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Editorial

By Milton S. Snitzer, Editor

THE IEEE SHOW WAS DOWN TO EARTH

Recently, we made our annual pilgrimage to the Institute of Electrical and Electronics Engineers (IEEE) Show. The Intercon (International Convention and Exposition), as it was called this year, was only a skeleton of its former self. In the past, this show was one of the largest industrial exhibits in the world. In 1970, for example, there were around 600 exhibitors and lots more were clamoring to get in. This number dropped to about 435 last year and there was a further falling off to only about 275 exhibitors this year. The show boasted a total of 60,000 engineers going through the exhibits in the late 1960's, but this was down to about 40,000 last year, and to an expected 30,000 this year.

In previous years all four floors of New York City's Coliseum were jampacked with exhibits and people. This year considerable space was closed off on the first three floors, while the fourth floor had no commercial exhibits at all. It probably would have been possible to hold the entire convention at the Coliseum rather than to hold the technical sessions at the New York Hilton hotel.

The little giants, such as Hewlett-Packard and Tektronix, still had large exhibits, but the big giants were conspicuous by their absence. For example, among the missing were RCA, Fairchild, Texas Instruments, Sylvania and IBM. Motorola, Westinghouse, and GE, who have had large exhibits in the past, had only small booths this year.

In spite of all the apparent gloom surrounding the show and the shrinkage of exhibitors, everyone we talked to sensed the beginning of a turnaround. People were cautiously optimistic. What has happened is that the electronics industry, which had been flying high (due to government spending) and enjoying its glamorous position for many years, has finally come down to earth. People from the smaller companies, many of whom were new to the show this year, were saying that things were beginning to look up for them.

We got the feeling that the companies mean business now and fewer are out in the blue sky with their plans. There was no shortage of new products at the show however, and most of them were practical and very much applications-oriented. Perhaps what we are seeing is the emergence of a stable, more conservative industry that is reaching its maturity rather than acting the role of a young swinger, as it has in years gone by. Hobbyists and professionals alike may not find things as hectic as before, but the electronics industry is far from lying down and giving up the ghost.

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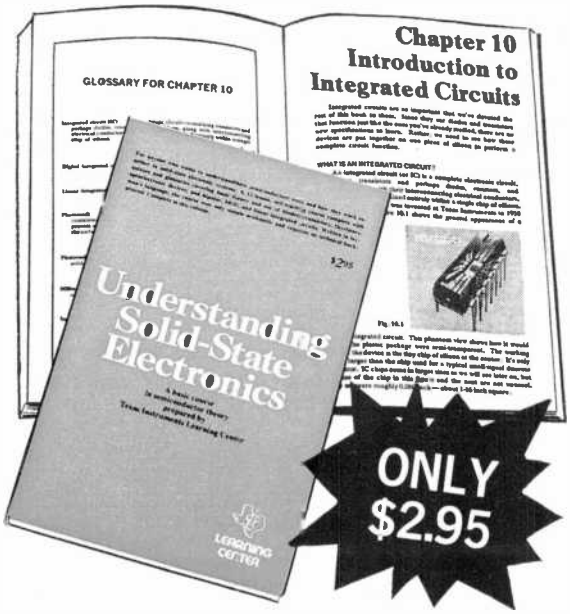

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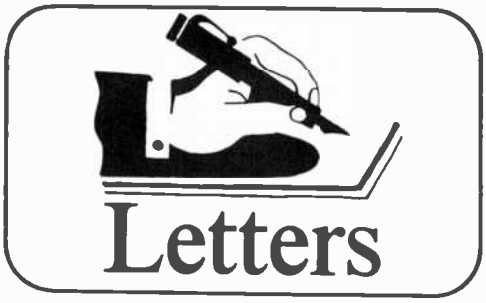


WHAT DO HAMS DO?

Congratulations on your article "What Do Hams Do?" (March 1972). This is exactly what is needed to introduce the electronics enthusiast to the world of ham radio, a realm with which he might not be familiar. The wide range of subjects covered in the article should be sufficient to contain at least one facet of interest for the reader to become involved. And interest is what makes future hams.

Keep up the good work.

HENRY MULLER, WA2SBU
Schenectady, N.Y.

I especially liked the article titled "What Do Hams Do?" in the March issue. Let's have more of the same. Also, how about an article on how to become a ham or on ham equipment?

GABE GARGIULO
E. Hartford, Conn.

A MIX-UP IN CALL SIGNS

I would like to point out an error in your article "Canada's New Voice On Shortwave" (April 1972). Instead of reading: "Best heard in the U.S. is CFRX on 6070 kHz out of Toronto, relaying CFCF," it should read, ". . . relaying CFRB." CFCX on 6000 kHz out of Montreal relays CFCF.

KEN WONG
Vancouver, B.C., Canada

MORE ON NOISE POLLUTION

Your article titled "Electronics Fights Noise Pollution" (October 1971) was excellent and performed a genuine service for your readers. I would like to add a few observations, as medical advisor in matters of health effects of noise to the California State Dept. of Public Health. First is that there is a continuing need for legislation and enforcement of laws to protect the general public from noise; most important among these are stronger building codes to isolate the individual from the noise-producing capacity of his neighbor. Another observation is that the definition of deafness as recognized by the American Medical Association must be broadened. At the

present time, the definition uses as a base line the human voice with deafness being recognized only when loss has occurred at 500, 1000, and 2000 Hz. Obviously, this leaves out a large portion of the audio spectrum which is important to many of us.

C. Richard Wolf, M.D.
Medical Officer
California Dept. of Public Health

Quite right; the AMA's definition of deafness is far from realistic, especially for hi-fi enthusiasts. It is also true that all of us as private citizens must do something to help bring about noise abatement legislation. However, it is also the responsibility of each of us, separately and collectively, to set an example even where no anti-noise pollution laws exist.

CRYSTAL BALL GAZING KAPUT?

In the Solid State column (January 1972), Lou Garner predicted that one of the things to come during 1972 is an electronic calculator in the under $150 price range. I would like to inform Mr. Garner that a calculator made by Brother is selling at this time for $129.50. Commodore is also marketing a calculator for a list price of $150. I also call your attention to an ad on page 121, placed by B & F Enterprises, which features a calculator kit designed around the Texas Instruments TMS1802NC chip at $88. It takes no crystal ball gazing to come up with "predictions" which are already fact.

Bruce Toback
Scottsdale, Ariz.

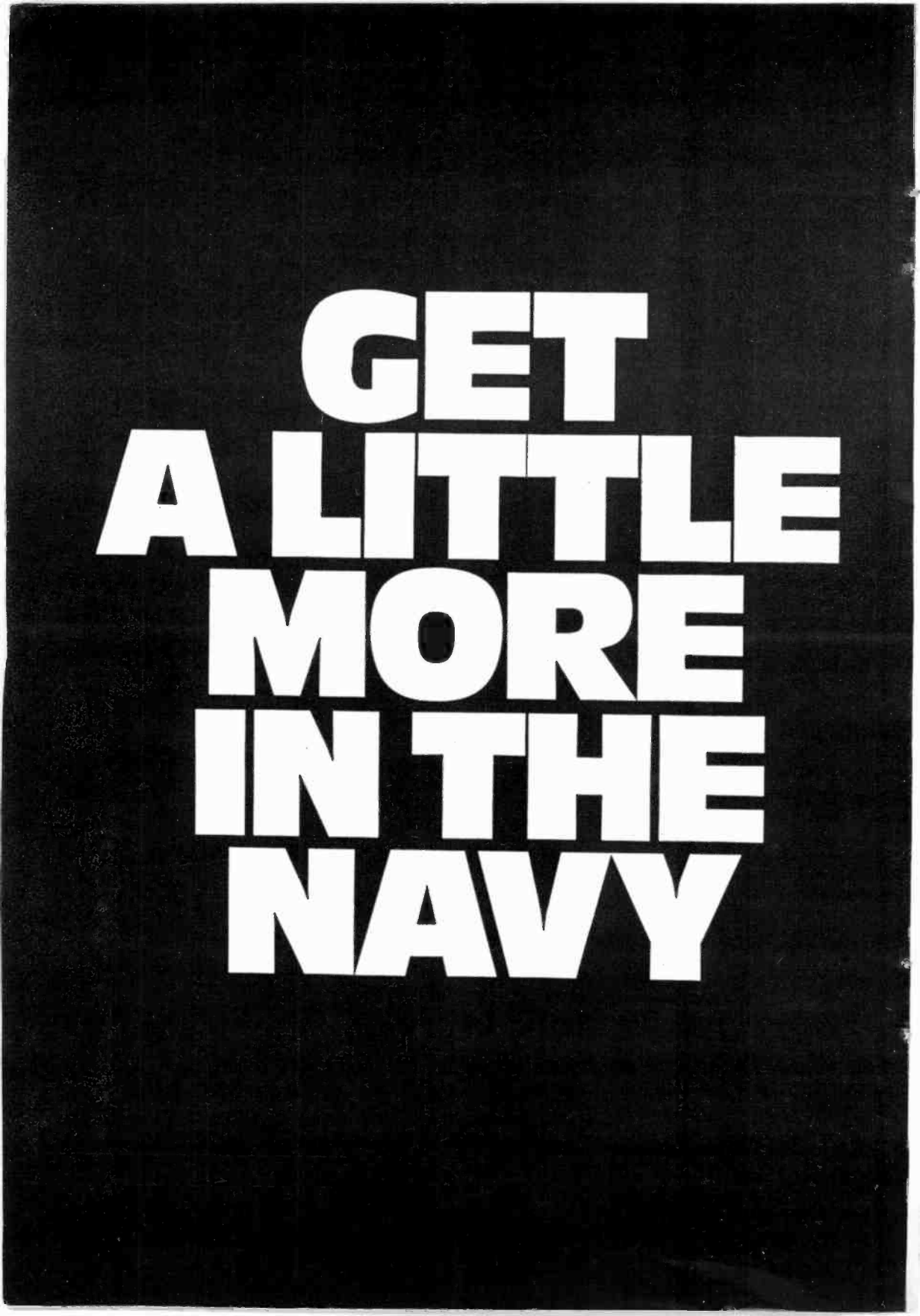
But when the predictions were originally made—two months before they actually appeared in print—they were just that and worthy of our semi-resident fortune-teller. The fact that they have already come true, due mostly to the stiff competition among suppliers during the Christmas rush, only bears out Swami Garner's talents. Also, you will note that the $88 calculator (an exceptional buy, to be sure) is a kit; Mr. Garner was referring to factory-assembled calculators.

ANOTHER EL PANEL DISTRIBUTOR

With reference to the May and September 1971 Interface columns referring to electroluminescent panel suppliers, we would appreciate your advising your readers that Astronics Corp., 300 French Rd., Buffalo, NY 14227 can supply EL lamps, alphanumeric indicators, and flat-screen displays.

Kevin T. Keane
Executive Vice President
Astronics Corp.

Interested readers should write directly to the address cited in the body of Mr. Keane's letter to request more information.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How To Select A CASSETTE RECORDER

FACTORS TO CONSIDER, ADVANTAGES AND DISADVANTAGES, ALONG WITH SPECIAL FEATURES AVAILABLE

BY JULIAN D. HIRSCH
Hirsch-Houck Laboratories

ALTHOUGH cassette and reel-to-reel tape recorders operate on the same general principles, the cassette system is sufficiently unique to warrant separate consideration.

A typical cassette deck, except for its size, resembles a basic two-head, single-motor open-reel tape recorder. Instead of placing a reel of tape on the supply hub, threading it across the heads (and sometimes around one or more tension rollers), and wrapping it around a take-up reel hub, the cassette user merely snaps a tiny cassette into a recess on the deck, and it is ready for playing (or recording). Removal is equally simple (and can be done at any time), since merely pressing an eject button or lever pops the cassette out of the machine.

The cassette itself is a miniature tape handling system, with supply and take-up hubs, tape, and the necessary guide rollers and pressure pads housed in a molded plastic case about 4″ x 2½″ x ⅝″. The tape is only 0.15″ wide (compared to 0.25″ for open reel tape) and moves at 1⅞ ips. Four parallel recording tracks, each about 0.020″ wide, occupy the width of the tape.

Holes and cutouts in the cassette case are provided for locating pins, the two tape hub drive shafts, the capstan and pressure roller, and the erase and combined record/playback heads. Like open reel tape, the four track cassette is played two tracks at a time. After one passage, it is turned over and the other two tracks are played in the opposite direction. Unlike open reel tape, however, the cassette can be turned around in only two or three seconds.

A unique feature of the cassette is its ability to safeguard against accidental erasure of a recording. Knocking out a small tab in the back of the cassette prevents the recording function of the deck from operating. If one desires to record on the cassette at a later date, a piece of tape may be placed over the hole to restore the recording feature.

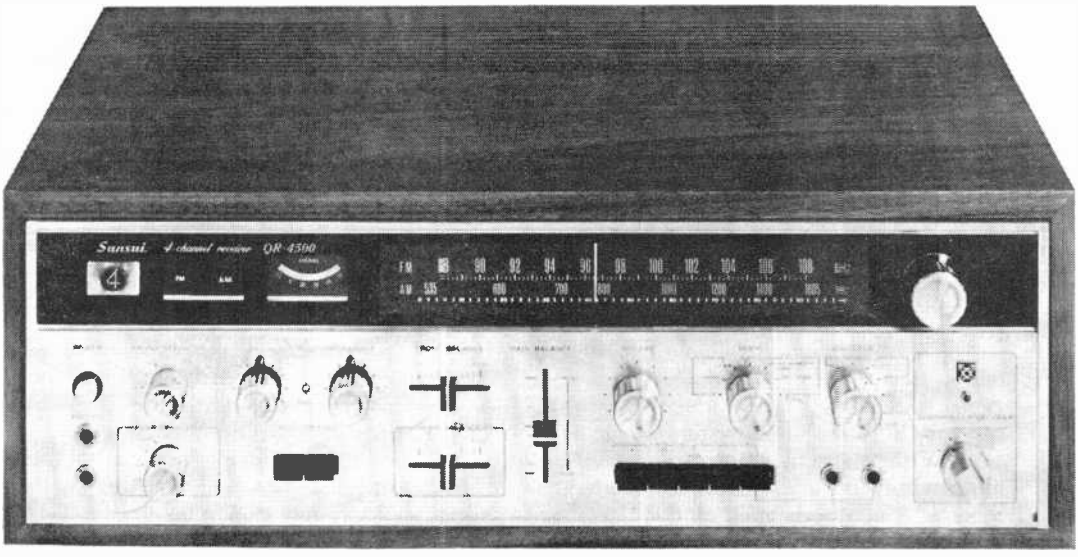
Cassettes are identified by their total playing time. The most widely used size, the C-60, plays for 30 minutes in each direction, or a total of 60 minutes. For shorter recordings, there are C-30 cassettes, which play for a total of 30 minutes; and longer playing times are provided by C-90 (90 minutes) and C-120 (120 minutes) cassettes. The very thin tape used in the longer playing types (particularly the C-120) may cause difficulty with some recorder mechanisms. When in doubt, follow the recommendations of the manufacturer of the recorder in which you are interested.

Advantages and Limitations. It is apparent that the cassette offers *unparalleled ease of handling, storage,* and *loading*—surpassing even disc records in these respects. This is obtained not without a price, however. Let us consider the limitations of the cassette medium, and see how they are being overcome.

1. The low tape speed (1⅞ ips) limits the high frequency response. Early cassette machines (and some of the lower priced current models) cannot reproduce frequencies above 8000 Hz. However, a 12,000-Hz frequency response is now common in medium priced models, and the best units go to 15,000 Hz or higher. In this respect, they are comparable to most good reel-to-reel tape recorders operating at 7½ ips.

2. The narrow track width, combined with the low tape speed, results in a rela-

WHICH WAY FOUR CHANNEL ?



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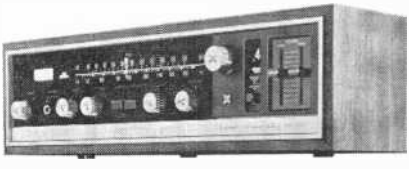

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tively high noise (hiss) level. With the latest tape formulations and low noise electronics, a signal-to-noise ratio of 45 to 50 dB can be achieved (compared to the 55 to 60 dB of good reel-to-reel recorders). However with the aid of a Dolby noise reduction circuit (offered on a few top-priced cassette recorders), a signal-to-noise ratio of 55 to 60 dB is possible.

3. Flutter is inherently high in cassette recorders since the tape tension is not completely under the control of the deck manufacturer. Although most cassette machines are rated to have 0.2% or higher flutter, some of the best cassette mechanisms have reduced flutter to less than 0.15%. (A medium priced open reel deck may have 0.1% to 0.15% flutter.) Such techniques as heavy flywheels and dual-capstan tape drives are largely responsible for this improvement.

4. Tape editing and splicing is very difficult with a cassette. With considerable patience and skill, it *can* be done, but in this respect the reel-to-reel system is far superior. Furthermore, a tape breakage or jamming within the cassette usually cannot be repaired since both ends of the tape must be accessible for splicing; and many cassette cases are ultrasonically welded and cannot be opened without destroying the cassette.

5. Off-the-tape monitoring, quarter-track mono recording, and special effects such as sound-on-sound and echo are not practical with cassettes, since there is no room for a separate recording head. All audio cassette systems are licensed by the originator, Philips of Holland, and they do not permit special head configurations which would not be compatible with stereo or mono cassette players.

6. Although tape quality is important with any type of recorder, it becomes paramount in the case of a cassette. Momentary drop-outs, due to uneven tape coating or head contact, that may be acceptable with the wider track open-reel format, can give cassette recordings an unpleasant roughness. The remarkable frequency response and signal-to-noise ratio of some modern cassette recorders is based on the use of premium-grade, low-noise tapes. Even more important, perhaps, is the mechanical quality of the cassette. Uneven tape winding, erratic friction in guide rollers or hubs, and similar mechanical flaws can ruin a recording, or in some cases cause a cassette to jam or break. Since it is possible for a spilling cassette tape to jam a transport mechanism, requiring disassembly to clear the obstruction, this makes "bargain" cassettes a poor economy indeed.

Applications of Cassette Systems. Many "serious" tape recording hobbyists will find the limitations of the cassette medium intolerable. The lack of editing convenience is the most damaging weakness of the cassette, but the flutter and drop-out problems may be equally annoying. Certainly, no one would expect to produce cassette tapes of professional quality in a "live" recording situation; yet this is not uncommon with moderately good reel-to-reel recorders.

On the other hand, a good cassette machine is capable of copying disc records and FM broadcasts with such fidelity that no difference (in frequency response, distortion, or noise) can be heard between the original program and the tape playback. Many home recording hobbyists use their reel-to-reel machines principally for dubbing records or broadcasts, and a good cassette recorder can usually match the performance of an open reel machine in this application. Some of them, in fact, are superior to comparably priced open reel recorders. Fortunately, when recording from discs, it is easy to do one's editing as the recording is being made so that the editing limitation of cassettes becomes less important.

The small size and light weight of cassette recorders simplifies their installation in systems with limited space. Battery operated cassette transports are common in the lower price ranges. They vary widely in quality and cannot be expected to have the low flutter and accurate speed of a good machine operated from the ac line.

If battery operation is important, be sure to listen to the recorder playing cassettes with piano music or similar material having sustained notes to determine whether its flutter is acceptably low. Unless independence from commercial power sources is a necessity, it is best to buy a recorder that operates on ac. The better machines have constant speed synchronous motors, and some have separate motors for the capstan and hub drives, with adequate torque to pull through the tape from a balky cassette.

A few cassette recorders offer such features as automatic tape reversal (sometimes even when recording) or automatic cassette changing for long periods of unattended operation. For many users, these

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conveniences are well worth their extra cost, though they are unrelated to the intrinsic quality of the recorder.

Noise Reduction Circuits. Since noise (mainly tape hiss) is one of the major weaknesses of the cassette medium, much engineering effort has gone into noise reduction systems. The most widely accepted technique is the Dolby B system, incorporated in a number of the better machines. Accessory Dolby units are also available from several manufacturers for use with recorders lacking this feature.

The Dolby system must be used both when making a recording and when playing it back. During recording, the higher frequencies are boosted at low program levels. In playback, they are reduced in an exactly complementary fashion. The net frequency response of the system is unaffected, but any noise introduced by the recorder is reduced by 6 to 10 dB. With the Dolby system, a good cassette recorder will have less noise than almost any program source one might use, and the hiss problem can be forgotten.

Many manufacturers of recorded cassettes use the Dolby process in their releases. When played back on a Dolby equipped machine, their noise level is generally insignificant—in marked contrast to the usually very audible hiss on ordinary commercially recorded cassettes. Even if the playback machine lacks the Dolby circuit, the Dolbyized cassettes can be played with excellent results. They may sound a trifle bright, but amplifier tone controls can usually take care of this and give a measure of hiss reduction at the same time.

Several other noise reduction systems have been developed in Europe and in Japan. Though differing in specific details, they are all "dynamic low-pass filters," whose cut-off action is controlled by the level and frequency content of the program. Unlike the Dolby system, they do not require specially processed program material, but under certain conditions, their action can sometimes be heard as a "swish" of the background noise. In general, however, they work very effectively and imperceptibly.

Chromium-Dioxide Tape. One of the significant factors in cassette sound improvement has been the development of chromium-dioxide (CrO_2.) tape. Properly used, it can slightly extend the high frequency response and significantly reduce noise levels. However, it requires somewhat different bias, equalization, and operating levels for fully effective results. Many recorders now provide for its use, with a switch marked "CrO_2" and "Normal." With a suitable recorder, the somewhat higher price of CrO_2 tape (available from several manufacturers) is justified for anyone wishing to get the most from his cassette machine.

Users of recorders not equipped for CrO_2 tape need not feel limited in their recording activities, however. There are a number of ferric oxide cassette tapes whose performance is comparable to that of CrO_2 formulations. Some, like CrO_2, are relatively expensive, but others can be purchased for a little more than an ordinary tape of less distinguished performance.

Automatic Level Control. Several cassette recorders have automatic recording level control. These circuits adjust the recording gain to prevent distortion from sudden peaks. During periods of low average level, they increase the recording gain so that a wide volume range can be recorded without fear of distortion during loud passages, and without attention from the operator.

Since automatic level control alters the program dynamics, it is usually used only for voice and non-critical music recordings. Lectures and classroom activities are typical situations where alc is a desirable feature. Most machines with alc also have a defeat switch so that their recording levels can also be adjusted manually.

Summary. Once you are aware of what a cassette recorder can—and cannot—do and have reviewed your own planned usage of the recorder, you can compare manufacturers' specifications, features, and prices. Then you can make an intelligent selection.

As with most audio components, the higher priced models have better quality and more flexibility. Decks selling for less than $100 may be quite good, but should be listened to carefully before purchase. Machines at lower prices, which include playback amplifiers and speakers, should be viewed with suspicion, unless top quality is not one of your objectives.

There are many recorders with first rate performance selling between $100 and $200. Those over $200 usually have Dolby circuits or other refinements. ◈

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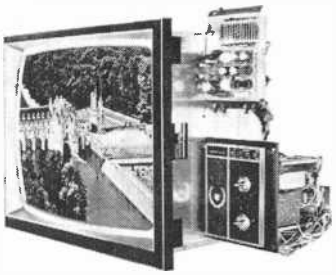

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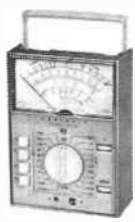

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CIRCLE NO. 18 ON READER SERVICE CARD

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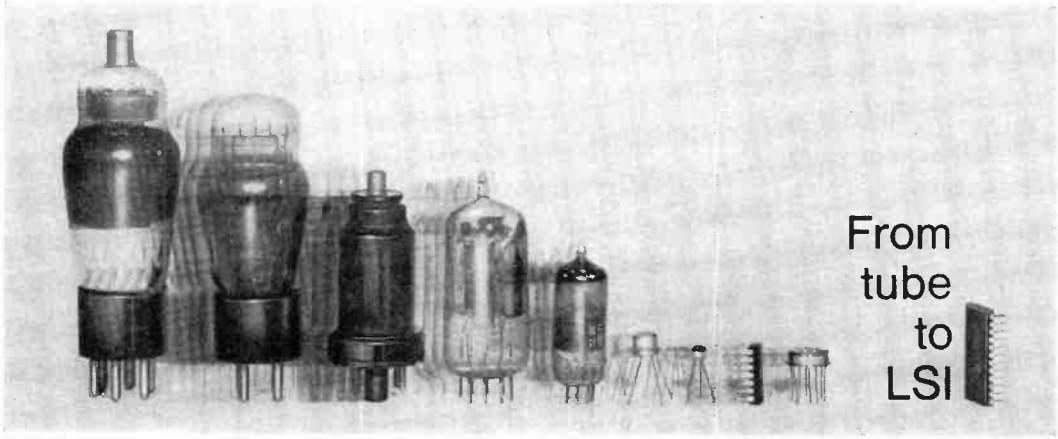

Take a look at the race in circuit technology. In the 1960's the tubes at the left made way for the transistors at the right. Today, transistors are surpassed by the large scale integrated circuit (LSI) at the far right. This circuit, less than a quarter inch square, replaces over 6000 transistors!

