slipping or rubbing drive belt. In most belt-driven turntables, proper centering of the belt in the motor pulley depends on the alignment of the motor as well as on the correct positioning of one or more belt-guide yokes. If the motor is crookedly mounted or a guide is misplaced, the belt will rub on the guide, causing rumble. Fortunately, many belt-driven turntables have an outer platter which can be turned over and placed upside-down on their inner platter, thus allowing you to observe the alignment of the belt while the turntable is running. If the drive belt is not centered on the motor pulley when the table is running, the motor is probably crookedly mounted, and you should check for a loose mounting screw or for tension on one of the wires going to the motor. If the belt is centered on the pulley but rubbing on the guide yoke, bend the guide until it just clears the belt. Don't try to center the belt in the guide, as some clearance at the other edge may be necessary to accommodate position changes for speed switching.

In the vast majority of cases, rumble problems are *not* the fault of the turntable, but are the result of incipient acoustic feedback, which has several identifying characteristics. First, it seems to appear suddenly when the listening volume is advanced to a certain point, and then increases in volume *more rapidly* than the music when the volume is advanced further. Second, it tends to make the bass in the program material sound boomy, and the higher the listening level, the boomier the bass. And third, the

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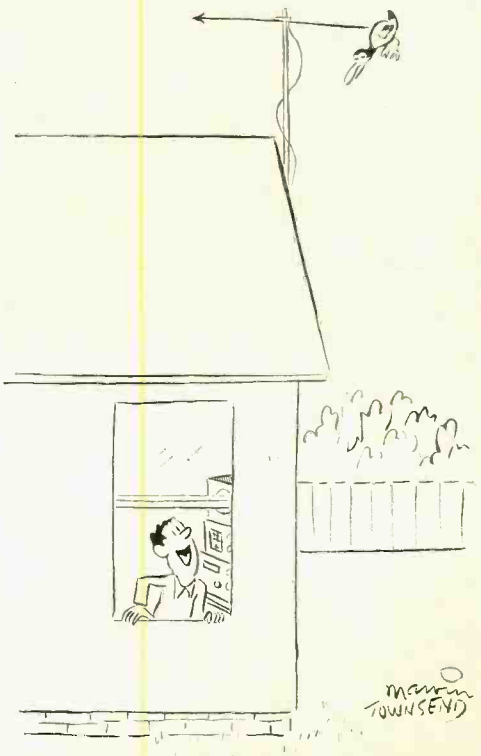
dead giveaway is that, when the volume is advanced to a certain point, feedback rumble will start to become self-sustaining, sometimes continuing to build in intensity until the entire program is submerged in a room-shaking boom or shudder.

It should be noted that virtually *all* phono systems can be persuaded to produce acoustic feedback if there is enough available reserve range on the volume control, just as you can get audible hum, hiss or burbling noises from most phono preamps by turning the gain up way past the normal listening range. For practical purposes, your concern is whether or not there is audible indication of incipient feedback at the volume-control settings at which you normally listen. If there is, don't blame rumble on the turntable drive; it is due to feedback.

There are two paths by which acoustic feedback from a loudspeaker can reach the phono pickup. One, against which most turntables are adequately protected, is by way of the room's floor and thus up into the cabinet or the shelf housing the phono unit. The other, which few turntables are designed to resist, is vibration of the entire "floating" platter-and-motor-board assembly by *airborne* sound waves. A clue to which path is causing a feedback problem is provided by the frequency at which the feedback occurs. Very low-frequency feedback, characterized by fluttering or shuddering rumbles, is generally floor-borne. Higher-pitched booming or grumbling noises are generally the result of airborne feedback. Another check on the source of feedback involves pressing down on the suspended system until it bottoms on the turntable base. If the problem is floorborne, this will make the feedback worse. If it is airborne, this will *reduce* the feedback. And that suggests the solution to either one.

If the feedback is floorborne, it can be reduced or eliminated by providing additional vibration-isolation for the phono unit, via one or two layers of foam rubber between it and the surface it is mounted on. (If you're raising an entire phono player with base, put a sheet of masonite or plywood between it and the underlying isolation layers to avoid closing off the ventilating holes in its bottom panel.) If the problem is airborne, you may be in trouble. Sometimes, screwing down the isolating springs until the floating suspension is bottomed on the base will alleviate the problem, as the mass of the base is then added to that of the suspended system, changing the resonance of the vibrating system. Sometimes, moving the phono unit to another part of the room (for instance, a part where the bass sounds weakest) will do the trick. Occasionally, it may be necessary to replace either the phono pickup or the tone arm, in order to change the system resonance to a frequency where "reception" of the loudspeaker output is less efficient.

A viscous-damped tonearm may be the best solution to a knotty airborne-feedback problem, for it prevents the resonance between the stylus compliance and the tone-arm mass from developing the sharp peak which invites feedback problems. And if you must listen to a phono system at very high levels, it may even be necessary to remove the entire phono unit (and the preamp, because you can't run long cables between them) to another room of the house. ◈



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SPECIFICATIONS

Frequency Response:	10 Hz to 30 kHz
Channel Separation. Nominal:	35 dB
Tracking Force:	¾ gram, +½ gram, −¼ gram.
Nominal Output:	4.4 mv
Stylus Tip:	0.0002" x 0.0007"

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SPECIFICATIONS

Frequency Response[2]:	10-50,000 Hz
Channel Separation:	35 db
Tracking Force[1]:	1-3 grams
Output[3]:	3.8 mv ±2 dB
Stylus:	Quadrahedral

Notes:
1. Recommended by manufacturer for optimum performance.
2. When the cartridge is terminated in the recommended load of 100K ohms and 100 PF.
3. Output with reference to 5.5 cm/sec record velocity.

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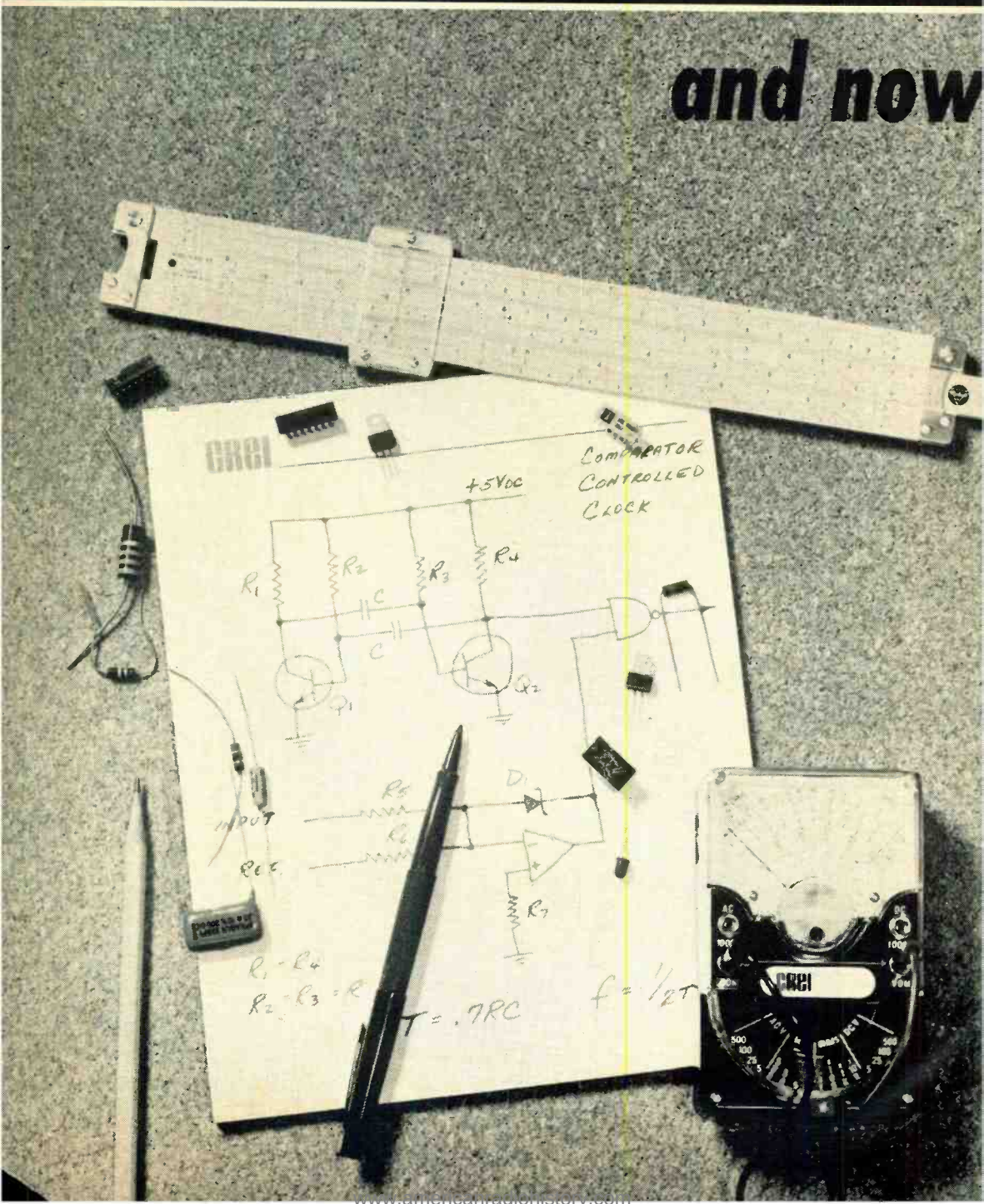

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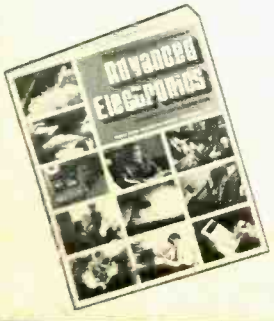

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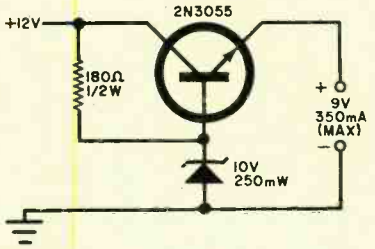
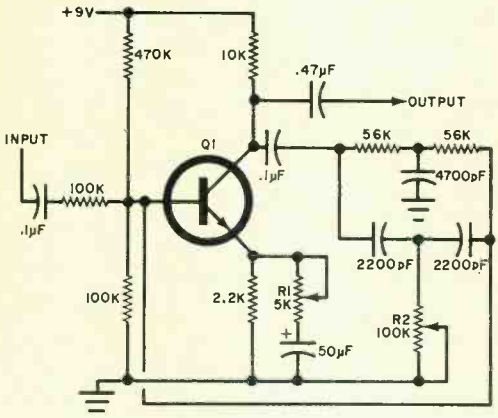
Hobby Scene

9-Volt Regulator

Q. *What's a simple 9-volt regulator for use with a cassette recorder in a car?*

A. Circuit at right will deliver 9 volts at a maximum of 350 mA. For 6 volts, use 330 ohms and a 6.6-volt zener; for 7.5 V, use 270-ohms and 8.1-volt zener.





Waa-Waa Circuit

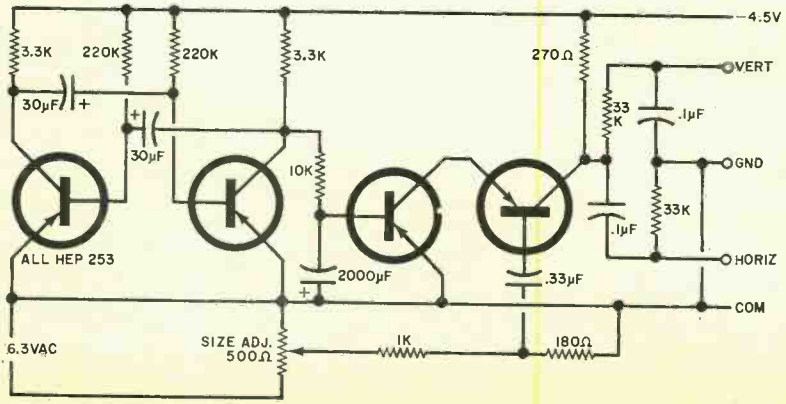
Q. *Can you show me a simple circuit that produces the "waa-waa" effect heard with certain rock groups?*

A. Though not the best of circuits, the one shown at left will work. Use a high-beta (150) transistor for *Q1*. The guitar input should be about 100 mV. With no signal input, set *R1* for minimum resistance and rotate *R2* until a howl is heard. Leave *R2* in loudest howl position and back *R1* down until howl stops. There should be no howl when *R2* is moved over its complete range.

Spooky Effects

Q. *Many horror movies use a scope-like device to produce "hypnotic" waveforms. Are these things real, and can I duplicate them?*

A. We can't divulge the origin of this circuit, but try it on your scope. You can use npn types by reversing voltage and capacitor polarities. Try it out in a dark room.



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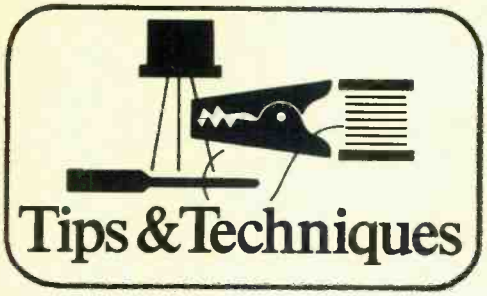


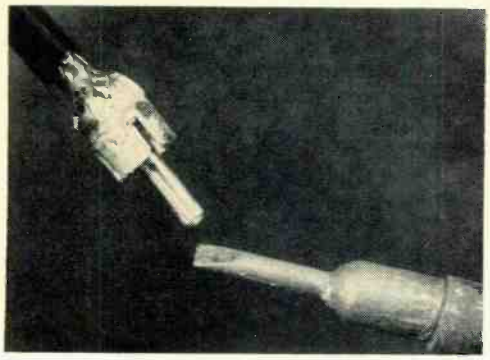
HOT-MELT GLUE GUN FIRMLY ANCHORS BULKY COMPONENTS TO CHASSIS

When it comes to mounting bulky components like can-type electrolytic capacitors, lightweight audio transformers, and the like in a chassis, you can avoid much of the mess and bother of drilling and cutting if you use a hot-melt glue gun. A thick bead of glue along the length or around the perimeter of the component, when pressed into the chassis, will form a heavy-duty bond. Do not, however, attempt to mount bulky heavyweights like power and output transformers in this manner; they will tear loose and inflict disastrous damage. Also, do not use this technique for mounting heat sinks that require chassis sinking.

—Robert M. Perlman, WB2VRW

HOW TO PREVENT CAPILLARY SUCTION WHEN SOLDERING PHONO PLUGS

One of the more annoying problems hi-fi enthusiasts have to contend with is solder being sucked up the center contact of a phono plug



when assembling cables. The thing to remember is that capillary action—aided by gravity if the job is tackled in the usual manner—is responsible. So, the trick is to make gravity work for, not against, your efforts. Hence, when soldering the center conductor of a cable to the center contact of the plug, do the job as shown in the photo, holding the soldering iron below the plug. It helps if you pre-tin the conductor and the inside of the tip contact. Then apply only enough heat and solder to "wet" the connection. *—Marshall Lincoln*

TOOTHPICKS AND ERASER END PHONO CARTRIDGE BLUES

Soldering a cable conductor to the end of a push-on phono cartridge terminal is anything but an enjoyable task. The operation requires some fancy juggling of terminal, cable, solder, and iron. Worse still, almost as soon as the solder flows, it fills in the push-on end of the terminal, and getting it out again is a major operation. You can end these phono cartridge terminal blues with the aid of a toothpick and an eraser. Plug one end of the toothpick into the eraser, and onto its other end, slide the push-on end of the terminal. Now you have only the solder and iron to juggle, and the toothpick will prevent the solder from fouling up the crimped push-on end of the terminal. *—Harry G. Barnett*

SOLDERING GUN DOUBLES AS RESISTANCE SOLDERING TOOL

When it comes to heavy-duty soldering jobs, nothing can beat the resistance soldering method. Forget specialized resistance soldering equipment. If you already have a soldering gun, you can adapt it for resistance soldering without modifying the gun itself. Just remove the soldering tip and replace it with two lengths of the same gauge solid copper wire, gapping them to suit the job to be done. In use, the tip leads go on either side of the connection to be soldered. Then, when the trigger is pulled, current will flow through the joint to generate enough localized heat to permit the application of solder—faster than would be possible with the ordinary tip. *—Jeff Jourard*

PLASTIC PILL CONTAINERS MAKE HOUSINGS FOR HI-FI CABLE INTERCONNECTS

Empty plastic pill containers are well known as small parts storage bins and test probe housings. Now you can add another use to your list: hi-fi cable interconnect housings. To use the containers in this application, first drill a ⅜" hole through their bottoms. Next, drill a hole through their caps, just large enough for a snug fit around the cable, pass the cable through and solder its conductors to the jack's lugs. If the interconnect is to be used in an input line, it is a good idea to line the container with aluminum foil, followed by heavy paper, to provide adequate shielding and insulation. *—John G. Wiegand*

TIPS WANTED

Do you have a "tip" or "technique" that might help your fellow readers? It may be worth money to you. Send it in (about 100 words, with a rough drawing and/or clear photograph, if needed) and you'll receive payment if accepted. Amount depends on originality and practicality. Material not accepted will be returned if accompanied by a stamped, self-addressed envelope. Send material to: Tips and Techniques Editor, POPULAR ELECTRONICS Including Electronics World, 1 Park Ave., New York, NY 10016.

News Highlights

CB Clubs Get Promotional Aid

CB clubs can receive free promotional material to spread the story of CB radio in their communities and promote membership in their organizations. The promotion kit includes an easel display card complete with a hundred explanatory pamphlets, along with a free rubber stamp made with the club name, address and telephone number. The kit also includes a publicity guide for obtaining local newspaper and radio coverage of the club's activities. CB clubs interested in obtaining this free material while it lasts should write their request on a club letterhead and send it with their club address and telephone number to: CB Club Kit, Room 700, 21 E. Hubbard St., Chicago, Illinois 60611. The kit is being made available by the Citizens Radio Section of the Electronic Industries Association.

NEA and NATESA Merger Attempt Fails

A merger or consolidation of the two national electronic service dealer associations was the number one priority item for a recent Kansas City convention. When the time came for a final vote, however, the NEA committee approved the articles of agreement, but were turned down at the NATESA annual meeting by a 3 to 2 majority. NEA went ahead to form a new association without NATESA, called NESDA (National Electronic Service Dealers Association). A few new groups coming into NESDA were formerly members of NATESA. According to NATESA, the total loss of membership due to the merger failure will at most be less than 200. NESDA starts out with 2500 dealer-members plus its technician subsidiary, ISCET, with membership of over 800 technicians.

New Shibata Stylus Production to be Doubled

A patent for the unique Shibata stylus developed by Victor Company of Japan has been applied for at the U.S. Patent Office. This specially shaped stylus was designed for use in the JVC CD-4 discrete four-channel stereo system. Upon obtaining a patent, JVC will immediately begin licensing U.S. diamond stylus manufacturers for the production of the Shibata stylus. JVC also announced that Namiki Precision Jewel Co. Ltd., a Shibata licensee and sole but non-exclusive manufacturer in Japan, is now producing 100,000 Shibata tips each month, sufficient to meet the expanding world-wide demands.

Updated FM Atlas and Station Directory

For those of our readers who do FM broadcast DX'ing, there is a revised and updated second edition of the "FM Atlas and Station Directory." This 80-page atlas includes a listing of FM stations by frequency (with effective radiated powers and antenna heights), as well as geographically. Included in the new book are outline maps showing the FM cities and frequencies of North America along with the station directory giving call letters, comparative station coverage estimates, music formats, stereo and other data on over 3300 FM broadcast stations and translators of North America. Price is $2.50 per copy from FM Atlas, Box 24, Adolph, MN 55701.

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ELECTRONICS IN CAMERAS

BY DAVID F. PLANT AND LEWIS EIGEN

How latest electronics makes the new cameras easier to use.

"YES SIR, it's completely solid-state." The words were those of a salesman, not one selling a hi-fi system, a TV, or a radio, but selling a camera. And electronic cameras are sweeping the market. Just what kind of electronics are going into modern cameras? What do they do and how do they do it?

To begin with, the use of electronics in cameras is directed toward one single and essential purpose: to get the right exposure, or putting it another way, to allow the appropriate amount of light to strike the film for the appropriate amount of time. Involved with this are four variables as shown in Fig. 1:

(1) The amount of light on the subject.

(2) The amount of light which is allowed to pass through the camera lens. (Most cameras have some kind of a diaphragm mechanism which produces a larger or smaller hole in the center of the lens through which light can pass. This is the familiar f-stop number.)

(3) The amount of time that the film is exposed to the light (the shutter speed).

(4) The sensitivity of the film (the ASA or DIN numbers).

Before electronic photography, the photographer had to use his experience, intuition and judgement to determine all the variables, and even with that he usually "bracketed" his shots with greater and lesser exposure shots just to make sure. Electronics, in a sense, brought single-shot photography.

Beginnings of Electronic Photography. In the development of the use of electronics in photography, one of the first steps was to measure the light on the subject (the first variable). The product that did this was a light meter, which usually used a cadmium sulfide (CdS) photocell hooked up to a meter in a bridge circuit. The amount of light on the subject was read and translated into the "appropriate" combinations of the other variables in order to get a proper exposure.

In the following years the light meter became standard equipment for most serious photographers, and electronics entered

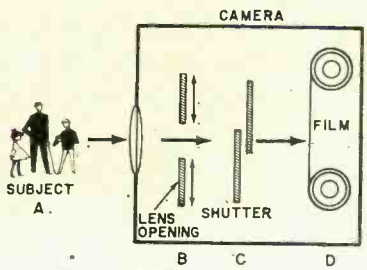
and became a permanent part of the state of the art.

Enter Automation. With electronics accepted as a means of taking better pictures, camera manufacturers then attempted to build the light meter into the camera housing and use its output to control the camera automatically.

The CdS cell was placed on the camera next to the lens so it would always point in the same direction as the lens. The light was "measured" and the bridge circuit was hooked up to an electromagnet. This would move the lens diaphragm blades to make a smaller or larger opening, thus changing the f-stop appropriately. The cameras had a fixed shutter speed and were designed for use with film that had only a narrow range of sensitivity. Unfortunately, in some cases the expense of the electronics put the cost of the camera beyond the budget of the casual user, yet it didn't give the performance required by the serious amateur or professional photographer.

With the evolution of the single lens reflex (SLR), manufacturers placed the CdS cell in the camera itself so it would more accurately indicate the light falling on the film plane. Also another cell was added so an average light level could be found between the two. This system became known as through-the-lens metering.

Ironically this was a step backwards because automation of the camera function was *decreased*. The operator would set his shutter speed, look in the view finder and adjust the lens opening (f-stop) until a built-in light meter needle was centered. At this point he would shoot his picture.



	DESCRIPTION OF VARIABLES	UNIT MEASURE
A	SUBJECT BRIGHTESS	FOOT LAMBERTS
B	APERTURE	f NUMBER
C	SHUTTER	TIME (IN SEC)
D	FILM	ASA VALUE

Fig. 1. Four variables in photography. Electronics can vary lens opening, shutter speed.

While automation was decreased, the elimination of lens aperture from the electronic circuitry together with other general improvements now made the cameras sufficiently accurate to be acceptable to advanced photographers.

The refinements of this semi-automatic type of SLR camera increased with every year and most of the major quality camera manufacturers introduced models using this feature.

Automation and Binary Logic. Using solid-state advances, several manufacturers automated their models by physically connecting an amplified light meter output to the lens aperture control, thus providing analog control of exposure. Although this system may have some shortcomings, there are several fine cameras on the market that use this technique.

The problem is that aperture control requires analog logic—continuous control from lens full open to closed. Not only is this difficult to do accurately, it is also mechanically very sensitive. This system of automatic exposure control is called "shutter priority" because the user manually selects a shutter speed as priority, and the camera selects the correct aperture.

Then a new principle was utilized—work backward! Instead of first selecting the shutter speed and then electronically attempting to match the lens aperture to the lighting conditions, the "new" cameras would require the user to manually select the f-stop (aperture)—or use a fixed f-stop—and the electronics would control the shutter speed.

The shutter is essentially a digital device in that it wants to be either open or closed. Because of electromechanical requirements, it is much easier to control. Simple, but still quite a breakthrough because now there is the possibility that automation can equal or better the accuracy of the old reliable mechanical controls that were considered the peak of perfection by the old pros.

Called "aperture priority" because the user selects the aperture (or uses a fixed preset aperture), this new system certainly has changed a lot of thinking. And, because there frequently is still over-ride provisions for those that want special effects, one now can buy a camera for all seasons.

The electronically governed shutter has

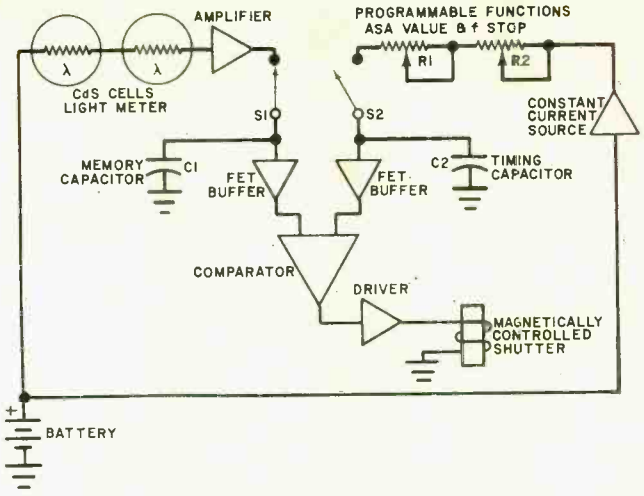


Fig. 2. The principal components that are employed in an electronic exposure system. Voltage on C1 depends on the lighting that is on subject.

its problems, of course. The main and most obvious being that the photographer never knew at what speed he was shooting his picture. Previous cameras had discrete shutter speeds, like 1/60 of a second, 1/125, 1/500, etc. The electronic control might decide that an exposure of 1/173 of a second, or a 1/422 is proper. How does one know? The answer we kept getting was that it wasn't really necessary to know more than a ball park number (which the camera provides) because the camera is accurate and the exposure is repeatable.

By the way, aperture priority offers quite another advantage because additional lenses can be added to the camera and be automatically compensated. Because controlling the aperture electronically is mechanically more difficult—again, the analog problem—the shutter priority cameras can't usually offer as much flexibility.

Looking At the Electronics. With these new cameras a lot happens when you start to press the shutter release. Referring to Fig. 2, "memory" capacitor *C1* is charged through the cadmium-sulfide cells to a precise voltage that depends on subject lighting. This level is then stored and fed to a comparator through a field-effect transistor buffer. As the picture is being taken, *S1* opens and *S2* closes, initiating the shutter opening.

The shutter timing capacitor *C2* then begins its charging cycle, controlled by the externally chosen programmable resistive functions of film speed and an f-stop. When the voltage level of *C2* equals *C1*, the shutter is closed until the next picture is taken.

Simple, yes, but not a one evening project. Removing the bottom plate of our new Pentax ES (see lead photo and Fig. 3) revealed four custom IC's, six potentiometers, several capacitors, and a PC board that wasn't made in the basement. According to the manufacturer's manual, all this electronics will function from −4° to +122°F.

Electronic exposure control has also entered the snapshot and casual user market with very sophisticated and complex electronics. Polaroid has recently introduced a major entry and from what we hear, it is a very sophisticated camera, offering both shutter and aperture control.

The new Kodak entry is a compact camera series called "pocket Instamatics". Some of these include a simple electronically governed shutter while the top-of-the-line models feature a very well designed automatic exposure system that includes both shutter and aperture control, and a host of other features in a camera housing that is one inch thick. And it works very well, too.

Kodak, in designing its pocket Instamatic series, had a much more stringent miniaturization requirement than most other camera manufacturers. As a result, they utilized "flex circuitry", a flexible circuit board composed of DuPont Kapton™ plated with copper. This design was chosen so the circuit could go around the body of the camera and not interfere with the light plane. The flexible circuit is only 8 mils thick, double insulated, yet it provides the mounting for all the electronics.

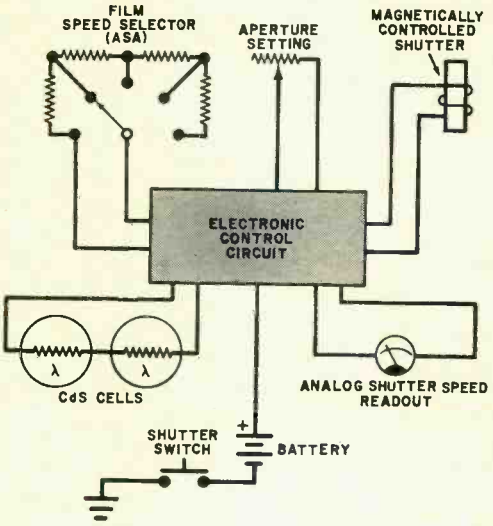


Fig. 3. The simplified electronic interconnections for aperture priority system such as that used in the Pentax ES. The ASA selector and aperture setting both program the camera. The electronics then takes that information plus the stored light meter reading from photocells and calculates the proper amount of time to keep the shutter open for correct exposure. The shutter speed is read out for various apertures (f-stops) on the meter which is seen through the view-finder.

To combat the problem of fading battery voltage (also, in cold climates those little batteries can drop 25% in voltage), Kodak used Schmitt triggers that were set up to respond to voltage ratios, rather than specific voltage levels. This technique works well and down to the very end of the battery. We know this because in lab testing the Instamatic 60 we ran down the battery by making a series of long exposure tests (far beyond typical usage situations) and then grabbed the same battery by mistake for a weekend sail. You can't buy batteries off-shore so we crossed our fingers. We got some great pictures. That voltage ratio technique will probably find additional applications, along with other improvements in the state of the art fostered by photography needs.

What's In The Future? In the next few years we'll probably see refinements and increased dynamic range capabilities with the electronic shutter cameras. In a hi-fi system, the speakers are usually the weakest link in the chain. In the electronically governed shutter camera the weak link is the CdS photocell, because it is not sufficiently accurate at low light levels. In the past, that was less of a problem because low-level photography was mostly empirical. Now, with better film and automatic exposure control, this facet of the art is becoming more common—and the CdS may get lost in the shuffle. The other problem with the CdS cell is that it has an inherent inertia, meaning that at a given moment it is still responding to a previous reading. This can seriously affect very rapid picture taking.

The answer to this problem may be here, depending on the performance of the hardware involved. Fujica has converted to a silicon cell that generates a voltage and is filtered to react to visible light the same way the film does. The silicon cell approach is claimed to be much faster, yet competitive with CdS in price.

Another area in photography that may soon enjoy an advance is meter read-out. The familiar needle in the viewfinder window is somewhat susceptible to mechanical damage and is difficult to see at very low light levels. Conversion to a digital format using light-emitting diodes could possibly save on eye strain. A new Fujica camera uses no less than seven LED's that light up in the viewfinder as they respond to light variations or to changes made in f-stop or shutter speed settings. Each diode represents a difference of one f-stop, the center one indicating the proper exposure.

Rollei, makers of the famous Rolliflex camera, has announced a 2¼ by 2¼ SLR which should come on the market next year. In it, the lens aperture and shutter settings are part of the motor circuits that control them. This technique is called a linear motor (really a solenoid) and can provide accurate analog control.

Historically, camera components were designed as mechanical devices and then electromechanically operated. Rollei has gone back to base one and designed a camera that wants electronic control. The new Rollei is said to operate at twenty times a second, a speed which would seldom be needed.

What else is there? Safe bets are more compact size, lighter weight, improved battery sources, better motorized film transport, and the application of digital logic to metering. One thing is for sure—your next camera will have some electronics in it. ◈

EXPERIMENTS WITH A SHORTWAVE RECEIVER

HERE ARE FIVE ACTION EXPERIMENTS YOU CAN PERFORM WITH YOUR SW SET

BY C.M. STANBURY II

1. The Changing Speed of Light. Most laymen are under the impression that electromagnetic radiation, which includes both light and radio waves (as well as X-rays, ultraviolet, and infrared) travel at a constant speed—a staggering 300,000 kilometers per second. Thus signals from two time stations such as WWV and WWVH should always be the same number of milliseconds out of sync (never more than about 60) at any given listening post on earth. Yet, if you listen to the second "ticks" (each of which is 5 milliseconds in length) on these two stations, you will note that sometimes they almost coincide, sometimes they only partly overlap (thus lengthening the sound) and occasionally two distinctly separate ticks can be heard.

These differences often fluctuate from second to second. A small factor producing these effects is changes in the height of the ionosphere at which the signals are being reflected (more accurately, refracted), thus slightly altering the distances that they must travel to reach your receiver. But most of the change is due to the fact that the speed of electromagnetic radiation is not constant. It varies with the density of the media through which it is passing; and the densities of the ionized layers of gasses in the ionosphere are in a constant state of flux.

To hear both WWV and WWVH at the same time, periodically check 10,000 and 15,000 kHz. On these frequencies, it can happen almost any time of the day or night. Add a tape recorder to document your observations, along with other illustrative props you can dream up (a map showing the locations of your receiver, WWV at Boulder, Col., and WWVH on Kauai, Hawaii, with appropriate distances). This could be the beginning of a good science fair project. Note that when one time signal is received by two drastically different ionospheric paths, similar observations can be made.

2. Set Up Your Own International Weather Office. How closely do weather patterns in

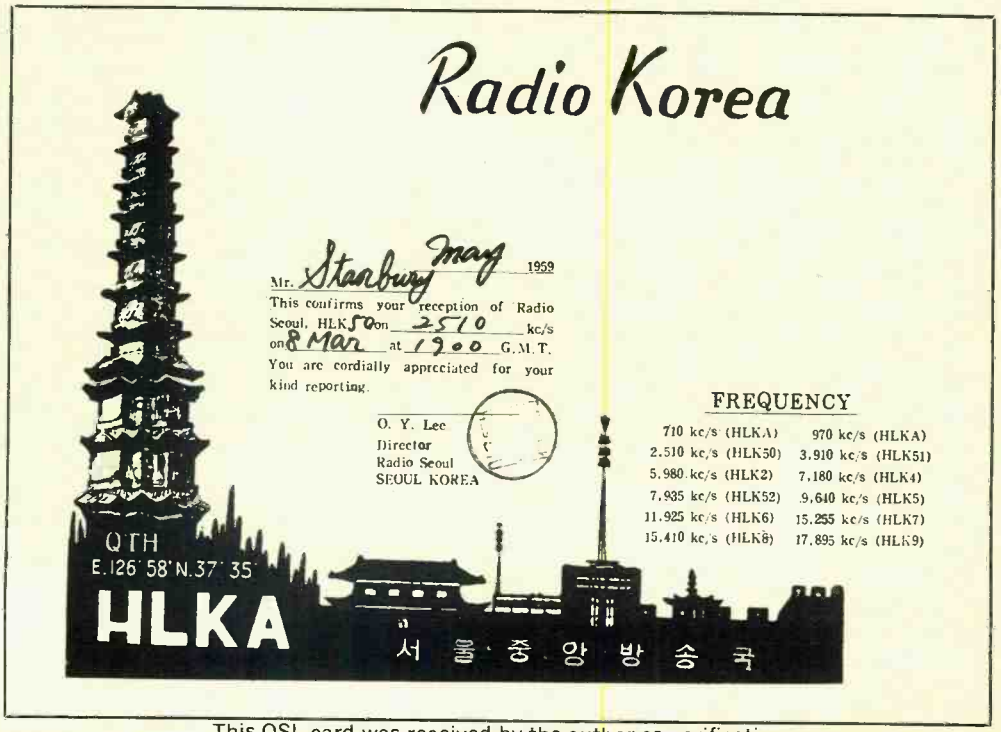
Europe and Asia follow those in North America? Speculation on global weather interconnections, usually linked to the sunspot count, date back at least to the beginning of international communication by radio. In fact, an extensive article on the subject appeared as early as the July 1927 issue of "Science & Invention" magazine. Interestingly, the article dealt with both long-term and seasonal variations in temperatures and precipitation—the areas still worth exploring today.

For example, if there are long-term factors which affect the weather on a global basis, there should be about the same number and frequency of blizzards this winter in the U.S. Pacific Northwest and in western Europe (excluding the Iberian peninsula) because both areas have generally the same sort of climate and should therefore be affected similarly by global and solar cycles. Daily conditions in the Pacific Northwest can be determined from WWV at 12 minutes past each hour or from weather broadcasts of Oakland Aeradio at 5 and 35 minutes past the hour on 2980, 5519, 8905, and 13,344 kHz. Conditions at London and other western European cities can be obtained from Shannon Aeradio on 5533; 8833, and 13,312 kHz on the hour and half hour.

3. Visual Shortwave Reception. Shortwave facsimile broadcasting has been around for quite a while. It has been used by the Navy and other government agencies to broadcast weather charts and similar graphic material, but only recently has equipment been available to the general public for its reception. Now the Xerox 400 Telecopier, intended for reception and transmission of visual material by conventional telephone, is on the scene. While this is the most expensive of the projects we are describing, it also has the most exciting potential. With direct broadcast TV satellites snarled in technical and legal hassles, some are looking at SW facsimile as a possible international visual alternative.

How well can you get your receiver to print those millibars and other weather patterns that are broadcast? And, compared to slow-scan TV, will the cost be reasonable?

Nationally, the Model 400 rents for $59.50 a month with a minimum rental period of three months. Some Xerox of-



This QSL card was received by the author as verification of reception of a Radio Korea broadcast on 2510 kHz.

fices, however, seem to rent for less and sometimes a 9-day trial rental can be negotiated. (One SWL recently paid $45 a month.) The ideal arrangement would be for three or four experimenters to pool their resources.

A facsimile signal sounds like a giant insect chirping (or maybe slightly lower in pitch). Feeding that signal from the receiver into the Xerox 400 is not difficult. Headphones are best because the machine is designed to accommodate a telephone headset. But a speaker can be used and, in fact, we have achieved good results with a small tweeter. One of the headphones (or speaker) should be placed over the 400's earpiece receptacle. To prevent possible feedback, the mouthpiece receptacle should be covered. The receiver's audio level should not be too great as there is a tendency to overload. The 400's manual start procedure is utilized. After a couple of days of practice you should have these mechanics down pat.

A shortwave receiver with automatic volume control is best but a clear frequency is even more important. Unlike the human ear, the Xerox 400 does not distinguish between different audio pitches. Thus, for example, a heterodyne whistle will usually spoil any print you attempt to receive. Therefore, depending on where you live, the stations to start with are either NSS (U. S. Navy at Annapolis, Md) on 3357, 4975, and 8080 kHz (24 hours a day) or NMC (U. S. Coast Guard, San Francisco) on 4346, 8682, and 12,788 kHz at 0445 EST (0145 PST) and on 12,788 plus 17,151.2 kHz at 1645 EST. You might also watch for ITT's facsimile broadcast from Brentwood, Long Island, N. Y. at 1450 to 1650 EST on 17,436.5 kHz (WFK67). Brentwood was formerly the location of a Voice of America transmitter.

4. Charting the Time of the Quiet Sun. Whether or not the sunspot count has a practical effect on the weather, it definitely affects the ionosphere. Once every 11 years, solar activity and sunspots drop to an absolute minimum. Although the next low is not due until about 1976, the ionsphere is already doing strange things to international radio reception.

Between Dec. 1, 1972 and Jan. 31, 1973, the Korean Central Broadcast station at Pyongyang was audible in eastern Canada on 2850 kHz between 1630 and 1730 EST on at least 40% of the dates. Both the frequency and time are very unusual; in the past medium-wave reception from the Far East was virtually unheard of at that time of day.

Does this mean that the effects of the sunspot low will be especially noticeable this time around? If so, as the count drops even lower, one would expect that, on some days this winter, Pyongyang's 2850 transmitter should be audible throughout eastern North America at some time during the 1630 to 1730 EST period. Another one to listen for is the lower-power Korean Broadcasting System ("Radio Korea") at Seoul on 2510 kHz (just above WWV). Scientifically minded SWL's should start keeping records around Dec. 1.

Similarly phenomenal reception in eastern North America was reported on the medium-wave broadcast band last winter. If the experimenter in western North America doesn't have a local station on 1520 or 1530 kHz, he should listen for Radio Peking's Urumchi relay on 1525 kHz (and the Soviet transmitters intended to interfere with it) between 1630 and 1730 PST or MST. If you want to limit yourself entirely to shortwave, reception of transmission from Urumchi during the appropriate time period on 4750 or 4400 kHz can be charted.

5. Monitor Rocket Blasts from Cape Kennedy. If a rocket trail passes across the ionospheric path of a signal to which you are tuned, reception will be affected. The signal will fade, jump or distort because of unusual phase/time-delay shifts. This is the most difficult of our five projects. From news accounts, you must learn the time of an expected launch then find a station whose signal passes near Cape Kennedy on its way to your location. From Boston, for example, a Managua transmitter would be ideal. At night, Union Radio on 675 kHz might do. From Cleveland, the famous missionary station HCJB (Quito, Ecuador) might come close enough.

For this project, a dedicated shortwave experimenter could spend time on maps (or, better still, a well-marked globe) and station lists, finding out which transmitters he can hear and when. Then make up a reference log of any station that falls on or very near the great circle that includes you, Cape Kennedy and the transmitter. Keep checking the frequencies on your list and, with considerable patience, you will gradually build up a workable list of rocket monitoring prospects. ◈

PE TESTED

BUILD A LOW-COST OP-AMP TESTER

TESTS GAIN, STABILITY, INPUT OFFSET AND BIAS CURRENT

BY HARRY GARLAND AND ROGER MELEN

AS OP AMPS become increasingly popular and useful, there is a growing need for a good, low-cost op-amp tester. The universal op-amp tester described here can be used to test virtually all of the popular units. It automatically checks the important parameters and has a red light-emitting diode (LED) to indicate the condition of the op amp.

The parameters which are checked by the tester are gain, stability, input offset voltage, and input bias current. The tester, which itself uses two op amps, can test internally compensated op amps, such as the 741, as well as uncompensated op amps, such as the 709 and 748. Both 8-pin TO-5 and 14-pin DIP sockets are provided.

Circuit Design. Integrated circuit *IC1* is used as a square-wave generator and the op amp being tested is used as an inverting amplifier with gain of 100. The output of *IC1* is applied to both *IC2* and (through voltage divider *R4* and *R5*) to the unit being tested. The output of the latter is applied as a second input to *IC2*, which is used as a summing amplifier.

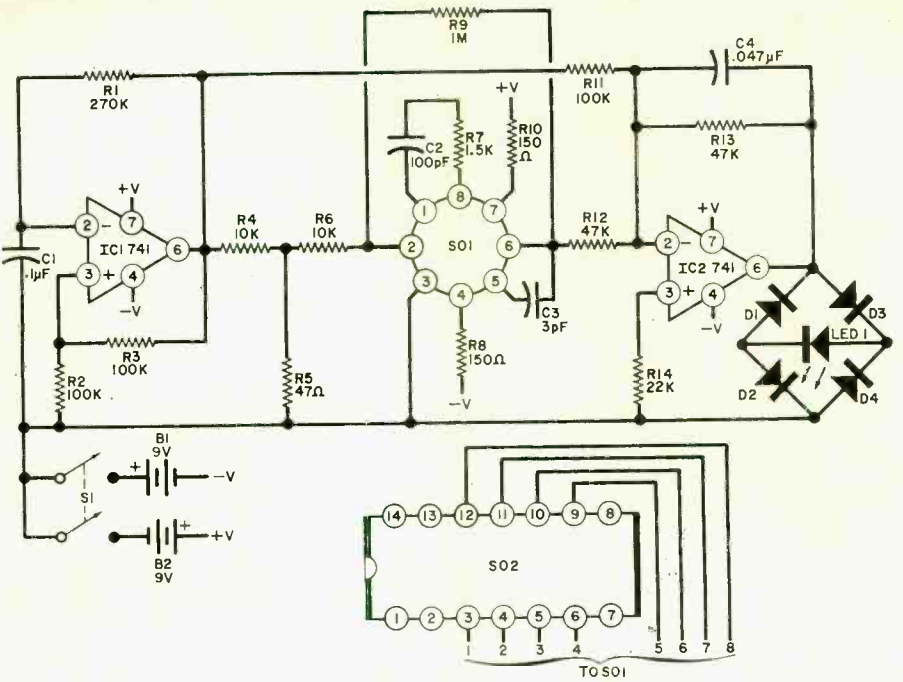
If the op amp being tested is good, its output will exactly cancel the square wave applied to *IC2* through *R11*. When these two signals cancel, there is zero output from *IC2* and *LED1* will not light.

If the op amp being tested is bad, the two inputs to *IC2* will not cancel and *LED1* turns on. Before *LED1* turns on, however, the ouput of *IC2* must exceed the threshold determined by the forward voltage drops of two of the bridge diodes (*D1* to *D4*) and *LED1*. Assuming a failure, this threshold will be exceeded if the op amp has a gain of less than 60, an input offset voltage greater than 30 mV or an input bias current greater than 3 microamperes. Any of the popular IC op amps should have parameter values better than these. Similarly, the LED will turn on if the op amp is unstable in the test circuit or has any "shorts" or "opens."

Construction. Most any type of assembly method can be used for the tester. For the prototype, the components were assembled on two perf boards mounted in a 2⅜" by 4¼" by 3" metal cabinet. Printed circuit boards could also be used.

The two test sockets (*S01* and *S02*) were mounted on one perf board with their associated components, and the board was fixed to the upper inside surface so that both sockets protruded through holes cut in the upper surface.

The second perf board (with *IC1* and *IC2* and their related components) was mounted on the bottom of the cabinet



PARTS LIST

B1,B2—9-volt battery
C1—0.1-μF capacitor
C2—100-pF capacitor
C3—3-pF capacitor
C4—0.047-μF capacitor
D1-D4—1N914 diode
IC1,IC2—741 op amp integrated circuit
LED1—Light-emitting diode (Poly Pak "Brite Red" or similar)
R1—270,000-ohm, ¼-watt, 10% resistor
R2,R3,R11—100,000-ohm, ¼-watt, 10% resistor
R4,R6—10,000-ohm, ¼-watt, 10% resistor
R5—47-ohm, ¼-watt, 10% resistor
R7—1500-ohm, ¼-watt, 10% resistor
R8,R10—150-ohm, ¼-watt, 10% resistor
R9—1-megohm, ¼-watt, 10% resistor
R12,R13—47,000-ohm, ¼-watt, 10% resistor
R14—22,000-ohm, ¼-watt, 10% resistor
S1—Dpdt momentary contact pushbutton switch
SO1—8-pin, TO-5 IC socket
SO2—14-pin, DIP IC socket
Misc.—LMB type 342 cabinet, rubber feet (4), mounting hardware, etc.
Note: The following is available from MITS, 6238 Linn, NE Albuquerque, NM 87108: complete kit of above parts, $29.95 plus postage.

If op-amp plugged into SO1 is good, LED remains off; if not, LED blinks.

with the two batteries. The LED was glued (with epoxy) to protrude through a small hole in the front of the cabinet with *S1* mounted beside it. Four rubber feet on the bottom of the cabinet will keep the tester from slipping around when in use.

Operation. With no op amp in either test socket, depress *S1*. The LED should flash on and off, indicating that the circuit is working properly. To test an op amp, plug it into the appropriate test socket and operate *S1*. If the op amp is good, the LED will not flash.

Any of the popular IC op amps with the same pin configuration as the 709 can be checked. This includes the 101, 301, 740, 741, and 748. Units with other pin configurations, such as dual op amps, can also be tested if extra test sockets are wired in parallel with the existing sockets.