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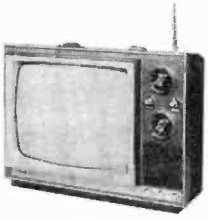

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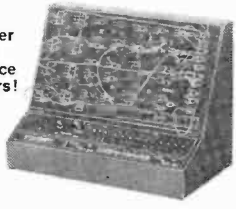

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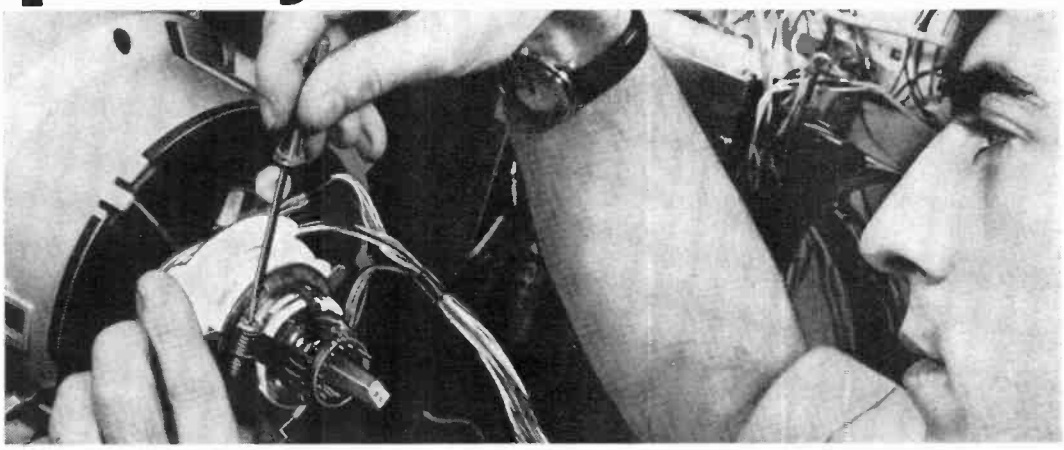

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Scan-Alert is a Cobra exclusive that alternately changes the channel of the receiver from your operating channel to Emergency Channel 9. The Channel Indicator light and the Channel 9 indicator light flash alternately. As Scan-Alert automatically switches between frequencies. When a signal is received on either Channel 9 or the selected channel, the receiver automatically locks on the active channel. The receiver resumes scanning after the transmission is completed. And if you want to respond to a Channel 9 call, just slide one switch, without upsetting your channel selector setting. The Cobra 880 combines normal and emergency guarding—and makes it easy.

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CIRCLE NO. 6 ON READER SERVICE CARD

News Highlights

RCA Records Releases Discrete 4-Channel Disc

A compatible, discrete 4-channel phono record was released in May by RCA Records. The disc has the same price as the company's 2-channel stereo records. RCA plans to begin regular but selective releases in the fall of the 4-channel discs. Eventually all new RCA recordings will be compatible with both stereo and discrete 4-channel playback equipment. The company is working in collaboration with Panasonic and JVC, who will make playback equipment available for the new disc.

Texas Instruments to Market Through Radio Shack

Texas Instruments and the Tandy Corp. have initiated a marketing program to retail electronic components through the Tandy Corp.'s nationwide chain of 1300 Radio Shack stores. This marks the first time in TI's history that the Dallas electronics manufacturer has made its products available to the hobbyist, professional, and education markets through a consumer electronics outlet. The semiconductor components will be sold in individual packages under the Archer label. Initial products consist of two dozen small-signal and power transistors.

Brazil Launches Nationwide Color TV Broadcasts

Brazil is the first South American country to launch nationwide color TV broadcasts. Official inauguration of color TV began March 31 as one of a series of events celebrating the 150th year of Brazil's existence as an independent nation. Start-up of manufacturing operations in Brazil for the production of Sylvania color TV sets and picture tubes has been announced by GTE International Inc. The Brazilian color TV market is expected to be between 50,000 and 80,000 sets this year, compared with the 900,000-set black and white TV market. About one-third of the 19 million households in Brazil currently own television receivers.

Minority Engineering Enrollment Figures

Equal opportunity employers will find help in locating minority-group engineers from a new report just released by the Engineering Manpower Commission of Engineers Joint Council. The report contains detailed statistics on enrollments from incoming freshmen to doctorate candidates in 282 engineering schools and 625 institutions offering technology or pre-engineering programs. A unique feature of the report is its special tables listing women, black, and foreign students. All told, 5303 women and 4831 blacks are included in the enrollment statistics. Each group makes up only about two percent of all engineering undergraduates.

Olympic Scoreboard to use 25,000 Triacs

Twenty-five thousand triacs will be used as switches in two massive electronic scoreboards in the main stadium at the 1972 Olympics being held this summer in Munich, Germany. Each triac, made by

RCA, will activate a 25-watt light bulb in the scoreboard display section. The display uses 75,000 bulbs to present messages and pictures relating to Olympic events. A computer will control the triacs to develop the correct sequence in light switching to change the messages and diagrams. The displays will be very similar to the latest scoreboards now in use in athletic stadiums around the country.

Radar Systems in the News

The Coast Guard is evaluating a radar system that could be useful to the International Ice Patrol's mission of recording the size and position of icebergs in the North Atlantic. The side-looking airborne radar was installed on a Coast Guard plane which recently completed a preseason ice patrol flight of the North Atlantic. The Navy is studying a radar that sees under the ground. The broadband radar system sends pulses into the ground and receives echos that indicate the sub-surface area profile. Finally, rainfall over Lake Ontario and its basin will be measured more accurately by a special radar system which recently went into operation. Three radars are used at Buffalo and Oswego, N.Y. and Woodbridge, Ontario. Each radar measures precipitation for a radius of up to 120 nautical miles from the site.

Ship-to-Shore Communications via Satellite

Comsat and the Cunard Line jointly announced a test to demonstrate high-quality, reliable communications between the Queen Elizabeth 2 at sea and Comsat Laboratories in Clarksburg, Md. The communications will go through the Intelsat IV satellite over the Atlantic Ocean. This is the first time that voice and data communications will be conducted via satellite with a commercial passenger liner at sea. The principal on-board equipment to conduct the experiment is an 8-foot parabolic antenna on the top deck. The remaining equipment and communications terminal are located in the children's play area on the sports deck.

Dolby Labs Enters Film Industry

A new cinema noise reduction unit for use during film exhibition has been announced by Dolby Labs. The new unit has the professional Dolby system already widely used in the music recording industry. The system reduces background noise of all kinds without affecting the original signal. This is said to open the way to high-fidelity optical sound tracks comparable in quality to magnetic tracks, but at lower cost and with greater convenience to producer and exhibitor. Recent films which used the system in production include "A Clockwork Orange" and "Ryan's Daughter."

Most Sensitive Radio Telescope To Be in New Mexico

A 3000-acre desert site, 50 miles west of Socorro, New Mexico, has been selected as the location of a Very Large Array (VLA) radio telescope. When completed, the result will be the most sensitive and accurate instrument of its kind in the world. The instrument will be used to listen to naturally produced radio signals from objects within, as well as far outside, our own galaxy. The initial budget request for the facility is for $3 million. Total cost of the facility is projected at $76 million. Subject to successful negotiations for land use and availability of funds, work on the telescope is expected to begin this year. The telescope will consist of an array of 27 dish antennas, each 82 feet in diameter. The giant antennas will ride on railroad tracks some 39 miles long and spread out in the shape of a "Y".

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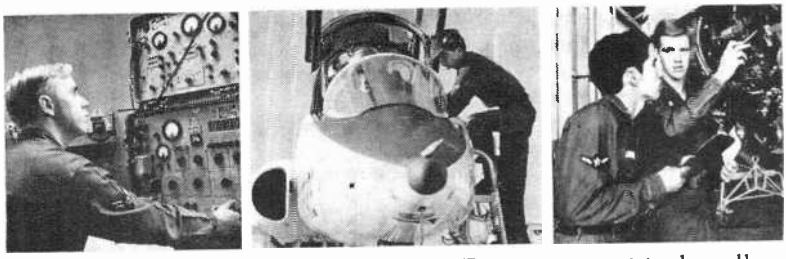

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OUTDOOR LOUDSPEAKER

We test nine popular patio speakers

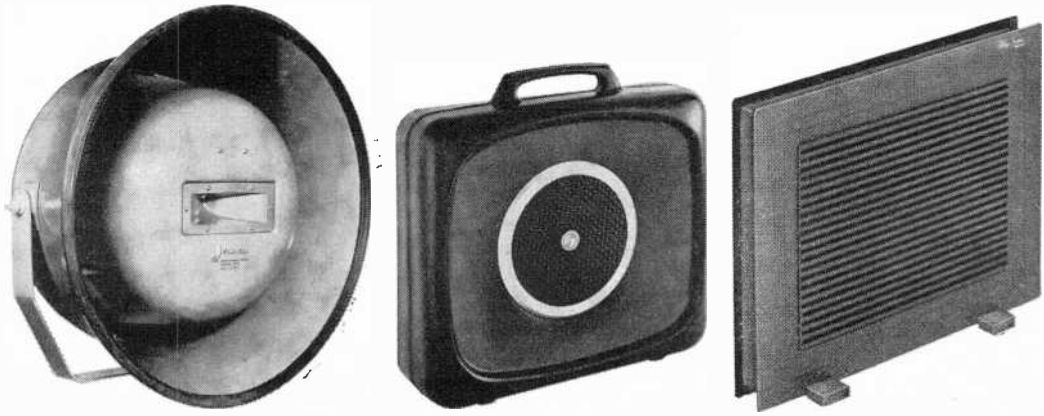
THE summer months have traditionally been the "off season" for hi-fi systems. What with the heat and humidity and the attraction of the beach and the open road, no one can be faulted for temporarily forsaking his carefully built up stereo system. The usual alternative, sad to state, is to expose one's hearing to the sonic mayhem inflicted by portable radio receivers and phonographs.

Fortunately, it is still possible to enjoy a high standard of sound reproduction out-of-doors on your patio or lawn. The program can usually be obtained from your regular hi-fi system since most such systems are designed to drive a second and even a third extra pair of speaker systems. Long speaker cables of up to 100 feet introduce little power loss or other undesirable effects. Of course, if you are fortunate enough to own a second receiver or a portable tape recorder with a built-in power amplifying system, it can be carried outside when needed, thus eliminating the need for additional wiring.

The loudspeaker is the most vital part of an outdoor music system. The rules for selecting outdoor speakers differ greatly from those used for selecting indoor speaker systems. For example, listening to an outdoor speaker in a dealer's showroom is not only a waste of time, but it could easily dissuade you from planning an outdoor installation. The best of the outdoor speakers sound mediocre in a normal listening room; most can be dismissed without comment. But the situation is not really as bad as it seems.

General Comments. An outdoor speaker

Jensen HF-100A *Electro-Voice Sonocaster I* *Poly-Planar G-401-P*



HI-FIDELITY ROUNDUP

BY JULIAN HIRSCH, Hirsch-Houck Labs.

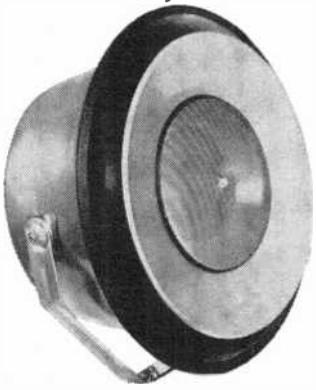
must function with little or no assistance from reflecting surfaces such as walls or floors. Almost all the sound leaving the speaker is fully absorbed by the surrounding air, lawn, etc. There are no ceilings or walls to reflect the highs. And as for the lows, the speaker must stand on its own since the listening environment is not a limited-volume enclosed room which augments low bass response.

Another result of operating a speaker in a free-field environment is the need for high acoustic output levels. Most indoor sound is heard by reflection. Outside, much more volume is needed to give the same listening level using only direct sound.

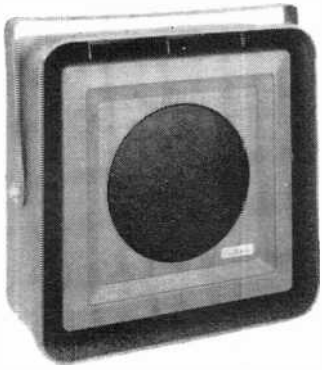
Most indoor speakers are rather inefficient and would require inordinately high amplifier power for outdoor use, even if they were capable of generating enough output without excessive distortion, which many cannot. Speakers designed for outdoor use are usually quite efficient. Reasonably small size and light weight characterize most outdoor speakers so that they can be mounted on poles, walls, or under eaves. The better speakers employ horn loading to achieve high efficiency in a small unit. Low frequency output is usually sacrificed to achieve this, and it is rare to find outputs below 150 Hz with any outdoor speaker. Nevertheless, many outdoor speakers manage to sound remarkably good even with their restricted frequency ranges.

Exposure to temperature and humidity extremes requires specially treated cones and other materials in the drivers of outdoor speakers. Enclosures are generally

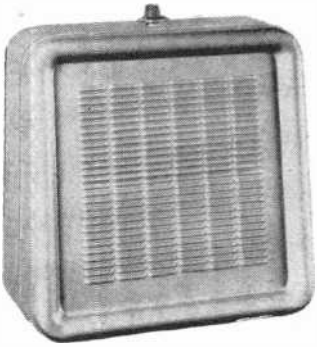
University CLC



Electro-Voice Musicaster IIA



Utah Mod-8



made of plastic or metal, although some designed for relatively sheltered locations have moisture-resistant wooden enclosures.

A few outdoor speakers are able to withstand direct rainfall; others are not. Study the manufacturer's recommendations carefully before installing any speaker in an unprotected location.

We tested a group of outdoor speakers which covered a wide range of prices, sizes, and quality. We made frequency response measurements out-of-doors with the speakers some distance from any wall surfaces, on the speaker axis, and at several angles off-axis. Listening comparisons were made in an A-B fashion to judge sound quality. We will discuss each in order of ascending market price.

UTAH MOD-8

The Mod-8 made by Utah Electronics and available from Lafayette Radio Electronics Corp. uses a conventional 8" cone driver which has been treated to resist moisture. The driver is mounted in a small steel case measuring 11" square by 5¼" deep and weighing 5½ pounds. The louvered front is angled to face downward when the Mod-8 is mounted under the eaves or upward when it is placed on the ground. A variable level control is provided with the peak 20-watt Mod-8. The speaker, priced at $11.95, comes with a 25-ft integral cable.

The sound of the Mod-8 was thin and a bit "peaky." (Of course, it is also the least expensive, by a sizeable margin, of all the speakers tested.) The frequency response curve explained what we heard; the output fell off rapidly below 300 Hz, and there was an on-axis peak of about 10 dB in the 3000-6000 Hz octave. Off-axis, the curve was smoother, but the peak was still perceptible. For a cone-type driver, the Mod-8 is characterized by relatively high efficiency.

POLY-PLANAR G-401-P

Manufactured by Magitran, the Poly-Planar G-401-P speaker features a unique molded plastic construction. It is a flat rectangular polystyrene foam panel measuring 16¼" × 13¼" × 1½" and weighing only 2 lb 5 oz. For outdoor service, this speaker should be mounted under the roof eaves (soffit mounting) or in a wall. It is rated at 25 watts maximum continuous power. Its price is $18.95 A similar unit, the E-41, has louvered plastic front and back covers, walnut feet for free-standing support, and an integral cable; it sells for $23.95.

Both speakers exhibited identical performance. The frequency response was irregular (as in all the speakers tested), with the output falling off below 200 Hz and above 5000 Hz. However, there was measurable output as low as 50 Hz and as high as 12,000 Hz. The efficiency was good, comparable to that of Utah's Mod-8. The sound quality, slightly rough by usual hi-fi standards, was not unpleasant.

ELECTRO-VOICE SONOCASTER I

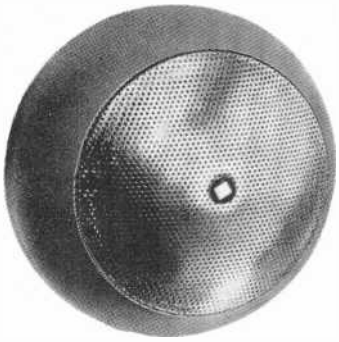
A portable speaker about the size and shape of a portable typewriter with the cover on, the E-V Sonocaster I's fully sealed plastic case has an integral carrying handle. About 17" × 16¾" × 5¾" in overall dimensions, it weighs 8 lb. The weatherproofed 8" cone driver employs a 2½" "whizzer" cone to provide improved performance above 6000 Hz. Power handling capacity is rated at 30 watts peak. The selling price of the Sonocaster is $27.95.

This speaker had a relatively smooth frequency response, but its efficiency was slightly lower than the Utah and Poly-Planar speakers. Although the output fell below 300 Hz, it was measurable down to 70 Hz. The upper limit was 15,000 Hz with a 10-dB peak at 11,000 Hz. Sound quality was quite good, about midway between the lowest and highest priced speakers we tested. In a normal listening room, this was one of the better sounding units.

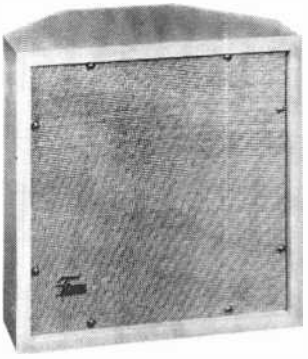
FRAZIER F8-1K

The F8-1K has a wooden enclosure which is not recommended for locations where direct rainfall might hit it. The enclosure's truncated rear corners allow easy installation in a corner or at a roof-wall junction for under-the-eaves mounting. The speaker measures 15¾" square by 8¾" deep and weighs 18 lb. Its two-way ducted-port system contains a weather-proofed 8" woofer and a 3½" cone tweeter. The price is listed as $49.75.

Tested in a free-standing location, the F8-1K was strong in performance down to 150 Hz, falling off at lower frequencies. The mid-range response was irregular, and there was a 13-dB on-axis peak at 11,000 Hz. The efficiency was rather high for a sys-



Maximus RSM



Frazier F8-1K

Altec 829A

tem with cone drivers rated at 15 watts power handling capacity. The sound quality was pleasant, considerably better than that of the less expensive units and quite close to that of the more expensive Altec 829A.

MAXIMUS RSM

Unusual in appearance, the Maximus RSM (for Round Sound Machine) is an 8″-diameter sphere containing a 6″ cone speaker. The sphere is mounted on a cast metal stand via a ball-and-socket joint which allows it to be aimed at the listening area. The stand can be placed on a flat surface, hung on a wall, or mounted under the eaves (the recommended placement for best bass response). The speaker weighs 4 lb 13 oz. The speaker cone is weatherproofed, and the fully sealed plastic enclosure is available in a choice of colors. Supplied with an integral cable, the Maximus RSM is priced at $49.95.

On-axis, the RSM had a relatively smooth response which rose gradually beyond 1000 Hz and fell off below 160 Hz and above 12,000 Hz. It was about 5 dB less efficient than most of the other cone-type speakers in the group, but it was still considerably more efficient than conventional acoustic suspension systems. According to the manufacturer, its sound can cover an outdoor area of about 200 sq ft which is consistent with our findings. Although it seemed a bit shy in bass and had a trace of brightness, its smooth response made the RSM easy to listen to.

UNIVERSITY CLC

The University CLC, like most of the speakers at or above its price, is a horn-loaded PA speaker suitable for home use. Its circular aluminum enclosure is 22¾″ diameter by 12¾″ deep and weighs 13 lb 8 oz. The 8″ direct radiator driver equipped with the whizzer cone is rear loaded by the reentrant horn; the lower bass emerges from around the periphery of the bell-shaped horn housing. An adjustable U bracket which can be used for either vertical or horizontal mounting allows the speaker to be tilted into the listening area. The CLC is rated at 30 watts capacity. List price is $80.72.

This speaker was one of the most efficient of those tested; 10-20 dB greater at most frequencies than the low-priced units. From 300 to beyond 10,000 Hz, its output had the same degree of irregularity found with the other speakers, although the response curve had no general upward or downward trend. Between 300 and 150 Hz, the output was 10-20 dB stronger than *any* of the other speakers, although it fell off rapidly below 150 Hz.

In listening tests, the CLC had the best bass performance, well-balanced with midrange and highs. It was quite free of the strident quality of many PA speakers; its sound reproduction should not offend ears accustomed to good hi-fi.

ALTEC 829A

The compact 829A made by Altec measures 14″ × 13½″ × 11″ and weighs 8 lb 12 ozs. Its molded plastic enclosure comes on a chromed stand which can be used for free-standing installations as well as for wall mounting. The speaker tilts to point into the listening area. The driver is an 8″ weatherproofed cone type. List price is $85.

On-axis, the 829A had the smoothest frequency response of the group, within ±6 dB, 200-14,500 Hz. (Most of the others

varied by 18-24 dB over the range.) It was quite directional, exhibiting considerable loss of response above 5000 Hz at angles of 30° or more off-axis. Efficiency was one of the highest of the non-horn loaded speakers; in fact, it was comparable to some of the horn speakers.

The sound quality of the 829A was good, ranking close to that of the most expensive speakers. Although the bass response rolled off below 200 Hz, it could be substantially boosted with amplifier tone controls to yield very satisfactory sound balance.

JENSEN HF-100A

The only fully horn-loaded speaker in the test group, Jensen's HF-100A features a circular aluminum shell measuring 24⅜" in diameter and 11⅝" deep. Weight is 23 lb. The 8" bass driver faces the rear and is front loaded by a reentrant horn so that radiation is from around the periphery of the horn's mouth. At 2000 Hz, there is a crossover to a forward-facing horn-loaded compression tweeter. Unlike the other speakers rated at 8 ohms, the HF-100A is a 16-ohm system capable of handling 25 watts of power. Retail price for the HF-100A, including tilt bracket, is $97.50.

With the usual irregularities, the frequency response of the HF-100A was uniform from 250 to 15,000 Hz, falling off at lower frequencies. Overall efficiency was one of the highest, comparable to that of University's CLC. The bass was subjectively good. The overall inherent sound quality for this speaker system, without tone control correction, was in our opinion the best of the test group.

ELECTRO-VOICE MUSICASTER IIA

A back-loaded horn of molded fiber glass, the Musicaster IIA is 21½" square by 8½" deep and weighs 31 lb—the heaviest of the group. The 12" cone driver radiates sound directly forward, aided above 4000 Hz by a whizzer cone. The lower frequencies radiate around the edges of the horn opening. A horn-loaded compression tweeter is also used above 3500 Hz. Program power handling capacity is rated at 30 watts. A rugged mounting bracket is supplied, permitting either wall mounting or free-standing use. Price is $101.10. (A similar system, Musicaster IA, lacking the horn tweeter, sells for $80.25.)

The Musicaster IIA had the smoothest bass and midrange response, within ±3 dB, 90-12,000 Hz. The output rose smoothly at higher frequencies with very good dispersion and strong response to at least 17,000 Hz. Efficiency was comparable to Altec's 829A.

In listening tests, the Musicaster IIA sounded quite different from the other speakers. Its highs were clean, strong, and well dispersed—comparing favorably to some of the better indoor speaker systems. Close up, it sounded rather bright, even though it had exceptionally good bass response. At a reasonable listening distance, it delivered creditable "hi-fi" sound over the entire audio spectrum.

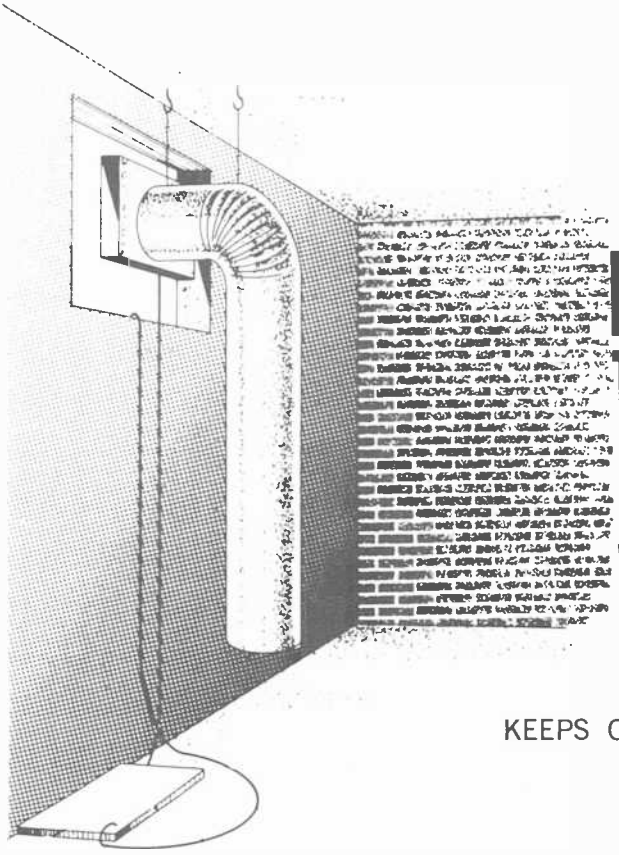
Closing Comments. Response irregularities should not be given undue weight since the measurement method used differed from our usual indoor speaker test procedure. We listened to these speakers indoors and can state that none of them can compare to good bookshelf speaker systems in the $50-$100 range. On the other hand, in an outdoor environment, all of them sound much better than the response curves suggested.

The Musicaster IIA, HF-100A, and CLC speakers exhibited the best overall sound. A specific choice from among these speakers would be purely a matter of personal taste and would depend strongly on installation requirements.

Although the smaller, less expensive speakers lacked the high acoustic output and wide frequency responses of the best (and necessarily expensive) units, they are a great deal less expensive than the three top offerings tested. Too, the smaller speakers are easier to install and will go into very limited spaces.

We consider that all the speakers reported on delivered sound qualities consistent with their prices and special features. All are fair values.

It is interesting to note that although most outdoor listening is done monophonically, we also obtained excellent results with two-channel stereo setups. It was natural curiosity to graduate to four-channel stereo to determine what this new medium has to offer. Our conclusion: quadraphonic sound can restore much of the liveliness usually lacking in an anechoic environment like an outdoor listening area. ◈



DIFFERENTIAL-TEMPERATURE BASEMENT VENTILATOR

KEEPS OUT MILDEW AND MOLD

BY JIM ASHE

FORTUNATE indeed is the home owner who can say that his cellar stays completely dry year round. When the weather is hot and humid outside and relatively cool and humid in the basement, moisture, mold, and mildew usually start to collect. The situation can be greatly improved by equalizing the temperature differences.