Since different op amps have different specifications, a "good" indication does not necessarily guarantee that the op amp meets all of the requirements. However, for nearly all practical applications, the tester will provide a valuable go/no-go decision. You will find the tester particularly useful for sorting through bargain, untested op amps and for quickly isolating the trouble in an op amp circuit that doesn't work. ◈

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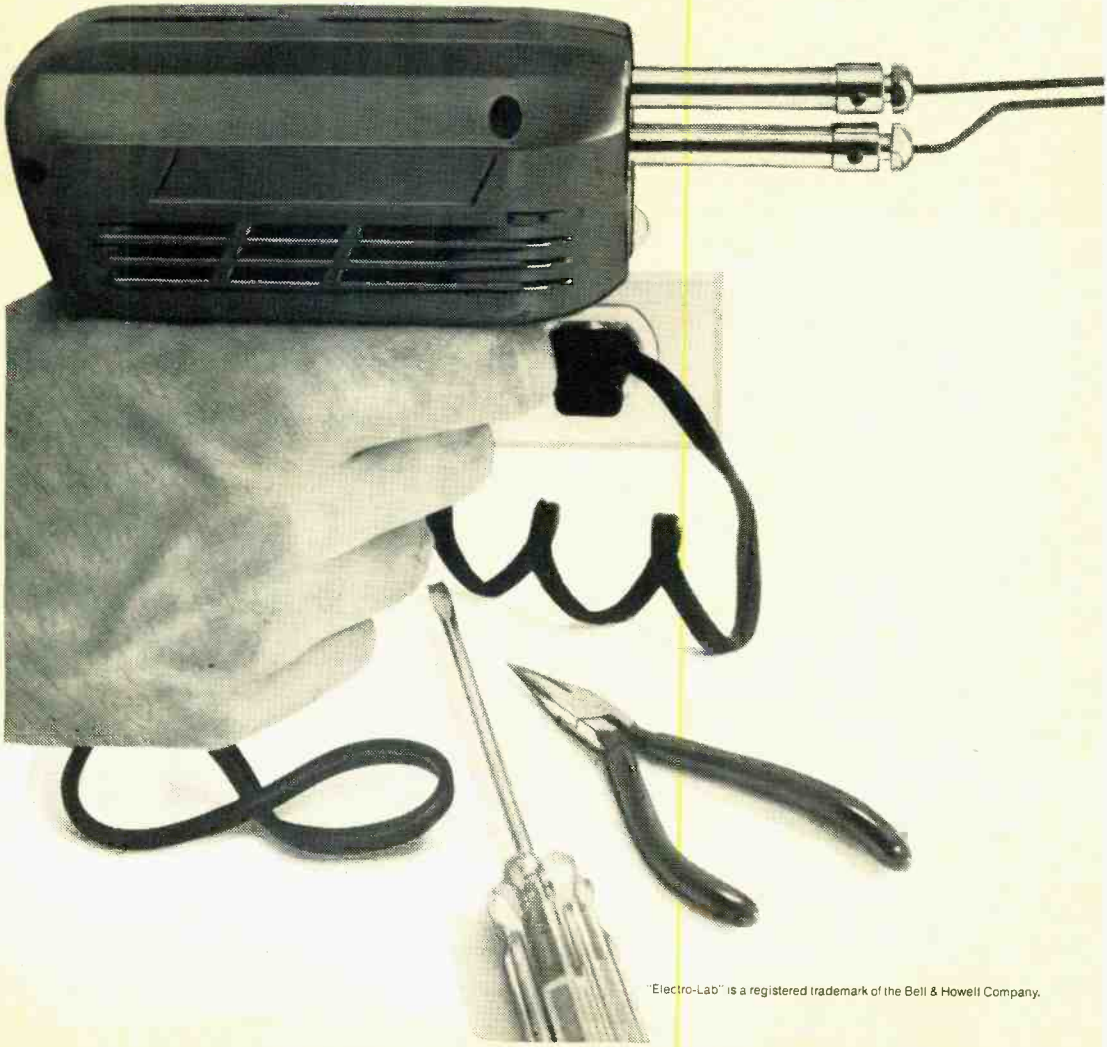

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he common household tools pictured at eft are all you need to start building your wn solid-state 25-inch diagonal color TV. lut that's just part of the enjoyment and liscovery you can look forward to in this omplete learn-at-home program . . . ecause this is the world's first television ourse employing *digital electronics* tech- nology – the remarkable new electronics levelopment that's certain to change all our lives in the next few years!

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SPECIAL REPORT ON HI-FI

POPULAR ELECTRONICS examines the state of high-fidelity components as we move into 1974. Where it has been, where it is at, and where it is going are explored by audio experts.

FOUR-CHANNEL FIRMS UP

Here are the state-of-the-art options available to go quadraphonic now

BY LEONARD FELDMAN

TO PARAPHRASE Charles Dickens, the year 1973 was the best of times, and it was the worst of times—at least as far as quadraphonic sound reproduction was concerned. After three years of flurried activity, partisan promotion of a variety of 4-channel formats, and sales of a variety of program-source material and component equipment, some measure of stability has come to this newest home entertainment sound medium. At the same time, some conflicts, ambiguities, and redundancies continue to exist in both the software and the hardware currently available to the consumer.

Records. In the U.S., the number of available discs issued by Columbia and other companies utilizing the SQ™ matrix encoding technique is greater than that of all other matrixed discs combined. The most recently issued of these display a growing understanding of the musically satisfying effects that can be engineered into such discs. Engineers have learned to take advantage of the desirable characteristics of SQ—full left-to-right separation, stereo compatibility, etc.—and to steer clear of its inherent limitations such as disappearance of center-rear vocalists in mono playback and minimal front-to-rear separation. Second- and third-generation playback decoding equipment has also helped to overcome some of the limitations imposed by the SQ encoding technique.

There still exists a battle between SQ and other matrix techniques, such as Sansui's QS or RM (Regular Matrix). In Japan, the RM format appears on more discs than does any other system, and the QS variation is popular and dominant. Even in the U.S., many records are available using this matrix and more are released or imported each month.

The availability of more than one kind of matrix has complicated matters. Manufacturers of amplifiers and receivers have been forced to incorporate a selector switch and associated circuitry in their equipment to vary playback to suit individual disc requirements.

Though a late entry in the 4-channel disc race, the CD-4, or "Quadradisc," discrete record developed by JVC and RCA promises to constitute yet another major factor in disc competition. For all its faltering starts and problems, CD-4 discs currently being released seem to have substantially improved. There is little doubt that the "discrete" disc is here to stay because so long as matrix systems claim to provide virtually the same separation capability as discrete 4-channel program sources, there will be listeners and manufacturers who will not settle for "virtually" if the real thing can be obtained.

When RCA introduced the Quadradisc, later than they had hoped from a competitive viewpoint, matrixed discs were already widely accepted. Were it not for the desire to get into the marketplace before it was too late, more sober judgment might have induced RCA to wait until all the technological problems were solved. But now the Quadradisc is a viable competitor.

Tapes. In spite of the fact that 4-channel sound can be recorded on open-reel machines with relative ease, the tape format has hardly taken the listening public by storm. The relative paucity of prerecorded open-reel 4-channel tapes has not helped much either. The rapid improvement in cassette deck performance has prompted open-reel machine producers to confine their products to the high-price category, where comparative audible superiority can still be achieved. Certainly, top-of-the-line Sony/Superscope and Teac 4-channel open-reel decks are nearly professional studio recorders, but how many audiophiles are ready to invest the kind of money these machines cost to get the very "purest" kind of 4-channel sound available?

The Q-8 cartridge, another RCA first, is in plentiful supply, but hardware manufacturers have not kept up with technological progress; the average 8-track tape player has just about the same poor signal-to-noise ratio and frequency response capability that have been its limitations from the beginning. That these machines rarely offer recording capability (there are only a few models that can be used for both recording and playing back) has also limited their popularity.

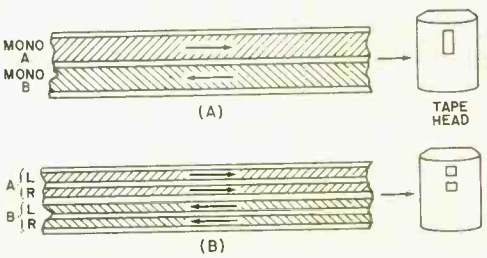


Fig. 1. To maintain compatibility, 4-channel system would have all four tracks arranged to pass over single tape-head gap in mono (A) and two gaps in stereo (B) cassette head.

Cassette decks should have been a "natural" for 4-channel use, but manufacturers have steered clear of the new sound for another reason. All cassette

recorder manufacturers are licensed by Philips Co. of Holland, the original developers. In an effort to popularize the cassette, Philips has always insisted that all cassettes and all cassette decks be compatible with each other. Thus, the mono machine head and tape have their tracks and gaps arranged as shown in Fig. 1(A), while stereo machines and tapes have the track arrangement shown in (B). A mono machine playing a stereo cassette will play the "sum" of both left and right stereo channels in each direction, while a stereo machine playing a mono-recorded cassette will simply reproduce the same program in each channel. In both cases, two-direction use of the cassette is possible.

If four quadraphonic channels were to be recorded in one direction using the presently available four tracks of a cassette, playing time would be halved, as is the case with open-reel 4-channel tapes. Worse, if such a cassette were played on a stereo machine, the listener would hear the two front channels only when playing side A. If he then attempted to play side B, he would hear only the rear channels playing *backwards*!

To retain the total compatibility insisted upon, Philips has suggested that the total number of tracks be increased to *eight*, with four being used in each direction. Manufacturers and tape duplicators, already plagued with the extremely narrow tracks of a cassette, have until recently unanimously resisted this suggestion. Further reduction in track width, besides causing severe alignment problems, would again degrade the hard-fought-for signal-to-noise ratio of tapes and the reasonably good frequency response now available with the better cassette decks. Much of the noise reduction achieved by the Dolby noise reduction system used in many cassette recorders would be offset by such new standards for quadraphonic cassettes. Still, 4-channel sound must and will come to cassettes. Already, JVC has

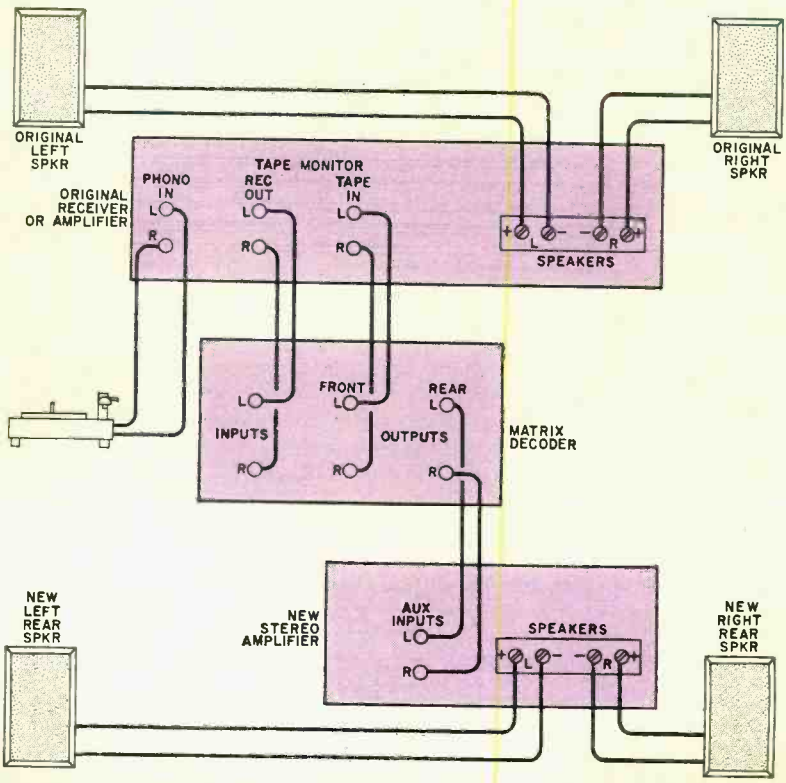


Fig. 2. First-generation quadraphonic hookups used separate decoder connected to the tape monitor jacks of the existing stereo system.

announced the production of a machine that follows the 8-track Philips suggestion. How soon tape duplicating companies will solve the problems implicit in reduced track width is anyone's guess.

FM Broadcasting. Since all matrixed records are basically "2-channel" discs, it has been possible from the outset to broadcast such recordings over the air via stereo FM. The same kind of decoder that extracts four program channels from matrix discs at home works for the decoding of quadraphonic broadcasts, and it works well. Some 200 stations around the country devote all or part of their broadcast days to quadraphonic programming, and more are joining the ranks weekly as the amount of available matrix-encoded music increases.

Because Quadradiscs employ a superaudible pair of carriers, at frequencies ranging from 20,000 Hz to 45,000 Hz, as part of their complex groove modulation, these records cannot be directly broadcast over FM at the present time. To broadcast them, it would be necessary to *first* decode them through a CD-4 demodulator and then to send out the four decoded signals using an as yet unapproved transmission system. The Federal Communications Commission and an industry committee called NQRC are currently studying no less than 10 methods for doing just this. Among the proponents are RCA, GE, Zenith, and Motorola, all of whose "systems" are variations of a method first proposed by Louis Dorren whose company, Quadracast Systems, Inc., has been at the forefront of 4-channel research for more than three years.

Dorren's system is also one of those being considered by the FCC and NQRC. Judging by past performance (it took more than three years to approve the 2-channel broadcast system), it is not likely that approval and standardization of a discrete 4-channel FM system will be

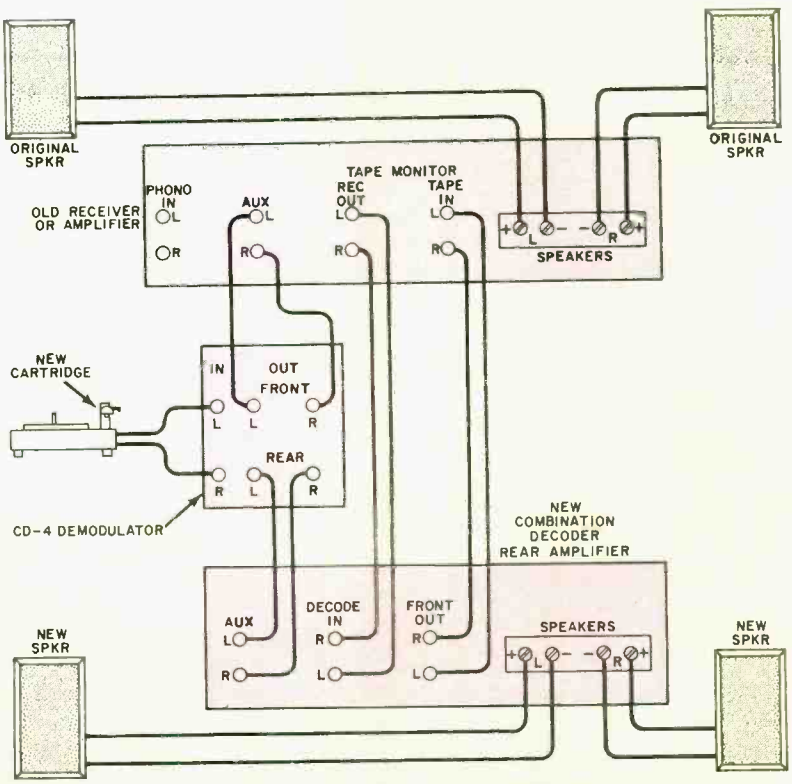


Fig. 3. A combination decoder/amplifier reduced the number of electronic components required—unless you want to add CD-4 disc playing capability.

forthcoming for some time to come. Experiments with Dorren's system conducted in 1971 on the West Coast proved that it worked well. All other systems will be field tested under controlled conditions (now slated for early 1974). Reams of data will have to be analyzed by the FCC and such problems as compatibility, further degrading signal-to-noise ratios, and possible adjacent-channel interference will have to be thoroughly explored. The continued use of FM by SCA services (background music and other private subscriber services) must also be considered since most of the proposed quadraphonic broadcast systems involve changes in those services as well.

Fortunately, all of the proposed systems will lend themselves to adaptation using present FM tuner designs, plus the inevitable "outboard" accessory decoder.

Equipment. In the four years since quadraphonic sound was introduced, four generations of equipment have come to pass. The earliest products were matrix decoders that easily connected to an existing stereo system as shown in Fig. 2. Early enthusiasts ended up with an extra pair of speakers, a second stereo amplifier, and the decoder of their choice. If there seemed to be too many knobs even for the inveterate twirler, it was small price to pay for the joys of "surround sound."

Such decoders were quickly followed by amplifier/decoder combinations. But that was before the introduction of CD-4 discrete 4-channel records; if you opted for that arrangement and now want discrete disc sound, you still need a separate demodulator "accessory" as shown in Fig. 3.

The first integrated receivers were merely tuners plus twin stereo amplifiers. Later, receivers sported switch positions for built-in SQ decoding and a variety of other matrix decoding schemes. In late 1972, Lafayette Radio Electronics introduced the Model LR-4000 receiver, the first high-powered unit of its type to include SQ decoding *plus* full dual-logic circuitry in an all-in-one receiver.

Logic circuitry simply senses channel dominance and enhances apparent audible separation of channels, when matrixed discs are played. While all current matrix systems provide four distinctly different program channels even in their simplest configurations, the ability of a matrix decoder to pinpoint sound sources is somewhat limited. This, in turn, makes the optimum "listening position" in the room more critical. The various "logic circuits" now available in third- and even fourth-generation quadraphonic equipment attempt to solve these problems with "gain-riding" circuits that emphasize the dominant channel and/or decrease the loudness of the other channels (or increase instantaneous channel separation).

Good logic circuitry is often more complex and more expensive than the basic matrix decoding circuits themselves. As the time approached for the introduction of the 1973-1974 crop of quadraphonic receivers, manufacturers hoped that such circuitry would have been reduced to IC's at low cost and that they would offer matrix plus logic plus CD-4 in receivers

Teac's Model 2340 tape recorder both records and plays back in discrete 4-channel format.

Pioneer's Model QX-747 receiver features RM and basic SQ decoders and CD-4 demodulator.

priced in a range consumers could afford. Unfortunately, the IC's were not ready on time. So, the latest receivers include CD-4 demodulation facilities and a variety of matrix-decoding options, but they do *not* include logic circuitry. Those receivers that have logic circuits generally do *not* have built-in CD-4 demodulators. The demodulator circuitry is also scheduled to be translated into inexpensive IC's, but their use is still about a year off. In summary, we know of *no* quadraphonic receiver that contains CD-4 facilities, matrix decoder, and full logic.

Many of the new receivers offer power-strapping facilities, an idea designed to coax reluctant buyers into purchasing a 2/4-channel receiver that performs at full capacity whether operated in the 2- or the 4-channel mode. In the earlier quadraphonic receivers, if you wanted to revert to stereo listening, you simply turned down the volume to the rear speakers—and cut the power capability of the receiver in half! In power-strapping amplifiers and receivers, a switch enables you to parallel connect the four amplifiers into two pairs, each of which produces more than double the power of a single quadraphonic channel.

In general, the new quadraphonic receivers offer considerably less power per channel (within a given price category) than did their stereo predecessors, which presents speaker selection problems. Most popular speaker systems are low-efficiency, air-suspension or acoustic suspension types that require fairly large amounts of driving power to produce reasonably loud sound levels. With lower-powered receivers, the rule rather than the exception in 4-channel gear, speaker manufacturers are attempting to devise small, more efficient enclosures.

Phono Cartridges. Quadradiscs contain frequencies of up to 45,000 Hz, while nearly all stereo phono cartridges roll off at 20,000 Hz or less. So, if you are planning to listen to discrete 4-channel discs, you will need a specially designed cartridge (stereo compatible, of course). Because of their specially shaped stylus tips and other critical requirements, the 4-channel cartridges are more expensive than their stereo counterparts. Demodulators, on the other hand, are no more expensive than top-quality matrix decoders with built-in logic; prices are likely to come down as the complex circuitry required for CD-4 demodulation is reduced to IC form. The availability of such IC's from one domestic and one foreign source has already been announced.

Headphones. Before you conclude that 4-channel headphones can be used only by mutants with four ears, listen to them. Quadraphonic phones may not offer the same sonic perspective you would get from four corner-positioned loudspeakers, but they afford front and rear sensations that are beyond anything you have ever heard from stereo headphones. Variation from model to model is great, and one's ear shape, hearing, and a host of other unexplored factors will undoubtedly determine which kind of 4-channel phones are best for a given individual—which is more or less the same sort of problem you would encounter when choosing a speaker system. ◈

Lafayette's LR-4000 has two synthesizers and full-logic SQ, but no CD-4 demodulator.

"Vario matrix" in Sansui's QRX-3500 offers improved QS and SQ separation, but no CD-4.

TRENDS IN TAPE MACHINES

BY HERMAN BURSTEIN

MORE than a quarter of a century has gone by since the first home tape recorder made its debut. Judging from the flurry of current design activity, the tape recorder is a long way from becoming a "settled" device. Today, differences among tape recorders tend to rival their similarities. But one thing is an incontrovertible fact: today's machines are a distinct breed from those produced only a few years ago.

To help provide a perspective on what tends to be a bewildering situation, we will be commenting upon what appear to be the chief trends in features offered and the state of the art achieved in tape recorders. Our main concern will be with high-fidelity equipment.

Cassette Recorders. Six years ago, even the very best cassette recorders suffered from inordinate noise, appreciable wow and flutter, high distortion, and deficient treble response. Today's machines, by contrast, are true high-fidelity decks.

With the aid of noise reduction circuitry, a substantial number of cassette decks meet or exceed the minimum requirement for good S/N ratio performance, running as high as 60-63 dB. An important share of the credit belongs to improved recording tapes. But much of the credit for quiet performance must be given to improved tape recorder electronics, particularly to the various noise reduction systems now in popular use.

In the early days, tape recorders that operated at 7½ ips were lucky to reach out to 8000 Hz on the high end. Considering that each halving of speed theoretically roughly halves the upper frequency limit, assuming constant S/N and distortion, it is little short of fantastic to find that today's better cassette decks maintain almost flat response out to 14,000 Hz (some to 16,000 Hz) at only 1⅞ ips.

Treble response, particularly with chromium dioxide tape, can be extended well beyond 15,000 Hz, but at the cost of reduced signal-to-noise ratio. Manufacturers on the whole appear to be foregoing super-extended treble response in favor of giving the listener the satisfying quietness of 60 dB or more S/N.

With increasing frequency, cassette decks are offering features usually the hallmark of open-reel decks. New cassette deck features that were once the province of open-reel recorders include: hysteresis motors, separate capstan and reel-driving motors, reverse operation, separate record and playback heads for tape monitoring. Cassette decks have also led the way with such features as: noise-reduction circuits, switches for varying bias (and often record equalization and bias current to accommodate various tape formulations), memory index counters that permit the cassette to be automatically rewound to a desired place on the tape.

The 4-Channel View. Because of the undecided state of affairs existing in 4-

channel sound, not much has been done to promote this new medium for tape recorders. Many recorders offer only stereo facilities. A few open-reel decks are designed for full 2-channel flexibility and offer playback—but *not* record—fa-

Tandberg Series 3300X has crossfield heads.

cilities for 4-channel tapes. Some decks can both record and play 2- and 4-channel material. But none of the open-reel machines currently on the market offer a matrix facility which would permit 4-channel material to be conveyed on two tracks.

There are several matrix decoders which could apparently be used with either quadraphonic (SQ™ or QS) discs or with two-track tapes made from such discs. Conceivably, encoders might eventually appear as auxiliary and built-in components.

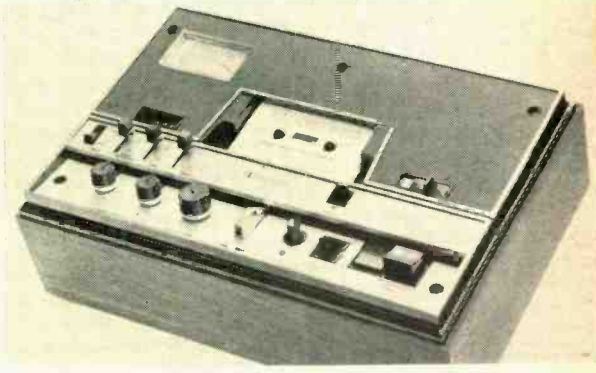
At this point, it is clear that the eight-track cartridge system has a natural advantage for 4-channel use. Four tracks could be used in *each* direction for discrete 4-channel sound. There are signs that eight-track machines might fulfill part of their destiny in 4-channel sound. A very few cartridge machines now permit 4-channel recording and playback in both directions, while a greater number operate conventionally in stereo and permit 4-channel playback. Most machines, however, still ignore 4-channel reproduction.