The project described here consists of a ventilating system to draw the cool, damp air from the floor of the basement and replace it with warmer air from outside. The system includes an electronic differential circuit which senses the temperature difference between inside and outside and turns on the ventilating fan when necessary.

A typical small axial fan, mounted in a 6″ diameter stove pipe can move about 100 cubic feet of air per minute. Assuming a 50′ x 20′ x 7′ basement, it will take the fan about 70 minutes to change the air. Of course, using a larger fan or having a smaller basement will change the time. For maximum benefit, the ventilator should be run every day.

How It Works. The circuit used to detect the temperature difference is shown in Fig. 1. Essentially it consists of an operational amplifier (*IC1*) whose output state is determined by the voltage drop across a pair of germanium temperature-sensing diodes, *D1* and *D4*. This voltage drop is dependent not only on the current flowing through the diodes but also on the ambient temperatures surrounding them. The integrated circuit is connected as a differential amplifier whose output is coupled to a Schmitt trigger consisting of *Q1* and *Q2*. The trigger circuit converts the relatively slow action of the output of the op amp (due to the slow rate of change of current through the diodes) to a fast-acting switch. The trigger, though it is a form of multivibrator, does not change the frequency of operation. Since such a circuit is regenerative, its action is fast; and slow input signals become sharp, decisive outputs.

Although it is possible to connect the motor control relay to the collector circuit of the Schmitt trigger (*Q2*), some added working margin is included by using the

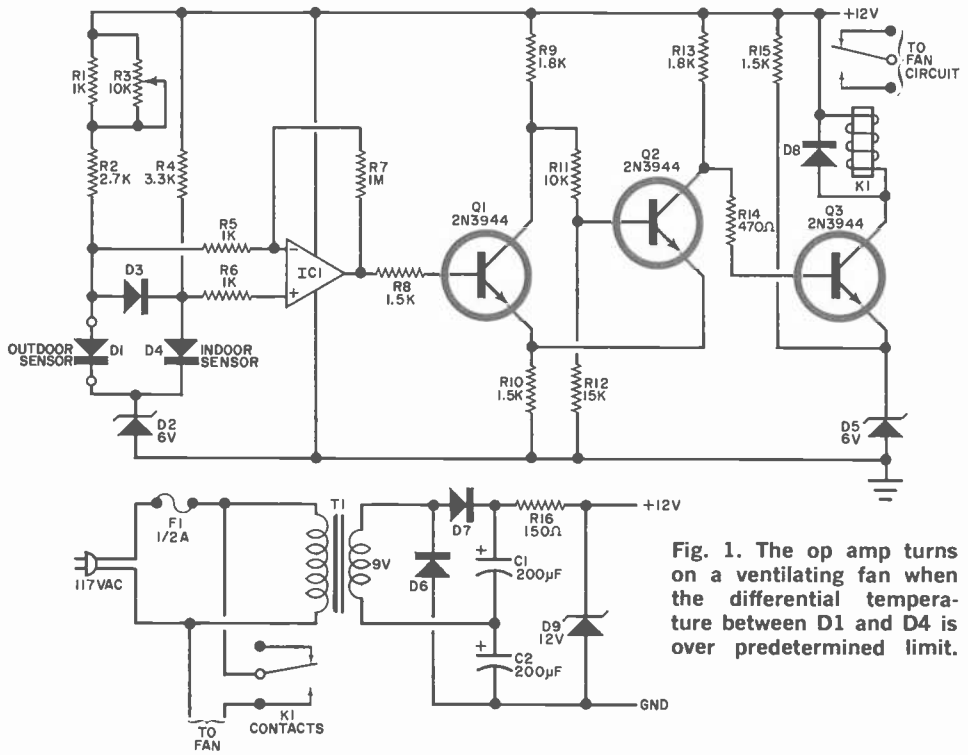


Fig. 1. The op amp turns on a ventilating fan when the differential temperature between D1 and D4 is over predetermined limit.

PARTS LIST

C1,C2—200-μF, 15-volt electrolytic capacitor
D1,D4,D8—Germanium signal diodes (HEP 134, D1 and D4 matched. See text.)
D2,D5—HEPZ0214 6-volt, 400-mW zener diode
D3,D6,D7—Silicon diode (HEP 154 or equiv.)
D9—HEP105 12-volt, 1-W zener diode
F1—½A fuse and holder
IC1—Operational amplifier (741 or similar)
K1—500-ohm, low-current dc relay
Q1-Q3—2N3944 transistor
R1,R5,R6—1000-ohm, ½-watt resistor
R2—2700-ohm, ½-watt resistor
R3—10,000-ohm, potentiometer
R4—3300-ohm, ½-watt resistor
R7—1-megohm, ½-watt resistor
R8,R10,R15—1500-ohm, ½-watt resistor
R9,R13—1800-ohm, ½-watt resistor
R11—10,000-ohm, ½-watt resistor
R12—15,000-ohm, ½-watt resistor
R14—470-ohm, ½-watt resistor
R16—150-ohm, 1-watt resistor
T1—Filament transformer; secondary: 9V at 100mA
Misc.—Length of two-conductor cable, chassis, stovepipe and elbow, 117-volt axial fan, socket for IC1 (optional), mounting hardware.

trigger to drive a biased power stage, *Q3*, which has the relay in its collector circuit. The emitter of *Q3* is biased by *R15* and zener diode *D5*, so that *Q3* is either on or off with no indecision. When the positive-going signal from *Q2* occurs on the base of *Q3*, it turns on very fast, energizing the relay.

Diodes *D1* and *D4* are connected in a bridge with balance provided by trimmer potentiometer *R3*. Diode *D3* acts as a safety diode if the circuit happens to have power applied when *D1* is not in the circuit. This is necessary to protect the op amp. Feedback register *R7*, in conjunction with the 1000-ohm input resistor produces a stage gain of 1000 in the op amp. To reduce temperature sensitivity, *R7* can be replaced by a smaller resistor to reduce circuit gain.

Zener diode *D2* clamps the input circuit at 6 volts, since the op amp cannot accept signals near ground or close to 12 volts. Most operational amplifiers do not have this problem as they are operated by either a positive or a negative supply.

Diodes *D1* and *D4* should be as alike as possible and should be checked by measuring their forward voltage drop. This is done by connecting a resistor in series with the diode and power source and measuring the

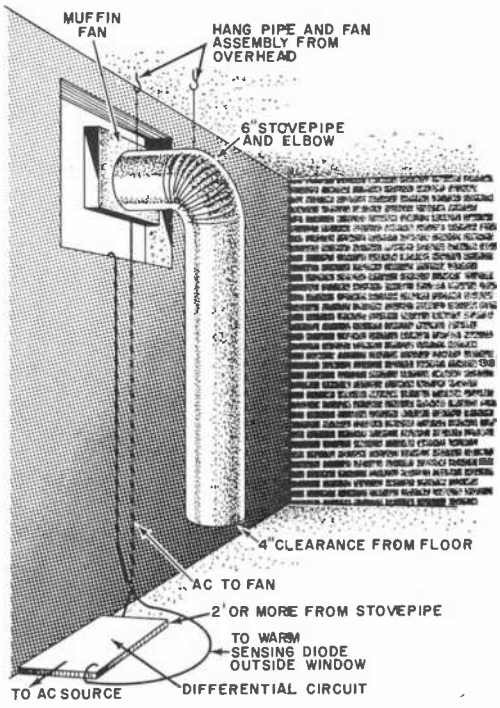


Fig. 2. Diagram shows how to install the fan (in stovepipe) in a basement window, to draw out cool, damp air.

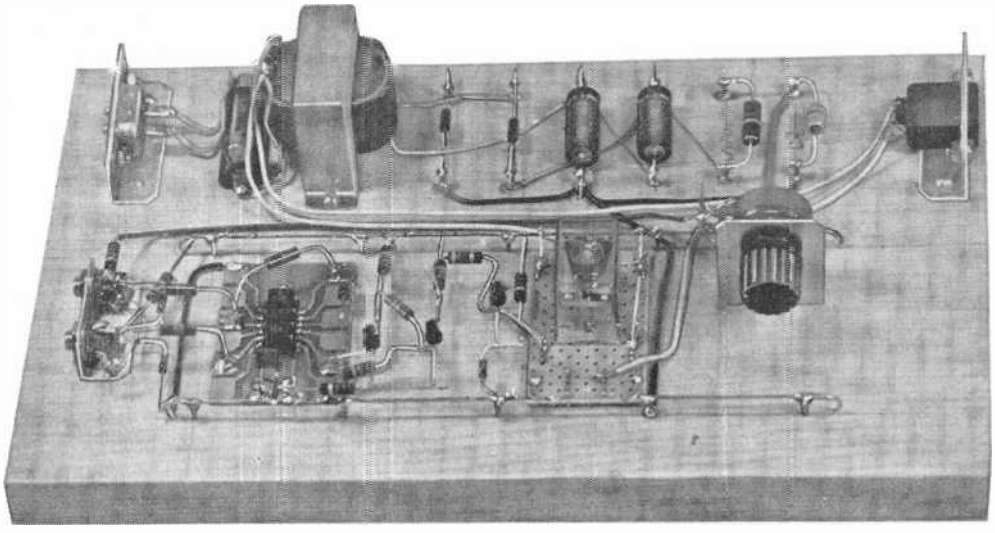
diode drop very carefully. Final adjustment of the bridge will be made by *R3*. Reducing the value of *R3* raises the *D1* current simulating a falling temperature outdoors or a rising temperature indoors.

Construction. The circuit can be constructed on perf board or a printed circuit board. There is nothing particularly critical about the circuit. Diode *D4* is mounted on the circuit board in such a way that air can circulate around it. Diode *D1* is mounted outside the basement window and connected by a length of ordinary two-conductor cable. Do not place *D1* where it will get direct sunlight, since the excessive heating will produce false results.

The mechanical arrangement is shown in Fig. 2. A suitable length of 6″ stovepipe with an elbow is the main element. The axial fan is mounted to the end of the elbow as shown and the entire assembly is suspended so that the fan is in the window (remember it exhausts the basement air) and the bottom of the stovepipe is about 4″ from the floor. Keep the electronic circuits, especially *D4*, at least two feet away from the bottom of the stovepipe so that the moving air will not cool the diode and produce a false indication in the differential circuit.

Calibration. With *D1* and *D4* close to each other, allow them to stabilize for an hour or so. Then set *R3* a little bit beyond where the relay opens. The two diodes are now temperature matched. If a large fan is required, and the current demand is more than the *K1* contacts can tolerate, use *K1* to drive a power relay or a simple SCR or triac controller. ◈

The electronic circuit for differential temperature sensing can be easily assembled on a breadboard as shown here. It should be positioned two feet from pipe.



THIS "TRIGGERED FUZZ" FOR YOUR GUITAR REPRESENTS A BRAND NEW APPROACH

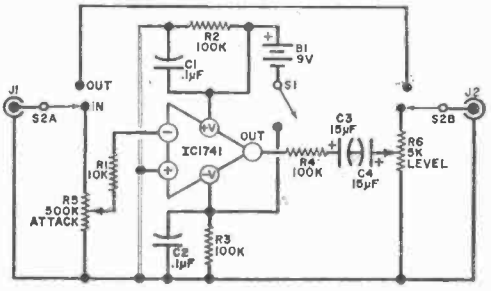
BY CRAIG ANDERTON

FUZZ adapters for guitars and other electronic instruments have been around for quite a while—in a variety of forms. Unfortunately, when in use, some adapters suffer from impaired clipping, noise, and feedback problems that cause them to deliver a fuzz that is "dirtier" than desired.

The "Optimum Fuzz" eliminates these problems since it comes into operation only when triggered on by the electronic instrument; and it delivers an output that is almost a square wave, which sounds much fuzzier than the sound produced by conventional circuits.

As shown in Fig. 1, *IC1* is connected as a modified comparator that produces an output only when the signal applied to its inverting input (−) is above a certain level. Below this level, the comparator automatically switches off and there is no output. Provisions are made, through *S2*, to bypass the fuzz when desired.

Fig. 1. Triggered square-wave output of op amp provides good fuzzy sounds.



PARTS LIST

B1—9-volt battery
C1,C2—0.1-μF disc capacitor
C3,C4—15-μF (or greater) electrolytic capacitor
IC1—741 compensated operational amplifier
J1,J2—Phono connector
R1—10,000-ohm, ½-watt resistor
R2-R4—100,000-ohm, ½-watt resistor
R5—500,000-ohm linear potentiometer
R6—5000-ohm linear potentiometer with spst switch attached
S1—Spst switch (part of R6)
S2—Dpdt push-on/push-off switch
Misc.—Suitable chassis, battery connector, perf or printed circuit board, clips, etc.

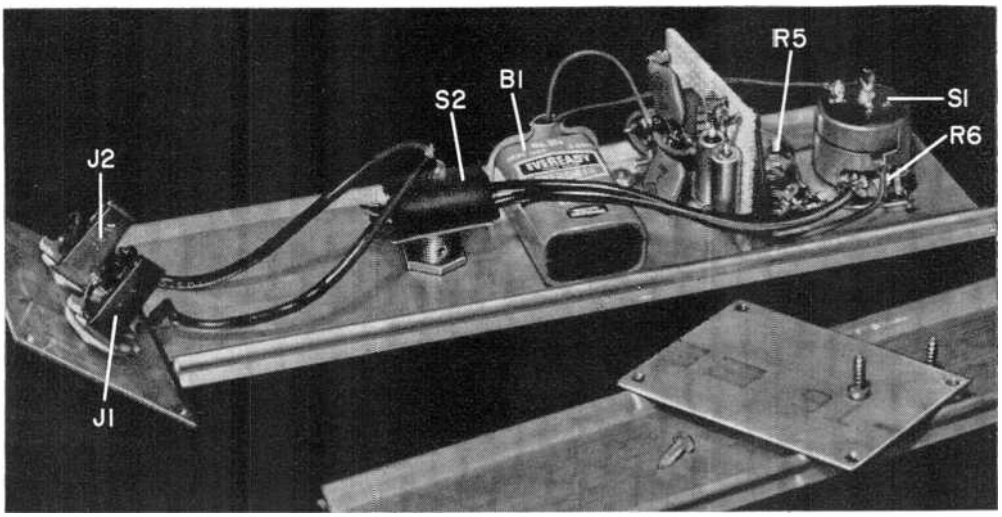
Construction. The prototype was built on a small piece of perf board using flea clips to hold the components. Alternately, a printed circuit board could be designed to do the job. The board can be mounted in any type of enclosure. The control switch (*S2*) should be a foot-operated device and must be enclosed in a sturdy housing. As shown in the photographs, the author put the entire circuit in a metal box.

Operation. Plug the instrument to be fuzzed into the input connector, *J1*, and connect the output terminal, *J2*, to the amplifier being used. Apply power to the fuzz by turning on *S1*. Turn level control *R6* and attack control *R5* about half-way up. Play the instrument, and operate the foot switch, *S2*, to make sure that you get both the straight and the fuzzed signals as the circuit is switched in and out.

When using the adapter with an organ, connect the adapter between the organ and any volume pedals, or the action may be unpredictable. The attack control (*R5*), while not making too obvious a difference with stringed instruments, allows considerable variation of the output sounds when used with organs or other types of tone-generated instruments.

You will have to play the Optimum Fuzz for a while to get used to the somewhat abrupt decay. It is much faster than that of conventional fuzzes (due to the triggering action); but with a little practice, this problem is easily overcome. ◈

Photo of author's prototype shows method of construction. You could also install the electronics in one chassis and the foot-controlled switch in another sturdier one with a cable to connect the two units.



X-RAYS FROM TV NO LONGER A HAZARD

The Food and Drug Administration has announced that government/industry efforts to reduce X-ray emissions from home television receivers have made it possible to rescind previous warnings to viewers. Several years ago, FDA recommended that viewers sit at least 6 feet from an operating set to minimize the relatively low biological damage potential of possible X-ray leakages. A new pamphlet ("What's Being Done About X-Rays From Home TV Sets," available for 10¢ from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402) says that there now should be no significant health hazard in watching a properly serviced and operated home TV at a distance at which image quality is satisfactory.

X-ray emissions from sets produced since about the middle of 1968 have been found to be too low to present a health problem. For older sets, replacement components have been redesigned and TV service technicians have been trained to adjust sets to reduce X-radiation producing capability. Primary cause of X-rays in TV has been found to be adjustment of operating voltages to too high levels.

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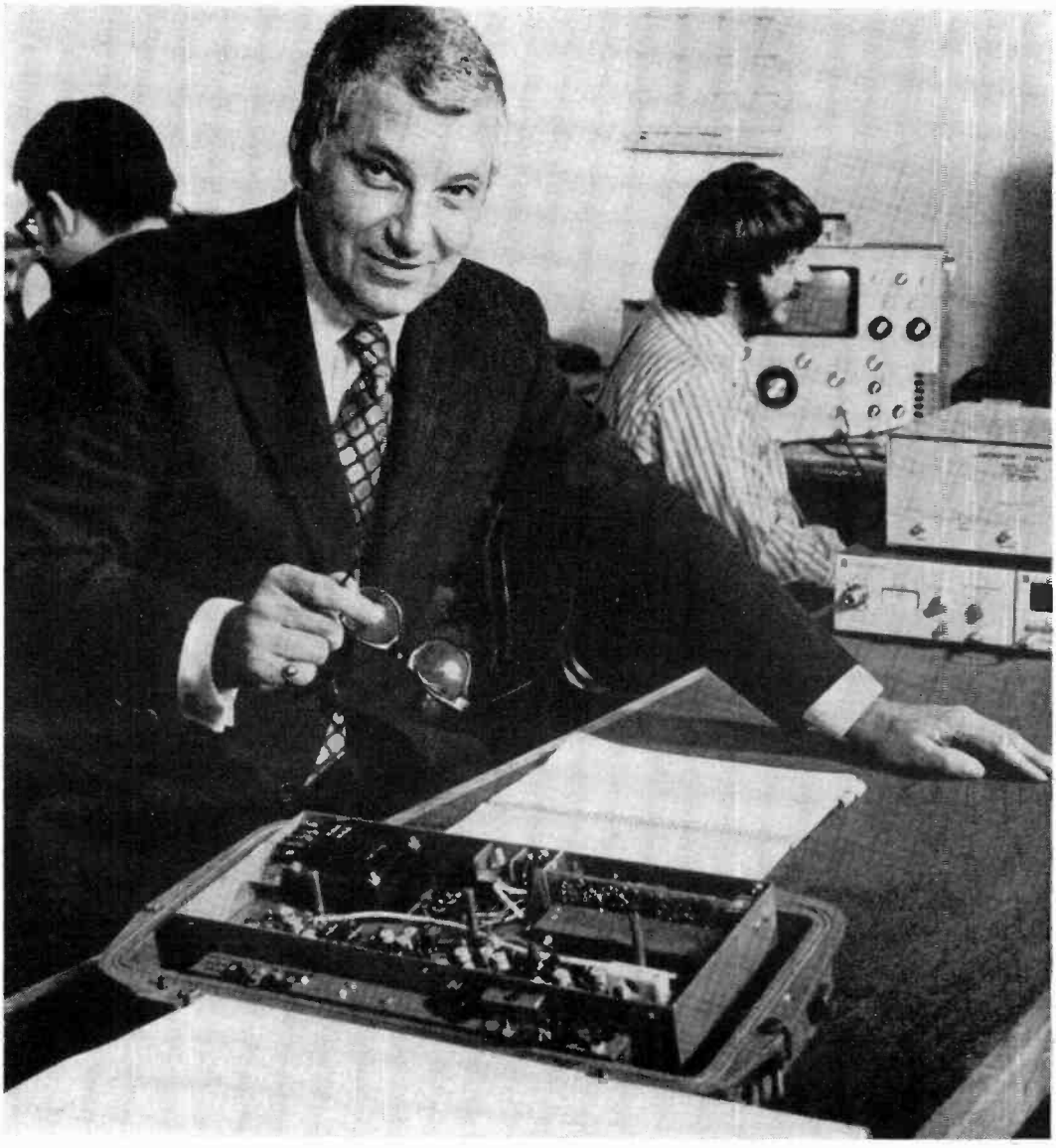
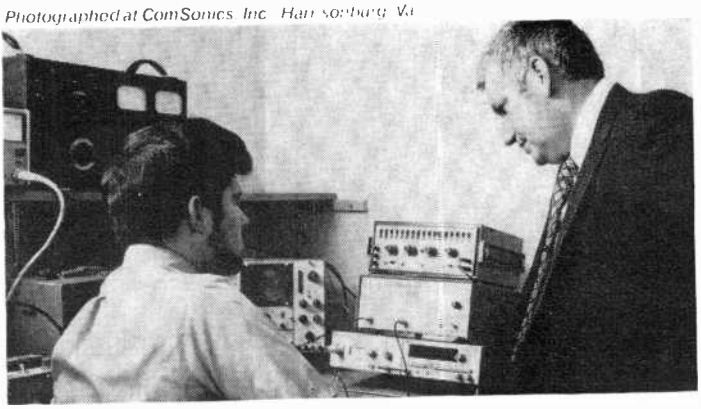
WARREN BRAUN, *President, ComSonics Inc., Virginia Engineer Of The Year, ASE International Award Winner,* **CREI Graduate**



Photographed at ComSonics, Inc., Harrisonburg, Va.



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BRITISH RADARS for Pleasure Boats

A report on recent inroads made by English electronics manufacturers into the young and lucrative pleasure-craft radar market

BY KEN ENGLERT

WITH the defeat of the Spanish Armada in 1588, England first proclaimed her supremacy of the High Seas! If current trends are any indication, Britain is again determined to dominate the world's waterways—at least with respect to marine radar in the rapidly growing pleasure-craft boating market.

In recent years, the production of small-craft radar by the marine divisions of such notable American electronics firms as Bendix, RCA and others has been discontinued. Among the major companies, Raytheon remains as the only "Yankee" manufacturer of radar for the yachtsman.

Almost without notice, English radar manufacturers have been quietly slipping their products into this country to fill the newly created void.

Among those Anglo-Saxon invaders who have led this assault on the American radar market are some of England's largest and most diversified electronics companies, including Decca Radar, Ltd., EMI (Electrical and Musical Industries), and Plessey Electronics Group. In addition, Kelvin-Hughes and Astron-Bird, Ltd. have taken their share of the radar market in North America.

This is an uncommon turnabout of the development of "electronics colonialism" of which U.S. electronics companies have often been accused—that is, the taking over or largely controlling segments of the electronics industry of Britain and other European countries since World War II.

Decca Radars. London-based Decca Radar, Ltd. has been the unquestioned industry leader, to date, producing its first marine radar in 1949. Decca has managed to stay "number one" in sales, in large part due to their sizable research and development organization. They have consistently turned out some of the industry's

most advanced state-of-the-art equipment.

This is evidenced by the very popular and stylish Super #101 18-mile range radar. The #101 has won, for the company, the coveted "Queen's Award to Industry" three consecutive years in a row, for outstanding achievement in exporting and technological innovation. In addition, Decca boasts a worldwide network of over four-hundred repair-warranty stations to service their radars, no matter where a Decca-equipped vessel might find itself.

The Decca technician in the field reports, in detail, on all repairs made and parts replaced. With this information a comprehensive "case history" file is compiled in England on every radar they have ever manufactured, which number almost 40,000 to date.

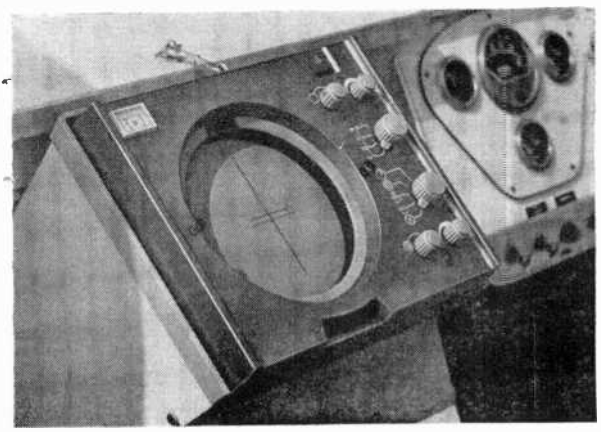
Decca is in sharp contrast to the stereotyped English business which conducts its commerce in a traditionally reserved and unimaginative manner. This is one company that has shown that American business holds no monopoly in salesmanship ability, in aggressively promoting their product line.

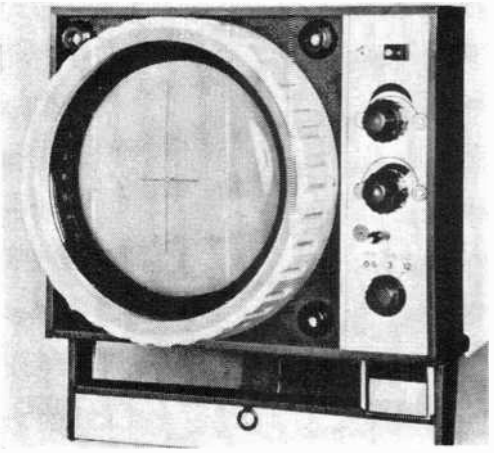
At the London and New York Boat Shows held in January of this year, Decca introduced their latest radar—Model *050*. The *050* is the smallest and least expensive radar that Decca engineering has so far produced.

It is designed to fill the need of the boatowner who, heretofore, had not been able to accommodate, or afford, the traditionally large and expensive radars.

Plessey Electronics. Having been one of the United Kingdon's largest producers of radar for defense, surveillance and meteor-

Decca 101 radar indicator is mounted conveniently on hinged fold-down door.





New Decca 050 radar has compact indicator which can be removed for stowage.

ology, it seemed quite natural for Plessey Electronics to enter the small-craft radar business in 1968. Their Model MR-12, 16-mile range radar, incorporates the latest technology and some rather imaginative engineering.

They have employed a rectangular cathode ray tube for viewing, rather than the traditional round picture tube. The MR-12 is also the first marine radar to use integrated circuits extensively, as well as to incorporate an advanced design logarithmic receiver. A special feature for the operator is an electronic bearing marker (rather than a mechanical one) which is usually found only on military and large commercial radar systems.

For ease of maintenance, most circuit functions are assembled on individual printed circuit boards to provide quick troubleshooting and replacement.

EMI Radars. A recent entry into the radar market is the new Electrascan, 16-mile range radar, from EMI (the giant, global corporate conglomerate). The Electrascan's most unique characteristic is its Autolert feature. When activated, a loud audible tone sounds out if any target, such as a rock, another vessel, or the coastline, becomes visable on the radar screen.

Autolert is like having an extra crew member aboard to keep constant watch with the radar. This leaves the vessel's skipper free to leave the helm, momentarily, for other duties or even to go below, should a need arise.

Plessey's unique MR-12 indicator has its operating controls in the handles.

A convenient panel-mounted meter assists the operator in obtaining optimum tuning for the sharpest picture, while alternately serving as a transmitted power level indicator. Installation of this radar system has been simplified by designing the power supply into the indicator, resulting in a radar of only two units (indicator and antenna).

Along with its marine radar, EMI has introduced a full line of instrumentation for the yachtsman, including a knotmeter with built-in log (water speed and distance indicator), two depth sounders and a combination wind speed and wind direction instrument.

Electronics Laboratories. Electronics Laboratories, Ltd. is headquartered in Poole, Dorset, on the English Channel. It has become the latest company to export marine radar to the States by its acquisition of the Astron-Bird group, a long-time producer of radar for maritime applications.

Electronic Laboratories, Ltd. is no newcomer to the marine electronics industry. They manufacture the Seafarer Range product line, which is well known to anybody who owns a boat bigger than a dinghy. They experienced virtually overnight success with their versatile and inexpensive Seafarer MK II Depth Indicator. In an amazingly short time, the MK II became the world's largest-selling depth indicator.

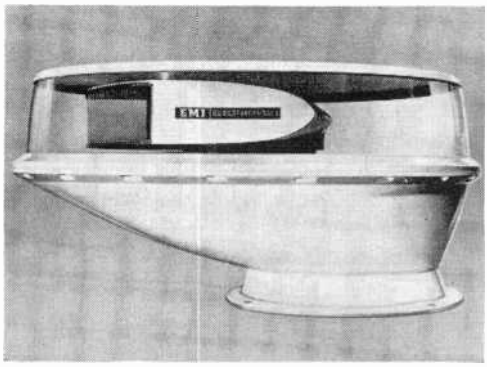
The Seascan will be their 1972 entry into the marine radar market and may yet prove to be the most exciting. The indicator is extremely compact, weighing only *12 pounds* and is priced to sell for less than $2,000.00—the lowest price ever for a complete six-range, 16-mile range radar with anti-sea and anti-rain clutter functions.

Power consumption is an unbelievable 48 watts—almost ⅓ the current power requirements of competitive units. The customary microwave klystron, used as the local oscillator in the receiver section of most marine radars, has been replaced with an advanced Gunn diode assembly in the Seascan, keeping its design in pace with the latest technology.

Only time will show if the Seascan will be another overnight success like the Seafarer MK II.

Two other new radars have been introduced to round out Electronic Laboratories, Ltd.'s line for the pleasureboat. The Seavista is a 24-mile range radar with a retangular CRT display.

The indicator is uniquely equipped with a carrying handle and quick-disconnect cables, allowing this radar to be moved to another location on the boat, if desired. The Astron 200, a deluxe commercial quality radar, also "sees" 24 miles in range, and will find applications on some larger luxury yachts.



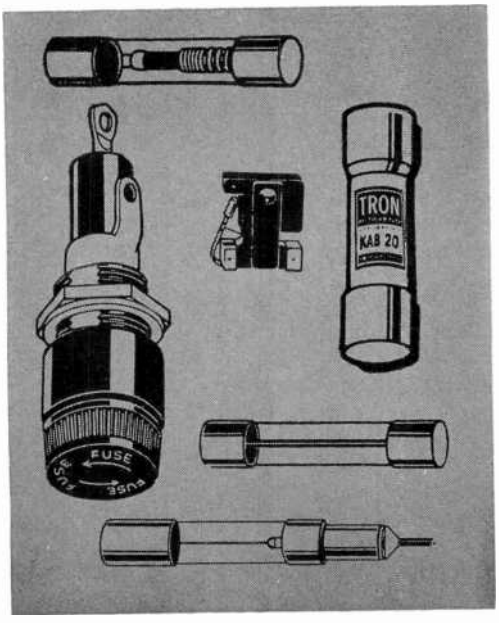
Rotating antenna can be seen through transparent window of EMI radar unit.

It is evident that the British, probably for the first time, have beaten us at our own game! They have successfully managed to take over a small electronics industry here in our own backyard. It's not that they are trying to get even with us for 1776 and 1812. It's just that, in this particular area, they have indeed shown technical and economic superiority. ◈

Fuses For Electronics

Types of fuses and where they are used.
How to select the right fuse for your circuit.

BY CHARLES W. JAMES
Special Applications Engineer
Bussmann Mfg. Div., McGraw-Edison Co.



FROM a strictly mechanical point of view, fuses may be placed into two general categories. The first category is the "clip-in" fuse, which must be placed into some kind of fuseholder or a pair of clips to perform its normal function. The other category includes those fuses that have leads soldered to the end-caps and are generally referred to as "pigtail" fuses. Pigtail fuses can be soldered directly into an electronic circuit or printed circuit board, without a fuse-holding device.

Time-Delay Fuses. One of the most popular fuses in use is the so-called "time delay" fuse (sometimes referred to as "slow-blow"). This is a general-purpose fuse with the ability to pass harmless transient currents and yet blow with sustained overloads or short circuits. It is usually constructed with a solder-alloy heat sink that can dissipate the heat generated by momentary transient currents and is spring operated when the current lasts long enough to cause the solder alloy to melt. This type of fuse is sensitive to ambient temperature and must be derated when applied in an extremely warm location in order to carry the load current.

Fast-Acting Fuses. Another very popular fuse is the "fast-acting" (or "normal blow") fuse. This is usually applied in circuits where there are no transient or surge currents to hamper its operation. This fuse generally has a single-element, wire link construction, without any heat sinks to absorb momentary overcurrents. Fast-acting fuses thus blow very quickly on overloads and must be applied very carefully with regard to the amount of full load current. Quite frequently these fuses are used to provide short-circuit protection only and, therefore, can be sized at approximately 250-300% of the full load current. Ambient temperature has very little affect on the performance of these fuses.

"Very fast-acting" fuses are becoming increasingly popular for use in circuits that require extremely fast operation to protect critical components, such as meters or semiconductor rectifiers. Electronic equipment that has very little ability to withstand overcurrents requires this kind of protection. This fuse is constructed similarly to the "fast-acting" fuse except that the link is usually surrounded by a special filler material and the fuse body is made of ceramic or phenolic material. The very fast-acting

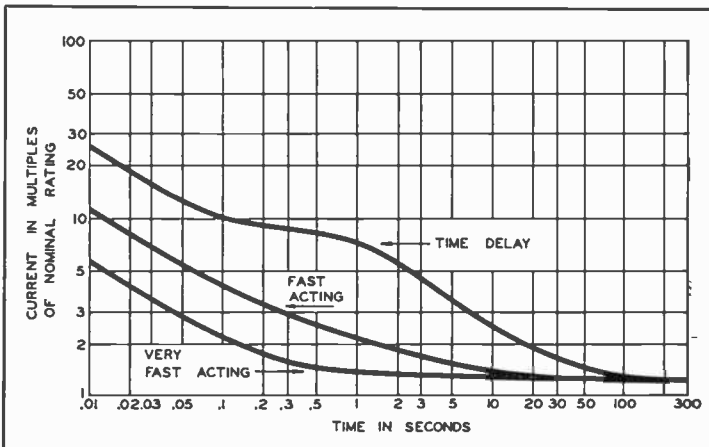


Fig. 1. Operating characteristics of three fuse types described in text.

fuse is essentially insensitive to ambient temperature.

Comparing Fuse Characteristics. Figure 1 shows the operating characteristics of the three types of fuses mentioned above. Consider that all three types carry a one-ampere full load rating but, as can be observed, the blowing time for each is considerably different for a given overload current. For example, when the overcurrent is 200% (2 amperes), the time-delay fuse takes 18 seconds to blow while the fast-acting fuse opens in approximately 1.4 seconds. A 2-ampere current, through a very fast-acting one-ampere fuse, causes the fuse to blow in 0.13 second.

It can be seen from the above that a knowledge of the circuit in which a fuse is applied is important. Will the circuit develop transient currents? How fast must the fuse operate when a short occurs? These and many other questions should be considered when initial circuit design is undertaken.

There are many fuses today which have been developed to meet special needs. Usually, the fuse dimensions or physical construction have been altered so that a special mounting means can be employed or so that an indicator can be built into the fuse to signal when it has blown.

These fuses have particular applications and are not considered to be general-purpose fuses. The fuses covered here are general-purpose types readily available on the market.

Criteria for Selecting Fuses. There are many considerations that should be given to fuse selection. Voltage and current ratings are the two most popular (often the only) parameters that are investigated when selecting a fuse. Other criteria that must be examined include short-circuit current rating, fuse characteristics, application temperature, fuseholders and mechanical dimensions of the fuse.

Voltage Rating. Select a fuse with a voltage rating equal to or greater than the voltage of the circuit. The standard fuse voltage ratings which are available for electronic fuses are 32, 125, and 250 volts. Keep in mind that a fuse with a higher voltage rating can always be used on a lower voltage circuit. For example: a 250-volt fuse can be used in a 125-volt circuit. The reverse procedure, however, can be very dangerous and *should always be avoided.* All 125- and 250-volt fuses have the voltage rating stamped on the end caps. If there is no voltage rating stamped on the cap, then it should be considered to be a 32-volt fuse unless reference to its symbol can be made elsewhere.

Automotive circuits use 32-volt fuses, while 125-volt fuses are often applied in the

TABLE I—EFFECT OF AMBIENT TEMPERATURE ON CURRENT-CARRYING ABILITY

Time-Delay Fuses		Fast-Acting or Very Fast-Acting Fuses	
Ambient Temperature °C	% Rated Current	Ambient Temperature °C	% Rated Current
40	95	40	98
60	85	60	95
80	75	80	92

input circuit of power supplies. Fuses rated at 250 volts, for example, may be applied in the B+ circuit of a TV receiver.

Current Rating. Once the voltage rating is determined, a fuse with an ampere rating greater than the expected circuit full load current should be selected. The generally accepted procedure is to choose a rating about 25% greater than the full-load current of the circuit, because fuses are built to carry their rated current in open air at room ambient; whereas they are usually applied in some type of enclosure and the enclosure temperature is often higher than room ambient.

An important point to remember is that the voltage rating described above does not in any way affect the *ampere* rating. A one-ampere, 125-volt fuse and a one-ampere 250-volt fuses have identical current-carrying capacities. Only the ability of the fuse to open a short-circuit current is affected by its voltage rating.

Another frequent mistake made in selecting the ampere rating of a fuse concerns the current waveshape. Many electronic circuits have unusual waveshapes, such as those in rectifier circuits. The object of a rectifier circuit is to produce a dc voltage from an ac source; thus, the normal thought would be to select a fuse for the dc circuit on the basis of the dc current that is flowing. This would be acceptable if the rectified wave were perfect; however, we know that in practical circuits, we do not need a perfect dc current and it is difficult to produce. Since the dc wave is not perfect, there is an rms value of that wave which, in many cases, exceeds the dc current value. Consequently, the fuse must be selected for the rms value. An example of this is the case of a simple half-wave rectifier with a one-ampere dc output and an rms value of the wave shape of 1.57 amperes.

The general rule to follow is to select a current rating based on the rms value of the current. Only when the rms value equals the dc value is it acceptable to pick the fuse size based on dc current.

Short-Circuit Current Rating. Should a severe short circuit occur in an electronic circuit, it is mandatory from a safety stand-

TABLE II—ELECTRONIC FUSE SELECTION CHART

Buss Catalog Symbol	Ampere Range Available	Voltage Rating	Characteristics	Dimensions Inches	Typical Application
AGX	1/500 to 2	250 or less	Fast-Acting	¼ x 1	Meters,
AGC*	1/500 to 3	250 or less	Fast-Acting	¼ x 1¼	Metering
	4 to 30	32 or less	" "	"	circuits,
ABC	¼ to 20	250 or less	" "	"	Instruments
	25 to 30	125 or less	" "	"	
MDL	1/100 to 1**	250 or less	Time-Delay	"	Power
	1-2/10 to 2-8/10**	125 or less	" "	"	supplies,
	3 to 30	32 or less	" "	"	B+ Circuits,
MDX	1¼ to 2	250 or less	" "	"	Motor &
	3 to 7**	125 or less	" "	"	transformer
MDA	1/100 to 20	250 or less	" "	"	circuits
	25 to 30	125 or less	" "	"	
FNM	1/10 to 10	250 or less	" "	13/32 x 1½	
	12 to 15	125 or less	" "	"	
	20 to 30	32 or less	" "	"	
BAF	1 to 15	250 or less	Fast-Acting	"	Meters, Instruments, Etc.
	20 to 30	125 or less	" "	"	
BAN	1 to 30	250 or less	" "	"	
GBB	1 to 10	130 or less	Very Fast-Acting	¼ x 1¼	Semi-conductor circuits
KAW	½ to 30	130 or less	" " "	13/32 x 1½	

*Pigtail Type would be GJV.
**Pigtail Type would be MDV.

point that the fuse clear the fault without rupturing. It is for this reason that fuses are given a *short-circuit* rating that goes along with their *voltage* rating and must never be exceeded.

A normal 125-volt circuit load current could be two amperes full load but, when a short occurs in the circuit wiring, the current might increase to 1000 or 2000 amperes. The fuse, in turn, must be able to open the circuit safely under this condition. Generally, short-circuit currents with magnitudes in the thousands of amperes are the exception rather than the rule in the case of low-energy electronic equipment. For most electronic devices, if a fuse of the proper voltage rating is selected, it will have an adequate short-circuit rating.

Temperature. How many times have you checked a troublesome circuit and found that the current was less than the fuse rating? Did you happen to check the temperature to which the fuse was being subjected as well? The effect of ambient temperature on fuse performance can be appreciable, especially where time-delay fuses are involved.

Table I shows the effect of temperature on the current-carrying ability of the various types of fuses previously discussed. If a time-delay fuse were to be selected for operation in an 80°C ambient and the circuit current were 375 milliamperes, then the ampere rating of the fuse should be at least ½ ampere. If the same temperature and current conditions were to be imposed on a fast-acting fuse, the fuse rating should be at least ⅓ ampere.

There are many applications where operating temperatures can be considerably higher than room temperature, especially in circuits where the components are enclosed by a cabinet or case, as in radios, TV's, power supplies, and amplifiers.

Time-Current Characteristic. Once the voltage and current ratings are decided upon, a major consideration is the time-current characteristic of the fuse. The circuit determines to a great extent whether a time-delay, fast-acting, or very fast-acting fuse is the correct choice. If harmless transient currents might occur, a time-delay fuse would be needed. If the circuit is a bridge rectifier, a very fast-acting fuse would be recommended.

Dimensions. Fuse dimensions are usually considered in initial design and can be critical when space is a factor. The most common electronic fuse dimensions are ¼" x 1", ¼" x 1¼", and 13/32" x 1½". A wide variety of mountings with a number of special features (if desired) are made for these fuse sizes.

Fuseholders. The most popular fuseholder for mounting on a chassis inside an enclosure is the ordinary Bakelite (phenolic) fuseblock which has fuse clips and wire terminals attached. For mounting the fuse in an enclosure or panel, the "panel-mounted fuseholder" is extensively used. This fuseholder has the advantage of being accessible from outside the enclosure.

Panel-mounted fuseholders with lamps to indicate a blown fuse are also available. These are particularly helpful where many fuses are used in the same area.

The pigtail fuse is, of course, the least expensive from a fuseholder point of view. However, a blown pigtail fuse is more difficult to remove from the circuit.

Table II is a quick reference chart of fuses giving their voltage and current ratings, operating characteristics, dimensions, and some typical applications. ◈

AMATEUR STATION HELPS LAND TWO AIRCRAFT

Amateur radio station W6AJZ, Santa Monica, Calif., recently responded to an emergency call from KC4USP, National Science Foundation Radio, at Palmer Station, Antarctica. KC4USP reported that two Navy aircraft, returning to Christchurch, New Zealand, due to bad weather, were short of fuel and were not likely to make their destination. Due to abnormal radio conditions, Palmer Station had no contact with Christchurch and they asked W6AJZ to contact Naval authorities in the States to set up commercial communications with Christchurch and let them know that both planes were attempting alternate landings at Dunedin, New Zealand. It was urgently required that the alternate airport implement emergency conditions including the turning on of all landlights, adjacent city lighting, etc., to guide the troubled aircraft.

After W6AJZ had made telephone contact with Washington, where communications were available with Christchurch, the amateur station served for 45 minutes as a relay between Palmer Station and Washington/Christchurch. When all preparations had been completed emergency radio contact was secured. The Navy telephoned W6AJZ later that day to advise that both aircraft had landed safely. ◈

ELECTRONIC PEST CONTROL

ULTRASONICS FORCES RODENTS AND INSECTS TO DEPART FOR QUIETER SURROUNDINGS

BY LYMAN GREENLEE

MANY experiments have been conducted by various schools and commercial enterprises to determine the effect of ultrasonics on insects, rodents, birds, and other small animals. Unlike chemical poisons that kill unwanted pests but also may be harmful to household pets and humans, low-intensity ultrasonics does not kill and leaves no undesirable contaminants.

One Japanese manufacturer is marketing an ultrasonic device for rodent (rat) control which is claimed to have an effective area of more than 225 square yards. The 19.5-kHz, 15-watt ultrasonic signal makes life so uncomfortable for the rodents that they leave to look for more peaceful surroundings. Experiments have shown that ultrasonic radiation is effective on insect pests (including mosquitoes) as well as rodents.

There are still many things to be learned about the use of ultrasonics. Among them are: the best frequency to be used; whether to use pulses (if so, what rate) or a continuous tone; whether the ultrasonic signal should be on all the time or for some period each day; how much power is needed for effective control; what is the effective range per watt of audio output; and finally, and most important, the effect on human beings exposed to the ultrasonic energy. It may be in this area that danger lies.

The ultrasonic pest control system described here provides a good starting point for experimentation in this new area of non-chemical control. Essentially, the output of an ultrasonic square-wave generator is amplified and fed through a gating circuit to drive a power amplifier, which supplies the speakers. Experiments have shown that a square wave is more effective in insect control than a sine wave (probably because of the harmonic content) and that in some cases, a pulsed circuit is more effective than a continuous wave. The power amplifier should be capable of putting out 15 to 20 watts of usable power in the ultrasonic region. In the prototype, the author used the "Li'l Tiger" amplifier described in the December 1967 issue of POPULAR ELECTRONICS. However, any good hi-fi amplifier with the proper high-frequency characteristics may be used. The selection of the speakers is very important. With ultrasonics, it is easy to burn out the speaker. Each speaker called for in the Parts List will safely handle up to 5 watts of ultrasonic energy—even that may be too much in hot weather or with inadequate ventilation. (It might be a good idea to put a 1 or 1.5 ampere fuse in the circuit to prevent burnout.)

Generator and Timing. The circuit shown in Fig. 1 includes the ultrasonic square-wave generator, the timing circuits, and the required IC power supply. Integrated circuit *IC1* is a dual two-input gate wired to form a square-wave generator. The frequency is determined by the coupling capacitors, *C1* and

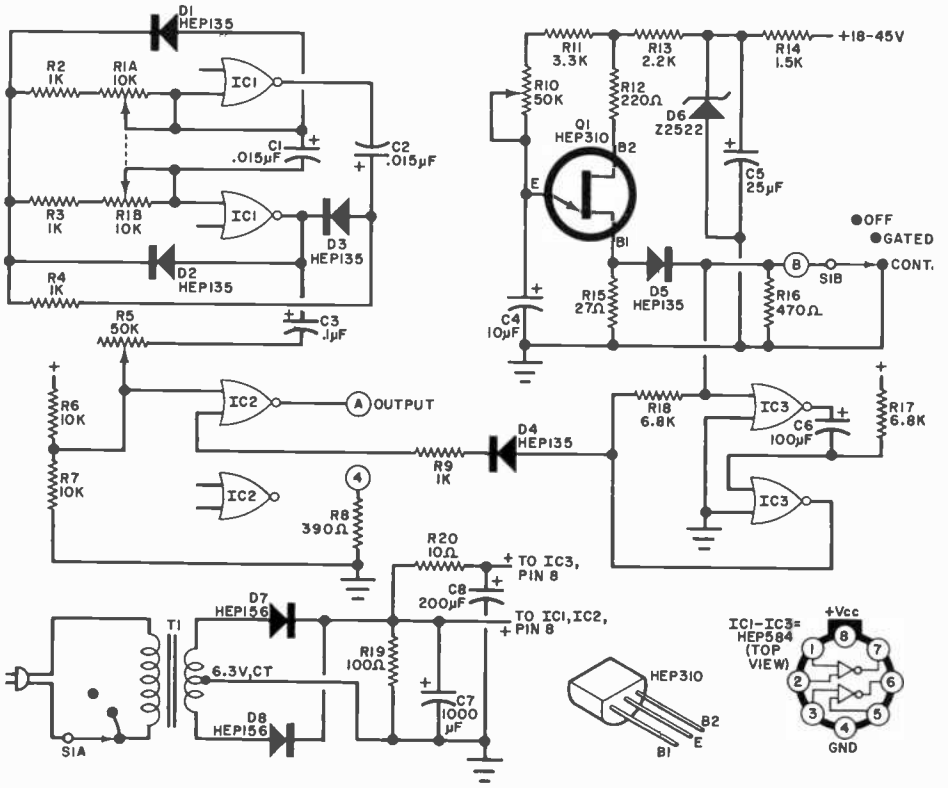


Fig. 1. Oscillator circuit offers choice of gated or continuous operation.

PARTS LIST

C1,C2—0.015-μF, 100-volt Mylar capacitor
C3—0.1-μF, 100-volt Mylar capacitor
C4—10-μF, 25-volt electrolytic capacitor
C5—25-μF, 50-volt electrolytic capacitor
C6—100-μF, 3-volt electrolytic capacitor
C7—1000-μF, 6-volt electrolytic capacitor
C8—200-μF, 15-volt electrolytic capacitor
D1-D5—HEP135 diode
D6—HEPZ2522 zener diode (18V, 1W)
D7,D8—HEP156 diode (1A, 100V)
IC1-IC3—Dual two-input gate (HEP584 or μL914)
Q1—HEP310 unijunction transistor
R1A.R1B—Dual 10,000-ohm potentiometer
R2-R4.R9—1000-ohm resistor
R5—50,000-ohm, PC-type potentiometer
R6,R7—10.000-ohm resistor
R8—390-ohm resistor
R10—50.000-ohm, PC-type potentiometer
R11—3300-ohm resistor
R12—220-ohm resistor
R13—2200-ohm resistor
R14—1500-ohm, 1-watt resistor
R15—27-ohm resistor
R16—470-ohm resistor
R17,R18—6800-ohm resistor
R19—100-ohm, 1-watt resistor
R20—10-ohm resistor
S1—2-pole, 3-position rotary switch
T1—Filament transformer; secondary: 6.3-VCT at 1.2A
Misc.—Circuit board, press terminals, multi-lug terminal strips, suitable chassis, mounting hardware, optional 117-volt indicator lamp. knobs, handle, line cord, etc.
Note—A kit of components is available from Negeye Engineering Labs., Box 1036, Anderson. IN 46016, for $29.75 (plus $2 for postage to Alaska, Hawaii, or Canada). Order Bugshoo Kit 1 Timing Components.

C2, in conjunction with the ganged frequency control potentiometers, *R1A* and *R1B*. Using the component values shown, the range will be about 4 kHz to 60 kHz. The output of *IC1* is applied to half of *IC2*, which is used as both a preamplifier and a disabling gate. Potentiometer *R5* is a gain control preset to the value required to drive the power amplifier. The second input to *IC2* is a gating signal from *R9*. When the latter is positive, the two-input gate is disabled and the output is blocked.

The gating signal is derived from a unijunction relaxation oscillator (*Q1*) whose

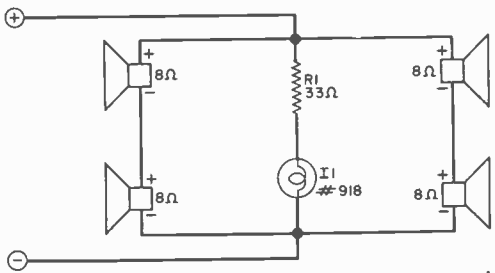


Fig. 2. Four 8-ohm speakers must be wired as shown to provide 8-ohm load.