Considering that cartridges operate at twice the speed of cassettes, they should be able to offer high fidelity performance in terms of frequency response and S/N ratio. True, a cartridge track is narrower than a cassette track, which reduces the S/N ratio somewhat, but the difference in track width is not all that great, and the faster speed should provide the necessary compensation.

Other Developments. In the tape recorder area, other developments, trends, or even lack of trends seem noteworthy:

Frequency Response. At 7½ ips, a number of open-reel machines are excellent in this respect, many virtually flat to at least 20,000 Hz and a few going out past 25,000 Hz. At 3¾ ips, some of today's machines are flat out to 15,000 Hz or better. However, at 1⅞ ips, none of the open-reel machines can vie with the cassette deck's performance. Typically, open-reel decks drop off beyond 8000 Hz or so at 1⅞ ips.

Reverse Operation. A substantial number of open-reel decks operate in both directions, but there are a great many that do not. Apparently, this feature has



Advent 201 has Dolby, tape/bias switching.

become a popular option but is not on the way to becoming "standard." Most decks that offer this feature provide it only for playback. Even though more heads are needed, reverse operation is also desirable for recording. Perhaps manufacturers will hear our plea for reversing operation during recording.

Signal-To-Noise Ratio. At 7½ ips, a goodly number of open-reel decks offer 55 dB or better S/N. Few decks provide figures as high as 70 dB; those that do are among the very best available.

Noise Reduction Systems. While Dolby and other noise reduction systems are strong in the cassette area, open-reel equipment is lagging behind. Obviously, owing to the lower speed and narrower track widths, the cassette deck is in most need of noise reduction circuitry. However, we forsee that noise reduction systems will eventually become as popular in open-reel equipment as they are in cassette decks.

Crossfield Heads. It has been some time since the introduction of the crossfield head that is placed opposite the record head, with the tape passing between the two. Audio current is supplied to the record head, and bias current is fed to the crossfield head. Thus, the tendency of bias current to erase the high frequencies is substantially reduced, permitting better treble response and higher S/N. If it proves to be more economical at the higher tape speeds than the Dolby noise reduction system in yielding superior S/N, more open-reel decks will likely contain the crossfield head.

Switchable Bias: The variety of tapes on the market calls for different bias currents, recording equalization, and audio drive current to achieve optimum performance. Many cassette decks provide switches for changing bias and often equalization and drive current. There is still a small but definite trend to provide switching in open-reel decks, but as yet, the going is slow.

Sony TC-228 cartridge record/playback deck.

Long-Life Heads: These generally have the term "ferrite" in their description. While conventional heads are supposed to yield about 2000 hours of good service, ferrite heads are claimed to last up to 200,000—if some claims are to be believed. An increasing number of tape machines boast these heads. However, considering the number of high-quality machines that do not use ferrite heads, it is possible that some of the non-ferrite heads have been improved in their life spans—at least one hopes so.

Peak-Indicating Meters: While VU meters appear to be professional looking devices, most do not indicate *peak* transient signal level. Most VU meters—assuming that they *are* VU meters—indicate *average* signal levels. Consequently, it takes some sixth sense to set up meter-equipped decks for optimum record levels. To circumvent the disadvantage of the average-indicating VU meter, some manufacturers have introduced the peak-indicating meter that allows the user to adjust recording levels so that peak signals will not overload the tape. Another approach is to provide a conventional averaging meter with a light that flashes whenever the peak signal level exceeds a preset acceptable distortion level. Hopefully, we will be seeing more decks with the peak-indication feature.

Wow and Flutter. As mentioned earlier, wow and flutter figures for good hi-fi cassette decks are generally much better than 0.25 percent. With respect to open-reel machines, all high-quality decks now specify wow and flutter at below 0.1 percent; a number are specified at about 0.05 percent; and at least one specifies 0.01 percent.

Miscellaneous. In many tape recorders are found such features as sound-on-sound, automatic shutoff, pause control, echo, and monitoring facilities. A fair number permit the mixing of one high-level and one microphone input on each channel, and one provides mixing facilities for up to four microphones or high-level inputs.

A few decks—but in increasing numbers now—permit true sound-with-sound recordings, providing facilities for using one channel of the record head as a playback head.

In connection with cassette decks, we note the appearance of the automatic changer, similar in function to the automatic record changer. Finally, there is a new breed of "combination" tape deck that attempts to be all things to a user: combination open-reel, cassette, and/or eight-track cartridge machine. ◈

TRENDS IN RECORD PLAYING EQUIPMENT

CHANGERS / TURNTABLES / TONEARMS / CARTRIDGES

BY JULIAN D. HIRSCH, Hirsch-Houck Laboratories

OVER the years, an interesting role change has taken place between record changers and manual players. With the adoption of balanced tonearms, heavy non-ferrous platters, and provisions for manual play of single discs, the "automatic turntable" has replaced the "record changer" in component hi-fi systems. But even modern single-play turntables are now equipped with integral tonearms that shut off the motors and return to their resting posts after playing a disc. Some will even index automatically to the record's lead-in groove when a lever or button is operated. Hence, today's single-play turntables can perform any function of an automatic turntable—except sequentially play a stack of records. Indeed, some manufacturers call them "automatic turntables," too.

In modern record players, better isolation from motor-induced rumble and flutter is usually possible with the flexible belt type of drive system used in most single-play turntables. (The better automatic players achieve nearly the same degree of over-all record-player performance with the idler-wheel system, whose tighter coupling simplifies operation of the changing mechanism without slippage.)

The early single-play technique of using the inertia of a heavy platter to reduce motor-induced flutter and rumble is still used in many of the finest single-play and automatic turntables. An equally effective approach uses a small lightweight synchronous motor to drive a very light platter. Operating at 300 to 600 rpm, the motor has very little rumble

BSR 810 automatic changer

Dual 701 automatic single-play

and concentrates its energy at subaudible frequencies.

Electronic drive systems are used in some of the finest single-play turntables, offering a convenient method of operating a low-speed motor that is immune to line voltage and frequency changes and provides a vernier control for adjusting speed. Perhaps the ultimate development is the direct-drive system used in a few of the most expensive turntables. A special motor operates at the desired 33 1/3 or 45 rpm speed. The platter is mounted directly on the shaft of the motor, and the rumble and flutter are reduced to almost unmeasurable levels.

Tonearms and Cartridges. Most tonearms are designed according to the same time-proven principles. At one end is the cartridge at an offset angle, while the other end is supported by low-friction pivots. A counterweight balances the arm to a level position, and the desired tracking force is set by a spring or sliding weight. Anti-skating compensation is applied by a spring, weight, or magnetic repulsion system. Most of the differences between tonearms are a result of the level of precision used in their manufacture.

Another important factor is tonearm mass. Low mass is essential with high-compliance cartridges to avoid audio-frequency resonances that could interfere with tracking warped discs or aggravate acoustic feedback from loudspeakers.

A few tonearms have been designed to carry the cartridge along the radial path followed by the recording cutter instead of in an arc as is the case with the conventional pivoted arm. Absent with radial arms is even the negligible tracking error of well-designed pivoted arms, and no skating effect exists. These tonearms are relatively bulky and expensive, and they cannot be used with all turntables. Another tonearm is available with a pivoted offset that results in little or no tracking error.

The phono cartridge has been dramatically improved in recent years. The trend in modern cartridges is toward reducing moving mass in increasing compliance to obtain good performance at low tracking forces. As this process is carried to its limits, a cartridge becomes more fragile and expensive, and the tonearm's requirements become more critical. Low moving mass, in particular, is necessary for the extended high-frequency response needed to play CD-4 quadraphonic discs.

Looking Ahead. We can see clear trends in automatic and single-play turntables. Both will continue their overlapping processes. Electronic drive systems and direct-drive turntables will become more wide-spread in higher priced equipment. There will be more integrated record players in which the cartridge is included in the overall design for optimum performance.

Radial tonearms will continue to hold their place, but without significant expansion. New cartridge designs will emphasize CD-4 operation. In all, we are confident that 1974's record playing equipment will be even better than the standards set in 1973. ◈

Technics by
Panasonic SP-10 transcription turntable

Garrard Zero 100C automatic changer

TRENDS IN SPEAKERS

BY VICTOR BROCINER
Vice President, Engineering, Stereo Products
Avid Corporation

UNTIL recently, the success of the acoustic-suspension principle seems to have restricted speaker system designs to a more or less uniform format. Lately, however, a spate of new designs have appeared. Some are elaborations of old attempts at the unconventional, others are modern versions of systems used in the past, and a few appear to be truly novel. In all, an impressive improvement has taken place in the tone quality and accuracy of speaker systems during the past few years.

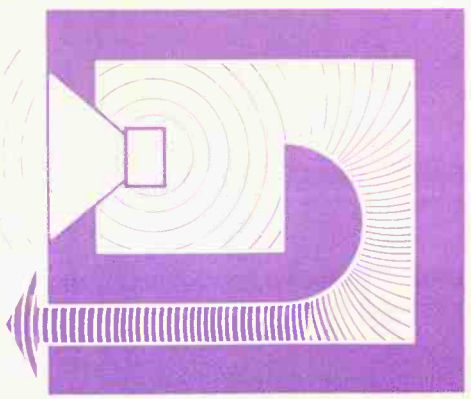
New Speaker Concepts. In a concert hall, most of the sound energy that reaches a listener's ears has been reflected by one or more walls. The ear accurately locates the sound source by distinguishing between the different arrival times of the direct and reflected sound waves.

When listening to reproduced sound in a home, most of the sound energy heard is also reflected. However, because of the room's smaller size, the reflected energy is not delayed nearly as much as it is in a concert hall. Proponents of the reflected sound principle claim that increasing the ratio of reflected to direct sound improves realism and reduces hardness during reproduction.

Several speaker system designs provide 360° horizontal sound distribution with multiple speakers aimed in different directions, reflectors, or specially designed enclosure/speaker setups. But truly omnidirectional sound requires full coverage in both the horizontal and vertical planes. This is accomplished in designs that approximate a radiating sphere where the speakers are mounted on the flat surfaces of the polyhedron that makes up the sphere.

Some designers feel that only a small fraction of the sound actually heard should be aimed directly at the listener. They state that the major portion of the sound would best be reflected from the wall behind the speaker system, originating from a number of loudspeakers mounted on the rear walls of the speaker cabinet. (This is the tack that Bose took in designing its speaker system in which a large number of identical speakers are used to cover the entire audio spectrum. The irregularities of each speaker are claimed to be cancelled out by the other speakers to produce a smooth, flat frequency response. The system also employs an electronic equalizer.)

Various means are used to obtain wide-angle distribution with speaker systems that are essentially front-radiating and intended for use against a wall. The most obvious and simplest means to accomplish this is to use speakers that are inherently capable of uniform distribution within their frequency ranges. But this is not easy to achieve. So the trend is to-



Cavity behind BIC venturi's woofer tapers into duct that opens into listening room.

ward the use of multiple tweeters aimed in different directions.

A new design uses five dynamic speakers—each for a separate frequency range—on a flat baffle. A dividing network equalizes their on-axis responses with special compensation for on-axis time-delay distortion to keep all phase relationships coherent.

A variety of interesting innovations in speaker driver designs have appeared in recent years. For example, the Heil Air Motion Transducer uses a rectangular diaphragm which is a thin plastic film with "printed circuit" conductors, folded accordion fashion, and suspended in a magnetic field. Audio-frequency currents in the conductors cause alternate folds of the diaphragm to move closer while the other folds spread apart. This squeezes

Called "the last loudspeaker" by Ohm Acoustics, the Model F employs a Walsh driver.

air out of one side and sucks in air on the other side of the diaphragm as the signal varies. The diaphragm is exceedingly light, and efficiency is relatively high.

A Walsh-licensed reproducer is another unconventional design. The cone of this speaker has a very small included angle. At frequencies above the piston range, the motion of the voice coil produces a wave that travels outward toward the cone's rim where it is absorbed. Essentially, this happens with all cones, but in the Walsh design, the material and shape of the cone are so coordinated that the wave reaches the edge of the cone just as the horizontally spreading wave from the voice coil reaches a circle on an imaginary cylinder through the cone's rim.

The Magneplanar is an electrodynamic counterpart of the full-range electrostatic speaker; it measures 6 ft by 4 ft by 1 in. Woofers and tweeters both have stretched thin Mylar diaphragms that carry "voice coils" of closely spaced conductors positioned in a magnetic field. Like the diaphragm of the Heil reproducer, these diaphragms are driven over a large part of their surfaces and have less tendency to "break up" into vibrational modes than do cones driven at their apices.

In spite of the advent of the new dynamic drivers that are claimed to offer the virtues of the electrostatic driver, the latter is still solidly with us. It is usually assigned middle-register and high-frequency duty, in conjunction with a conventional woofer.

Ceramic tweeters (or "super tweeters") for reproducing the extreme highs are a recent novelty. One spherical-surface tweeter, claimed to provide uniform angular distribution, is used in a full-range electrostatic reproducer. Not to be overlooked are the tremendously improved woofers, midrange drivers, and tweeters of more conventional design. A great deal has been learned in recent years about design, materials, and quality control in large-quantity production.

Woofers and Their Enclosures. There has been a rebirth of "different" designs in woofer/enclosure combinations to challenge the supremacy of the acoustic-suspension woofer. The "new" designs are almost without exception modern versions of devices originated many years ago. For one thing, bass reflex enclosures are back to provide greater efficiency, extended bass range (or both), lower distortion, and new woes. The basic principle is unquestionably valid—if very careful attention is given to enclosure design.

The passive-radiator design replaces the auxiliary opening of the vented enclosure with a second cone that is elastically suspended and mechanically—*not* electrically—driven by the air pressure in the box.

Also available are enclosures that act

as tuned pipes (folded horns) to "load" the speaker over certain frequency ranges. The modern versions of this design (it goes back some 25 years) are smaller than their forebears. A physically similiar design is the transmission-line, or untuned pipe, system. With sufficient absorption in the pipe and suitable acoustic termination, this design is claimed to resistively load the woofer, absorbing the back wave without raising the basic resonant frequency of the loudspeaker.

A truly signficant development has taken place in the design of closed-box and vented enclosures. With the aid of computers, enclosure dimensions can be optimized for any given speaker, particularly for low-frequency drivers whose enclosures must at all costs be optimized.

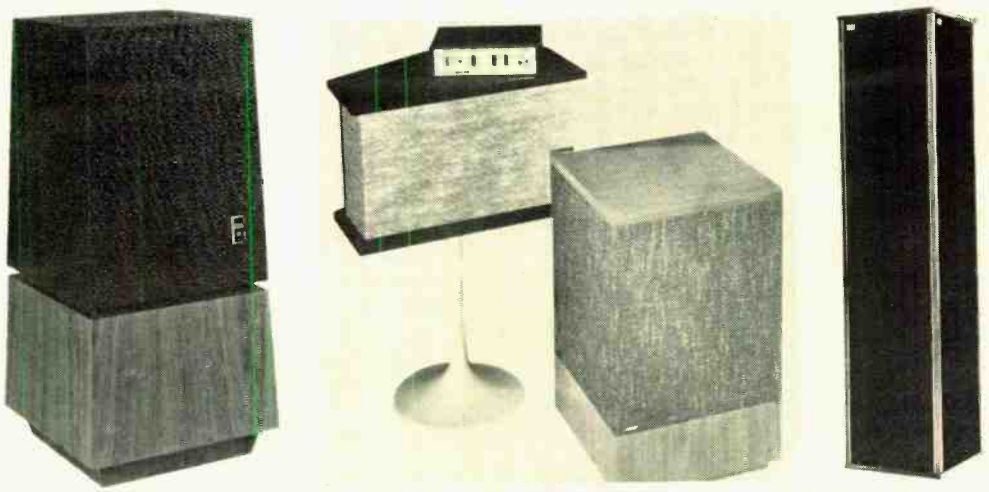
What To Expect In 1974. Predictions in speaker system trends over a one-year period of time are risky, but certain trends are evident. For example, wood is fast disappearing as the principal cabinet material. It is rapidly being replaced by durable vinyl-covered particle board that has been so greatly improved that it can be indistinguishable from wood grain.

Semi-automated V grooving machines and other advanced production techniques afford economical cabinetry that is expected to dominate the field. "Value engineering" in computer-aided electrical and acoustic design should result in highly optimized systems designs in which all of the parameters will contribute to performance, rather than to the fads and personal preferences and prejudices of the designer.

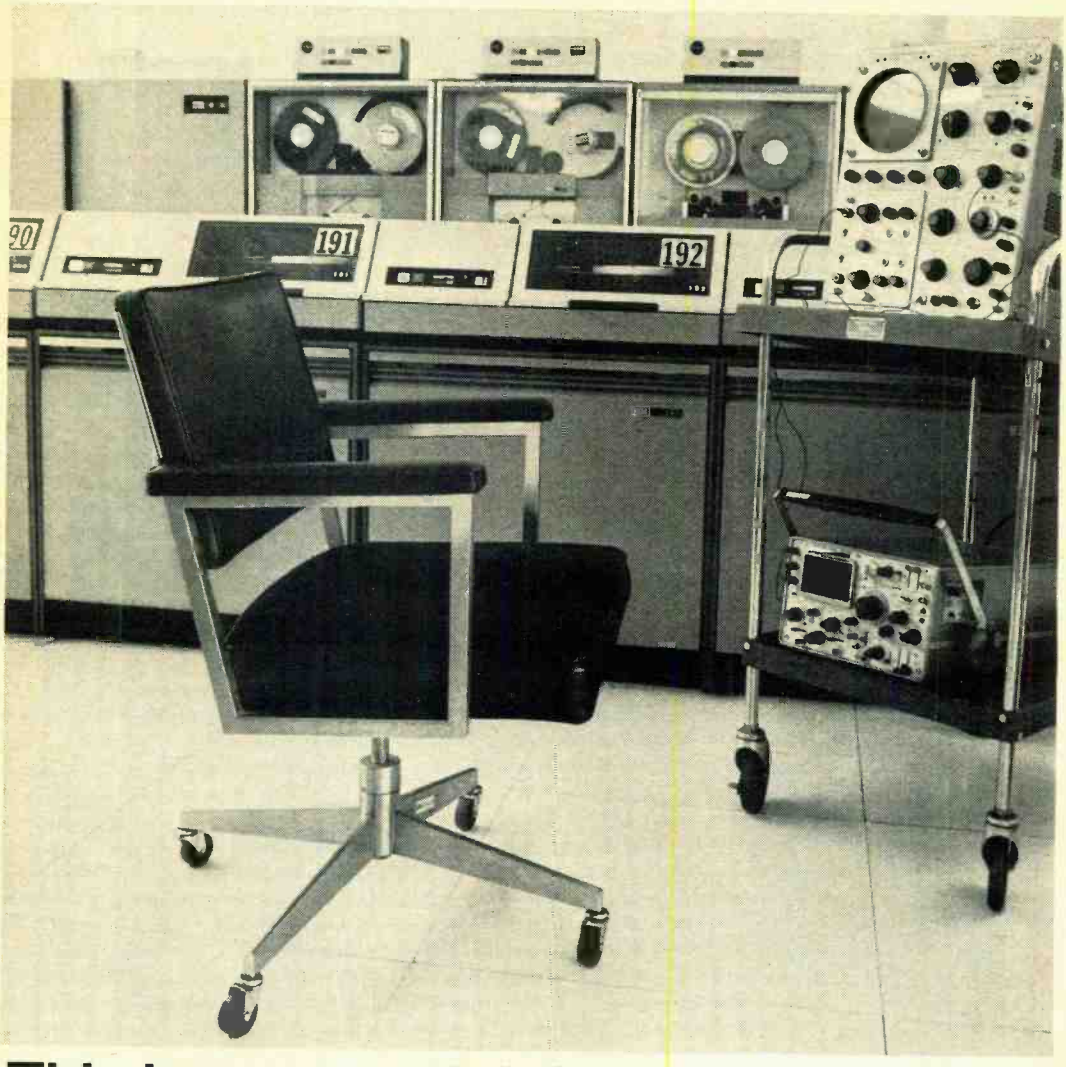
Automated testing procedures will permit a complete performance check of each speaker system manufactured—at less cost than the rather sketchy techniques heretofore employed. This will eliminate the human testing error and assure greater production uniformity in same-model systems.

Still more attention will be paid to the speaker system/listening environment/listener combination as a system, rather than the speaker system as a single unrelated element.

Quadraphonic reproduction poses the problem of locating four speaker systems in a room without detracting from the decor. This might put considerably more pressure on manufacturers to emphasize compact speaker systems in their lines. Column-type speaker systems offer an attractive alternative to the bookshelf system; some even look like lamp tables. Also, a decorator assist is offered in those "picture-frame" systems that require no floor space at all, looking like an ordinary painting or print when hung on the wall. However, these "flat" speaker systems do not provide the sound obtainable from traditional designs. ◈



The ESS amt1 (left) employs a Heil Air Motion transformer. Bose 901 with equalizer (rear) and lower-cost 501 (foreground) are shown at center. EPI Model 1000 "Tower" is at right.



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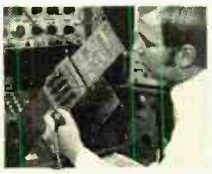

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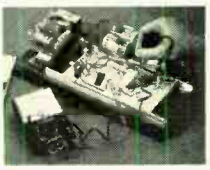

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PE-53

CIRCLE NO. 5 ON READER SERVICE CARD

AN ELECTRONIC SIREN

BY PAUL EISENBRANDT

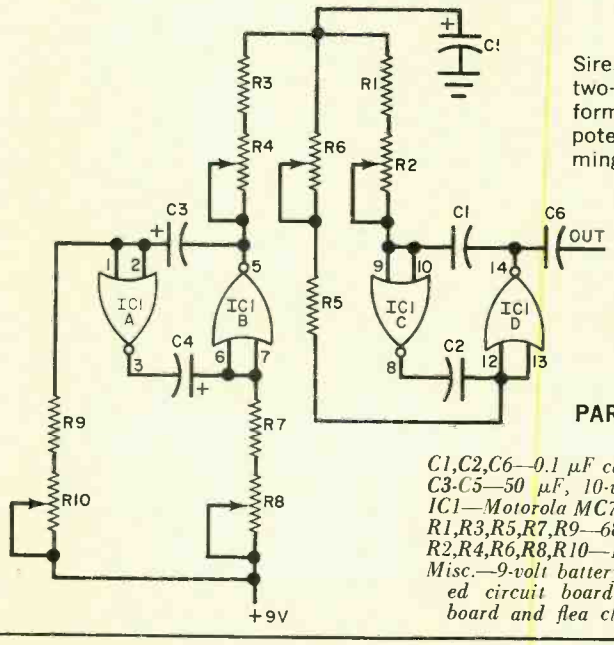
For entertainment or for auto burglar alarm

WHETHER for sound effects purposes or for use in a theft alarm system, a great many experimenters have tried to make the electronic equivalent of a police siren. Many designs have appeared in the past, but very few can match the range of adjustability provided by the one shown in the diagram.

The heart of the electronic siren is a quad two-input gate MC717 integrated circuit. The four gates are used in pairs to make two oscillators. One oscillator varies the frequency of the other.

Assembling the electronic siren is a straightforward procedure. You can use a printed circuit board of your own design, or you can go the perforated board-and-flea clip route. If you choose the latter, plan on using a socket with *IC1;* don't try to solder the interconnecting wiring directly to the IC's leads. Also, during assembly take care to properly index *IC1* and observe the polarity of *C5.*

After the circuit is assembled, connect its output to the input of an audio amplifier (your hi-fi system will do fine). Turn on the system and familiarize yourself with the effects each potentiometer has on the sound you hear. Setting all pots to mid-position should yield a sound much like that of an air raid siren. Experiment with the pots, and you will soon have the sound like that of a police siren. In fact, as you experiment with the pot settings, you will find that this circuit will do a lot more than give just siren sounds. ◈



Siren circuit uses single quad two-input gate IC. Gate pairs form two separate oscillators; potentiometers permit programming a wide range of effects.