PARTS LIST

Speaker—Olson Electronics S-846, 2⅞" tweeter Jensen, Model TE-40 "Sono-Dome" Allied Radio Shack, Ultra-Tweeter University MS Supertweeter or T-203W Sphericon Tweeter
R1—33-ohm, ½-watt resistor
I1—Indicator lamp, 12V, 0.035mA (Sylvania 918)
Note—A kit of four special speakers is available for $24 from Negeye Engineering Labs., Box 1036, Anderson, IN 46015. Order Bugshoo Kit 3, Speakers.

period is determined by *R10*, the pulse rate control. When the positive going pulse across *R15* is fed to the *IC3* timing gate (wired as a monostable), the gate cuts off until *C6* discharges. Repetition rate with the values shown is 1 to 10 pps.

The conventional low-voltage supply provides power only for the IC's, while the UJT power comes from an external power amplifier. The ultrasonic audio output (gated or continuous, depending on the setting of *S1*) is available at point A.

Construction. Either a printed circuit or a perf board can be used for the project. If a perf board is used, the IC's are mounted on push-insert terminals and the UJT should have a socket. Potentiometers *R5* and *R10* are of the PC type and should be fixed to the board. Other than the IC power supply, components are wired point-to-point using terminals where required. The mounting of components in the prototype is shown in the photograph.

The two power supplies (one for the IC's and one for the power amplifier) are built up on multi-lug terminal strips on the U-shaped chassis. The voltage-regulating network for the UJT, consisting of *R14, R13, D6,* and *C5* is also built up on a multi-lug terminal strip.

The four tweeter speakers are mounted in suitable holes on the rear panel of the main chassis. As each speaker has an impedance of 8 ohms, the four are wired as shown in Fig. 2, to provide an 8-ohm load for the amplifier. Be sure that the speakers are wired in phase as shown.

The indicator lamp in the speaker circuit provides a visual indication when the speakers are working because they cannot be heard on the high-frequency range. The speakers can be mounted in a cluster as shown or separated to cover four small areas. Because of the high frequencies involved only a very small baffle is required.

Why use four speakers? Tests show that the four speakers produce three times as much acoustical output as one speaker with the same drive to the amplifier. It was also found that a single speaker could not carry the full output without burning up after a few minutes.

Adjustment and Use. Test the power amplifier and speaker system by feeding an appropriate audio signal into the amplifier and running the test generator frequency up from the audible range to about 30 kHz. If convenient, monitor the output at the ultrasonic frequencies by using a scope or VTVM. Otherwise, you must assume that, if the audio system seems to be working properly through the audio range, it is working at the ultrasonic frequencies. Disregard any distortion you may see on the scope waveform.

Arrange drivers as shown for best dispersion and maximum acoustical output.

Now connect the generator and gating board output (point A) and the ground to the power amplifier. With power applied to the board and with *S1* set to "continuous"

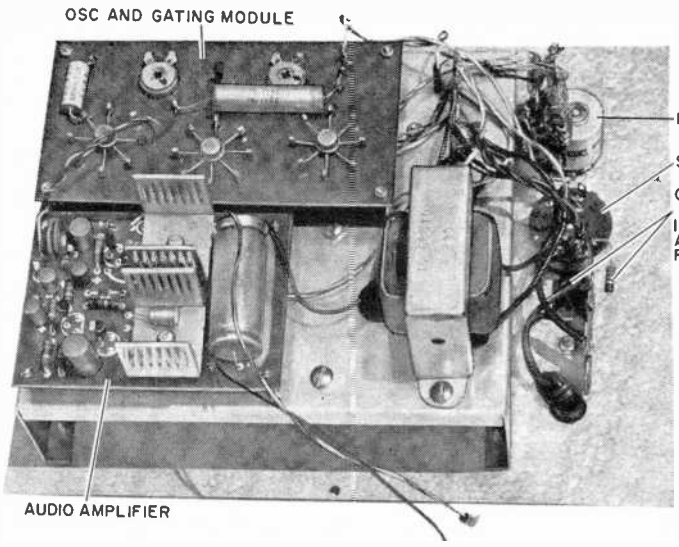


Photo shows typical layout of subassemblies, including audio amplifier.

output, adjust *R5* for the output required to drive the power amplifier properly. (With the Li'l Tiger, this is about 1.5 volts rms.) Place *S1* in the gated position and adjust *R10* for the desired trigger timing. Shut down the system as soon as you think you have the correct pulsing rate.

To prevent speaker burnout at the ultrasonic frequencies, adjust R5 for a maximum of 10 volts across the speaker coils, when the line voltage (nominally 117 volts) is at its daily maximum. (Remember that line voltage can be greater than 117-volts at some time of the day or night.) Another protection technique is to use a one-ampere slow-blow fuse in series with the speakers. If the fuse blows, lower the amplifier input level via R5.

Do not listen to the output for long periods of time—even though you think you are hearing only a series of clicks. The system is emitting a relatively powerful burst of ultrasonic energy which may be harmful to your hearing or nervous system. The main beam from the speakers should be aimed only where the pests are expected to be. Be sure that you are not just aiming at some suspected pests and that the beam is not going past that area and reaching people or household pets farther away.

To test the system on rodents, start with some controlled experiments by selecting a place where the rats or mice are known to run. Put out some bait to get them to come in numbers. After they know where the food is and are used to coming for a free meal, aim the speaker cluster at the food and turn on the device. Note the effect on the remainder of the bait the next time around. You may have to adjust the frequency or the rep rate to arrive at the maximum repulsion.

In any ultrasonic control device, the frequency and timing are very important. Different pests respond to different frequencies; and while many rodents respond to frequencies of 10 kHz or more, some insects require up to 25 kHz for maximum effect. Little is known about the pulse rate, so you will have to experiment. Mosquitoes, for example, are repelled by ultrasonic energy; but they are attracted by a humming sound at about 2 kHz.

Since 25 kHz is about the top for speaker efficiency, put a mechanical stop on the dual frequency control (*R1*) at this point.

To test the system on mosquitoes or bugs, let the device operate outside for an hour or so before you go out. Then turn it off before you go out. It may take some experimenting (with both frequency and pulse rate) to find out just what the ultrasonic system will do.

Remember. Though you may not hear anything from the system but a series of clicks, powerful bursts of ultrasonic energy are being transmitted. This energy can cause annoyance to acoustically sensitive people—even though they are a considerable distance away. Also remember that many household pets, particularly dogs, may have strong reactions if they wander into the ultrasonic beam area. ◈

CRYSTAL-CONTROLLED FM TUNER DESIGN

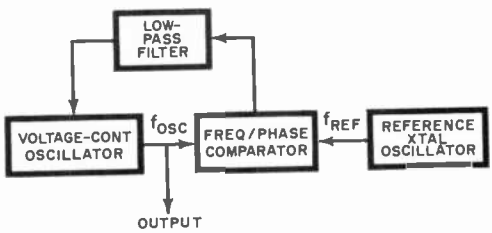
NEW TUNER USES SINGLE CRYSTAL AND DIGITAL FREQUENCY SYNTHESIS

BY KLAUS J. PETER

AN IDEAL tuner must be sensitive and selective, have good spurious and image rejection, have good capture ratio, and provide recovered audio with low distortion. Since low distortion is achieved only when the r-f signal is properly tuned, low drift is essential to maintain this condition. For operating convenience, a method of station pre-selection as well as the ability to scan should also be available. The readout accuracy should be such that there is absolutely no doubt as to which frequency or channel is being received. Manual fine tuning to reach the center or low distortion point of a signal should be eliminated because mistuning is probably the greatest source of distortion in FM reception.

The most obvious and simplest solution to eliminating fine tuning of the oscillator is to use a crystal-controlled oscillator. Since the oscillator frequency is always 10.7 MHz above the receiving frequency, 100 crystals covering from 98.8 MHz to 118.6 MHz in 200-kHz steps would be required for all channels. A 100-position rotary selector switch would serve as a tuning knob and provide a mechanical or electrical readout determined by its shaft position. This system effectively eliminates the need for fine tuning but is far too expensive since the quartz crystals alone amount to about $200 in parts cost. Using frequency mixing techniques, it is possible to bring the number of crystals down to 20 for dual conversion and 15 for triple conversion but the additional switchable filter requirements also make this approach expensive. Furthermore, multi-conversion designs may be troubled by spurious response and poor image rejection performance due to the nonlinearity of the mixer circuits.

Fig. 1. Simple phase-locked loop circuit locks oscillator to reference.



The Crystal Oscillator. The oscillator of the Scott 433 digital FM tuner is crystal controlled on every frequency but uses only a single quartz crystal as a reference standard. This is accomplished by making the oscillator part of a digital phase locked loop (PLL) circuit. In order to understand this principle, let us look at the simplest PLL circuit which locks an oscillator to a reference frequency.

When the system shown in Fig. 1 is first turned on, the voltage-controlled oscillator frequency will not be exactly the same as the reference frequency. The output of the frequency-phase comparator is an error voltage which tunes the VCO in a direction to minimize the error until phase-lock condition is established and $f_{osc} = f_{ref}$. Since the control voltage for the VCO is ideally a dc voltage, the low-pass filter is used to remove any high frequency components which might be present at the output of the comparator.

In order to generate a large number of frequencies from a single reference, a programmable divider is inserted into the PLL as shown in Fig. 2. The loop behaves as before except that a submultiple of the VCO is now presented to the comparator and the frequency relationship becomes

$$f_{osc}/N = f_{ref}$$
$$f_{osc} = Nf_{ref}$$

In North America, stations are assigned to fall on 100 channels from 88.1 to 107.9 inclusively with a spacing of 200 kHz. Since the channel spacing requirement is 200 kHz, the reference frequency of the crystal oscillator must be 200 kHz if its multiples are to fall on each FM channel plus 10.7 MHz. Let us calculate what the divide ratio must be when the tuner is receiving 88.1 MHz or the bottom channel on the band.

The oscillator frequency will be

$$88.1 + 10.7 = 98.8 \text{ MHz}$$

Substituting into the earlier equation to find the divide ratio N:

$$N = f_{osc}/f_{ref} = 98.8/0.2 = 494$$

This means that the voltage-controlled oscillator will be at a frequency of 200 kHz multiplied by 494 or 98.8 MHz. The next channel higher at 88.3 MHz will require a divide ratio of 495 and so on until 107.9 MHz, the top of the band, is reached at a divide ratio of 593.

For the tuner to scan the entire FM band, the programmable divider must therefore be able to divide from 495 to 593 inclusively.

Consequently every time a new station is desired, the divide ratio must be altered. Since several IC counters are available with a variable modulo or programmable count sequence, one of these is used here. The divide ratio is altered by inserting a binary code which affects the length of the count sequence and hence the divide ratio. Each channel or frequency requires a unique code which is presented to the divider.

The code itself is derived electronically and can be generated in a sequence which will make the tuner appear to scan across the FM band. It actually "steps" across the band rather than scans continuously since it only pauses (phase locks) on assigned channels. The tuner can also be tuned or programmed by cards which present a binary code to the code generator which in turn decodes it and passes it on to the programmable divider. The card system overrides the other forms of sequential tuning and allows instantaneous preselection of stations by using the desired card.

Scott 433 digital FM tuner circuitry is described in text by its designer.

Digital Frequency Readout. The tuner uses the familiar cold cathode neon indicator tubes which were chosen for reliability, long life and reasonable cost. The display is actuated by the same binary code which the code generator supplies to the programmable divider to set its divide ratio. Aside from displaying the frequency in MHz which the tuner is receiving at any given moment, the display serves as a self-checking feature for the code generator as well as the card reader. The binary code from the code generator is decoded into decimal form and used to drive the display; if an incorrect or non-allowable code is presented to the divider such as one caused by a damaged card, the readout will immediately show the error.

The digital readout in the tuner is not simply hooked up to a frequency counter which counts the oscillator frequency minus 10.7 MHz. The frequency counter is a "passive" addition which will work with any existing tuner while the PLL design is an "active" system which requires an electronically tuned r-f section. In the passive system, manual fine tuning is still required. With a PLL system the oscillator is forced to lock at each channel center, which always falls exactly on the assigned frequencies of the broadcast stations.

The digital PLL system provides an r-f oscillator of crystal stability on all frequencies plus an absolutely accurate digital display of the frequency being received. The binary code generator setting the divide ratio allows the operator to scan the FM band manually at a preselected speed or to let the circuit search for a station or stereo station automatically. If one station of known frequency is desired, a pre-punched card can be used to tune to it immediately. This feature will appeal to the discriminating music listener who has a small number of favorite stations and selects definite programs. The scan feature on the other hand might appeal to the less critical listener who usually scans the band until he hears something he likes.

Other Features. One of the extremely useful by-products of this system is automatic interstation muting. The tuner just won't tune between channels. Noise muting is also provided however for silencing emp-

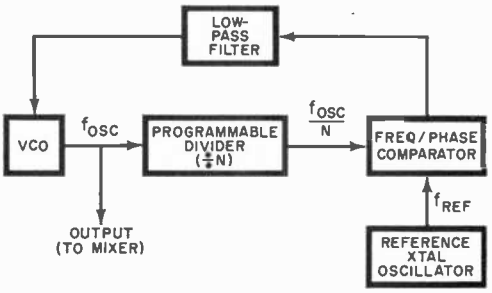


Fig. 2. The programmable divider allows tuner to synthesize multiple frequencies.

ty channels; this type of muting is defeated by a front panel switch. During the automatic "Stereo Station" scan mode, all mono stations are muted. When tuning from one station to another regardless of which tuning mode is used, the sound disappears without the usual transient swish or thump and reappears out of complete silence again with the absence of annoying noise bursts and distortion.

All muting is done after the multiplex decoder by two FET series-gate switches which reduce the signal by at least 60 dB in the muted condition without introducing a dc transient.

The r-f section in the tuner employs selected high-gain, low-noise FET's for both r-f gain and mixer functions. A FET is also used for impedance matching and low noise in the first stage of the i-f amplifier. Two 6-pole elliptical filters shape the passband of the i-f and achieve a selectivity in excess of 70 dB which allows this tuner to select any one station from a crowded area on the band.

The "Station" light on the front panel indicates the presence of a carrier and is actuated by a zero-crossing detector coupled to the output of the ratio detector; the station light is also a double check on the PLL and reference standard because it is actuated only if the station is tuned to exact center. On noise which is present on empty channels, the station light is extinguished automatically. The "Stereo" indicator will light up in the presence of a 19-kHz subcarrier when the signal level is sufficient to give an acceptable signal-to-noise ratio. A "Card Program" indicator shows at a glance whether or not card tuning is being used. Aside from providing instantaneous preselection of station frequencies, the card serves as a permanent memory since the code generator's volatile memory loses the station code when power is turned off.

Trend to Complexity. The trend in consumer electronics is toward greater circuit complexity made possible at low cost due to the use of integrated circuit technology. The circuit designer gains flexibility in achieving performance goals and operating convenience for the customer. Unless proper steps are taken, however, servicing of this type of equipment can become a problem as troubleshooting time and test equipment expenditures increase drastically.

The best approach seems to center around modular construction with each module representing a functional sub-assembly which can be replaced with no more effort than the vacuum tube in an old TV set. Fault location is greatly simplified by the fact that each module performs a definite function which can be monitored individually with a minimum of test instruments. Once the faulty module is replaced by the service shop, it is sent back to the factory where automated test facilities localize the fault to a component on the subassembly and it is either repaired or scrapped. This module exchange policy has been used for some time and is gaining in importance as equipment complexity increases. The customer also has the advantage of knowing exactly how much the repair will cost if it is done after the warranty period has expired because definite module exchange prices have been established. Even service shops with limited facilities can repair a unit as complex as the digital FM tuner if a set of PC modules or even another operating unit is available. Each module is simply interchanged with a new one until the fault disappears.

Although the complexity of circuitry has increased, reliability has increased also. Through the use of MSI (medium scale integration), the number of hard-wired interconnections has actually decreased thus avoiding a significant number of failures. By screening IC's in incoming inspection, testing assembled modules under worst case conditions before they are mounted into complete units, and extensive life testing of finished products, the failure rate has been reduced to a fraction of what it was a few years ago. The IC's used as building blocks in the digital sections are of the standard variety already well proven in the computer industry and second sourced widely. ◈

How to become a "Non-Degree Engineer"

Exciting careers in the new industries of the Seventies are waiting for men with up-to-date electronics training. Thousands of engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright...and the training can now be acquired at home—in your spare time.

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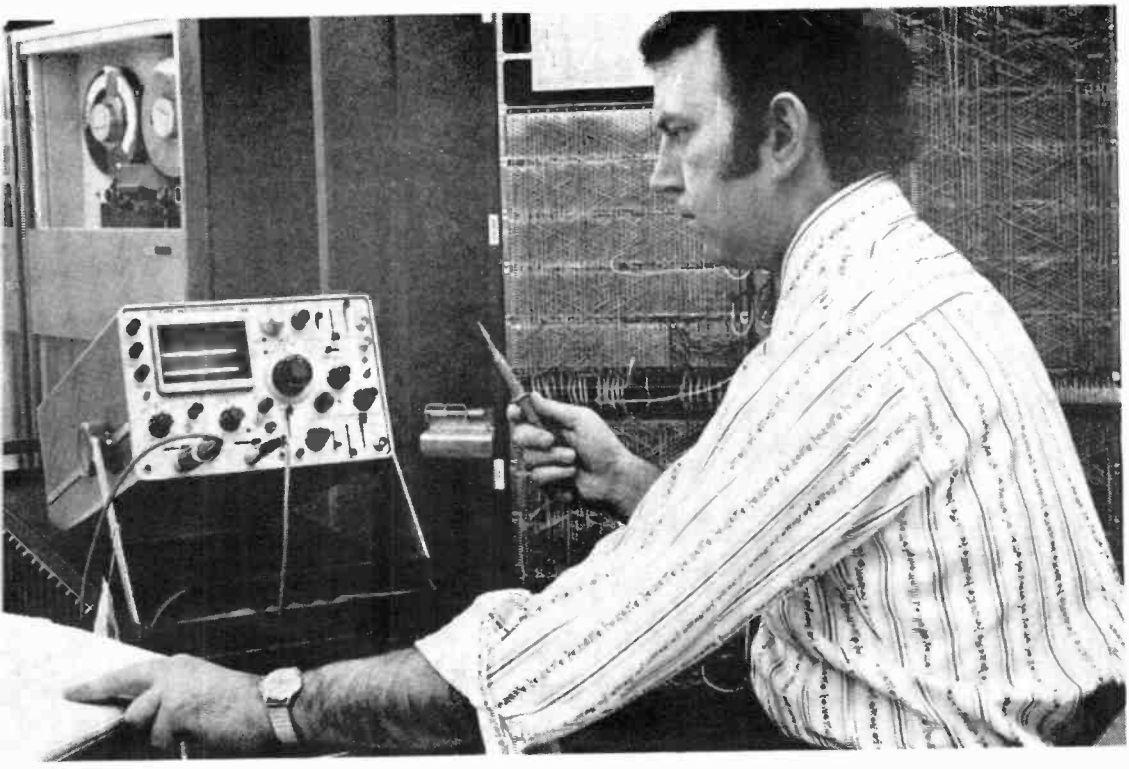

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FLIP-FLOP WITH OP AMPS

NEW DIGITAL USE FOR THE VERSATILE LINEAR OP AMP

BY HARRY GARLAND

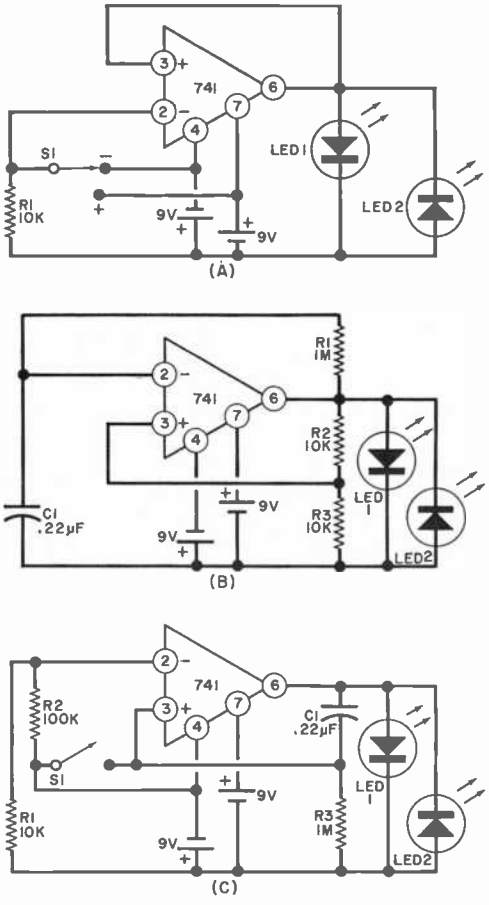
THE multivibrator is one of the most important circuits used in computers and other digital applications. Early multivibrator circuits used vacuum tubes with neon lights to indicate the "state" of the circuit. About ten years ago, transistorized multivibrators, using incandescent-lamp state indicators became popular. Now, a third generation of experimental multivibrators has evolved. They use linear integrated circuits with light-emitting diodes as the state indicators.

Three easy-to-build multivibrator circuits, using IC op amps, are shown in the diagram. The output of each of these circuits, as in all digital circuits, can only be at one of two voltages or states. Two light-emitting diodes (LED's) are used in each circuit to indicate whether the output is positive or negative.

Any of the popular gallium-arsenide-phosphide LED's will work well in these circuits. Each circuit uses two standard 9-volt transistor batteries and a type 741 operational amplifier.

Bistable Multivibrator (Flip-Flop). The easiest multivibrator to understand is the flip-flop, shown at (A) in the diagram. Assuming the output of the op amp (pin 6) is initially positive, *LED1* will be forward biased and on, with *LED2* reverse biased and off. The circuit is held in this condition by feedback to the positive (pin 3) input.

Now, if *S1* is momentarily switched to the positive supply voltage, the output will switch from positive to negative. Then



Unique digital uses for op amp: (A) a bistable flip-flop; (B) astable multivibrator; (C) monostable multivibrator.

LED1 goes off and *LED2* goes on. The feedback to pin 3 holds the circuit in this new state. If *S1* is now momentarily switched to the negative supply voltage, the output will flop back to its original state.

Because the flip-flop is stable for both postive and negative outputs (until *S1* is switched), the circuit is referred to as "bistable."

Astable Multivibrator. In contrast to the flip-flop, the circuit at (B) is not stable for either of the two possible outputs. To understand how this astable multivibrator works, assume that the op amp output is initially positive. In this case, *LED1* is on, *LED2* is off, and *C1* is charging up through *R1*.

As soon as the voltage across *C1* exceeds the fixed voltage at the positive input of the op amp, however, the output swings negative. Then *LED1* goes off and *LED2* goes on. Now *C1* charges negatively through *R1* until its voltage is less than the voltage at the positive input of the op amp. When this occurs, the output swings positive again and the cycle repeats.

For the component values shown, the LED's flash back and forth about twice a second.

Monostable Multivibrator (Single-Shot). While the flip-flop has two stable states and the astable multivibrator has no stable state, the monostable multivibrator, or single-shot, has one stable output state. The circuit of a single-shot is shown in the diagram at (C). Since the negative power supply is applied to the negative input of the op amp (through voltage divider *R1* and *R2*), the stable output state is positive. Now, *LED1* is on and *LED2* is off.

The single-shot can be triggered by momentarily closing *S1*. This applies a negative voltage to the positive input which causes the output to go negative. As soon as the switch is opened, however, *C1* will begin to charge through *R3*. When the voltage at the positive input exceeds the voltage at the negative input, the output will go back to its stable, positive state. The delay between the release of *S1* and the return of the circuit to its stable state is determined by the values of *C1* and *R3*. For the component values shown, the delay is about 0.5 second. ◈

LIQUID-CORE, LOW-LOSS OPTICAL FIBER

A SCIENTIST at Bell Laboratories has developed a new type of optical fiber which may be useful for optical communication systems of the future. The fiber is a liquid-filled fused quartz capillary which can transmit light signals with low transmission loss. The liquid used is tetrachloroethylene. The core diameter is about 65 microns, and the wall is about 15 microns thick. Loss characteristics for the fiber are 20 dB/km or less for 0.84-0.86 micron and 0.98-1.10 micron wavelengths.

Fiber research until now has focused on fibers with solid cores. The new liquid-core fiber, developed by Julian Stone, may someday be used in the Bell System for on-premises telephone connections, interoffice trunk lines, and large-capacity intercity phone links.

Optical fibers hold considerable promise as a high-capacity transmision medium in the future because of their small size, large bandwidth capacity, and potential low price. Bell Labs is conducting research in optical transmission techniques to anticipate the nation's needs for high-volume communication services in the future. It may not be long before fiber optics replace wires for the transmission medium. ◈

MAC'S SERVICE SHOP

Salvaging Dunked Radios

By John T. Frye, W9EGV, KHD4167

SUMMER had finally come with a vengeance. After a hot and humid night, the morning sun blazed from a cloudless sky and was already pushing up the mercury when Barney stepped gratefully into the air conditioned coolness of Mac's Service Shop.

"Man, it's going to be another scorcher," he said to his employer busy training a heat lamp and a small fan on an uncased transistorized radio lying on the end of the service bench. "Oh, oh!" he broke off. "I see the dunking season is upon us."

"Right on both counts: it *is* going to be hot and humid, and people *have* started dropping their radios into oceans, lakes, ponds, rivers, creeks, swimming pools, bilge water, and bathtubs."

"I'm always a little astonished at how many of these victims you're able to resuscitate," Barney admitted, "especially since I know what an enemy of electronic components moisture can be."

"In the beginning, I was pretty pessimistic myself," Mac said. "It all started years ago when a customer brought in a big console Philco radio with the first remote control system I ever saw. This system used a low-frequency r-f control signal and a complete control receiver, together with thyratrons, a stepping relay, and electric motors to tune the receiver and control the volume.