PARTS LIST

C1,C2,C6—0.1 μF capacitor
C3-C5—50 μF, 10-volt electrolytic capacitor
IC1—Motorola MC717P or HEPC2502
R1,R3,R5,R7,R9—680-ohm, ½-watt resistor
R2,R4,R6,R8,R10—1-megohm potentiometer
Misc.—9-volt battery or power supply; printed circuit board or perforated phenolic board and flea clips; IC socket; etc.

How to add LUXURY FEATURES to ELECTRONIC DIGITAL CLOCKS

MAKE YOUR DIGITAL CLOCK "FAIL-SAFE"

1

BY CALVIN DILLER

A MAJOR problem encountered with electronic digital clocks that operate from the ac power line is that they become useless if they are disconnected from the power line for any reason, even if the disconnect lasts for only a small portion of a second. Once this happens, and when the power is restored, the readouts will indicate the wrong time and the clock must be reset.

What is needed is a power source that will automatically take over if there is a power-line outage and some type of "clock" signal that closely approximates the 60-Hz timing signal normally derived from the power line. This should also come on automatically (preferably without losing a second) when the power goes off.

Automatic Power Supply. Two possible dc power supplies are shown in Fig. 1. In normal operation, the supply delivers operating power to the clock logic and readouts, while *R1* supplies a small charging current to the rechargeable battery. Diode *D1* is reverse biased in this mode so that it doesn't "see" the load. When the ac power fails, *D1* conducts and permits the battery to carry the load. The battery selected should have the correct voltage and capacity to drive the load for as long as desired. To determine the battery current required, operate the clock from the

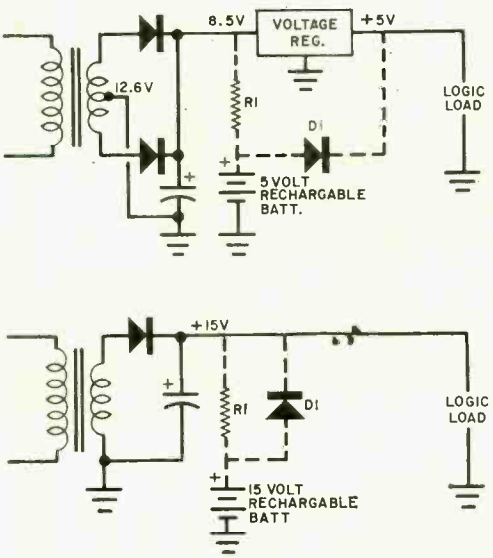


Fig. 1. Typical digital clock power supplies. Modifications are shown in the dotted lines.

ac power and insert a dc current meter between the regulator and the load and record the clock current requirements. Add a little to the value to be on the safe side. Diode *D1* is any silicon rectifier, while the value of *R1* is selected to provide the trickle-charge current required by the battery. This value should be listed in the battery specifications.

Automatic Timer. The circuit shown in Fig. 2 uses a 555 timer and is designed to oscillate at 60 Hz with the values shown.

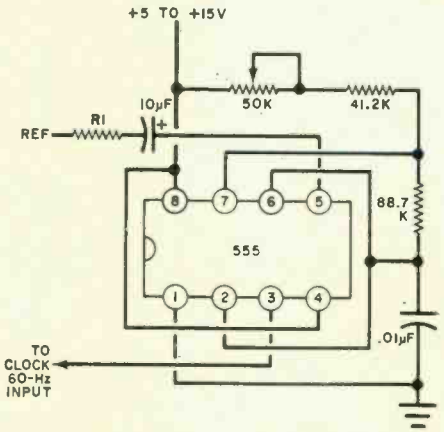


Fig. 2. This oscillator operates at 60 Hz when battery powered and it automatically synchronizes to the 60-Hz power line when on.

With the addition of the two components to pin 5, the circuit will automatically synchronize with the 60-Hz line frequency. If the power fails, the 555 will continue to oscillate at 60 Hz as long as it is supplied with dc from the rechargeable battery. The system can also be changed to operate at 50 Hz. As soon as the ac power is restored, the 555 immediately jumps into exact line synchronism.

The line reference signal required should be sinusoidal and is usually obtained from the clock's power transformer. It is referenced to ground. Measure the ac rms voltage available, and use Fig. 3 to determine the value of *R1*.

The auxiliary timer can be set to exactly 60 Hz by connecting a frequency counter to pin 3 and adjusting the potentiometer. If you do not have access to a frequency counter, try the phase detector scheme shown in Fig. 4, using silicon diodes for the bridge and any type of 15-volt dc meter as the indicator.

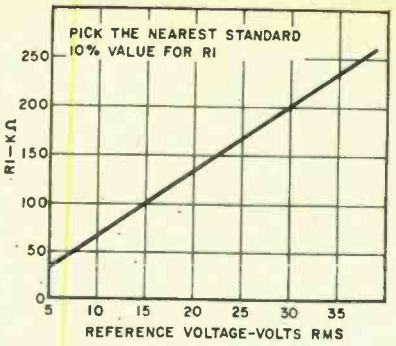


Fig. 3. Use this chart to determine value of RI (Fig. 2) when 60-Hz reference voltage level in rms is known.

With the rechargeable battery and auxiliary timer connected to the digital clock, disconnect the clock from the ac line. The readouts should still indicate the time (showing that the rechargeable battery circuit is working), but the actual time may start running fast or slow (showing that the auxiliary timer is working but is not exact). With the phase detector circuit connected as shown in Fig. 4, note that the voltmeter needle has a quivering motion, indicating that there is a phase (frequency) difference between the auxiliary timer and the power line reference. Adjust the auxiliary timer potentiometer until the motion of the needle slows down and comes to a stop. The auxiliary timer is now operating at the power-line frequency. The meter needle may drift about a little indicating a slow change in the free-running frequency.

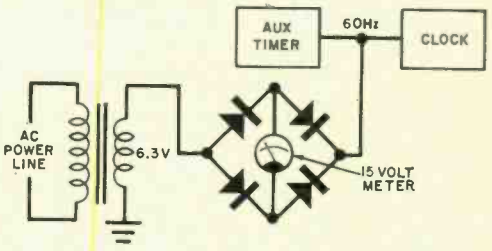


Fig. 4. Simple phase detector is used to set the auxiliary timer to exactly 60 Hz.

Reconnect the digital clock to the ac power line and note that the meter needle deflects to some point on the scale and remains there indicating that the auxiliary timer has locked in phase with the power line. ◈

2 UNIVERSAL DIGITAL CLOCK ALARM FUNCTION

BY EDWARD FRIEDMAN

The popularity and availability of electronic digital clocks suggests some interesting applications and modifications of these devices. The most obvious change is to add an alarm function, and this is the purpose of the circuit shown below. Although this circuit is general in nature, it will show you one approach to creating the alarm function.

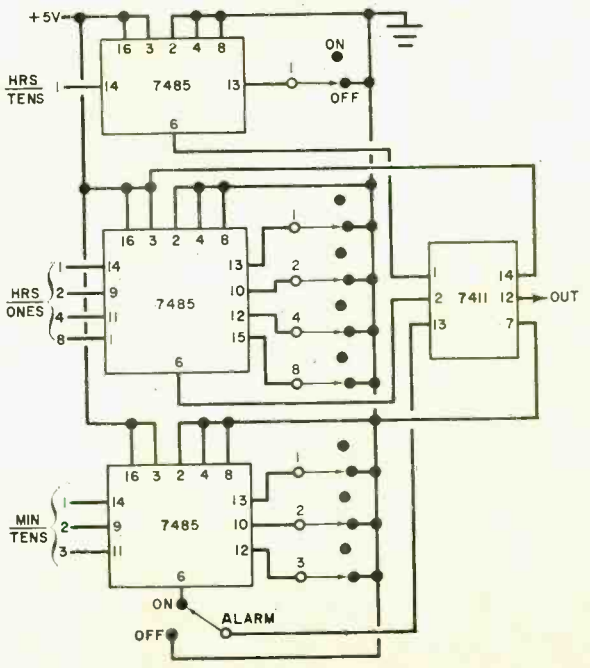
The BCD data (1,2,4,8) from the tens and unit hours and the tens of minutes are extracted from the appropriate digital counters. The data from each digit goes to a 4-bit comparator (7485) which is wired to produce a positive-going output (at pin 6) when the counter input data exactly matches the switch-selected values of the desired alarm time.

Let us assume you wish the alarm to sound at 07:30. The hours-tens switch is left closed (off); the hours-ones switches are all opened (on) except "8" (1+2+4=7); and the minute-tens switch 3 is opened.

It should be noted that with the exception of the minute-tens digit, the standard 1-2-4-8 code is used. The minute-tens digit must reset to 0 after a count of 5, and the output of this modulo-6 counter is coded 1-2-3.

If the switches are set as just described, at exactly 07:30, all three 7485's will have positive outputs. If the "alarm" switch is turned "on", this data will appear at the three-input AND gate (7411) which then produces an output signal for as long as the switch settings are appropriate. In this case, the alarm will remain on for 10 minutes, or until the "alarm" switch is turned off.

The output of the 7411 can be used to drive an npn transistor using a couple of



Four comparators combine the clock digit counters with switch-selected inputs and, when the combination is correct, an output is developed to sound alarm.

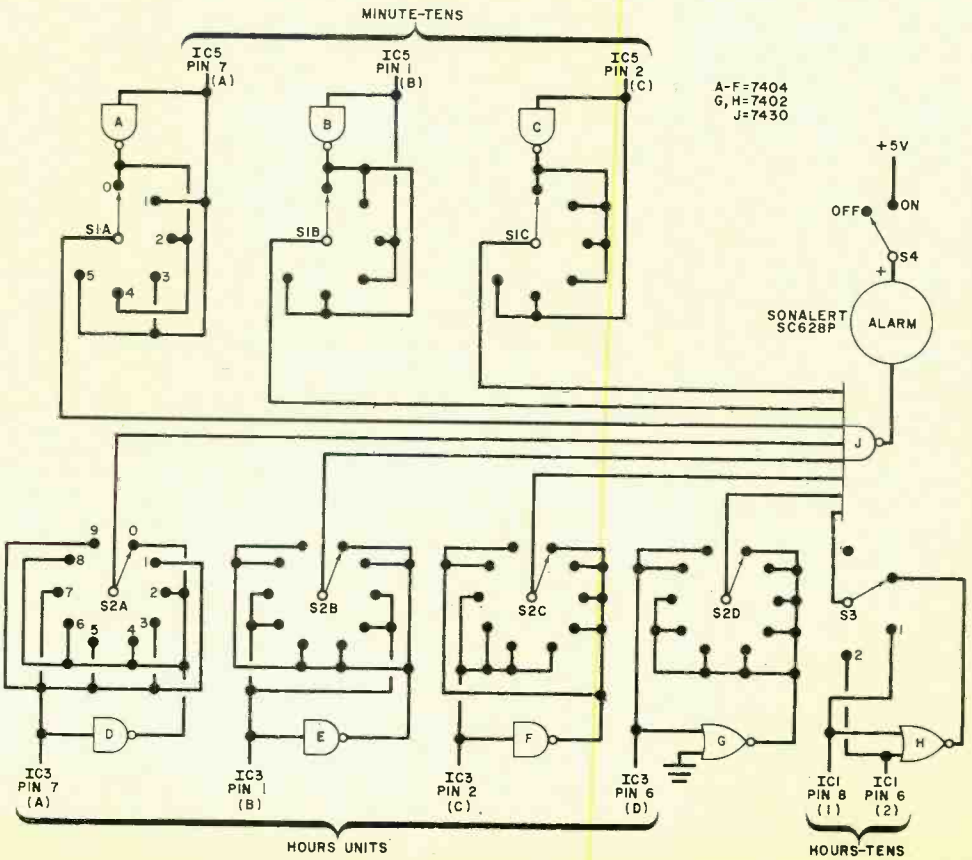
hundred ohms in series with the base. The load for this transistor can be a lamp, LED, buzzer, or other audible alarm device. A relay can be used as the collector load, with this relay driving almost any type of alarm. You can also use this output to drive an SCR or Triac if higher driving power is required. ◈

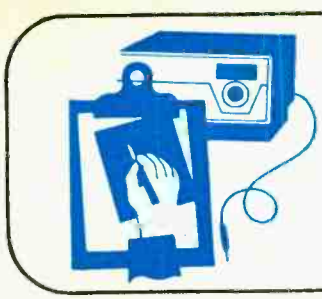
ALARM SYSTEM FOR THE POPULAR ELECTRONICS "LOW-COST DIGITAL CLOCK" 3

BY DAVID G. REESE

ONE good addition to most electronic digital clocks is an alarm system. The alarm described here was specifically designed for use with the "Low-Cost Digital Clock" described in POPULAR ELECTRONICS Including ELECTRONICS WORLD in March 1973. The complete circuit is shown in the schematic. It uses three low-cost, readily available TTL logic IC's; a 6-position, 3-pole rotary switch; a 10-position, 4-pole rotary switch; a spst switch; and a commercial tone alarm. The power can be derived from the original clock. Switch *S1* selects the tens of minutes, switch *S2* selects the unit hours, and *S3* selects the tens of hours.

For example, assume you want an 07:30 alarm. Set *S3* to 0, *S2* to 7, and *S1* to 3. When the 7430 gate has the correct levels on its eight inputs, it will cause the alarm to sound for a ten-minute interval until 07:40, if it is not turned off by *S4*. ◈





Product Test Reports

TEAC MODEL 450 CASSETTE TAPE DECK
(A Hirsch-Houck Labs Report)

THE Teac Model 450 departs from the conventional format for cassette recorders in that its major operating controls are on the front panel where they are most likely viewed and operated from eye level. The tape cassette, however, loads from the top in the conventional manner. The transport's control levers, legended on both the top and front panels, can be operated from the front or above. If installed on the shelf, the recorder requires only 9½" of vertical space. The 17½ in. by 10⅝ in. by 7 in. Model 450 weighs 21 pounds. It comes complete with wooden end plates and a smoky plastic dustcover at a retail price of $400.

General Description. The recorder's outer-rotor hysteresis synchronous motor and heavy flywheel provide unusually low flutter claimed by Teac to be less than 0.07 percent. The light-pressure transport keys control cassette ejection, recording interlock, rewind, play, fast forward, stop, and pause functions. Below the three-digit index counter is a row of red lights that glow sequentially to indicate both the direction and speed of tape movement.

The front panel of the deck is dominated by two large illuminated VU meters that are similar in size and performance to those used on Teac's open-reel machines. A light-emitting diode flashes when peak recording levels exceed +3 VU; another LED serves as a recording indicator.

Three pairs of slide-type potentiometers are used to control microphone and line input gains and playback output levels. Inputs from dynamic microphones (150-600 ohms impedance) can be mixed with the line inputs during recording. The two phone-jack mike inputs and a stereo headphone jack are located on the panel to the left of the VU meters. Above these controls are five toggle-type switches and a pushbutton power switch. Two of the toggle switches are used to select bias and equalization, both recording and playback, for NORMAL and HIGH energy ferric-oxide and chromium-dioxide tape formulations. (The new 70 μs playback equalization characteristic is used for chromium-dioxide tape to yield the best signal-to-noise ratio.)

One of the toggle switches controls the built-in Dolby Noise Reduction System. A DOLBY FM/COPY switch adds unique flexibility to the Model 450, allowing a Dolby-ized FM broadcast to be recorded "as received" while passing it through the recorder's noise-reduction circuits on its way to the playback output jacks. The broadcast can thus be heard with its full dynamic range and correct frequency response, even if no recording is made. Later, when the tape is played back through the Dolby system, it will also be heard under optimum conditions.

When the DOLBY FM/COPY switch is on, the front panel recording level controls are replaced by two screwdriver-type adjustments located on the rear of the deck. Once these have been set for the correct meter indications, using the test tones that are periodically broadcasted by FM stations using the Dolby system, there is no need to repeat

the process or to disturb the normal recording level control settings each time an off-the-air recording is made.

The remaining toggle switch, labeled TIMER, allows an off-the-air recording to be made in the absence of an operator. With an FM tuner plugged into the deck's switched ac accessory outlet, the recorder is connected to a clock timer. It is placed in the record mode, with the PAUSE control, TIMER, and POWER switches activated. When the timer applies power to the system, there is a short delay to allow the tuner to stabilize. Then the PAUSE control releases and the recording is made. When the tape runs out, the mechanism disengages automatically and switches off the power to the recorder.

In the rear of the recorder are the line inputs and two pairs of outputs, as well as a DIN connector and the DOLBY FM calibration pots. A well in the top of the deck holds up to six cassettes without their cases.

Laboratory Measurements. The playback frequency response with a Nortronics No. AT200 test tape was ±1.5 dB from 55 Hz to the upper limit of 10,000 Hz. The output rose at lower frequencies—to +6.5 dB at 31 Hz. Using TDK SD tape with HIGH bias and equalization, the measured record/playback frequency response was ±2 dB from 22 Hz to 13,500 Hz. With TDK ED or Capitol 2 tape, the high end was slightly improved, with a ±1.5 dB variation from 25 Hz to 14,000 Hz. Chromium-dioxide tape yielded the best results: ±1.5 dB from 25 Hz to 16,000 Hz.

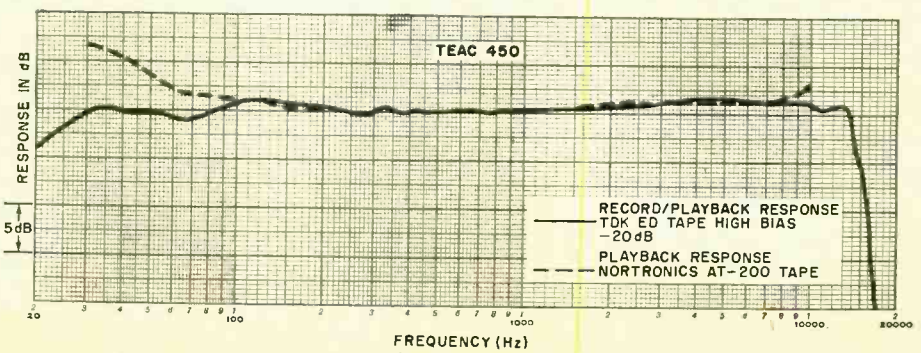
Although the NORMAL bias and equalization are presumably intended for "standard" tape formulations, the recorder seemed to be over-biased for a typical "standard" tape such as the Memorex. The response fell off above 7000 Hz to −5 dB at 11,500. The Dolby circuits tracked well, affecting the overall frequency response by less than 2 dB.

A line input of 73 mV (or microphone input of 0.16 mV) was needed for a 0-VU recording level. The corresponding playback output was 380 mV. The recording level indicator began to glow at +4 VU.

This tape recorder has considerable recording "headroom." The distortion at 0 VU was only 1.2-1.7 percent (depending on the tape used). To reach the standard 3-percent THD reference level, ferric-oxide and chromium-dioxide tapes had to be recorded at +7 VU and +5 VU, respectively. The unweighted S/N ratio, referred to 3-percent harmonic distortion, was between 55 and 56 dB with both ferric-oxide and chromium-dioxide type recording tapes. At maximum gain, the microphone preamplifiers increased the noise level by 27 dB, but at a more normal 3 mV (for 0 VU output), there was no increase in noise over the line inputs.

The tape speed was very accurate, within 0.1 percent of the correct value. In the fast-forward and rewind functions, a C-60 cassette wound from end to end in 92 seconds. Using a Philips flutter test tape, the flutter measured out at 0.19 percent, but since the tape was rated with a residual flutter of 0.2 percent, this figure has little meaning. The combined record/playback flutter was 0.11 percent, which tends to confirm the machine's impressive 0.06-percent weighted flutter specification.

Headphone volume was good, appreciably higher than we have found is the case with most cassette decks. The ballistic characteristics of the VU meters were excellent. The meters indicated within 1 dB of the correct value on tone-burst test signals. This is considerably better than we have found with other meters in most home tape recorders, open-reel or cassette.



User Comments. The Teac Model 450 deck did a superior job of recording and playing back cassettes. Its bass response was audibly better than most cassette machines, which usually have a roll-off or irregular bass response. Unlike the typical cassette recorder that requires great care in setting level to avoid tape saturation and distortion, the Model 450 was almost as non-critical as the better open-reel machines. As long as the VU meters indicated on-scale, there was no problem with overloading.

We could never hear flutter, and recordings made from discs or FM broadcasts were indistinguishable from the original programs. The recorder was very easy to use, and we appreciated the bonus of being able to listen to Dolby-ized FM broadcasts as they were meant to be heard. (It is a pity, though, that no provision was made to shut off the recorder's motor when using the system as an FM Dolby playback processor.)

Although the Model 450 is considerably more expensive than most high-quality cassette decks, it delivers a correspondingly high level of performance and flexibility. As of now, we would rate it among the best recorders that we have tested.

Circle No. 65 on Reader Service Card

TECHNICS BY PANASONIC MODEL SA-6000X RECEIVER
(A Hirsch-Houck Labs Report)

THE Technics by Panasonic Model SA-6000X is a highly versatile, competitively priced ($360) 2/4-channel AM/stereo FM receiver. Its direct-coupled amplifiers are conservatively rated at 10 watts/channel into 8-ohm loads with all channels driven simultaneously and over a range of 20 Hz to 20,000 Hz. A switch on the rear of the receiver straps the front and rear channels on the left and right sides to provide at least 35 watts/channel in the 2-channel stereo mode. The FM tuner section has a rated IHF sensitivity of 1.9 μV and correspondingly good specifications throughout.

General Description. The upper half of the receiver's front panel is occupied by a "black-out" window, behind which are the AM and FM dial scales and a relative signal strength meter that light up when power is turned on. A large tuning knob is also located on this part of the panel.

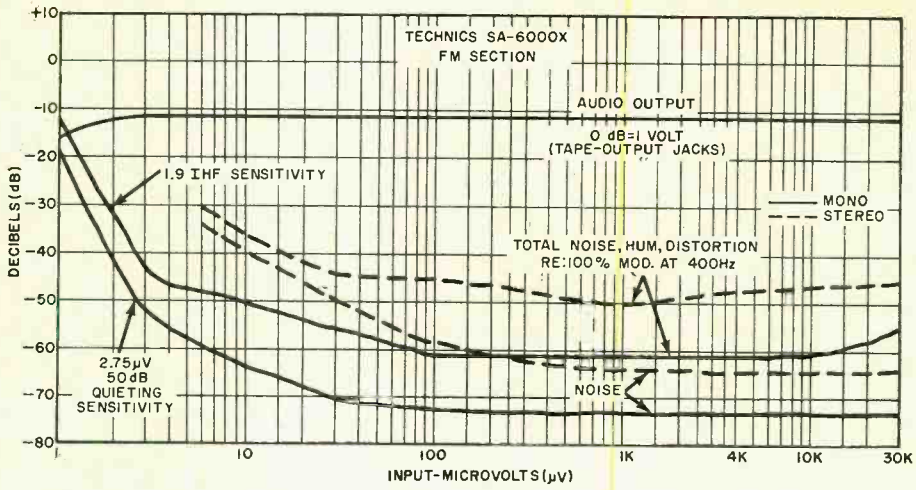
Three pushbutton switches below the dial control power to the receiver and the tape monitoring facilities for two stereo tape decks or an external CD-4 demodulator and one tape deck. The lower half of the front panel is dominated by the large volume control located in the center. The volume control is flanked by four individual channel level control knobs, the positions on the panel representing the usual placement of speaker systems in a 4-channel installation.

Separate headphone jacks for the front and rear channels are located at the extreme left of the panel. Plugging phones into either jack automatically disables the corresponding speaker systems. The bass and treble controls affect all four channels simultaneously. Two lever-type switches are assigned to FM interstation muting and loudness compensation duty.

On the right side of the control panel are the MODE and source SELECTOR switches. The latter has positions for AM, FM (with automatic stereo/mono switching), PHONO, AUX 1, AUX 2, and MIC. The nearby phone-type MIC jack accepts microphones in the medium-to-high-impedance range. The output of the microphone appears equally in all channels as well as at the tape outputs.

The MODE switch has positions for MONO, STEREO, and three 4-channel setups. A large illuminated numeral 2 appears to the left of the dial scales when this switch is set to the STEREO position. It changes to a numeral 4 when the switch is set to any of the 4-channel positions. There are two decoding matrices for discs, with a choice of 0° or 90° phase shifts, and a DISCRETE position for a 4-channel tape deck or an external CD-4 demodulator.

A unique feature of the receiver is two horizontal slide-type controls labeled AFD (Acoustic Field Dimension). When decoding a 4-channel matrixed recording, one control varies the apparent width of the sound pattern, while the other varies the front-to-rear

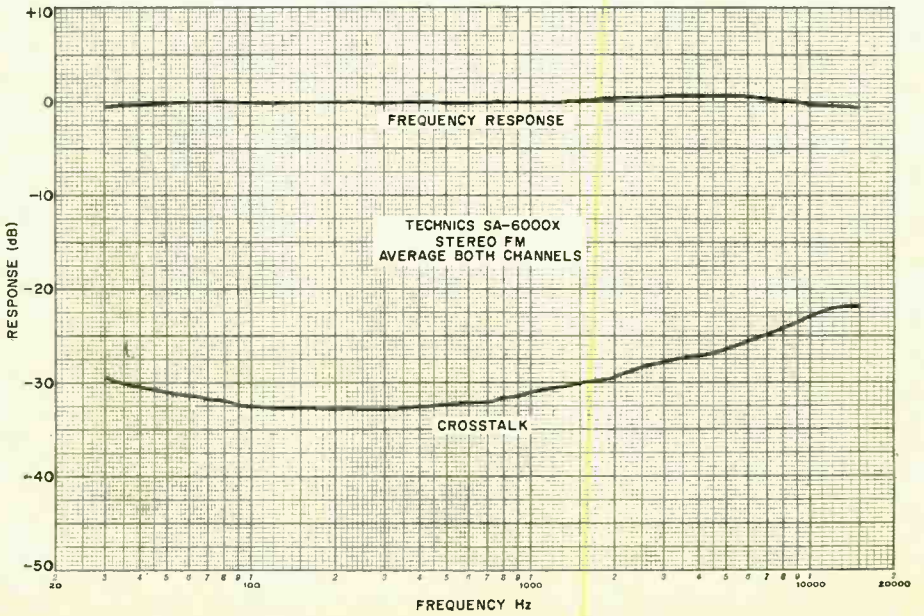


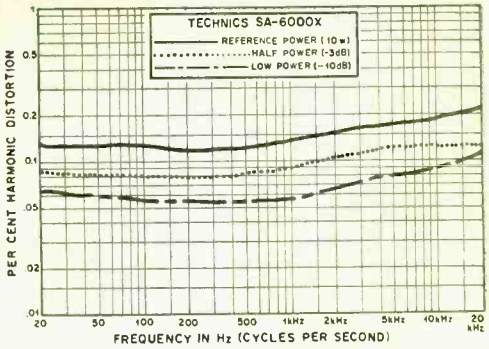
depth. The user is encouraged to experiment with the control settings to obtain the most satisfactory quadraphonic effect, but each control has optimum positions marked for the SQ and RM matrices.

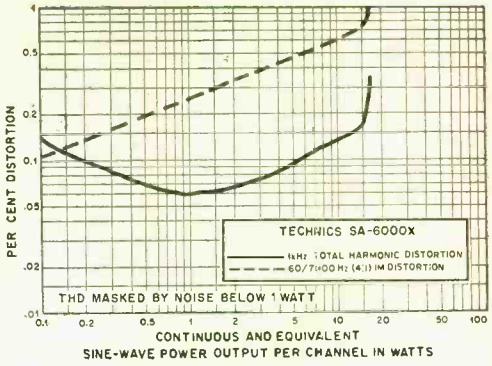
On the rear of the receiver are the various input and output connectors, screw-type speaker outputs and output protection fuses, antenna terminals, and one switched and one always-live ac accessory outlets. A 4 CH MPX jack is provided for use with any discrete quadraphonic FM broadcasting system that might be developed (and approved by the FCC). Finally, there is a socket for plugging in an optional Model SH-1011 remote balance control, a "joystick" device that simplifies balancing the sound levels from the four speakers.

Laboratory Measurements. With all four channels driven simultaneously into 8-ohm loads, the output waveform from the SA-6000X receiver clipped at 15.6 watts/channel at 1000 Hz. This increased slightly to 16.2 watts when only two channels were driven simultaneously. Into 4 ohms, the output was 24 watts/channel, and into 16 ohms it was 11.3 watts. In the "strapped," or 2-channel mode, the output was 41.5 watts/channel.

The 1000-Hz harmonic distortion was less than 0.1 percent (typically about 0.06







percent) up to several watts output, attaining 0.15 percent as 15 watts/channel. The IM distortion increased smoothly from 0.1 percent at 0.1 watt to 0.75 percent at 15 watts. Using the manufacturer's 10-watt/channel rating as a full-power reference level, the THD was between 0.13 percent and 0.22 percent from 20 Hz to 20,000 Hz. At half power, it was between 0.08 percent and 0.13 percent, and at one-tenth power (1 watt), it was 0.055-0.11 percent from 20 Hz to 20,000 Hz.

The AUX input sensitivity was 235 mV for 10 watts output, with a 77.5-dB S/N ratio. Through the PHONO inputs, sensitivity was 3.6 mV and S/N was a very good 70.4 dB. These measurements were made with the individual channel gains set as recommended—about 3 dB below their maximum values. The phono input circuits overloaded at a very safe 100 mV input.

The bass tone control characteristic had a variable turn-over frequency that ranged from about 1000 Hz to less than 200 Hz. The loudness compensation boosted only the low frequencies as the volume control setting was reduced. The RIAA equalization was within ±0.5 dB from 30 to 15,000 Hz.

The measured FM tuner sensitivity was 1.9 μV, exactly as rated, and 50 dB of noise quieting was reached at only 2.75 μV. The ultimate S/N ratio was about 72.5 dB in mono and 64 dB in stereo. In mono, the FM distortion was a very low 0.1 percent; in stereo, it was typically 0.5 percent.

The capture ratio was a very good 1.1 dB. AM rejection was 52.5 dB, image rejection was 64.5 dB, alternate-channel selectivity was 60 dB, and 19-kHz leakage was −59 dB—all good. The muting and automatic stereo switching threshold was 6 μV.

The stereo FM frequency response was ±0.5 dB from 30 Hz to 15,000 Hz. Channel separation was between 30 dB and 32 dB from 30 Hz to 1500 Hz and remained a strong 22 dB even at the upper limit of 15,000 Hz. The AM quality was average, with a limited frequency response that was down 6 dB at 100 and 3100 Hz.

User Comments. As a stereo receiver, the Technics by Panasonic Model SA-6000X acquitted itself admirably. Its ease of handling and general sound quality left nothing to be desired. The FM muting circuit operated with no clicks or thumps, and tuning was not critical, giving the impression of a small amount of afc action.

Although the phono sensitivity was somewhat less than that of many other receivers and amplifiers, we found it more than adequate even when using high-quality cartridges and low-efficiency speaker systems. In this regard, we noted that four relatively low-power channels can produce a surprisingly high overall volume level since all four speaker systems are normally driven even in the mono and stereo modes. Of course, if only two speaker systems are used, the 41.5 watts/channel available in the strapped mode places the receiver firmly in the "light-heavyweight" class. There is no provision for operating the receiver with two or three sets of speaker systems, but this should not inconvenience most users.

We judged the 4-channel performance of the receiver by listening to various SQ- and RM-encoded discs. Frankly, it was difficult to determine the optimum settings for the AFD controls and phase selector by ear; their effects were relatively slight with any type of program material. A pleasing 4-channel effect was obtained with all discs. However, we would guess that the decoding matrix does not employ any form of logic for directional enhancement.

HEATH MODEL GR-110 VHF SCANNING MONITOR RECEIVER
(A Hirsch-Houck Labs Report)

THE communications activities of police and fire departments, ambulance and marine services, MARS, CAP, and other public services are conducted in the 148-174-MHz band, using narrow-band FM. It is often necessary to monitor the channels used by several neighboring communities or services. Obviously, the use of several receivers to accomplish this is uneconomical.

A convenient solution to the problem is the automatic scanning monitor receiver, in which a crystal-controlled local oscillator is sequentially switched through a number of frequencies that correspond to the active channels being monitored. The r-f and mixer circuits, of course, must be "broad-banded" to provide coverage of the frequency band being scanned.

The usual practice is to mute the audio output and scan continuously until a signal appears in one of the channels. The receiver then pauses on that channel and comes out of mute for the duration of the transmission. When transmission ceases, the receiver again mutes and resumes scanning.

Vhf monitor receivers with the scan function have been available from several manufacturers, but it is now possible to build your own from a kit—at an appreciable saving in cost. The Heath Model GR-110 scanning monitor can receive up to eight channels in any 9-MHz segment of the 146-174-MHz band. The extension to 146 MHz makes the receiver useful for monitoring the amateur FM repeaters in the 2-meter band.

The Heath Model GR-110 vhf scanning monitor receiver is list priced at $120. Crystals may be ordered from the company at $4.95 each.

General Description. The receiver has two r-f amplifier stages and a mixer, all using dual-gate MOSFET transistors. Five coils between the antenna and mixer are easily aligned for proper sensitivity across the selected 9-MHz-wide band. A simple crystal-controlled alignment generator is supplied with the kit. It heterodynes the local oscillator output to generate a signal at the receiver's input frequency.

After conversion to 10.7 MHz, the i-f signal passes through two crystal filters that supply a rated 40-dB selectivity against signals 30 kHz removed from the desired channel. Two IC amplifiers provide gain, limiting, and quadrature FM detection. A five-transistor squelch circuit cuts off the first audio amplifier in the absence of a predetermined signal level. The audio amplifier supplies about 2 watts of power to a built-in loudspeaker or to an external 4-ohm speaker.

The heart of the receiver is its switchable crystal-controlled local oscillator. A digital control system that uses four IC's connects each of the eight crystals in sequence to the oscillator transistor (at a rate of about 17 channels/second). The oscillator frequency is tripled and amplified before being applied to the mixer.

A unique feature of this receiver is its "priority" channel on which any activity will be heard regardless of the usage of the other channels. Every four seconds, the local oscillator switches to the priority channel's frequency for about 20 ms, returning to the original frequency if no signal is present. If a signal is received, the scanner remains tuned to the priority channel during its transmission, after which it returns to the scanning mode or to any manually selected channel. Whenever a signal disappears from a channel, there is a delay of about four seconds before scanning resumes.

The front panel of the receiver contains eight pushbutton switches that correspond to the specific channels for which the receiver is set up. Any channel—or group of channels—can be disabled by pushing in the appropriate button or buttons. A switch is used to select between automatic and manual operation. In the latter mode, a second momentary-contact switch advances tuning by one channel each time it is pressed. The number of the channel being received is indicated by a seven-segment incandescent readout. An internal connection permits the readout to blank during scanning, illum-

inating only when the scanner stops on a channel.

A SQUELCH knob permits adjustment of the muting threshold, and an AUDIO volume control is combined with the power switch. Built into the receiver is a 117-volt ac power supply and facilities for operation on 13.8 volts dc for mobile use. The built-in speaker faces downward; a phono jack on the rear of the receiver disables this speaker when an external speaker is plugged into it. Another phono jack is used for the antenna input.

Laboratory Measurements. The GR-110 receiver met or surpassed all of its published performance specifications. The sensitivity for 20 dB of quieting (rated at 1 μV or better) was 1 μV on one channel and 0.6 μV on another. The adjacent-channel selectivity ($\pm$30 kHz spacing) was 60 dB—considerably better than the 40-dB specification. The image response, which was difficult to measure repeatedly, was -32 dB, compared to its rated -40 dB.

The modulation acceptance bandwidth of the receiver is rated at $\pm$7.5 kHz; we found that deviations of as much as $\pm$10 kHz could be accommodated without excessive compression. The audio output was 2.7 watts into 4 ohms and 1.25 watts into 16 ohms. The muting threshold could be adjusted from just above the noise level (0.7 μV) to 12 μV.

User Comments. The scanning and priority functions of the GR-110 receiver operated exactly as claimed. The periodic "quick-look" at the priority channel could be heard as a slick "tick" every few seconds.

The orange-filtered channel indicator was bright and easy to read. We preferred to leave it activated during scanning to use as an indication that the receiver was operating, since no "power-on" light is included on the front panel.

Circle No. 67 on Reader Service Card

MITS MODEL 1440 DIGITAL ELECTRONIC CALCULATOR

IT SEEMS like only yesterday that we built our first digital electronic calculator (see the November 1971 issue of POPULAR ELECTRONICS). That kit sold for a fat $180 and provided us with little more than the capability of adding, subtracting, multiplying and dividing via its eight-digit entry/readout scheme. Although it was a major breakthrough at that time, it did not take us long to "use up" the calculator and come to the decision that we needed a more powerful calculator. That first model was retired to homework use for the kids as newer, more versatile calculators took its place.

Recently, we obtained a new MITS Model 1440 digital electronic calculator kit that retails for $200. For that $20 more, we obtained the usual four arithmetic functions, a 14-digit entry/readout display, a "scratch-pad" memory, a constant-data memory, a square-root function, a squaring function, and a very useful exchange function.

After unpacking the newly arrived kit, we were very much pleased with the high quality of both the materials supplied and the extremely well written and illustrated assembly/operating manual. Both were of the highest caliber—something we would

like to see more of in equipment from other manufacturers.

One interesting feature of the 1440 is that it contains provisions for later addition of a programmer and printer (both will be available in kit form in the near future). This means that when we get to the point where we feel that we need an even better calculator (you would be surprised at how quickly you can outgrow a calculator), or have a need for a hard-copy print-out, we can quickly and relatively inexpensively expand our 1440 to perform the functions needed. There is no need to "trade up" the 1440 for a "better" model. We will just get the modification kits as we need them.

Our kit went together very easily. Thanks to the excellent manual, we encountered neither electrical nor mechanical problems during assembly. The bulk of the electronics

was mounted on a large "mother board." Two other boards were used: one was for the power supply, and the other was for the readout subassembly.

Using the Calculator. The assembled 1440 calculator is a cinch to use. The problem is entered just as it would be written on a piece of paper. If an entry error is made, depressing the CE (clear-entry) key can be depressed to permit reentry of the correct digits. Operating the CE key clears the last entry without wiping out the stored previous calculations and entries.

The decimal point can be positioned at any of the seven places provided. If an improper move is attempted, the calculator simply stops everything and displays an E (error) on the left-most display indicator. This same signal also occurs if an attempt is made to enter too many digits. (When the "constant" function is switched on, the left indicator displays a C.)

If it is desired to store a number for later use, operating the "M+" key does the job. This automatically enters the displayed readings in a memory until it is recalled by depressing the "MR" (memory recall) key. If desired, numbers can be added to the memory by depressing the "M+" key or subtracted by operating the "M-" key.

A very useful function is performed by operating the "EXC" (exchange) key. Depressing it permits the two numbers of an operation to be interchanged. This is particularly valuable when it is desired to use the digits stored in the memory.

Why We Assembled the Kit. You may be wondering why we chose to assemble a kit rather than buying an assembled calculator at almost the same price. Well, since almost all of the equipment we have came in kit form, we realized that we could obtain a better piece of equipment for the price if we assembled it ourselves. But there is another side to this approach. There was the thought that this calculator might someday require service. By assembling it ourselves, we became intimately familiar with the "innards" of the calculator. Should the time come when it might need it, replacing a component would be a lot easier —and a great deal less expensive—than it would be if someone else did it.

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B&K MODEL 281 DIGITAL MULTIMETER

Many service technicians and experimenters have not had the experience of owning and operating a decent digital multimeter. Perhaps the main reason why this is so has been the relatively high prices demanded in the past for these instruments. What with bottom-end prices starting in the $200-$250 range, many technicians and experimenters have stuck with their old analog-meter VOM's.

Now, however, there is a $170 DMM—B&K's Model 281—that should go a long way toward removing the price obstacle and get this modern test instrument into a great many more hands. This 2½-digit instrument has designed into it the most common and useful field and bench service function/range complement.

General Description. The Model 281 DMM has five dc voltage ranges, going up to 100 mV, 1 V, 10 V, 100 V, and 1000 V

full-scale, with an overrange capability of 100 percent. Input resistance is 10 megohms, and accuracy is within 1 percent of full range ±1 digit. The dc voltage circuit can accommodate both positive and negative inputs. If a dc voltage of the wrong polarity is applied to the input, the first digit stays on while the other two blank out.

The ac voltage circuit is calibrated to provide readings is rms. In this function, the ranges and overrange capability are the same as on dc volts. Accuracy is ±1.5 percent (calibrated at 60 Hz). The input impedance is 10 megohms, and frequency response is 20-1000 Hz. If input voltage to the ac voltage circuit exceeds 200 percent of full scale, all digits blink on and off.

Both alternating and direct currents can be measured with the DMM in ranges that top off at 100 μA, 1 mA, 100 mA, and 1 A full-scale. There is a 100 mV drop across the input terminals at full range. Overrange capability is 100 percent and accuracy is 1.5 percent of full range.

There are seven resistance ranges in decade steps that go from 10 ohms to 10 megohms full-scale, all with 100 percent overange capability. Accuracy is 2 percent to 1 megohm and 3 percent on the 10-megohm range. The test voltage is 0.1 V on the 10-ohm range and 1.0 volt on all other ranges. The maximum test currents are: 10 mA on the 10- and 100-ohm ranges, 1 mA on the 1000-ohm range, 100 μA on the 10,000-ohm range, 10 μA on the 100,000-ohm range, 1 μA on the 1-megohm range, and 100 nA on the 10-megohm range.

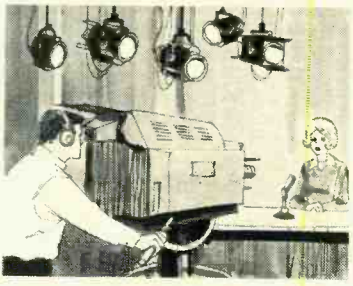
The circuits are protected by diodes and series current-limiting resistance on the ac and dc voltage ranges and a fuse and diode on the resistance ranges.

Physically, the Model 281 is 9 in. by 7 in., by a slender 3½ in. high. It weighs only 5 pounds. A carrying handle attached to the instrument doubles as a tilt stand for easy viewing of the display system. Also furnished with the 117-volt ac operated DMM is a test probe into which is built a switch that permits selection of direct or 100,000-ohm isolation input.

How It Fared. We put the digital multimeter through its paces using our laboratory dc voltage standard and our selection of very close tolerance resistors. In all cases, we found the Model 281 came within its stated specifications.

Circle No. 69 on Reader Service Card

Great careers



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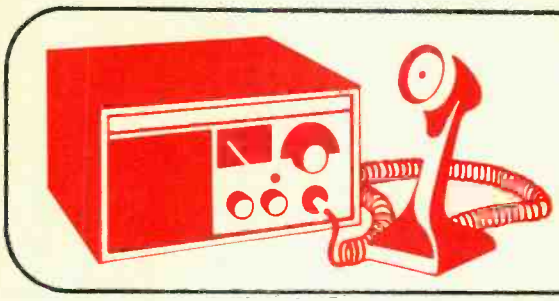


CB Scene

By Matt P. Spinello, KHC2060

UPWARDS of 50 ALERT and REACT teams, individual clubs and CB'ers honored CB Scene with personal invitations to visit on site with their memberships this past year. The requests grew out of POPULAR ELECTRONICS' Monitour conducted in 11 heavily CB-populated regions from as far West as Las Vegas, Nevada to as far East and South as Washington, D. C. Additional mail and telephone response to the Monitour concept has drawn positive reaction at a ratio of about 100:1. The *one* negative retort came out of New York State from a reader who felt that PE was wasting money shipping Matt Spinello around the country to listen in on CB radio transmissions. The assumption drawn by our reader may be that CB radio is the same, no matter where. But is it?

Monitour, POPULAR ELECTRONICS *monitoring tour* across country, was conducted during the second and third quarters of 1973. The tour drew more than the applause of readers. It zeroed in on conditions as they actually exist. Reading mail from an area is one thing; sitting across from CB'ers in that same area with a mug of whatever turns you on can produce something else! In person, veils are lifted, discussions become more frank and "live" exchanges generally bring out more truths. That is not to say that CB'ers reports to electronics journals are colored. Most individuals will, however let their verbal hair down and speak more freely in person than on paper.

Monitour uncovered problems more common to specific parts of the country and prompted CB'ers to bring case histories to our attention. It also found them asking for advise on how to cope with situations such as the heavy use of linears by truckers through the state of Pennsylvania, flagrant misuse of CB channels by RV motorists throughout the country and the use of linears and directional beams in the Shenandoah mountain range that all but knock out communications on the upper part of the band for licensees in Maryland, Virginia and the District of Columbia.

If Monitour generates nothing more than the riling of the CB community on which it reports, it accomplishes a worthy mission. If you nodded in agreement at reports we made this year regarding code names, linear amplifiers and lengthy, unnecessary chit-chat, do something about it! If illegal operations reported parallel conditions that surround you, make your move! Start with the district FCC field office nearest you (listed in the telephone directory under U.S. Government) with a *written* complaint specifying the condition, requesting action and a written response. To add strength to your request, include a petition signed by as many CB'ers as you can muster, being sure to include their callsigns and full addresses. Keep several copies of all correspondence you initiate. Follow up like clockwork by calling the district office once a week to see what action has been taken. Log your conversations by date, time and subject discussed.

If your efforts have not produced satisfactory results within a reasonable amount of time, write a formal complaint to the FCC in Washington, D. C. Send 12 copies of your letter, your telephone log with the

Year-End Prose & Con's

district office, the petition and all other correspondence pertaining to the original subject matter. You have at least two more steps to take if all else fails: write to your Congressman and your state Senator. Be sure to include the hefty bundle of correspondence, petitions and replies you have accumulated. Don't write the White House. They have their own communications problem to deal with.

In essence, Monitour provides CB Scene with the shape of current trends and those to come; it calls to the attention of the FCC extreme trouble spots; it reminds local CB'ers that it's time they organize to work with (and prod if necessary) governmental agencies to make 27 MHz a better place to live. In the final analysis, readers have been more factual in their reporting since the publishing of Monitour and the tour has prompted many to fill us in on their club and team activities as well as conditions that plague their communities. It also weighs down the mail bag that arrives across this desk, and that's the heart of what enables us to report what's happening coast to coast.

If your CB organization is interested in having CB Scene make a "live" Monitour appearance in your area in 1974, have a club officer forward a request on your club letterhead, filling us in on your organization: officers, membership totals, activities and if available, glossy action photos. In addition, be sure to include some back issues of your newsletters and place us on your mailing list for future releases. Address all material to Matt P. Spinello, CB Editor, Popular Electronics, One Park Avenue, New York, N. Y. 10016.

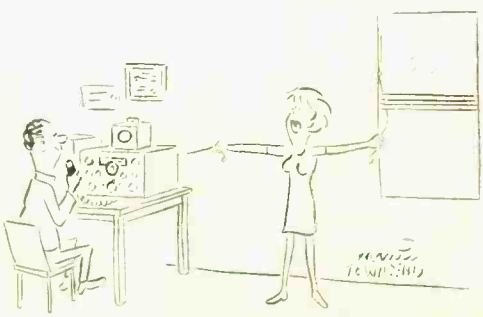
SSB Tech Tip. It does not require a direct hit from a bolt of lightning to cause damage to your rig. Two recent mishaps occuring to SSB transceivers were created by a *nearby* strike which affected the antenna circuits in both rigs, destroying a rectifier in the SWR bridge and simultaneously destroying the bfo transistor in one. AM transmit and receive were not affected. Symptoms resulting from non-grounded systems that have been in thunderstorm areas may include one or several of the following: garbled SSB reception, loss of control of r f gain and limiter adjustments, loss of meter functions in the SWR, power and internal load positions. Although thunderstorms are seasonal, now is a good time to get at all those things we promised would be done last summer. To protect your system and youself install a coax lightning arrestor. Radio Shack makes one available for under $4 (catalog #21-1049). It attaches easily between the antenna input of the transceiver and the antenna coax. You need only attach to the set screw on its barrel a heavy duty wire not less than 12 gauge and run it to a water pipe, attaching it securely with a clamp. You should also consider grounding the antenna mast for the same protective reasons.