"It had a very impressive chassis, and it was a real mess. The river had come up suddenly in the night while the owner was away from home, and when he waded out to his house on the following day he found the receiver floating speaker-down in three feet of muddy water. He simply loaded it into his trunk and brought it right in here to the shop.

"Everything, including the tube-type battery-operated remote control unit that was about the size of a football, was caked with a thin coating of mud. The veneered cabinet was already starting to split and break. I took one look and advised him to forget about it, but he was stubborn. He said he liked the way that radio operated and sounded, and he was not concerned with the looks of the cabinet. He wanted it repaired, no matter what it cost. He was willing to pay me for my time if I would just try to make it work. Money was of no concern at that point."

"Must have been a well-heeled bank robber," Barney observed.

"No, just a well-heeled bachelor brick layer," Mac answered. "Anyway, I took on the job.

"First I washed off all of that mud I could with the garden hose and then wiped off the rest. Then I used a couple of heat lamps and a big fan to dry off the moisture as fast as I could before I started checking. The tubes, of course, were unaffected. I checked out all the paper capacitors and replaced a half dozen or so that showed leakage.

"The electrolytics were OK; and resistance checks looked all right; so, with considerable misgiving, I turned it on. It began to play at once. For three days I kept it going continuously with the fan blowing on it; then I shut it off and completely realigned all tuned circuits, including those of the remote control receiver. After it ran for three more days without the least trouble, I gave it back to the owner with a request to let me know how it worked out. I did not see him again for over a year, and then the trouble was simply a burned out tube. The set, he reported, had been working per-

fectly all the while. And fortunately, there had been no more floods."

What About PC Boards? "That was a hand-wired job," Barney pointed out. "I imagine things may be a little different with a printed circuit board where short leakage paths can really foul things up."

"That seems reasonable," Mac agreed; "but, as you yourself pointed out, we've had very good luck reviving transistorized receivers that have even been dropped into salt water—if they have not been in the water too long and if we get them reasonably quickly after their baptism. If the receiver is dropped into salt water, the best thing the owner can do is to rinse it thoroughly in fresh water just as soon as he can. The idea is to wash away, or at least dilute, the corrosive salts before they have time to eat into metal parts and to attach themselves to the circuit board. If these salts are allowed to dry on the board, they can still continue their dirty work because of their hygroscopic nature. They can readily absorb moisture from the atmosphere and continue to cause their chemically corrosive action."

"One thing that helps protect these radios from moisture damage," Barney suggested, "is the coating over the circuit board and the wax impregnation of the coils. Transistors, of course, are hermetically sealed, and electrolytic capacitors that have been sealed to keep the electrolyte moist are also protected against the entry of water. One item, though, that has no protection is the paper cone of the speaker. I notice that quite often you replace the speaker.

"That's right. Oddly enough sometimes the cone suffers no warping at all after being soaked, while again it may come out looking like a washboard. This probably has something to do with the nature of the cone material or possibly with the synchronization of the drying action of the different areas. At any rate, I replace the speaker if there is any rattle or distortion in the sound or if the cone is visibly warped. Since the owner is usually convinced his favorite radio —quite often one with a deep sentimental value—is hopelessly ruined, he is very glad to pay for a new speaker.

"Incidentally, a final critical check of a dunked radio is a comparison of the measured current drawn by the receiver with the manufacturer's specification. Any appreciable increase in this current indicates

leakage that will impair performance, shorten battery life, or both. The current must be brought down to normal before the receiver is returned to the owner."

"Summer vacation time is pretty hard on electronic equipment that is not dropped into the drink," Barney observed. "Radios and tape recorders are left in the boat, on the dock, or by the swimming pool all night. A thundershower soaks a portable TV or hi-fi left on the screened-in porch. Night-flying bugs and even mice crawl into portable TV sets operated out-of-doors or in cottages and are electrocuted."

"Yes," Mac agreed, "and while most people have learned you shouldn't leave your loaded camera on the back ledge of a shut-up car on a hot summer day, they still leave their radios and tape recorders there. Sun shining on such an item through the rear window can raise the temperature inside the case to 140 degrees or higher—hot enough to melt the wax of capacitors, dry out the electrolytics, and shorten the battery life. The radio or recorder is much better off under the seat where it is safe from both the sun and the eyes of a possible thief."

"Hey!" Barney interrupted, "when our basement was flooded by a cloudburst a couple of years ago, the gas company men came out and shot carbon tetrachloride into the various furnace controls to take the moisture out of them. Why don't we use carbon tet to dry out radios?"

"For the same reason we don't use it as a degreaser," Mac answered promptly. "It is too dangerous to use except under carefully controlled conditions by carefully trained technicians. However, there are several aerosol chemical products on the market, such as General Cement's *Dri-Spray* and their *Formula 70 Moisture Remover* that will do the same job safely. You'll find both up there in the cabinet."

Effects of Air Conditioners. "I'd think the widespread use of air conditioning would make things a lot easier on electronic equipment in the home during the summer time," Barney remarked. "Not only does it keep the temperature down, it also takes the harmful moisture out of the air."

"Again you make sense," Mac replied, "but I can recall at least one instance in which things did not work out that way. This was the case of a roll-around color TV set that seemed to have more than its share

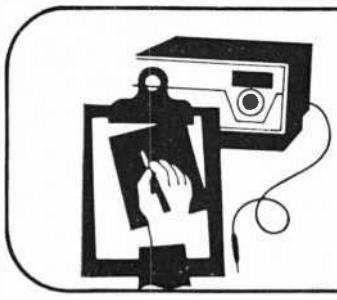
of summer breakdowns. After the third call to replace components in the high voltage system, I checked that set out very carefully and was puzzled to discover the chassis was actually rusting in several places; yet the owner assured me the receiver was never used outside the house or in the basement. Persistent quizzing, though, revealed the source of the trouble:

"The set was ordinarily used in the living room right next to a window air conditioner. The owner noticed the cabinet became quite warm during operation—it was a tube type receiver—so he was accustomed to pulling the receiver away from the wall and directing the cold air stream from the window unit directly into the back of the cabinet. This kept the chassis cool all right, but it also kept it yo-yoing up and down through the condensation point as both the receiver and the air conditioner went on and off. Moisture condensed on the metal chassis and the metallic leads of the printed circuit boards. High voltage arced across various points and either burned out components directly or formed carbon paths that did the job more slowly. I suggested he discontinue his practice of 'cooling it,' and that was the end of the summer complaint with that set."

"Just goes to show you can get too much of even a good thing," Barney said. "But it's still a good idea to protect electronic equipment from heat and humidity. The two in combination are particularly harmful. That's why it is murder to install such equipment in a warm, moist basement. Many a ham has learned to his sorrow that a snug basement ham shack is not a good idea at all unless the humidity can be carefully measured and controlled continuously. Persistent moisture is especially rough on high-voltage transformers. I had one ham friend who blew three of these before he finally got the message and moved upstairs."

"I know, I know," Mac said. "That is one of the chief reasons I put air conditioning in here. Before I did, I was having a lot more trouble keeping the instruments in calibration and in good operating condition during the summer season."

"Did you have to go and say that?" Barney asked plaintively. "Here all this time I thought you put the air conditioning in to provide for Matilda's and my comfort! Can't you leave a guy a single illusion? I certainly hate to realize I've been playing second fiddle to a VTVM!" ◈



Product Test Reports

SHURE MODEL M688 STEREO MICROPHONE MIXER
(A Hirsch-Houck Lab Report)

THE *Shure Brothers* Model M688 stereo microphone mixer is a moderately priced, highly versatile input control system for tape recording and public address applications. It provides inputs for four microphones and a high-level auxiliary source, each with its own gain control. A master gain control is also featured.

The microphone inputs (through professional three-pin female connectors) can be switched individually for low-impedance balanced or high-impedance unbalanced operation. On low impedance, the inputs will accept sources ranging from 25 to 600 ohms; on high impedance, they will accommodate any impedance greater than 20,000 ohms.

The outputs and the AUX inputs of the M688 are duplicated for stereo operation. Three of the microphones can be switched to either the left or the right channel by means of slide switches above their respective level controls. The fourth microphone input has a slider-type "pan pot" which can be smoothly adjusted so that its electrical position is in either the left or the right channel, or anywhere between.

The AUX and MASTER gain controls are each concentric pairs, slip-clutched for individual channel balance. A MONO/STEREO switch connects the rear-panel AUX output jacks to the individual channels or provides a summed output to both AUX outputs for monophonic operation. A three-pin male connector MONO MIC OUTPUT jack carries the summed L+R output from all sources to the microphone or line inputs of the outboard amplifier or tape recorder. It also has an impedance selector switch which supplies a few millivolts to a 25-600-ohm microphone input when set to LOW, and up to 200 millivolts to a load of 20,000 ohms or greater when set to HIGH.

A pair of MIX BUS jacks can be used to parallel two or more M688 mixers to provide greater flexibility. In this case, all input sources appear at the outputs of each mixer.

The M688 is designed primarily for ac line powering, drawing only a few watts in operation. A pair of pin jacks on the rear panel can provide up to 21 volts at 5 mA to an external accessory. By connecting a source of 26-30 volts dc at 7.5 mA to these jacks, the mixer can be operated independently of ac line power.

Lab Tests. The specifications sheet supplied with the M688 mixer is quite extensive. We checked only the major points in our lab tests. The frequency response was better than +0.5/−1.0 dB from 20 Hz to 20,000 Hz. The voltage gain from the HI impedance microphone inputs was 40 dB and from the AUX inputs, 19 dB. In the MONO mode, gain was 6 dB less.

There was less than 0.1 dB of level change on any input from any positioning of the other input controls. The HI impedance microphone inputs clipped at 330 mV, much higher than would be delivered by any microphone likely to be used with the mixer. The output waveform clipped at 6.5 volts. At 2 volts output, with 70 mV applied to a HI impedance microphone input, we measured harmonic distortion of 0.22 percent which was well below the 1.0 percent specified.

The signal-to-noise ratio, referred to a

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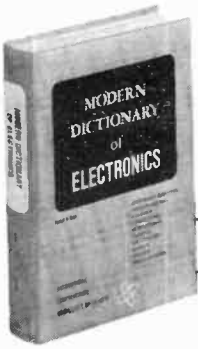

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1-volt output with all controls set at maximum, was 46 dB and consisted largely of hum over a 20 Hz to 20,000 Hz measurement bandwidth. With all frequencies below 300 Hz attenuated, the S/N ratio was 51.5 dB. At minimum gain settings, the corresponding figures were 66 dB and 73 dB, respectively. In normal use, where most controls are set well below maximum, hum and noise should be negligible. We did note a sensitivity to magnetically induced hum, suggesting that the M688 should be placed well away from any other ac-powered component employing a power transformer.

General Comments. The Shure M688 mixer is a compact unit, measuring 11⅜" x 7" x 2½" and weighing 5 pounds. It offers the tape recording enthusiast a fully flexible stereo input system at modest cost ($114) and an excellent control unit for sound reinforcement systems.

A broad line of accessories for use with the M688 mixer is also available from the manufacturer. Included are a phono equalizing preamplifier, a stacking kit for multiple mixer installations, input and output cable kits, a rack panel mounting kit, carrying case, and a battery pack.

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PACE MODEL 100-S CB TRANSCEIVER

THE *Pace* Model 100-S CB transceiver is a 6-channel solid-state unit designed for mobile service. Its most unique feature is its very compact construction, measuring only 1¼" thick by 4¾" wide by 6¼" deep. This makes it ideal for installations where available space is at a premium. Added to this is its attractive styling which includes miniature chromed control knobs and a chrome-finished bezel around the front of the steel scuff-proof gray painted case.

The transceiver comes supplied with crystals for operation on REACT channel 9 and the most commonly used channel 11. Crystals to meet the individual CB'er's other channel requirements, selectable via a front-panel control, are available separately. The transmitter operates at the maximum legal power limit set down by the FCC.

Aside from the usual adjustable squelch control and the power on-off/a-f volume control, there is a meter which indicates received signal strength or relative transmitter power output. During receive, an amber lamp comes on; during transmit, the amber light extinguishes and a red light comes on. A full-time series-gate automatic noise limiter is built in.

A mobile mounting bracket is supplied with the transceiver as is a detachable dynamic microphone which has a push-to-talk switch and a coiled cord.

Technical Aspects. The circuit of the 100-S is straightforward and simple, with 16 bipolar transistors and 10 diodes. The receiver is designed to operate with single

conversion to a 455-kHz i-f and selectivity obtained by a ceramic filter. Good sensitivity is ensured with an r-f amplifier stage, while fine image rejection is the result of three tuned r-f circuits at the 27-MHz operating frequency.

The age applied to the r-f mixer and first i-f stages is designed to provide a relatively flat age characteristic and to minimize overloading. In addition, shunt-connected diodes at the antenna input for the receiver are used to protect the r-f amplifer transistor from overload damage.

The audio system feeds into a push-pull class B output stage. The loudspeaker is a 2½" dynamic type; as usual, it is mounted facing downward so that the sound emerges from the bottom of the transceiver.

The transmitter has a straight-through oscillator which uses crystals at the channel frequency selected. No synthesis system is employed; so, for a given overall frequency tolerance needed to meet the legal limitations, the tolerances of the individual crystals need not be held as closely as otherwise required in a synthesizer/dual-conversion system involving three crystals for each channel. Operation on channels 9 and 11 with the crystals supplied was within a 0.001 percent frequency tolerance.

The crystal oscillator is followed by a

driver for the power-output amplifier; each is collector modulated using the receiver's audio power amplifier. An uncommon feature is a triple-section pi network at the r-f power amplifier output. This provides better than usual harmonic attenuation, rated at −65 dB.

A source of trouble often experienced with CB gear using a relay to transfer the antenna between receiver and transmitter is faulty operation due to dirty contacts. In the 100-S, this problem is avoided by means of electronic r-f switching accomplished with the aid of a diode switch. This diode is one of the protective ones used at the receiver's input. During transmit, it is biased into conduction, short-circuiting the receiver's r-f input. This allows the antenna to be permanently connected to both receiver and transmitter, which offers a measure of protection for the transmitter's PA transistor.

A relay is used in the 100-S for transferring other circuits. However, where it is used, it presents no danger to components in the circuit.

The transceiver is designed to operate from a primary source of 11-16 volts dc (nominally 12 V dc). Either a negative- or a positive-ground system will accommodate it without any internal wiring changes. This can be done because the dc supply lines are electrically isolated from the transceiver's case. A fuse is located externally in the positive supply lead. The supply circuit features an L filter to minimize the possibility of ignition noise pickup.

Performance. Although small in size, the Pace 100-S provides performance comparable to larger units. Sensitivity and selectivity are good—as are the smoothness of the squelch and the effectiveness of the noise limiter. Good transmitted signal "punch" is obtainable with modulation that, in our model, clipped at 90 percent on the positive peaks.

There are no provisions for connecting an external speaker which might be desirable for better sound directivity. Also, one price paid for the compact size of the enclosure is that the small meter cannot be easily read in some mobile installations. In addition, the position of the channel selector knob cannot readily be determined.

The detachable microphone is a good feature which allows the mike to be removed during unattended periods, thus pre-

venting operation by unauthorized persons. Also, both the antenna transmission line and power leads plug into the side of the case to simplify accessibility.

For those who are interested in statistics, our box score on the performance measurements of the 100-S were so close to those listed by the manufacturer that giving them here is unnecessary. The only exception to this was the age characteristic which is listed at a 6-dB a-f output change with an r-f input change of 0.5-100,000 uV. Our measurement was 14-dB change.

It should be noted that in addition to the useful information provided, the manual goes into technical facts regarding tampering with, adjustments to, and operation of the equipment.

The Pace 100-S is made in Japan. It sells in the United States for $79.95.

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HEATHKIT MODEL IM-102 DIGITAL MULTIMETER KIT

AS YOU might imagine, our service and test bench has some sophisticated and expensive test equipment on it. The latest addition to the array is beginning to look like it will take one of the top places. It is the *Heathkit* 3½-digit multimeter kit, Model IM-102, currently on the market for $229.95. Just looking over the list of technical specifications made us anxious to start assembling the kit.

There are five voltage ranges for both ac and dc measurements. They provide maximum measurement capabilities out to 200 mV, 2 V, 20 V, 200 V, and 1000 V. The two lowest ranges are overload-protected to 350 volts (250 volts rms on the ac ranges). The ac ranges are designed to yield useful measurements over most of the audio spectrum. Resolution in both modes of operation is listed at 100 μV.

There are five resistance ranges which provide readings out to 200 ohms, 2000 ohms, 20,000 ohms, 200,000 ohms, and 20 megohms. Test current is a maximum of 1 milliampere on the 200-ohm range, dropping to 100 nanoamperes on the 20-megohm range. Consequently, the IM-102 is safe to use for just about any resistance measurement. Overload protection on the resistance ranges is 250 volts rms.

There are also five ac and five dc current ranges which go out to 200 μA, 2 mA, 20 mA, 200 mA, and 1 A with a nominal voltage drop of 0.2 V on both the ac and dc ranges. The ac current can be measured over a frequency range of 40 Hz to 10,000 Hz. Resolution is 100 nA.

In addition to the range and function flexibility, the IM-102 has a couple of extra features you will welcome. The first (and most useful) is its built-in automatic polarity indicator which eliminates the need for switching test leads or flipping a switch when moving from one test point to the next. Automatically sensing the polarity of the voltage being measured, the IM-102 has a built-in indicator circuit which clearly indicates the polarity. The second welcome feature is an overrange indicator which blinks if an attempt is made to measure a parameter beyond the capability of the range selected.

The IM-102 is small for the operational performance it provides, measuring only 3″ high by 7″ wide by about 8″ deep. It weighs a meager 4 pounds. The front panel is clean and uncluttered, and the swivel carrying handle can be adjusted to serve the instrument as a tilt stand.

Assembly Notes. The entire multimeter is assembled on a single large epoxy-fiberglass printed circuit board. To avoid any possibility of heat damaging the delicate integrated circuits, the *Heath* people supply Molex Soldercons which, when soldered to the foil pattern on the PC board, serve as IC sockets. All other components solder directly to the board's foil conductors.

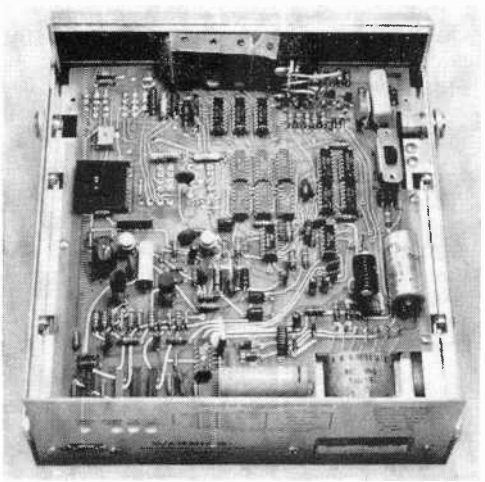
Assembling the IM-102 presented no difficulties. Practicing common sense and taking a bit of care, we had the digital multimeter ready for checkout in about 14 hours, aided all the way by the usually excellent assembly manual.

With the IM-102 kit is supplied a fac-

tory-built dc calibrator which employs a reference cell. This device allows the builder to optimize the performance of his instrument, providing measurement accuracies to within 0.2 percent. No other calibration device is needed. Of course, if you have access to an extremely accurate laboratory standard, it is possible for you to get the accuracy to within 0.1 percent.

Electronically, the IM-102 is built around the latest IC technology. Its readouts are of the large-numeral 0-9 gas discharge type to assure long life and easy visibility under most ambient lighting conditions.

Integrated Circuits. The circuit design is first rate. Besides employing digital techniques, the instrument makes use of operational amplifier IC's arranged in the reliable dual-slope, or ramp, configuration to provide integration for measuring the basic dc voltages. To measure resistance, an op amp is used as a scaled constant-current generator to pass a predetermined current through an outboard resistor while the dc voltmeter portion measures the voltage drop. Ac voltage measurements are made with the aid of another op amp arranged as an ac-dc converter so that it senses the average value of the applied ac voltage and converts it to a proportional dc voltage, which is then measured.



The multimeter is easy to assemble. All components are on one PC board, with special sockets to hold the IC's.

Currents are determined by measuring the voltage drop developed across a close-tolerance shunt network. If the current is dc, it is measured directly; if ac, it is passed to

the ac converter which produces a proportional dc voltage which can then be measured.

We put our newly assembled IM-102 through a number of tests. It performed admirably and, in truth, sometimes beyond our expectations. Many of our tests were made using a laboratory voltage standard, an unquestionably accurate instrument, and the IM-102 hit the voltages right on the head every time. We checked some 0.1-percent tolerance resistors, all accurate Mil-Spec types, and again the IM-102 came through with flying colors. Ditto to ac voltage and ac and dc current measurements.

At this writing, we have been using the IM-102 for about a month. It is used a minimum of two hours a day. So, when we state that it is well worth the asking price, we mean it.

Circle No. 67 on Reader Service Card

WAHL ISO-TIP CORDLESS SOLDERING IRON

ONE BY ONE, most of the technician's and experimenter's problems are being solved by sharp manufacturers. While the electronics group is making big and rapid strides in test gear, a couple of tool manufacturers are coming up with real winners on the mechanical end of things.

Witness the latest item from the *Wahl Clipper Corp.* Their "Iso-Tip" cordless soldering iron, retailing for $19.95, is a real innovation. Instead of using a chemical cartridge for generating tip heat, this handy tool uses electricity to generate the heat of a 50-watt iron. It is small enough to fit the palm of the hand and to tuck neatly away in a tool kit or drawer. It has a built-in work light as well.

The Iso-Tip iron is just the thing for those who often have soldering jobs away from any electrical outlet. It is ideal for use in a boat, car or truck.

The iron is powered by a rechargeable nickel-cadmium battery (built in, of course). On full charge, it is capable of handling up to 60 solder joints. For recharging, which can be accomplished overnight, the Iso-Tip iron is supplied with a special stand which houses a trickle charger to plug into any convenient ac receptacle.

The user handles the Iso-Tip as he would any other soldering iron. The big difference is that to energize the tip, a large red button switch must be depressed. When the switch is depressed, not only does the soldering tip come quickly up to working heat, but the work light instantly comes on and lights the work area.

Because of its small size and complete isolation from the ac power line, the Iso-Tip soldering iron is the ideal tool to use on printed circuit boards and normal home use where the danger of leakage must be avoided at all cost. Also, it is one of the few soldering tools safe enough to use when

soldering into place IGFET's and MOSFET's since no ac electromagnetic field is generated during the heating cycle.

User Notes. We used the Iso-Tip for about a month. Most of the time, it was put into service on our workbench where it performed well. The fact that there was no trailing cord to get in the way showed us how clumsy, by comparison, many ac-powered irons are on a crowded bench. Out in the field, this iron was by far the best line-independent tool we have used to date.

Since it is most convenient to store the Iso-Tip soldering iron on its charger stand, every time it is put down it is being recharged. Too, during our bench and field tests, we never really discharged the nickel-

cadmium battery to the point where it would not supply enough heat energy for soldering. This means that unless the joints to be soldered are rather massive by present standards, the 60-joint capability specified for the tool is somewhat conservative.

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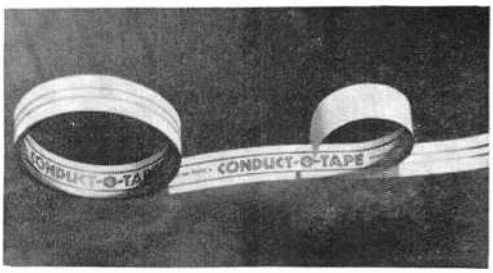
HOBBY HILL "CONDUCT-O-TAPE"



ONE of the biggest problems encountered in wiring a room for 4-channel, and sometimes even 2-channel, stereo sound is in trying to hide the unsightly wires that connect the amplifiers to the speakers. Actually, this problem is the same for the guy who has to couple any low-power electrical or electronic assemblies together when there is a doorway, window, or other opening between them. If you have such a problem, we suggest you take a trip to your nearby distributor of the *Hobby Hill Inc.* line of products and look at the "Conduct-O-Tape" display. Chances are, you will find exactly the item you need to overcome your problem.

Conduct-O-Tape consists of a pair of slender, flat copper leads buried in a sandwich of pressure-sensitive tape. The copper conductors are hefty enough to accommodate up to 24 volts at 2 amperes; so, they will safely transmit up to 48 watts of power.

Because it is adhesive-backed, Conduct-O-Tape can be pressed onto almost any surface where it will adhere without any other mechanical fastening and lie absolutely flat, even following irregular contours. On the surface, it is just slightly thicker than masking tape. And, because the conductors are safely buried inside the insulation, Conduct-O-Tape can be painted over to render it virtually invisible.

The tape comes in various lengths up to 50 feet. It costs about 25 cents a foot, which is reasonable enough when you consider how much work it saves you on a single installation.

Accessories. When you browse around the Conduct-O-Tape display, you will also notice that there is quite an array of accessories you can use with the tape. They include 90° corners and bends, splices, and power connectors. Prices for these items vary with quantities purchased and styles selected.

Incidentally, we have discovered one very useful application for Conduct-O-Tape, which all of you who who lose fender-mounted telescoping automobile radio antennas to vandals will welcome. Having lost several in the past few years, we applied a length of the tape across the top of our car's windshield where it was out of the line of vision and coupled it to the antenna feed going to the car radio. After adjusting the receiver's antenna trimmer for best reception, we found that our vandal-proof antenna operated every bit as good as the telescoping one.

Once we discovered the antenna possibilities of Conduct-O-Tape, we tried making a hide-away folded dipole antenna for an FM receiver which has always had to share antenna time with a TV receiver. Applying our home-made antenna to the wall behind the FM receiver and hooking it up with 300-ohm twin-lead, we found it to be a very satisfactory setup.