Scanner/Monitor Frequencies . . . Monitoring of the Public Service and emergency radio bands by CB'ers has become increasingly popular of late. Scanner monitors are especially useful to emergency monitoring teams for base and mobile station operation.

The CB monitor must be careful not to re-transmit the public service message he is receiving. Also, the Communications Act of 1934 does not allow the divulgence of information intercepted from the agency dispatcher.

Many CB Scene readers have requested information regarding the frequencies used in their areas by Public Service agencies. A complete directory of callsigns and frequencies for the area of your choice is available from CRB Research, Inc., P.O. Box 56, Commack, N.Y. 11725. Their directories cover every state, county, municipal, police, fire, sheriff and local governmental agency service in their respective areas. They include all base and mobile channels on the vhf low and high bands and the uhf band. If monitoring railroads, jet pilots and control towers interests you, these frequencies are also available from CRB.

I'll CB'ing you next year. ◈



"Do you mean it will be Monday before you can buy more lead-in wire."

FOUR-WAY FLASHER

Ideal for older cars and campers

BY M. D. HILKER

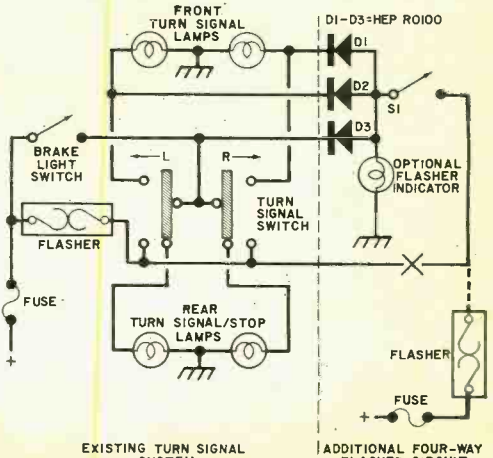
Four-way flashing lights are standard on most new cars. However, if you have an older car or a trailer that you want to equip with four-way flashers, use the circuit shown below.

The existing turn signal circuit is shown at the left and the additional circuit at the right shows how to install the new four-way system. The three silicon rectifier diodes effectively isolate their respective leads due to their high back resistance. However, they conduct quite readily in the forward mode. The flashing is turned on by closing *S1*. The other side of *S1* can go to either the vehicle's normal flasher (ignore the break at "X" in this case) or through an extra flasher and fuse to the vehicle battery (break the lead at "X" in this case).

In some cases, the car's present flasher may not be able to handle four lamps. If this is so, use a heavy-duty flasher.

The silicon diodes called for can handle six amperes, so a camper with several lights can be flashed. The circuit will work on 6 or 12 volts, and if you have a positive ground, simply reverse each diode.

If you use the external flasher, install the fuse, heavy-duty flasher, switch, optional indicator, and silicon diodes in a separate small box near the dashboard. ◈



Solid-State Gifts for the Holidays

By Lou Garner

IN ADDITION to visions of sugar plums and glittering decorations, the Holiday Season generally entails the happy, though often puzzling, task of choosing gifts for one's family, friends, relatives, neighbors and business associates or school pals. The task can be a rewarding experience rather than a chore if you combine a dash of imagination with a modest budget. Chances are you can find just the right gift for virtually every one on your list from among the wide variety of solid-state products available in today's market. As in the past, we'd like to offer a few suggestions.

You'll find scores of exciting gift ideas in the annual and special catalogs published by the major distributors and kit manufacturers, such as Radio Shack (2617 West 7th St., Fort Worth, TX 76107), Lafayette Radio (111 Jericho Turnpike, Syosset, L.I., NY 11791), the Heath Co. (Benton Harbor, MI 49022), Eico (283 Malta St., Brooklyn, NY 11207), and GC Electronics' Calectro Division (Rockford, IL 61101).

For that extra special someone, you can even put "something of yourself" in a gift by personally assembling a project, either from a kit or from scratch, following a construction article published in current or past issues of this magazine. The choice is wide, and the total cost can range from less than five dollars to as much as you wish (or can afford) to spend. An inexpensive gift for a wife or mother might be Health's photoelectric lamp switch, No. GD-600, priced at only $5.00 in kit form.

Transistorized receivers make excellent gifts for everyone from sub-teens to retirees, and can be purchased at virtually every price level. Small AM pocket sets are available for under five dollars, while a generous giver with a pocketbook to match could spend well over a hundred dollars for a multi-band AM/FM/SW receiver. Most girls (and ladies) would adore one of Radio Shack's cuddly plush animal radios; listed at $9.95 each for poodles and terriers, prices range up to $14.95 for a collie. And with bicycle travel increasingly popular at all age levels, you might consider a bike radio as a gift. These are available from both Radio Shack (Cat. No 12-1168, $14.95) and Lafayette Radio (Cat. No. 17 E 86003, $16.95), and the latter is even equipped with a built-in light.

You may prefer to select a gift which complements your recipient's avocation. Here, the selection is so broad that the only limits on choice are your imagination and budget. Typically. . . .

Audio buffs—amplifiers, preamps, audio test equipment, color organs, or even a sound level meter (Radio Shack, No. 33-1028, $49.95).

Auto enthusiasts—burglar alarms, electronic tachometers, solid-state ignition systems, tune-up meters (Heath, No. ID-29, $29.95), radar sentries (Radio Shack, No. 28-4008, $24.95), or perhaps an electronic speed control (Lafayette, No. 11 E 59011, $22.50).

Boaters—gas fume detectors, multiband receivers, weather receivers, depth finders, dock strobe lights, power megaphones, or even a combination power hailer/foghorn.

Campers—camper burglar alarms, CB walkie-talkies, cab-to-camper intercoms (Heath, No. GD-160, $25.95), treasure finders (Radio Shack, No 60-3001, $34.95), or maybe a dc/ac power inverter (Radio Shack, No. 22-130, $49.95).

Fishermen—Mini weatheradios (Radio Shack, No. 12-162, $14.95), CB walkie-talkies, thermo fish spotters, (Heath, No. MI-104, $24.95).

Home Handypersons—lamp dimmers (Heath, No. GD-1018, $7.95), motor speed controls (Lafayette, No. 13 E27006, $9.95), burglar alarms, door answering intercoms (GC/Calectro No. N4-101, $14.95), flood alarms (Lafayette, No. 14 E20504, $14.95), disaster alarms (Radio Shack, No. 28-4006, $19.95), or flashlight/battery chargers (GC/Calectro No. N4-053, $6.95).

Hunters—CB walkie-talkies, Mini weatheradios (Radio Shack).

Musicians—amplifiers, preamps, "fuzz" sound adapters (Lafayette, No. 99 E 91993, $14.95), FM wireless microphones (Radio Shack, No. 33-1048, $17.95), reverberation units (Lafayette, No. 99 E 92025W,$24.50) electronic metronomes (Radio Shack, No. 28-3392, $12.95; Heath, No. TD-17, $9.95).

Shutterbugs—electronic strobe flashers, automatic slave flashers, enlarger timers.

If you're choosing a gift for someone who, as yourself, is interested in electronics, you could select something as inexpensive as an interesting new IC device from Motorola's extensive HEP line or a project manual—perhaps even a subscription to PE/EW. A beginning ham might appreciate a code practice oscillator or inexpensive SW receiver kit. With more to spend, your gift might be a test instrument kit or one of Kurz-Kasch's new Powrboards.

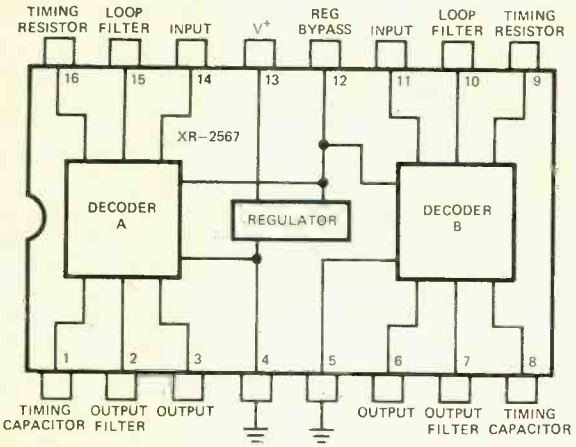


Fig. 1. Pin connections for Exar's new XR-2567 IC containing two PLL tone decoders and a voltage regulator. Fig. 2 shows some applications.

A technically inclined sub-teen might appreciate an inexpensive assembly kit from Radio Shack's Science Fair® "P-Box" line or an Eico Eicocraft kit. If your budget permits, a good choice might be one of the multi-project kits offered by Radio Shack and Lafayette. Available at prices ranging from less than ten to nearly thirty dollars, some of these may be used for assembling over a hundred different circuits.

Where your budget is unlimited, your possible choice of gifts multiplies considerably and the sky's the limit. Give a deluxe quadraphonic hi-fi system or a solid-state color TV. A pocket calculator makes a nice "stocking stuffer," while a cassette recorder would be appreciated by both students and business men (and women). An automatic telephone answering device is a gift that would be welcomed by nearly everyone from a housewife to a professional or business person. These range in price from less than a hundred dollars (Radio Shack's *Duo-Fone*®, $79.95) to several hundred dollars, depending on brand, model number, and included features. The less expensive models will answer the phone automatically, play a pre-recorded message, and record an incoming call, while the more expensive models may include facilities for two-way recording and remote playback. Finally, if you really want to splurge, you might consider a solid-state digital wristwatch for that super special someone . . . in a precious metal case, the watch could cost well over a thousand smackers!

A Dual Tone Decoder IC. Comprising two 567-type PLL (phase-locked loop) tone decoders and a voltage regulator in a single 16-pin DIP, the XR-2567, Fig. 1, can be used in a variety of hobbyist, commercial and industrial applications. Typically, it can be used for Touch-Tone® telephone decoding, in communications paging systems, for ultrasonic remote control and monitoring, in wireless intercoms, and as a precision oscillator in signal and function generators. With a center frequency range of 0.01 Hz to 500 kHz and an adjustable bandwidth from 0 to 14%, each decoder section consists of a phase-locked loop, a quadrature AM detector, a voltage comparator, and an output current driver capable of handling loads up to 100 mA. The device can be operated on supply voltages of 4.5 to 12 volts dc, with internal voltage regulation provided for sources of 7 to 12 volts. A mono-

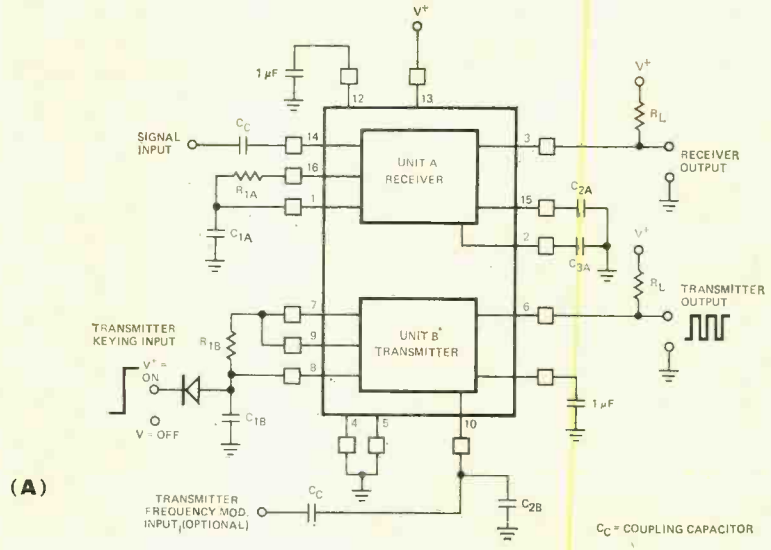
lithic unit manufactured by Exar Integrated Systems, Inc. (750 Palomar Ave., Sunnyvale, CA 94086), the XR-2567 is available primarily through local franchised industrial distributors, but also is stocked by some mail order outlets.

In operation, each decoder's center frequency is set by external components which determine the free-running frequency of its PLL oscillator. When an input signal is applied within the circuit's passband, the PLL locks on this signal, and the output, normally *high*, switches to a *low* state. In addition, each decoder's oscillator output is available separately as square or triangular waveforms, permitting the device to be used in function and signal generators. Each decoder section is independent, and they may be used separately, simultaneously, or interlocked.

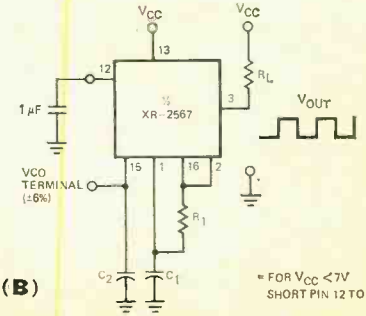
Typical XR-2567 circuit applications are illustrated in Fig. 2. These were abstracted from the 8-page specifications/applications bulletin published by Exar for the device.

Both tone detection and tone generation functions are combined in the duplex tone transceiver circuit illustrated in Fig. 2(A). Unit A serves as a tone receiver, unit B as a tone transmitter. The transmitter section can be keyed by applying control pulses to pin 8 through an isolation diode. If desired, the transmitter also may be frequency modulated by applying a modulation signal to pin 10. This basic circuit may be used in a variety of interesting applications. Typically, it could be used for selective calling of wireless intercoms, for remote monitoring, for remote control, etc.

Suitable for use in such projects as signal generators, CPO's, musical instrument tone generators, function generators and similar applications, the precision oscillator circuit given in Fig. 2(B) uses only half of an XR-2567. Capable of switching loads of up to 100 mA, the oscillator's frequency can be modulated over +6% of its f_o by applying a control voltage to pin 15 (or pin 10 if the second unit is used). ◈

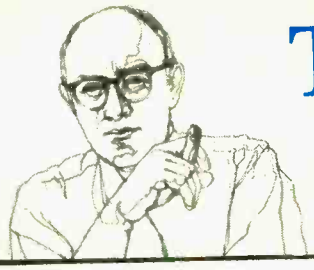


(A)



(B)

Fig. 2. Two applications for the XR-2567 dual tone decoder. In the duplex tone transceiver circuit shown at (A), unit A serves as a tone receiver and unit B as a tone transmitter. In (B), at right, only half of the IC is utilized to form a precision oscillator for use in circuits such as a musical instrument tone generator.



Test Equipment Scene

By Leslie Solomon, Technical Editor

A Magnetic Discussion

WE HAVE meters for measuring just about every electronic parameter—and when a meter won't do the job, we usually turn to other readout instruments, like scopes. However, there is one parameter that we always overlook, yet it plays a very important role in the servicing and operation of much of our equipment. At one time or another, we have all noticed the effects of this parameter, but we didn't realize what was causing the trouble. Many times, of course, we didn't even realize that something was wrong. One reason that we haven't given much consideration to this problem is that it is "hidden" from us when using everyday test equipment. There has really been no easy way to detect this parameter, let alone measure it.

We are speaking of magnetism. Probably the closest that most of us have ever come to this subject is to use some form of degaussing coil on a color TV receiver or a head demagnetizer on an audio tape set. In these cases, we do not really know if we are applying the demagnetizer in the right place, or whether or not we are doing a complete job.

It Starts With Steel. The problem of magnetism actually starts with the need for physical strength. When we purchase a piece of equipment—tape recorder, color TV, or whatever—we want it to stay all in one piece for a decent period of time, not falling apart with reasonable use. Although plastics seem to have taken over most of the world, there are still some places where steel (in various forms) has to be used.

Steel is strong, low in price, long-lasting and readily workable into many strange and different forms for electronic gear. Sometimes steel is employed because of its magnetic properties, so it is used in transformers, relays, electric motors, and tape recorder heads—to name a few applications. This type of steel is metallurgically designed for its high magnetic permeability and also for its very short magnetic memory (retentivity).

There are other types of steel that are alloyed, heat-treated, or work-hardened to be used where superior mechanical strength is required. Although this type of steel has less ability to conduct magnetism, it usually has a relatively good magnetic memory when exposed to a magnetic field. It is these latter steels that are used as capstans, guides, rollers, springs, mounting hardware, etc.

Two of our most common consumer devices work because of controlled magnetic fields. A tape recorder utilizes magnetically sensitive tape to operate properly, and a color TV receiver uses controlled magnetic fields to achieve color purity. Of course, there are other magnetically operated devices (meters and speakers, for example) but these are not as susceptible to stray magnetic fields as are recorders and TV receivers.

Unfortunately, there are many hard-steel elements in a recorder's tape path that can magnetically "bias" the tape as it passes through, thus producing all types of distortion in the reproduced audio. The previously mentioned capstans, guides, rollers, and springs are examples of these.

In color TV, the use of the "wrong" mounting hardware, the close presence of speakers (especially outboard types), or various items containing steel that can be placed close to or on top of the cabinet can induce the stray magnetic fields where they are not wanted. That is why most CRT devices include a Mu-metal shield and automatic degaussing (in the case of color TV).

Other Types of Fields. There are other types of magnetic fields. Whenever a current flows in a circuit that is external to the recorder or TV set, a magnetic field is generated. Inductive spikes can cause some really large currents (and associated magnetic fields). True, most of these events are rare and may not affect the device in question; but what of inadvertently magnetized steel tools? There are many tools that come into contact with the steel parts of recorders and TV receivers.

Fairly long iron or steel construction members that may be oriented with the earth's magnetic field may be magnetized, with their magnetic field extending some distance from the end; and, even though the end may be within a wall, the wall may not shield the magnetic field.

The solution is not to place expensive, magnetically susceptible equipment too close to the ends of steel girders and pipes, if they are oriented either vertically or in a general north-south direction.

Also keep in mind that transistor radios have a powerful magnet (the speaker) enclosed in a plastic (hence non-magnetic shielding) case. Keep these away from magnetically sensitive devices. Don't forget that VOM meter movements or photometers also contain magnetic devices.

As a rule of thumb, anything that measures more than one gauss (the earth's field is about half a gauss) should be suspect. Great, you may say, but how can the electronics experimenter or service technician make these kinds of measurements?

Low-Cost Magnetometer. This problem confronted us too, until we ran into the low-cost, portable magnetometer made by the R. B. Annis Co. (Indianapolis, Ind.). It is 2 inches in diameter and is about $7. It comes with scales indicating from 0.5 gauss to 20 gauss full scale. We used the one that indicates to 5 gauss.

We had a close look at the steel tape-

path parts of several tape recorders and were surprised at the levels of some of the unwanted magnetic fields. It took many applications of our demagnetizer tool to reduce the unwanted effects. Before doing any mechanical work, we checked our tools; and lo and behold, if we had used that particular set of tools to replace anything, we would have re-magnetized everything the tool touched. Now we have a special set of demagnetized tools which are magnetically checked before use and kept exclusively for all our tape recorder work. We keep them in an old Mu-metal CRT shield which we have formed into a small box.

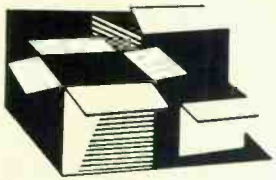
When using a demagnetizer, it is important to shift the physical relationship between the steel part and the demagnetizing field during the process. This will insure optimum demagnetization.

Another important point is that there must be no sudden interruption of the power to the demagnetizer when it is in close proximity to the part being demagnetized. If this does occur, the chances are that the steel part will be left in a highly magnetized state as a result of being magnetized by the last half cycle of the power line prior to the interruption.

Always move the still-powered demagnetizer with power on as far away as possible before turning the power off. This, of course, applies to both tape head demagnetization and to color-TV degaussing.

A look around some color-TV chassis and cabinets showed us why some sets could not be converged. In some cases, someone had installed extra speakers in the large wooden cabinets, and sometimes long steel mounting hardware had been used. In another case, a dc clock, converted from a vehicle type, had been installed on the front of the color TV. After checking them out with the magnetometer, we discovered some really strange magnetic fields that the receiver designer never imagined. After removing these unwanted fields, the owner discovered that his set could be converged and could produce a pretty good picture. We had only one case of a metal building member affecting a unit; and once the equipment was moved, the problem was cured.

The pocket magnetometer has now found a permanent place with our other test equipment, and has enabled us to defeat one more source of headaches. ◈

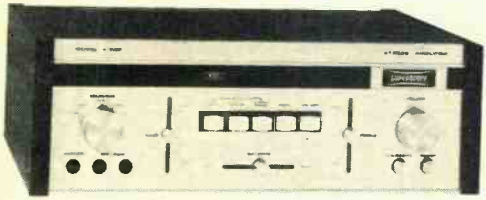


New Products

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 at the address given.

SUPERSCOPE QUADRAPHONIC AMPLIFIER

Superscope, Inc., has announced availability of their Model A-260 integrated amplifier with Quadraphase® circuitry. This new top-of-the-line amplifier developes 45 watts of IHF power and features a high level of flexibility and performance. It was designed to provide 2- and 4-channel compatibility. The exclusive Quadraphase circuit, plus a pair of extra speaker systems, enables the amplifier to derive 4-channel effects from both ordinary stereo and matrix-encoded sources. Features are a loudness contour switch, graphic balance control, bass and treble controls, mono selector switch, and stereo headphone jack, The preamplifier and power amplifier can be made to operate as independent units.



Circle No. 70 on Reader Service Card

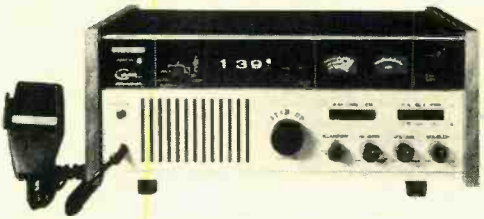
MOODY TOOLS PHILLIPS/ALLEN TOOL KIT

Moody Tools Inc. is offering a six-piece Phillips-head driver and Allen-type wrench tool kit. Designated the Model PA-5, the kit contains Allen wrenches in #4, #6, and #8 sizes and Phillips drivers in sizes #0 and #1. All five tools fit interchangeably into a rugged chuck-type handle. The handle has a swivel top for operating convenience. The kit comes in a handy two-piece molded plastic case.

Circle No. 71 on Reader Service Card

COURIER AM/SSB BASE STATION

The new Centurion AM/SSB base station for CB from Courier employs a crystal lattice filter on SSB to provide freedom from adjacent channel interference and better than 80 dB (at 20 kHz) selectivity. A mechanical filter is used in the AM receive mode. Two separate i-f strips, one each for AM and SSB, provide peak performance in each operating mode. Also featured are a ±600-Hz clarifier control, a separate microphone jack, and a digital (mechanical) alarm clock. The power, blanker, and PA/CB switches are rocker type. Illumination is provided for the "on-the-air" transmitter indicator, channel selector, receive mode indicator, and the calibrated S/r-f and power meter.



Circle No. 72 on Reader Service Card

SCOTT INSTRUMENT SOUND LEVEL METER

Scott Instrument Laboratories has announced availability of their new Model 451C professional sound level meter with "C" weighting. Designed for both professional and amateur use, the pocket-size instrument gives direct readings that meet or exceed existing ANSI type S3C accuracy. Its range of 45-130 dBC

sound pressure level permits measurements of ambient and background noise, as well as signals of interest. The 451C is housed in a rugged metal case. It uses a single 9-volt battery that gives more than 200 hours of operational life.

Circle No. 73 on Reader Service Card

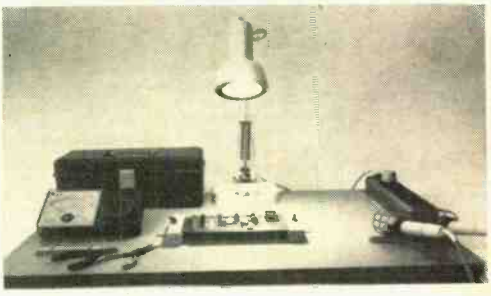
ACE AUDIO BASIC STEREO PREAMPLIFIER

The Ace Audio basic preamplifier is said to be a perfectionist's control center where the audio signal is subjected to as few operations as possible. Because it contains no tone controls or complicated switching, the preamplifier reportedly delivers an inherently clean sound without compromise or subtle deteriorations. The preamp features only five controls: source switch, tape input switch, power switch, and left and right volume controls. Balancing the two channels is accomplished by adjusting the volume controls. The preamplifier can be used alone to provide true flat response without tone control error, or with a graphic equalizer for complete control over tone.

Circle No. 74 on Reader Service Card

CHRISTIANSEN RADIO ASSEMBLY STATION

With the Christiansen Radio electronic assembly station, you can quickly convert any office, classroom, or workshop area into an ideal place for drawing up designs and building electronic projects. The station consists of a 30 in. by 20



in. work surface, topped with Formica; a circuit board vise; a lamp; a six-outlet switched and fused power distribution box; and an adjustable, temperature-controlled soldering iron with holder. Optional equipment for the electronic assembly station are a tool box with tools and a multimeter.

Circle No. 75 on Reader Service Card

RECTILINEAR BOOKSHELF SPEAKER SYSTEM

Rectilinear's Model XIa is designed to optimize all design elements in a simple, moderately priced two-way speaker system. A high-efficiency 10" woofer crosses over at 1000 Hz to a 3½" closed-back cone-type tweeter. An unusual series-type crossover network manages to achieve steep attenuation slopes with only one choke and one capacitor, partly by

using the natural roll-off of each driver. A tweeter level control is provided. The tube-vented cabinet is tuned for optimum bass response to maintain efficiency down to the low bass frequencies without roll-off. The 8-ohm system can be driven by a 10-15-watt amplifier but will handle up to 50 watts rms. Frequency range is flat from below 60 Hz to almost 30,000 Hz.

Circle No. 76 on Reader Service Card

KURZ-KASCH STUDENT MODEL LOGIC PROBE

Kurz-Kasch, Inc., has announced availability of their Model LP-520-002 overload-protected logic probe. This special probe was designed to withstand the abusive treatment often encountered in technical school laboratories and by unskilled persons. The probe can test all 2.4-

5.5-volt dc logic circuits. It indicates white for logic zero, red for logic 1, and blue for logic f for pulses faster than 35 ns. All indicators remain off to indicate an open circuit or unwired pin. An amber overvoltage lamp protects the probe input, and the probe is also protected against power lead reversal.

Circle No. 77 on Reader Service Card

NEW SQ 4-CHANNEL DECODER FROM SONY

A new 4-channel decoder, the Model SQD-2020, has been announced by Sony Corp. of

America. The decoder handles SQ and RM discs. Since SQ-encoded 4-channel records normally retain full left-to-right separation but exhibit reduced front-to-rear separation during playback, the SQD-2020 has a dual logic circuit that substantially increases front-to-rear

separation. A special wave comparator circuit also eliminates possible crosstalk along the sides of the listening area. SQ separation is 20 dB across the front and rear and 15 dB between the front and rear. Included in the decoder are a master volume control, individual-channel level controls, bass and treble controls for the rear channels, and four VU meters for monitoring and balancing program material.

Circle No. 78 on Reader Service Card

SSI LOW-FREQUENCY EQUALIZER

Those bass notes that you hardly hear from many of today's bookshelf speaker systems can come alive with the Model BD-1000 low-

frequency equalizer introduced by Sound Systems International. This device boosts frequencies below 250 Hz without affecting the midrange or high frequencies. And it can be used with all types of speaker systems currently in use. For convenience and flexibility, the BD-1000 also has its own mode switch that allows the user to switch the equalizer in and out of a hi-fi system as desired.

Circle No. 79 on Reader Service Card

MITS CALCULATOR WITH METRIC CONVERTER

A new handheld calculator with built-in automatic (on command) metric converter is now available from MITS, Inc. The Model 941 calculator, available in both factory-wired and kit forms, features 36 metric conversions (length, area, volume, liquid, mass, and temperature), the usual four arithmetic functions, and a percent function—a total of 41 functions in all. Other features include an eight-digit LED display, chain calculation capability, memory, floating decimal system, sign indicator, true credit balance, overflow indication, low-battery indicator, display blanking to conserve battery power, etc.

Circle No. 80 on Reader Service Card

HEATHKIT C/D IGNITION SYSTEM

Any car or truck with a conventional negative-ground electrical system can get increased gas mileage and go longer between tuneups with the Model CP-1060 capacitive discharge igni-

tion system from the Heath Company. The CP-1060, available only in kit form, delivers a higher voltage to the spark plugs for more complete combustion. It automatically varies spark duration, yielding longer firing for cold-morning starts and shorter firing time for high rpm running. It also puts very little current through the points, substantially reducing the heat that causes pitting and burning. An external override switch is included, permitting switch-over to the conventional ignition system when desired.

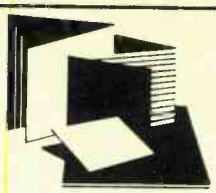
Circle No. 81 on Reader Service Card

ABOUT YOUR SUBSCRIPTION

Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of POPULAR ELECTRONICS each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.



New Literature

TRIPLETT TEST INSTRUMENT CATALOG

A comprehensive 16-page catalog featuring an easy-to-read tester selection guide that allows direct comparison of performance characteristics for each model listed is available from Triplett Corp. The No. 59-T catalog lists the full range of Triplett VOM's—both analog and digital—and accessories and a temperature tester. A photograph of each tester model and accessory is shown, accompanied by a list of technical specifications and retail price. Address Triplett Corp., Bluffton, OH 45817.

GC RELEASES NEW CALECTRO HANDBOOK

Filled with practical do-it-yourself information, charts, formulas, and tables, the new Calectro No. FR-73-C handbook published by GC Electronics features a free, easy-to-use Ohms Law calculator and giant wall chart of electronic symbols. The 72-page handbook illustrates and describes hundreds of basic Calectro parts and accessories available through distributors throughout the U.S. and Canada. Address: GC Electronics, Div. of Hydrometals, Inc., 400 S. Wyman St., Rockford, IL 61101.

AMPEX BLANK RECORDING TAPE BROCHURE

An eight-page brochure that details the features and specifications of Ampex's complete line of blank recording tape for consumer use is available for the asking. The full-color booklet ranges in description from the all-purpose and economy cassettes to the top-of-the-line studio-quality cassettes and professional recording tapes. Copies of brochure No. T973 are available from: Ampex Corp., 401 Broadway, Redwood City, CA 94063.

TEAC HAS TAPE RECORDING BOOKLET

"Expanding the Art of Tape Recording" is the title of a new 24-page booklet available from Teac. It describes how various accessories or extensions to a tape recorder are engineered to increase their productivity and usefulness. Shown in the booklet are microphone and impedance converters, service accessories, special effects accessories, pause/repeat accessories, timer controls, remote controls, etc., as well as a troubleshooting chart and essentials to the

care of a tape recorder. Address: Teac Corp. of America, 7733 Telegraph Rd., Montebello, CA 90640.

RADIO SHACK CATALOG FOR 1974

Radio Shack's new 1974 electronics catalog (No. 238) introduces the company's new line of stereo and 4-channel receivers, electronic calculators, automatic tape cartridge changer, and a complete telephone answering system. Also featured in the 180-page catalog are a complete line of home-entertainment products, audio equipment, CB radios, test instruments, antennas, Archerkits, automotive products, and much more. Thousands of hard-to-find items for the hobbyist/experimenter round out the listings. Address: Radio Shack, Dept. R-24, 2617 W. Seventh St., Fort Worth, TX 76107.

POMONA ELECTRONICS GENERAL CATALOG

Featuring more than 500 products in its 64 pages, the 1973 general catalog of electronic test accessories from Pomona Electronics highlights the company's latest version of their "Grabber" mini test clip. Other new products include two molded breakout test cables, a 0.04-in. in tip patch cord, a twinax cable plug, an 11-pin relay test socket adapter, and a large cover plate for D-size shielded "black boxes." The catalog gives illustrations and complete engineering information on all products. Address: Pomona Electronics Co., Inc., Union Bank Plaza, 201 S. Lake Ave., Pasadena, CA 91101.

ANTENNA SPECIALISTS CB ANTENNA BOOKLET

Dozens of subjects related to CB antennas are covered in an interesting eight-page information booklet (titled "Why CB Antennas?") available from Antenna Specialists. Profusely illustrated with diagrams, patterns and sketches, the booklet explains the technical side of CB antennas. The brochure also includes a handy table of definitions used for CB antennas and a gain-to-effective-power chart. Address: Personal Products Dept., The Antenna Specialists Co., 12435 Euclid Ave., Cleveland, OH 44106.

RCA AUDIO POWER AMPLIFIER BROCHURE

A 20-page brochure that describes the basic concepts and techniques employed in the design of transistor power amplifiers is available from RCA. "Audio Power Amplifiers," Publication No. APA-550, describes significant design features, basic circuit configurations, rating methods, and stability requirements for solid-state power amplifiers. The classes of operation and selection of optimum class for a given power output are discussed, drive requirements are defined, and the effects of operating conditions on circuit design are analyzed. Address: RCA Solid State Division, Route 202, Somerville, NJ 08876.

Electronics Library

NORTH AMERICAN RADIO-TV STATION GUIDE, Ninth Edition

by Vane A. Jones

This handy guide contains listings for all radio and television stations in the U.S., Canada, Mexico, and the West Indies, a total of more than 10,000 stations in all. The AM, FM, and TV stations presently in operation, scheduled to start operation soon, or temporarily off the air are each listed by geographical location, frequency or channel, and call letters. Important statistics such as day and night power, height of FM antennas, and sharing of time with other stations are given. Also listed is the network affiliation for each station. Educational stations are designated, as are FM stations broadcasting in stereo.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 160 pages. $4.50.

INTRODUCTION TO MEDICAL ELECTRONICS

by Burton Klein

This book ties together medicine and electronics in a manner that can be understood and digested by members of both professions. For nonmedical personnel, the human body is described as an anatomical and physiological system. There is continuing tie-in of physiological activities of the body with the equipment designed to detect, amplify, and present data signals concerning the body. As an aid to cross-discipline understanding, one section of the book is devoted to electronics for non-electronics personnel. The discussion covers basic principles of physics and electricity, giving only sufficient background so that medical personnel will be aware of the accurate and safe use of electromedical equipment.

Published by Tab Books, Blue Ridge Summit, PA 17214. 272 pages. $9.95 hard cover; $6.95 soft cover.

BASIC ELECTRICITY: THEORY AND PRACTICE

by Milton S. Kaufman

This is an introductory book, written especially for occupational and trade students with reading and comprehension difficulties. Well-illustrated and inherently self-instructional, the material is presented at a slow pace, then is reinforced in programmed reviews. The book covers ac-dc topics (magnetism, voltage, current, resistance, inductance, capacitance, and Ohm's Law). In addition, motors, generators, simple measuring instruments, transformers, house wiring, and other applications are examined. The math level never rises above simple arithmetic. The book is written for students with at least an eighth-grade reading level.

Published by McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. Soft cover. 528 pages. $9.95.

COLOR TELEVISION: Theory And Servicing

by Clyde N. Herrick

Analyzing basic color fundamentals, this book surveys color TV technology as it is today. Covered are all types of operation—from systems, color CRT principles, and operations to r-f and i-f circuitry. Explained is troubleshooting based on picture analysis and instrument application. Carefully detailed is the R-Y and B-Y systems before the I/Q system is introduced. In addition, color TV accessories and optional features, test equipment, receiver installation, setup procedures, and CATV systems are discussed. The

text is fully illustrated with line drawings and photos, 14 of which are in color.

Published by Reston Publishing Co., Inc., Box 547, Reston, VA 22090. Hard cover. 376 pages. $13.95

BUCHSBAUM'S COMPLETE HANDBOOK OF PRACTICAL ELECTRONIC REFERENCE DATA

by Walter H. Buchsbaum

In this timely guide, you will find hundreds of formulas, graphs, charts, and tables to help you work more efficiently in every major area of electronics. The book covers all of the latest aspects of electronics. The text contains valuable definitions, standards, and basic reference information for the circuit designer, systems analyst, space scientist, medical technologist, and those people who teach courses in the various areas of electronics.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 529 pages. $15.

THE PRINCIPLES OF SWITCHING CIRCUITS

by Frederick H. Edwards

A unified treatment of switching theory, with particular emphasis on sequential circuit theory, is presented in this book. The first four chapters deal with basic principles and combinational circuit theory. They introduce number systems, binary codes, Boolean algebra, switching functions, analysis and synthesis of combinational gate circuits, and threshold logic, among other topics. The remainder of the book is devoted to sequential circuit theory. A general treatment is emphasized by classification of the sequential-circuit operation as either fundamental mode or pulse mode, and as either clocked or not clocked.

Published by The MIT Press, 28 Carleton St., Cambridge, MA 02142. Hard cover. 329 pages. $15.50.

DIGITAL INTEGRATED CIRCUITS MANUAL, Second Edition

More than 1500 digital integrated circuits are listed by type number and case/pin configuration in this handy updated manual. This second edition contains three times as many listings as were included in the first edition. The scope has been expanded to include, in addition to TTL devices, many DTL, ECL, MOS, and special circuits. A listing in order of type numbers appears first, followed by a listing in order of case configuration numbers. Short function descriptions follow each IC listing.

Published by Electronetics Co., Inc., P.O. Box 278, Cranbury, NJ 08520. 41 pages. $3.95.

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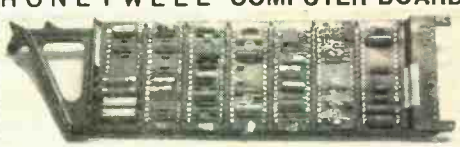

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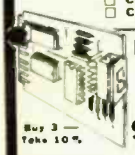

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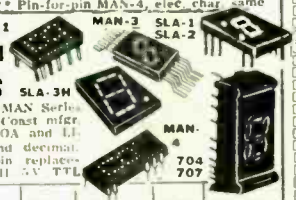

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☐ MAN-3 equal	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3A equal*	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3M equal*	.127	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3 equal	.115	Red	***	10	SN7448	1.95	3 for $5.
☐ MAN-3M equal*	.127	Red	Yes***	10	SN7448	1.95	3 for $5.
☐ MAN-4 equal*	.190	Red	Yes	15	SN7448	3.25	3 for $9.
☐ MAN-4 equal*	.190	Red	Yes***	15	SN7448	2.75	3 for $8.
☐ 707** (MAN-1)	.33	Red	Yes	20	SN7447	3.25	3 for $6.
☐ 704** (MAN-4)	.33	Red	Yes	20	SN7448	3.25	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	Yes	20 15	SN7447	3.25	3 for $6.

* Red epoxy case, others clear. ** Litronix and Opcoa's pin-for-pin equals and electrical specs as MAN-1 or MAN-4. *** LED "dot" missing.

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☐ SN7425	.30	☐ SN7461	.35	☐ SN7493	1.30	☐ SN74156	1.42	☐ SN74196	1.50
☐ SN7426	.37	☐ SN7462	.35	☐ SN7494	1.30	☐ SN74157	1.55	☐ SN74197	2.10
		☐ SN7464	.50	☐ SN7495	1.30	☐ SN74158	1.55	☐ SN74199	2.65
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Size	1-4	5-9	10-25	1-4	5-9	10-25
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12x12	1.60	1.40	1.25	2.00	1.75	1.55
12x18	2.30	2.10	1.80	2.75	2.45	2.00

Note: Prices quoted are PER UNIT price for designated quantity.

6032 INFRA-RED CONVERTER TUBE

With this tube, an appropriate power supply, optics and I.R. light source, one can "see in the dark." Tube converts infra-red radiation imaged on front to visible image on back of tube. With it, one can see I.R. emitters such as I.R. light emitting diodes, very hot objects. Or see in the dark by using an incandescent light behind a I.R. filter. Full instructions included. Requires 10-20,000 volts to operate.

- ☐ 6032 tube only, with data $7.50
- ☐ 6032 tube, with solid state voltage converter 12 volts D.C. to 15 KV instructions $27.50
- ☐ 6032 tube, voltage converter and optics instructions. Price $47.50

GIANT 2¾" NUMERAL "NIXIE" CLOCK KIT

New! For factories, offices, and commercial establishments, and those people who like large displays, characters appear as a bright commuous line which can be read from distances as great as 150 feet. All drive circuits are solid state, and unit employs new custom LSI clock chip. Indicates hour, minutes, and seconds. May be wired for 24 hour or 12 hour operation with a simple jumper change. Kit offered complete with or without case for custom installations. Parts include P.C. board, sockets, solid state components, hardware, resistors, caps, viewing filter, etc.

Sh.Wt. 15 lbs.

- ☐ GNNC/C With Case $98.50
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☐ Low-cost Digital Clock Kit $47.50

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Burroughs B7971 alphanumeric nixie tube. Giant 2¾" character height. Forms all letters of the alphabet, and numerals 0 thru 9. Consists of 15 segments in "star" matrix. When used as numeric display only, it is wired as a seven segment display, requires 170 volts D.C.

This is the same unit we use in our Giant Clock.

B7971 tube, brand new with used socket $7.50
B7971 tube, removed from equipment $2.50
Socket for above (only with tube) ..... $.50
4 for $7.50

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We have two new lenses available, both in production quantities. Excellent for opaque projectors, copy cameras, and inexpensive enough to have around the lab for all kinds of optical breadboarding.

Copy Lens 1, 1¾" dia. mount, 4¾" focal length, speed F 5.6. Covers 5" x 5", 9 x 9 at 1:1 conjugates. Manufactured by Edmund Scientific.
LCEO 1 ..... $6.00

Copy Lens 2, 2-1/16" dia. mount, 8½" focal length, speed F 5.6. Covers 9 x 9 inches at infinity, 14 x 14 at 1:1 conjugates. Manufactured by Edmund Scientific.
LCEO 2 ..... $9.00

Both lenses for $13.50
Two(2) of each type for $25.00

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We are always getting requests for power resistors to use in testing amplifiers, power supplies, etc. We have an assortment of resistors of various values ranging in power from 5 watts to 100 watts. If you use just one, it is easily worth twice the cost of the entire assortment.

Sh.Wt. 2 lbs.	PRA (10)	$1.00
6 bags of 10	6PRA (10)	$5.00/6

2.25 AMPERE VARIAC

This is a useful item to have for variable power supplies, testing, heater control, etc. 0-115 vac in, 0-130 vac out. Removed from equipment ... $8.00
Add $1.00 for postage and handling.

LOUDSPEAKER SYSTEM COMPONENT SPECIALS

We have made an excellent purchase of an excess inventory of a local manufacturer's speaker systems, although we are not allowed to mention the mfg's. name, the space should make it self-evident. The woofer is a 12" free-edge (acoustic suspension) unit, with 2" voice coil and a No. 2 magnet. The mid-range is a 5" sealed back speaker and 3-¼" flare dome tweeter for best high frequency dispersion.

Crossover between woofer & mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided. The level controls provide frequency response to suit room acoustics, with realism that will delight even the most critical listener. Response – 25 to 20K + Hz. Power – 40 watts RMS. Impedance – 8 ohms.

Sh.Wt.12 lbs.

- ☐ LSCS $36.00
- ☐ 2LSCS ..... 2 for $65.00

DECADE COUNTING UNITS WITH READOUTS

Always one of B & F's most popular items, now revised to include drilled boards, I.C. sockets, and right-angle socket for readout. Arranged so that units can be stacked side by side and straight pieces of wire bussed through for power, ground and reset. Several different units are available as follows:

7490	Basic 10 MHz counter. Used in frequency counters and events.
74196	Same as 7490 except presettable 50 MHz unit. Used where higher speed and/or presettability is required.
74192	Bi-Directional Counter, 32 MHz operation. Has two input lines, one that makes the unit count up, the other down. Uses include timers, where the counter is preset to a number and counts down to zero, monitoring a sequence of events, i.e., keeping track of people in a room by counting up for entries and down for departures.
7475	Adds latch capability. Used in counter so displays continue displaying frequency while new frequency is being counted for uninterrupted display.
7447	Basic decoder module. Drives basic seven segment display which is included for all modules.

NEWEST DCU!

This DCU combines all of the features of our other counting units, that is, high speed counting, up-down operation, storage, and preset. In addition it includes a comparator (7485) and a thumbwheel switch in order to provide comparison and preset capability. With this combination you can do the following:

1. Count up or down at speeds to 33 MegaHertz.
2. Store previous count during new count.
3. Preset to any number, count down (or up) and generate a logic level when count of zero is reached. Stack several units and generate logic level for any count greater than zero.
4. Preset to zero, count up (or down) and generate a logic level for any number greater or equal to the number preset at the thumbwheel switch. Stack several DCU's and generate a logic level showing whether number is greater than, equal to, or less than number preset on switches.

- ☐ 910 K ..... 7490-7447 Counter $8.25
- ☐ 910 LK ..... 7490-7475-7447 Counter $9.25
- ☐ 911 LK ..... 74196-7475-7447 Counter $10.25
- ☐ 912 K ..... 74192-7447 Counter $9.75
- ☐ 913 K ..... 74192-7475-7447-7485 Universal DCU $14.50

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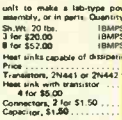

Like-new assembly surplus from the I.B.M. Company contains the following: (6) 150-Watt transistors, (6) heat sinks, (6) .133 5W resistors, 12V, 20 Amp circuit breaker, 5 16-ohm 10-Watt resistor, 50-Watt resistor, terminal strip, (2) 16-pin P.C. edge connectors for regular cards. An 3000 mfd, 15V computer grade capacitor is also provided. All on a nice mounting plate as it would be a neat unit to make a lab-type power supply. Unit is sold as an assembly, or in parts. Quantity is limited.

Sh.Wt. 20 lbs.	IBMPSRA	$7.50
3 for $20.00	IBMPSRA	$20.00/3
8 for $52.00	IBMPSRA	$52.00/8

Heat sinks capable of dissipating 150 watts of power.

Price	$1.00 ea.
Transistors, 2N441 or 2N442 type, TO-36 case	$1.00 ea.
Heat sink with transistor	$1.50 ea.
4 for $5.00	$5.00/4
Connectors, 2 for $1.50	$1.50/2
Capacitor, $1.50	$1.50 ea.

HEWLETT PACKARD SOLID STATE NUMERIC INDICATOR

These fantastic L.E.D. indicators have built-in decoder/driver with memory. They use a 4 x 7 dot array for much better readability. They are packaged in a standard Dual-In-Line (DIP) package with built-in contrast filter. Completely DTL TTL compatible. HP part number 5082-7300 (right hand decimal).

HP 5082 ..... $9.75

AIRCRAFT AUTO BOAT QUARTZ CRYSTAL CHRONOMETER

Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2⅝" x 2⅛" x 23/8", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2¼" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or on the event of power loss (i.e., replacing battery in car). The clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligible power drain. The low price is only possible because of a new one chip MOS clock. Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit to 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

- ☐ Quartz Chronometer, Kit Form $69.50
- ☐ Quartz Chronometer, Wired $99.50
- ☐ 24 Volt Adapter $10.00

New Style AUTO/BOAT/PLANE QUARTZ CRYSTAL CHRONOMETER

As you can see from the illustration, we have provided a new enclosure for our most popular kit, the ARIES Model AR-720K Quartz Chronometer. This enclosure can be mounted in many convenient variations, i.e., over or under the dashboard, over the center drive tunnel, or under the roof above the windshield.

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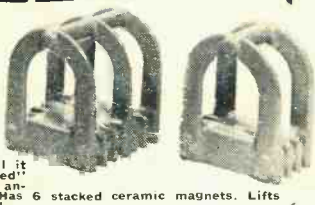

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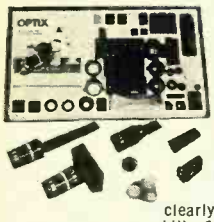

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