There are many applications for Conduct-O-Tape which an imaginative user can come up with in short order. We can think of a list right now, but you will get ideas of your own once you visit the display.

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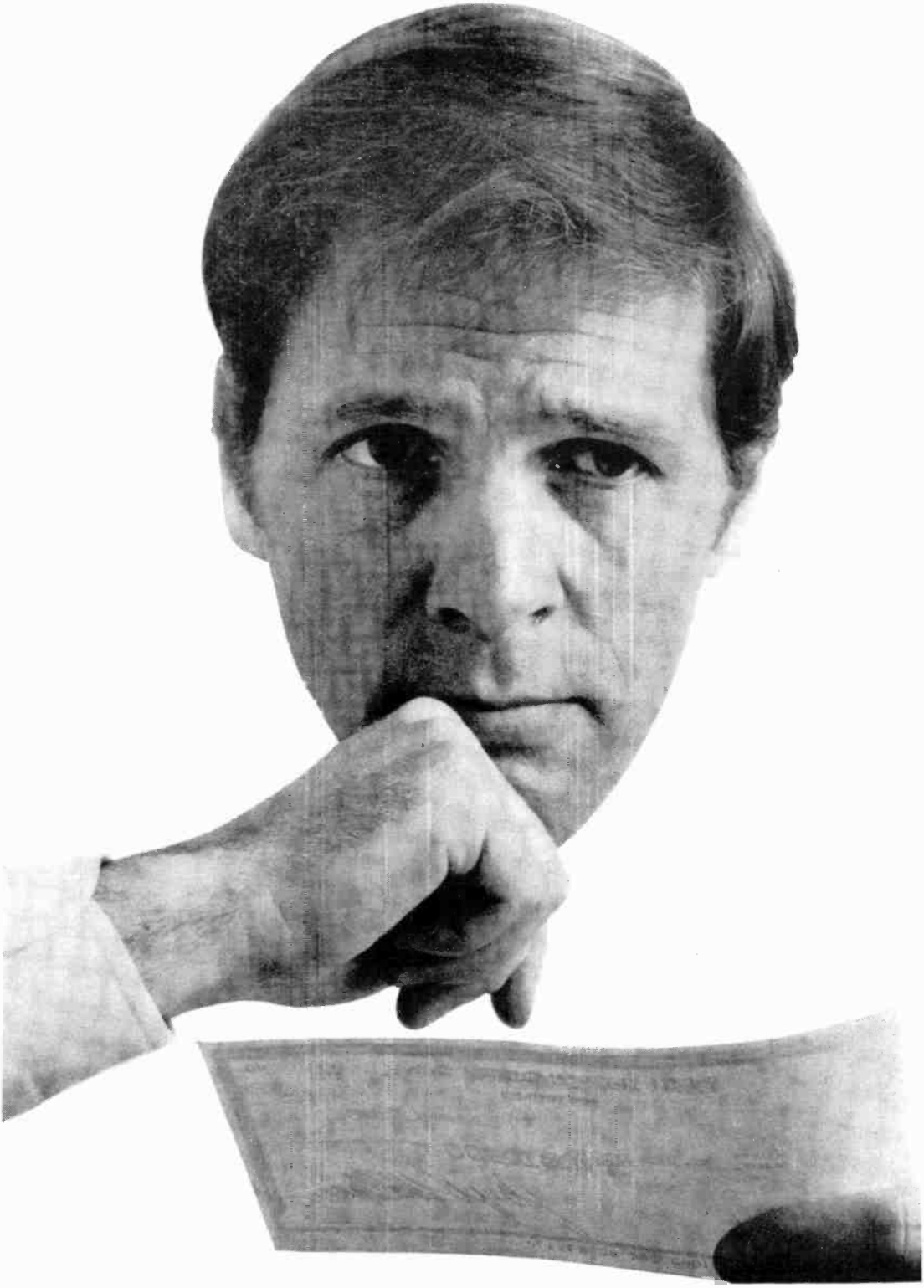
I'm not really that dumb. They're just trying to educate me beyond my intelligence.



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How To Use Hi-Fi Headphones

THE PROPER METHODS FOR CONNECTING PHONES TO SPEAKER OUTPUT TERMINALS

BY JIM ASHE

HI-FI headphones are invariably low-impedance devices which employ high-quality, wideband transducers. Convenience and comfort are designed in. The ear cups, fitted with resilient air seals, are designed to exclude outside noise as well as to provide perfectly matched acoustical environments for the transducers to insure superior stereo sound reproduction.

If we take 7 mV as the typical sensitivity of the phones to provide a strong, clear signal reproduction, we can see why some users obtain poor results from phones when they are connected directly across the speaker terminals. Hum, hardly noticeable through the speaker, becomes intolerable when fed directly to the ears via the ear-cups' enclosed environments instead of through the air in a large room.

Since it is designed to deliver lots of power to a speaker system, the amplifier is incapable of controlling power at the milliwatt levels which is what the headphones require. Matching impedances is no problem; it is simply that power amplifiers do not have milliwatt controls.

Fortunately, large signals can be easily pared down to levels usable by headphones. All it takes is a simple resistive attenuator network.

Attenuator Networks. An attenuator between an amplifier's speaker output terminals and the headphones has three functions: to load the amplifier, attenuate the signal, and load the phones.

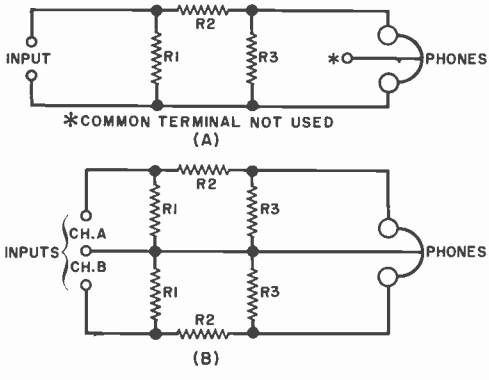


Fig. 1. Attenuator networks connect phones to speaker outputs of mono (A) and stereo (B) amplifiers. In (A) no connection is made to common contact.

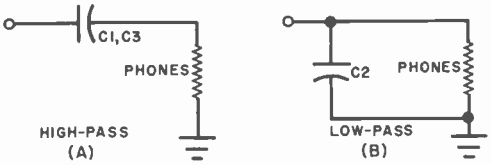


Fig. 2. High-pass filter (A) attenuates low frequencies; low-pass (B) bypasses high frequencies to ground.

Typical attenuator networks for monophonic and stereophonic hookups are shown in the schematics in Fig. 1. It is often necessary to use a power resistor for *R1* since this load will be required to dissipate several watts of power.

Rough values for each resistor in the attenuator network are given in the table for phones with a resistance of about 16 ohms. For most applications and phones, the resistor values given should be about right. However, if it is necessary to obtain optimum performance, it is recommended that some experimentation be done, starting with the quoted figures. Also, if you change values in one channel of the stereo circuit, it will be necessary to make the identical revisions in the second channel. The 8-ohm value for *R1* will work for 3.2- and 16-ohm speaker outputs since a variation by a factor of two from the indicated value is unlikely to upset any circuit operating at the average amplitude settings you will normally use.

SWL Adapter. For the shortwave listener who requires the same sensitivity and linearity but a lot narrower bandwidth, the high-pass and low-pass filters shown in Figs. 2A and 2B respectively are handy means for adapting hi-fi phones for SWL'ing. The circuit in Fig. 2A attenuates low frequencies while freely passing the high frequencies to the phones. In Fig. 2B, just the opposite takes place; the low frequencies are passed, while the high frequencies are attenuated. The two circuits can also be put together to provide attenuation of both the upper and lower frequencies, in which case we would have a bandpass filter which allows a narrow band of frequencies to pass, rejecting all frequencies above and below.

Knowing that a low-pass filter can be combined with a high-pass filter, we can design and build the practical bandpass filter shown schematically in Fig. 3. Capacitors *C1* and *C3* are connected in series to appear as a 70-μF capacitor feeding a load of approximately 8 ohms. (A 15-ohm resistor in parallel with 16 ohms of phone resistance.) This provides a lower cutoff frequency of about 300 Hz. Attenuation with this circuit will be about 15 dB at 70 Hz

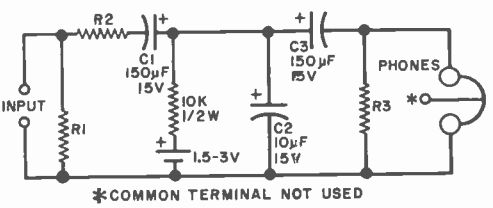


Fig. 3. High- and low-pass filters are combined in this circuit to provide passband of roughly 300-2000 Hz.

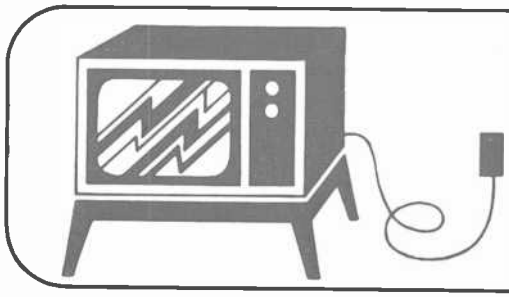
Capacitor *C2* is in parallel with the load; it bypasses all frequencies beyond about 2000 Hz. At 8000 Hz, attenuation is again down by about 15 dB.

At first glance, battery *B1* appears to serve no useful function since the network contains no active elements. However, if you note that *C1* and *C3* are large-value *electrolytic* capacitors in a circuit which should contain *no* polarized elements, the reason for *B1* should become apparent. The battery is there to provide the necessary polarizing voltage to maintain the chemical films on the capacitors. Hence, a pair of electrolytics connected back-to-back as shown safely takes the place of a single non-polarized capacitor. And, since *B1* delivers only tiny leakage currents in operation, it should last as long in the network as it would on a shelf. ◈

RESISTANCES FOR ATTENUATOR NETWORKS
(For Figures 1 and 3)

Notes:
All resistors are ½ watt except as noted below for R1.
R1 is 8.2 ohms, ½ watt, except 1 watt for 30 db attenuation, 2 watts for 40 dB, 25 watts for 50 db.
R3 for mono is 15 ohms.
R3 for stereo is 8.2 ohms.

Attenuation (db)	Mono R2 (ohms)	Stereo R2 (ohms)
10	18	10
20	68	33
30	270	150
40	820	390
50	2700	1500



Television Scene

Picking a Good TV Man

By Forest H. Belt

"NOBODY fixes anything right anymore." How many times lately have you heard that? You've probably said it a few times yourself. You're rare indeed if you haven't experienced frustration when something stopped working and you couldn't find anyone to fix it.

In these days of consumerism rampant, almost everyone rumbles about poor service. The television repair business draws a disproportionate share of these barbs. Some are deserved; a majority are not.

To separate unjust carping from earned criticism, you have to slip behind the scenes. You need to see what goes on: how dependable shops conduct their business; how they find men who can "fix things right"; and how certain lucky (and satisfied) customers are treated. Knowing all this puts you in a position to make a better choice when your own TV fails and you don't know what to do about it.

Who Can and Who Can't. Today's best electronics technicians have one qualification in common. They are well trained. Some learned during military service; others attended electronics schools or studied by correspondence. A few went to vocational high schools, and then apprenticed in shops.

Where a man got his training affects his competence to some extent. Far more important is how deeply he absorbed what training he got. Electronic devices, particularly television receivers, grow more complex with each year's models. The competent servicer knows electronic theory well enough to understand and cope with advanced designs.

By contrast, the repairman who "just picked it up" in his spare time, unless he is exceptional, seldom learns his trade completely. He may fix many sets; and if he's glib, he can satisfy quite a few customers. But new TV sets and tough troubles in older models are usually beyond him. Unfortunate indeed is the owner who calls a marginal technician and the TV failure happens to be complicated. Both become sorely frustrated before the encounter ends. Worse, the set owner comes out convinced "*nobody* fixes anything right anymore."

Top-notch TV men have something else in common. Their training never stops. Years after they finish electronics school, you find them still reading books and magazines about the subject. Nights out they spend at seminars and training clinics. That's how they keep up with developments. That's why they stay at the top of the profession.

Is There Really A Shortage? The rising cost of television repair sometimes gets blamed on a shortage of competent technicians. The shop owner accused of shoddy work may cite incompetence among the help he employs. Phoning for service in some towns signals a two- or three-day wait —because of "the shortage." It appears there just aren't enough technicians to keep up with all the work.

The shortage is not entirely myth. Some cities—and many rural areas—have a real scarcity of qualified service people. The key word there is *qualified*. There are many around who call themselves TV men. What

is in question is how capable they all are. Not all do the best job.

What does *qualified* mean? Put simply: A competent technician can test, diagnose, and repair virtually any television breakdown. Furthermore, he experiences only a modicum of normal post-repair failures (hidden or delayed defects that don't show up until a while after the initial repair).

Some localities enjoy a plentiful supply of qualified technicians. But you still have to find them. A sort of "musical chairs" shuffle leaves certain service firms with a lion's share of the top men. Self-styled experts, slow-starting apprentices, and the half-trained scatter among the other shops.

Which Shops? By now you must have an inkling of one secret to finding a top-rated technician: find the shop to which better technicians gravitate.

Phone-book ads seem an easy way to start. The drawback is, you can't judge a company's technicians by the advertising. Marginal businesses sometimes depend on large flashy ads to pull customers. Yet, a big phone-book ad obviously is no reason to downgrade a company. Good ones advertise too.

You can go around looking shops over, if you have time. In general, technicians of high capability have a healthy streak of pride—in themselves, in their work, and in the company they work for. Tumbledown shops, cluttered and messy, may or may not have one good technician (usually the owner). Generally, it takes a clean, well lighted shop to draw high-grade technicians. They work more efficiently in pleasant surroundings. Clutter on the workbench where a set is being repaired signifies "man at work," but disorderliness everywhere implies that no one cares much. You'd be uneasy leaving your TV set there.

If you choose to inspect the shop that you ask to do your TV repair-work, go behind the facade. One shop owner I know has a tidy and attractive front counter. But in back, the working area is something else. He has trouble keeping technicians of any kind.

Satisfied customers mean more to a service store than any other advertising. In fact, a recent trend among top shops is *not*

to advertise much. Word-of-mouth brings as many customers as they want to handle. So . . . ask your neighbors.

There's one excellent source of information on where the good technicians work. Ask the local new-set distributor of your brand of television. I don't mean a big retailer or a discounter, I mean the wholesale distributor. He's in the Yellow Pages.

The manager there knows who does a good job on that brand and who doesn't. If several shops in town are good, he'll direct you to one near you. The distributor has a vested interest in helping you locate the kind of service that keeps your set playing well.

Why Good Men Stay. The service firm that *keeps* qualified technicians also keeps its customers. That's another clue for you.

Ask any technician why he works for the shop he does. Pay close attention to *the way* he answers. Evasiveness or hesitation means he's not satisfied, whatever the reason. There's no mistaking the enthusiasm of a fellow who truly likes the place he works.

Surveys disclose two chief attractions a shop can offer. One is salary; the other is work conditions. Of the two, the latter takes precedence.

The term "work conditions" means more than a congenial boss and a nice building. Late-model testing equipment means something. Any good technician likes to do his best work, and with modern tools he can. Fellow employees also play a part. Top technicians lose interest around a shopful of inepts or has-beens. A top home-service technician won't drive a ramshackle truck for long. His pride in work and self won't stand it. Listen to how a technician describes his shop (if you haven't seen it). You can guess closely whether it's modern and well-equipped.

Salaries for TV technicians, for many years disgracefully low (though the public didn't generally know it), have risen almost to a level with other skilled workers. Top technicians, those with talent, training, and experience, demand and get what they're worth. Only apprentices and the mediocre need settle for low wages. Only poorer shops get by with puny salaries.

Recognizing A Top Man. A good TV technician doesn't fly a flag of competence.

Sometimes even an experienced professional has trouble sorting the capables from the incapables. But certain telltale hints guide you toward a satisfactory guy.

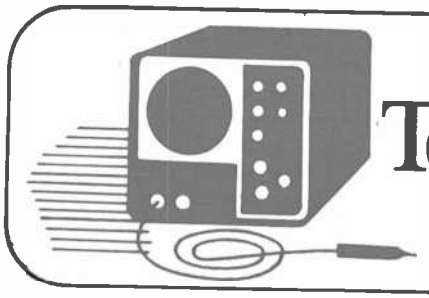
A technician's appearance tells you a couple of things. Sloppy shoes, unpressed trousers, soiled white shirt with the tail only half tucked in, mussed-up tie, frayed jacket—any of these is enough to turn off most customers.

Observe the way he works. The service technician who comes to your home has one objective: to diagnose as directly as possible what's wrong with your television receiver and either fix it or take it where it can be fixed properly. Idle chatter may be friendly, or it may cover up ineptness. The approach that best serves your pocketbook and your TV set is courteous, businesslike, and quick. A good technician listens attentively while you explain what happened to the set, but gets on with his own tests while you talk. When he's finished, he explains briefly what he did, writes a bill, collects, and goes on to his next call.

Experience counts. Experts generally agree it takes two solid years of training and another four years of guided experience to develop a top technician. A few make the grade in less time; some never do. Don't brush off the young technician. Many start early, and get better training than some old-timers. The learn-by-doing fellow who skipped "useless" theory may work 10 or 20 years, and still be only fair.

Money is no measure of competence, either. You can't go by how much a technician charges. Steer clear of bargain TV fixers; there are precious few bargains in good service. On the other hand, high prices don't always buy top technicians. You do best to leave dollars out of your judgements. It is better to pick the technician you feel can and will do the best job for you and then pay his standard fee. Chances are, he'll turn out to be your best bargain.

Almost any town has some excellent technicians. But there's one more factor in getting one of them to work on your TV. Ask yourself: Am I the kind of customer for whom a top technician will do his best? In the end, that plays a deciding part in whether the technician you've picked "fixes things right." ◈



Test Equipment Scene

Vectorscopes for Showing Color TV Angles

By Leslie Solomon, Technical Editor

THE difference of only a few microseconds can convert a good color-TV picture (with perfect hue) into a so-so one. This very short period of time makes up about three degrees of phase shift of the chroma signal, which is enough to produce a detectable change from one color to another.

Now, you have to admit that making this kind of timing adjustment manually can be a little tricky, but with the proper electronic help, it is very easy. This proper "tool" is called a vectorscope.

Color TV "works" because there is a fixed phase shift between the red and blue signals, the shift being derived from the receiver chroma demodulators. The amount of phase shift used is determined by the particular receiver manufacturer and his data should be consulted. It is from these two angular displacements (or vectors) that green is derived.

What Is a Vectorscope? Essentially it is a very simple form of oscilloscope having identical phase response in both the vertical and horizontal deflection circuits. In most cases, direct connections are made to the deflection plates since the red and blue CRT drive signals usually have sufficient amplitude to deflect the CRT beam without further amplification. If the vectorscope does have internal amplifiers, then both channels must have identical (or very close to it) phase-shift characteristics. This is the major reason why the internal amplifiers of most conventional scopes can't be used as vectorscopes. What produces the various phase shifts? Just think about the frequency-sensitive reactances of stray capacitance and inductance and the effect of slightly different values of capacitance or inductance in the active circuits.

There seems to be some mystery surrounding the vectorscope; but its operation is so simple that, once understood, it makes a very handy instrument for just about all chroma alignment (and troubleshooting) enabling "on the head" adjustments quickly and easily. The vectorscope does for chroma alignment what the sweep generator does for i-f alignment.

The operation of the vectorscope is based on the obtaining of a Lissajous figure (or pattern). Figure 1 shows the simple concept. If two sine waves of the same frequency and amplitude, but 90° apart in phase are applied to the deflection plates of a CRT, the beam produces a circle. Any phase differential in the CRT deflection-plate circuits causes the circle to distort accordingly. The amplitude of the applied waveforms determines the diameter of the circle.

Vectorscopes usually do not work alone, but in conjunction with a keyed rainbow generator; and many vectorscopes include this feature. All color generators include the keyed feature, along with many other signals, enabling this useful instrument to work alone in servicing

a color receiver particularly in convergence adjustments. However, here we are concerned with keyed rainbow operation in conjunction with a vectorscope.

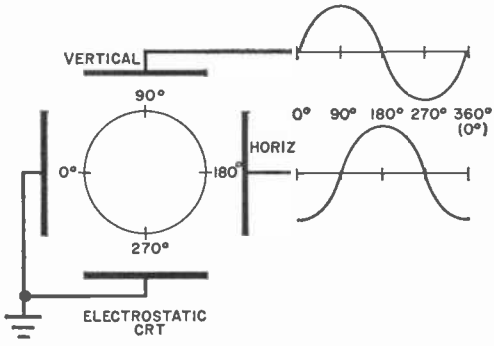


Fig. 1. Other than the CRT operating voltages and a chassis, this is all there is to a basic test vectorscope.

Keyed Rainbow Generator. A typical keyed (or gated) rainbow generator uses a 3.563795-MHz crystal oscillator to drive the chroma generator. Because the color-TV receiver uses a 3.579545-MHz internal crystal, the difference frequency between these two becomes 15,750 Hz. Since the receiver chroma phase lock occurs at the beginning of each horizontal line, the 15,750-Hz signal goes through a 360° phase change over each horizontal line to produce a smooth rainbow on the color CRT. The rainbow starts in a yellowish color, goes to the reds and magentas, then passes through the blues and greens on the right-hand side.

Now, if the rainbow is keyed (or gated) at a frequency 12 times higher than 15,750 Hz, or at 189 kHz, 12 color bars will result. Because of the 360° phase shift over each horizontal line, each gated bar of color is 30° apart in phase. Because one of the gated bars acts as the color-burst for synchronizing the chroma portion of the receiver, and one disappears in the horizontal blanking, the result is 10 visible bars of different colors across the screen. On the vectorscope, this shows up as 10 "petals" of an electronic "flower," each petal displaced 30° from the preceding one, starting at zero degrees (called the burst reference) as shown in Fig. 2.

Because the color receiver "hue" or "tint" control determines the rotational position of the petals, rotating this

control makes the entire "flower" rotate (usually making the 3rd petal swing from about 60° to 120°) while operating the set's "chroma gain" or "color" will make the flower larger or smaller.

Note that in Fig. 2, petals 3 and 6 are specially indentified, and in a 90°-demodulator system should rest 90° apart. This is typical of a receiver set up according to the manufacturer's instructions for a 90° red and blue demodulator.

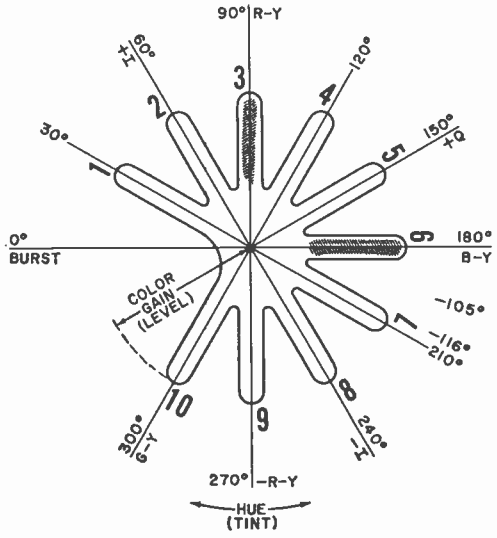


Fig. 2. Idealized vectorscope pattern using 10-bar chroma generator. Bars 3 and 6 are set for 90° demodulation.

If you have a set using 105°, then set the 3rd bar at the 90° mark, and the 6th bar at 105°; if 116° is called for, the 3rd bar will be at 90° and the 6th at 116°. You may also see that at the higher demodulation angles, the pattern will get out of round, and this is perfectly normal. Consult the manual of the color set for the pertinent phase angles.

Obviously, if these alignments cannot be carried out, the set's tint (phase angle adjust) controls and adjustments need to be touched up.

Now you can go on to the other chroma circuits. For example, the bandpass amplifier should be aligned properly using an r-f sweep generator, with the 10-bar generator used for the final touchups.

If you feed the keyed generator through the r-f section, make sure that the fine tuning is correct. Also, try to make the sides of the petals as straight as you

can while keeping the tips bright and the center circle as small as possible.

A loss of the red or blue signals will cause the vectorscope pattern to collapse with a horizontal line indicating problems in the R-Y portion, while a vertical line indicates that the B-Y signal is the culprit. Severe degradation of either the R-Y or B-Y signals (in level) will cause elliptical patterns to appear. If the pattern looks fuzzy, try aligning the 3.58-MHz traps.

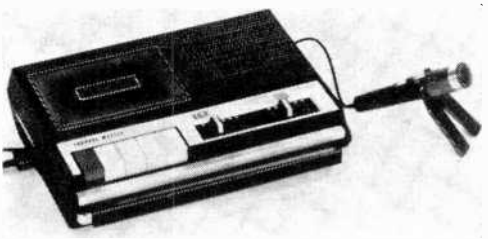
If the petals are very wide and have some overlapping, check the receiver's i-f or chroma bandpass alignments. Check the i-f alignment first using a conventional sweep generator, not the pattern generator. You can use the r-f sweep generator to align the chroma bandpass stage; or you may use the pattern generator and vectorscope to clean up the pattern. Full instructions are usually given by the generator/vectorscope manufacturer.

So now you can see that a vectorscope is more than a fancy piece of test gear, and if properly used, there are very few chroma problems that you can't identify within a very short time. It is best to practice with a vectorscope and keyed generator on a set that is known to be working properly so you can "diddle" with the various chroma adjustments and see the resulting display. ◈

A typical commercial vectorscope.

CHANNEL MASTER CASSETTE PLAYER/RECORDER

The newest addition to the *Channel Master* player/recorder line, Model 6310, features automatic stop at tape's end and a built-in capacitor microphone. Auto Stop prevents excess tape wear and assures the user of longer



and more dependable player life. The capacitor mike picks up sounds within a 10-foot radius, making the Model 6310 ideal for use in conference and group recordings where an external mike (also provided) would prove impractical. Automatic level control is featured, as are a cassette viewing window and pop-up eject.

Circle No. 70 on Reader Service Card

SENCORE TRIGGERED SWEEP OSCILLOSCOPE

Sencore, Inc., is marketing a low-cost, dual-trace oscilloscope, Model PS163, featuring both triggered and free-running sweeps. The PS163's stable triggering circuit and time base, calibrated to 2% accuracy, allow precise time and frequency measurements. Special TV vertical and TV horizontal sweep positions with a sync separator stage have been added to permit stable displays of complex TV signals. The matched vertical amplifiers are calibrated to 2% accuracy and have rated sensitivities of 5 mV. Vertical bandwidth is dc-8 MHz ±3 dB. Another feature of the PS163 is its built-in vectorscope facility.

Circle No. 71 on Reader Service Card

HICKOK PORTABLE DIGITAL MULTIMETER

The *Hickok* Model 3300A is a completely portable digital multimeter which can operate 24 consecutive hours off its own built-in batteries before requiring recharge or in the conventional manner from the ac power line. Battery operation allows complete isolation for laboratory measurements when desired. Five ranges for each of the ac and dc voltage functions allow measurements of from 100 mV to 1000 volts with maximum resolutions of 100 μV. The five current ranges for ac and dc go from 100 μA to 1 ampere; resolution is 100 nA. Seven resistance ranges provide measurement capability of 100 ohms to 100 megohms. Input impedance on dc is 11 megohms; ac, 1000 megohms shunted by 75 pF. The 3½-digit display is non-blinking. Polarity is automatically indicated. An out-of-range indication warns against erroneous readings.

Circle No. 72 on Reader Service Card

METROLOGIC SPEED-OF-LIGHT LASER KIT

What once required thousands of dollars worth of scientific instruments can now be done on a football field with a low-cost laser and some simple laboratory equipment made by *Metrologic Instruments, Inc.* The new speed-of-light measuring kit, Model 60-715, gives schools and universities the opportunity to perform the experiment within their budgets and time limitations. With the laser, students send a modulated signal from one corner of the football field to a mirror located in the diagonally opposite corner. The mirror bounces the beam back to give the frequency reading. This reading is then used in a simple mathematical formula to calculate the speed of light.

Circle No. 73 on Reader Service Card

TFE TONE-BURST GENERATOR

The Model TBG-4 tone-burst generator made by *TFE* is available in both kit and wired forms. This is a gated type of instrument with a 2-MHz, 3-dB bandwidth. The burst width adjusts from 1 μs to 100 ms, and period varies from 10 μs to 1 second. Overshoot and ringing

are extremely low; rise and fall times are 170 ns; input-output delay is 70 ns; output is 5 volts peak-to-peak; and input and output impedances are 10,000 ohms and 2 ohms, respectively. Gate switching is phase coherent with the input.

Circle No. 74 on Reader Service Card

ADVENT CASSETTE STORAGE DEVICES

Advent recently announced the availability of two new ways to store cassettes. The Visible Storage Cabinets keep close at hand a selection of favorite and/or new cassettes. Available in two sizes, they hold either 24 or 48 unboxed cassettes on a series of tiers that dis-

play the cassettes and their titles. The models are the VSC-24 and the VSC-48, respectively. The second storage device, the Cassette Storage Album, comes at no extra charge with the purchase of six blank Advocate C-60 or C-90 chromium-dioxide cassettes.

Circle No. 75 on Reader Service Card

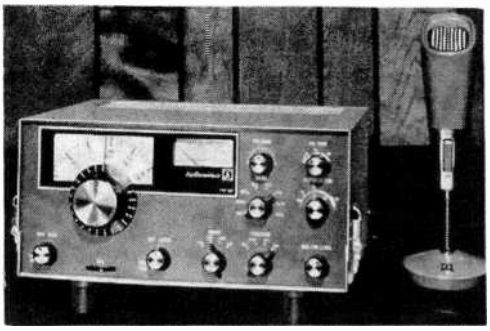
EDI SOLID-TUBE REPLACEMENT

The R-3DB3 is a solid-state replacement for high-voltage vacuum-tube rectifier types 3DB3 and 3DJ3 in color TV receivers. It is available from *Electronic Devices*. In addition to eliminating a potential source of X-radiation, the R-3DB3 provides greater reliability, longer life, and a reduction in burn outs. The R-3DB3 starts instantly, operates cool, and helps to prevent circuit and socket damage. It also makes the filament winding of the fly-back transformer unnecessary. Maximum ratings are: 45 kV PIV, 100 mA peak repetitive forward current, 5 mA average forward current, and 50-volt drop at 5 mA.

Circle No. 76 on Reader Service Card

HALLICRAFTERS SSB/CW TRANSCEIVER

The Hallicrafters Co. has added a low-cost SSB/CW transceiver, the Model FPM-300, to their ham equipment line. It provides the user with an extended VFO range (600 kHz) with full frequency coverage (80 through 10 meters), allowing the system to be used in a



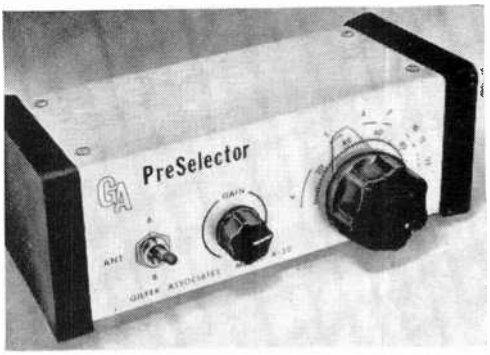
wider range of applications for communication services adjacent to the amateur bands. The transceiver features low power drain and is conservatively rated at 250 watts PEP input power on SSB with selectable upper and lower sideband and 180 watts input on CW.

Circle No. 77 on Reader Service Card

GILFER SHORTWAVE PRESELECTOR

The first of a series of specialized products for the shortwave listener has been introduced by *Gilfer Associates* as their Model A-20 PreSelector. It is designed to greatly enhance weak signal reception, improve S/N ratios, and virtually eliminate images in single-con-

version receivers. Its single tuning range goes from 3.9 to 22.5 MHz. The noise figure is less than 2 dB and gain is not less than 18



dB, variable from the −40-dB signal cutoff point to maximum. A slow-motion calibrated dial permits the user to peak the A-20's passband (not less than 200 kHz wide at the −3 dB points).

Circle No. 78 on Reader Service Card

KENWOOD TAPE DECK WITH BIAS ADJUSTMENT

Kenwood's Model KW-4066A is a three-head, three-speed stereo tape deck which incorporates a special bias adjustment switch for low-noise and regular tapes. The deck features a low-noise record/playback preamplifier for well-balanced hi-fi recording and reproduction. It is possible to record both sound-with-sound and sound-on-sound. A special Sound-On-Sound switch/Volume control and independent left and right recording switches make both operations simple to perform.

Circle No. 79 on Reader Service Card

HEATHKIT DC-15-MHZ DUAL-TRACE SCOPE

The IO-105 solid-state oscilloscope kit available from *Heathkit* features dual-trace display, triggered sweep, and dc-15-MHz bandwidth. Two separate inputs can be individually displayed in channel 1 or channel 2 modes. Alternate and chopped modes allow both signals to be displayed at once for direct comparison. Both input channels are precisely balanced for less than 5% phase shift out to 50 kHz.

Circle No. 80 on Reader Service Card

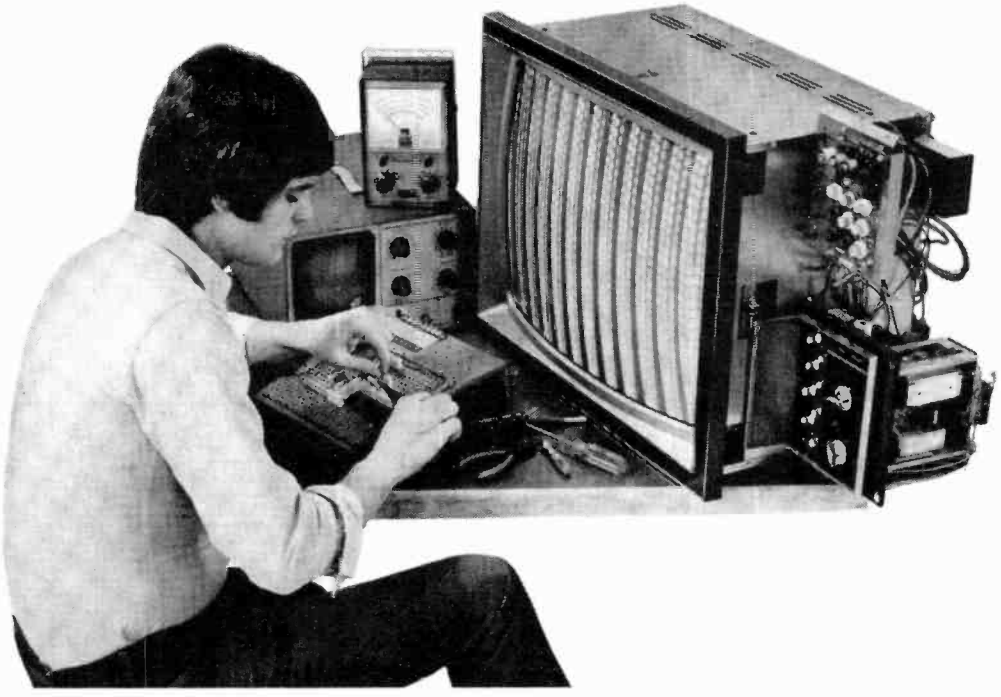
TOYO STEREO CASSETTE DECK

Toyo's new Model 591 is a full-capability stereo cassette record playback deck featuring REPEAT and REVERSE facilities. REPEAT rewinds the tape automatically and repeats it as long as power is on; REVERSE causes the play or record heads to switch from one pair of tracks to the other automatically when the end of the tape has been reached, then play or record the second pair of tracks backwards.

Circle No. 81 on Reader Service Card

Out of Tune

"Build a 175-MHz Prescaler," April 1972. Excessive inking during printing resulted in an error in Fig. 2. In the reproduced etching and drilling guide shown below, an arrow at the upper left points to the trouble area. The solder pad should NOT contact the pattern passing around to its left. Note also that the guide shown here is not to scale and should be used for reference purposes only.



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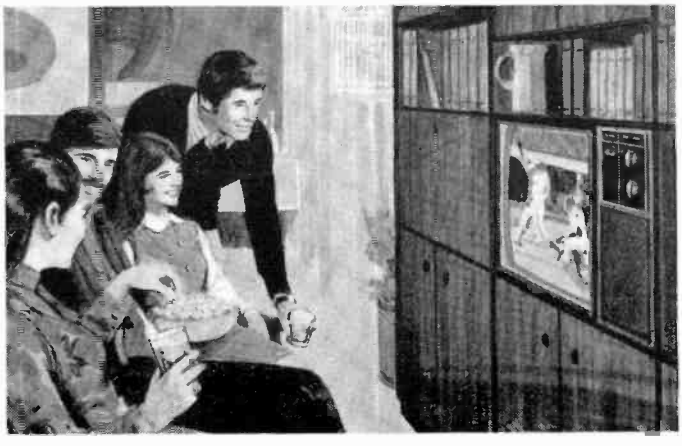

Earn extra money part time... or start a full time business of your own!

Bell & Howell Schools has helped many thousands of people start new careers or businesses of their own in electronics. You may earn extra money—or start a business of your own in color TV servicing—with the skills you acquire through this exciting new program.

Not just a "kit"—a complete at-home learning program in home entertainment electronics!
You'll enjoy the challenge of this new learn-at-home program from Bell & Howell Schools. Not just a "kit"—a *complete* learning program prepared by skilled instructors.

Enjoy the personal satisfaction of building your own color TV
You'll find it especially absorbing to build this superb color TV set. And you'll take pride in it because *you did it yourself!*

Follow simple, step-by-step instructions
This color TV project is part of a *complete* step-by-step program prepared by skilled instructors. If you'd like some personal advice, attend a special "help session" and meet a Bell & Howell Schools instructor *in person!*

Master the most up-to-date solid-state circuitry
As color TV moves more and more in the direction of *total* solid-state circuitry, you'll be thoroughly familiar with the most advanced "trouble-shooting" techniques for these sophisticated circuits.

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Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 192 pages. $5.95.

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Some 13,000 technical words from every area of electrical and electronics engineering are defined in this new dictionary. Each definition is an official standard of The Institute of Electrical and Electronics Engineers, Inc. The definitions are arranged in alphabetical order for convenient reference and are supplemented by such helpful information as preferred usage, variations in meaning among specialties, cross-indexing to related words, and code numbers which identify the source of information and the field in which it originated. American usage is stressed, although recommendations of the International Electrotechnical Commission have been adopted in many cases.

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Published by RCA Solid State Div., Box 3200, Somerville, NJ 08876. Soft cover. 175 pages. $2.50.

HI-FI FOR THE ENTHUSIAST

by M. L. Gayford

The main emphasis in this book is on the efficient selection, assembly and use of modern commercial hi-fi units, modules and construction kits. With the information given in the text, the enthusiast will be able to build a system that both suits his individual needs and provides a high standard of reproduction at an economical price. Matters such as room acoustics, amplifier power, pickups, and speaker systems, manufactured commercially and home-built, are dealt with in detail. Links with visual sources such as TV receivers and movie film and slides are also dealt with.

Published by Tab Books, Blue Ridge Summit, PA 17214. 176 pages. $6.95 hard cover, $3.95 soft cover.

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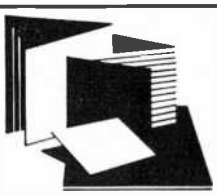

New Literature

ENVIRONMENTAL PRODUCTS CATALOG

Digital experimenters will welcome a new catalog available from *Environmental Products*. It lists and describes in detail a liquid-crystal readout audio-frequency meter, a precision pulse generator, and an analog power supply. Kits include a variety of decade counters with drivers and readouts, frequency standard modules, and power supplies for digital and analog IC systems. Individual linear and digital IC's (including the newest COS/MOS chips and an opamp capable of dissipating 15 watts of power), incandescent and LED 7-segment readouts, a stick of four liquid crystal readouts, and lots more are also listed. Address: Environmental Products, Box 406, Lafayette, IN 47902.

OLSON ELECTRONICS CATALOG

There are 80 pages packed with all kinds of electronic device listings in the latest *Olson Electronics* catalog. The listings start off with hi-fi/stereo equipment and go on to other home-entertainment items such as color and monochrome TV and BCB and SW receivers. Next comes a section devoted to CB and commercial PA systems; then listings for test equipment, tools and accessories, and components for the hobbyist/experimenter. Address: Olson Electronics, 260 S. Forge St., Akron, OH 44327.

MONTGOMERY TOOL AND EQUIPMENT CATALOG

"Time Savers for Tool Makers" is a new 24-page catalog available from *Montgomery & Co.* The catalog lists standard and unusual tools and equipment for machinists, toolmakers, engineers and craftsmen. Address: Montgomery & Co., Inc., 12 Commerce St., Chatham, NJ 07928.

GAVIN COLORFINDER ANTENNA BROCHURE

Reflecting its expanded dealer support program, *Gavin Electronics* is making available a full-color brochure describing the Colorfinder outdoor color TV antenna line. The 6-page brochure describes and illustrates all seven vhf-uhf-FM antenna models offered. Address: Gavin Electronics, Inc., 1450 Hwy. 22, Somerville, NJ 08876.

Surplus Scene

By Alexander W. Burawa, Associate Editor

MORE COMPANIES TO GET ACQUAINTED WITH

SINCE we started this Surplus Scene column in January, it has been our foremost intention to acquaint readers with information on various companies in the field. This month, we're introducing you to more companies which have not been mentioned in past columns.

We'll lead off with a company called Leasametric (822 Airport Blvd., Burlingame, CA 94010). They are making available a 16-page catalog entitled "Used Instruments For Sale." This catalog serves as a "blue book of prices" for the used equipment market. This catalog should satisfy all those readers who have written in requesting information on where they could obtain used laboratory quality test equipment.

While we're on the subject of test equipment, Baynton Electronics Corp. (2709 North Broad St., Philadelphia, PA 19132) has a catalog listing hundreds of hot items by such names as General Radio, Tektronix, Polarad, RCA, Hewlett-Packard, Fluke, and many other names well-known to R&D labs and OEM users. Listings include both new and reconditioned equipment. There are also extensive listings of waveguide and coaxial components, panel meters, power supplies, and relays.

Barry's Green Sheet (Barry Electronics, 512 Broadway, New York, NY 10012) is a 16-page catalog of particular interest to ham radio operators. It lists a diversity of items from transceivers to individual components such as panel meters, transistors and diodes, Varian and Bomac klystrons and Eimac power grid tubes, capacitors, and high-current transformers.

Glancing through the latest catalog put out by Fair Radio Sales Co. (1016 E. Eureka St., Lima, OH 45802) reminds this writer of his service days with the Air Force. Such listings as the TV-7/U tube tester, FR-67/U frequency meter/counter, and the BC-221 frequency meter (what ever happened to that old standby, the AN/PSM-2 multimeter which could survive even a direct mortar hit, I wonder?) go with the days when the wardrobe was all blue like the fair maiden's eye. Getting back to the point, this catalog is a bonanza of military and government surplus communications gear, test equipment, and parts. If you're a ham and don't have this catalog, you're missing plenty.

Edlie Electronics, Inc. (2700 Hempstead Tpke., Levittown, NY 11756) used to do business out of lower Manhattan before the twin towers of the World Trade Center drove them out to Long Island. Though their business location has changed, their activity in the surplus area hasn't. Their current catalog features a good variety of surplus test equipment and equipment used for communications. The catalog is rounded out with hi-fi and audio equipment, radio and TV receivers, and small-parts listings.

The final entry in this month's edition of the Surplus Scene comes to us from north of the border. The name of the company is Etco Electronics (464 McGill St., Montreal 125, Canada), and though they aren't surplus dealers in the traditional sense (their offerings are mainly new hi-fi and audio equipment and accessories, components, and the like), they do offer great buys in used and traded-in hi-fi equipment. ◈

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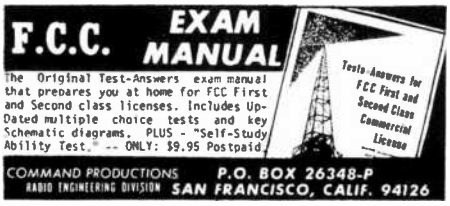

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7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
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7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
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7443	1.27	1.21	1.14	1.07	1.01	.94
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7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
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7451	.26	.25	.23	.22	.21	.20
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7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
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7494	1.18	1.12	1.05	.99	.93	.87
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74161	1.89	1.79	1.68	1.58	1.47	1.37
74162	1.89	1.79	1.68	1.58	1.47	1.37
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NE533	3.81	3.58	3.36	3.14	2.91	2.69
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NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
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709	.42	.40	.38	.36	.34	.32
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723	1.00	.95	.90	.85	.80	.75
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1N270	.15	.14	.13	.12	.11	.10
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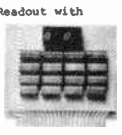

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SANKEN HYBRID AUDIO AMPLIFIERS AND SUPPLY KIT

We have made a fortunate purchase of Sanken Audio Amplfier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- ☐ 10 Watt RMS Amplifier . . . . . $ 4.75
- ☐ 25 Watt RMS Amplifier $14.75
- ☐ 50 Watt RMS Amplifier $22.50
- ☐ Complete kit for 100 watt rms stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00
- ☐ Same for 50 watt rms stereo amplifier includes two 25 watt Sankens, etc. $58.00
- ☐ Same for 20 watt rms stereo, includes two 10 watt Sankens, etc. $30.00

DIGITAL CLOCK KIT WITH NIXIE DISPLAY

We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

- ☐ Clock Kit, complete less outside cover $57.50
- ☐ Aluminum blue or black anodized cover (specify) . . $ 4.50

INTEGRATED CIRCUIT SPECIALS

709	Operational Amplifier	.50
711	Dual Comparator	.50
741	Compensated Operational Amplifier	.50
558	Dual 741	.95
723	Voltage Regulator	1.25
536	F.E.T. Operational Amplifier	4.75
595	Four Quadrant Multiplier	3.75
740	Power Driver, for 100 watt AB amplifier	2.75
2111	FM Detector and Limiter	2.75
555	Timer 2 μSeconds to 1 hour, Special!	1.25
1103	1024 Bit Ram Memory, MOS	9.25
2501	256 Bit Ram Memory, MOS	8.75
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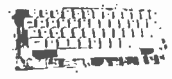
7490	Decade Counter	1.25
74141/7441	Nixie Driver	1.75
74192	Bidirectional Counter	1.75
7475	Quad Latch	1.25
7447	7 Segment Decoder Driver	2.25
7489	64 Bit Random Access Memory	5.75
7492	Divide by 12 Counter	1.25
74196	50 MHz Divide by 10 Counter (presetable)	2.25
NE560	Phase Locked Loop	5.00
561	Phase Locked Loop	5.00
562	Phase Locked Loop	5.00
565	Phase Locked Loop	5.00
566	Function Generator/Tone Encoder	5.00
567	PLL/Tone Decoder	5.00

SANYO CALCULATOR, MODEL ICC 804

This calculator with L.E.D. readout and rechargeable self-contained nickel cadmium battery was advertised in our March ad at $215.00 (if you ordered it at the higher price we will refund you the difference in merchandise on request). Due to a special purchase, we can now offer this $299.00 list calculator at only $175.00, making it the outstanding calculator buy in the USA. Comes complete with charger/power supply and case. Has eight digit display, with 16 digit capacity. Unit is only 1½" thick, easily slips in pocket. You can charge it by phone to BankAmericard or Mastercharge.

- ☐ Sanyo Calculator . . . $175.00

KEYBOARDS



Three keyboards are available, as illustrated. 20 key calculator keyboard, 40 key alphanumeric, and 12 key touch tone. All have separate contacts brought out to edge connector.

- ☐ Touch Tone Keyboard . $ 9.50
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Including Electronics World

JULY 1972

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Printed in U.S.A.

Popular Electronics

INCLUDING **Electronics World**

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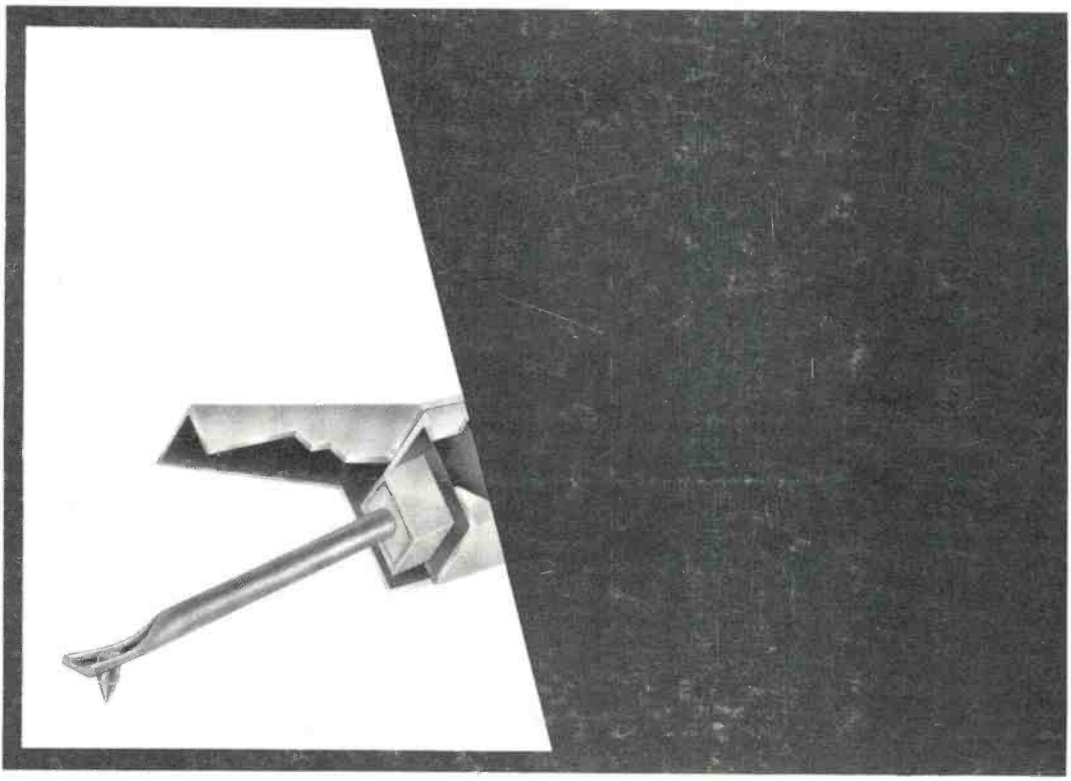

Straight talk about a stylus

Listen carefully and you can still hear some audiophiles refer to the record stylus as . . . "the needle." Although we are not about to quibble over semantics, we would like to go on record, so to speak, as observing that the stylus of today bears no more resemblance to a needle than it does to a ten-penny nail. In fact, it is probably the most skillfully assembled, critically important component in any high fidelity system. It must maintain flawless contact with the undulating walls of the record groove — at the whisper-weight tracking forces required to preserve the fidelity of your records through repeated playings. We put everything we know into our Shure Stereo Dynetic Stylus Assemblies — and we tell all about it in an informative booklet. *"Visit To The Small World Of A Stylus."* For your copy, write:

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