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- Studio Insulation
- Home-Brew Multi-Media
- Interview:  
AMPEX ATR-100 Part II

# OTARI MX-5050 the original (and still the best) compact professional recorder

Just over two years ago, Otari introduced a unique new product—the first truly professional recorder in a compact package—the MX-5050. Since then, the performance and reliability of this innovative new machine have been tested and proven in over a thousand critical professional applications—by broadcasters, recording studios, A/V departments, musicians, and semipro recordists worldwide. Universal acceptance and repeat orders by these satisfied customers tell this remarkable recorder's success story better than we can.



*Bias can be re-optimized in seconds.*

As you compare the MX-5050 with other recorders, keep this in mind. The MX-5050 is not a hi-fi machine with a few professional features added later as an afterthought. It was designed from the ground up based on Otari's 10 year experience as Japan's leading manufacturer of professional recorders and high speed duplicators. It is a full professional machine with the performance, features, and field proven reliability that you expect to find only in the larger professional recorders.

Here are some of the key reasons why the MX-5050 is the best compact recorder available today.

**Production Features:** Creative production is simplified with: Front panel edit to spill tape. Lift-up head cover to mark splices and clean heads. Built-in splicing block on head cover. Adjustable cue to defeat head lifters. Selective reproduce to add new tracks in perfect time synchronization. Two speed operation, 15 and 7½ or 7½ and 3¾ ips (field changeable in dc servo versions).

**Performance Features:** Headroom is 19 dBm, a full 15 dBm over the switch selectable fixed output of +4 dBm. This standard reference level output can be rear panel switched to -10 dBm to drive a PA system or power amplifier. S/N ratio is NAB weighted 69 dB full track, 68 dB half track, and 65 dB quarter track. Crosstalk is greater than 60 dB half track. Outputs are 600 ohm balanced (standard on half track) or unbalanced. Line input and output connectors are XLR.



**Operating Features:** Bias is front-panel continuously adjustable (not limited to fixed positions). With built-in test oscillator (not available on other compact professional recorders) bias can be optimized in seconds when changing tape. Record EQ and standard reference level are also front adjustable. Straight-line tape path simplifies threading. Capstan is located on back side of tape for improved tape life. An extra reproduce head is standard on all versions to allow playback of tapes in different formats. For pitch control and freedom from power line variations, an optional dc capstan servo is available with ±10% correction range.



*Easy threading; capstan on back side.*

**Versatility:** Available in full-track (with half-track reproduce capability standard), two-track, and quarter-track versions. Walnut case (standard), rugged portable road case, rack mounting adaptor, or floor console. Universal power supply standard. Low impedance input and output transformers and remote control also optional accessories.

See your nearest Otari dealer for the full story or contact Otari. And, if it's multichannel you need, ask about the standard-setting four and eight channel versions of the MX-5050.

## OTARI

Otari Corporation  
981 Industrial Road  
San Carlos, Calif. 94070  
(415) 593-1648 TWX: 910-376-4890

Otari Electric Co., Ltd.  
4-29-18 Minami Ogikubo  
Suginami-ku, Tokyo 167, Japan  
(03) 333-9631 Telex: J26604

Circle 10 on Reader Service Card

**coming  
next  
month**

● A viewpoint on the right kind of reverberation to use is discussed in an article by William H. Hall.

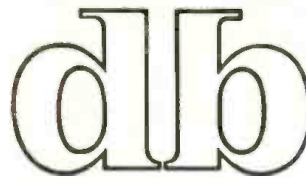
● A good low cost oscillator is a must in many aspects of studio setup and operation. Evert Fruitman has contributed a construction article for a low distortion single frequency oscillator that you can build for around ten dollars.

● At the other end of the measurements scale can be found the Sound Technology 1710A. This combines in one package a wide-range, low-distortion oscillator and a harmonic analyzer as well as an optional intermodulation analyzer. We will have a test report on this remarkable and versatile tool.

**about  
the  
cover**



● An engineer's eye view into the studio.



THE SOUND ENGINEERING MAGAZINE

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# dbx

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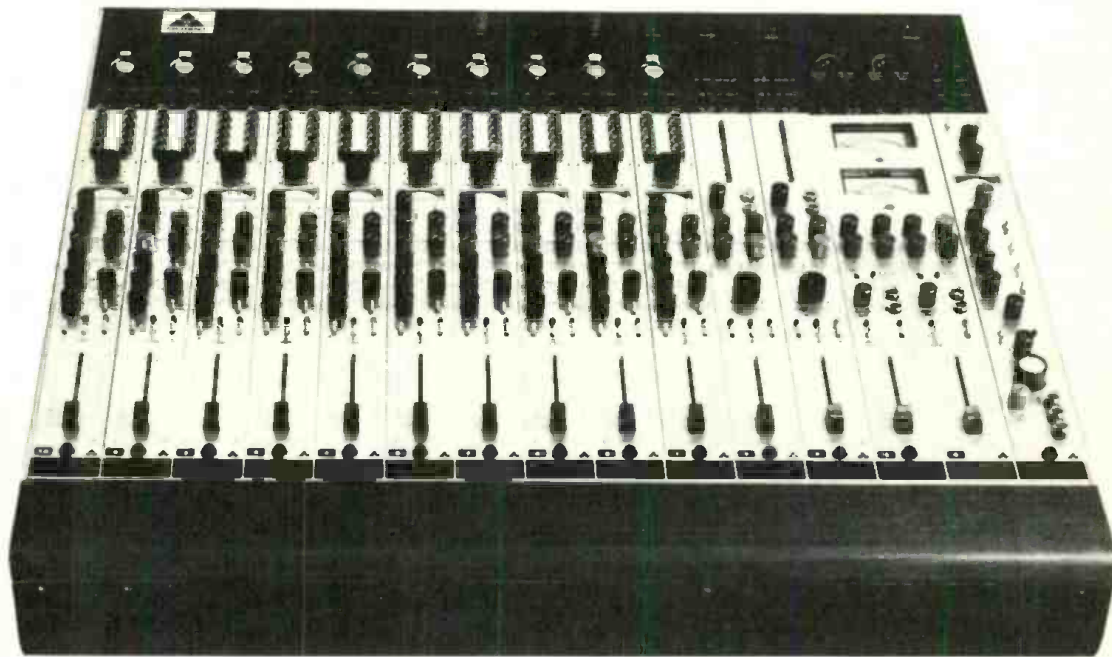
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Fleximix is designed for high quality Public Address, Bands, Recording Studios and Theatre applications and many of its features are normally only to be found on expensive studio consoles.

A number of exciting new modules will shortly be available which will extend even further the system's versatility. These will include a Compressor Limiter module, Quick Joystick module and Line Balancing module.

If you're looking for a new mixer you have just found it!

*Send for details to:*

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Sales Office: 112/114 Wardour St.  
London, W1V 3AW, England.  
Tel: 01 734 9901. Telex 27782.

Factory address:  
Shepperton Studios  
Squiresbridge Rd.  
Shepperton, Middx.  
England.  
Tel: Chertsey (09328) 60241.

*U.S. Agents:*

Studio Maintenance Service  
2444 Wilshire Blvd. Suite 211  
Santa Monica, CA 90403  
Tel: (213) 990 5855  
Contact: David Michaels.

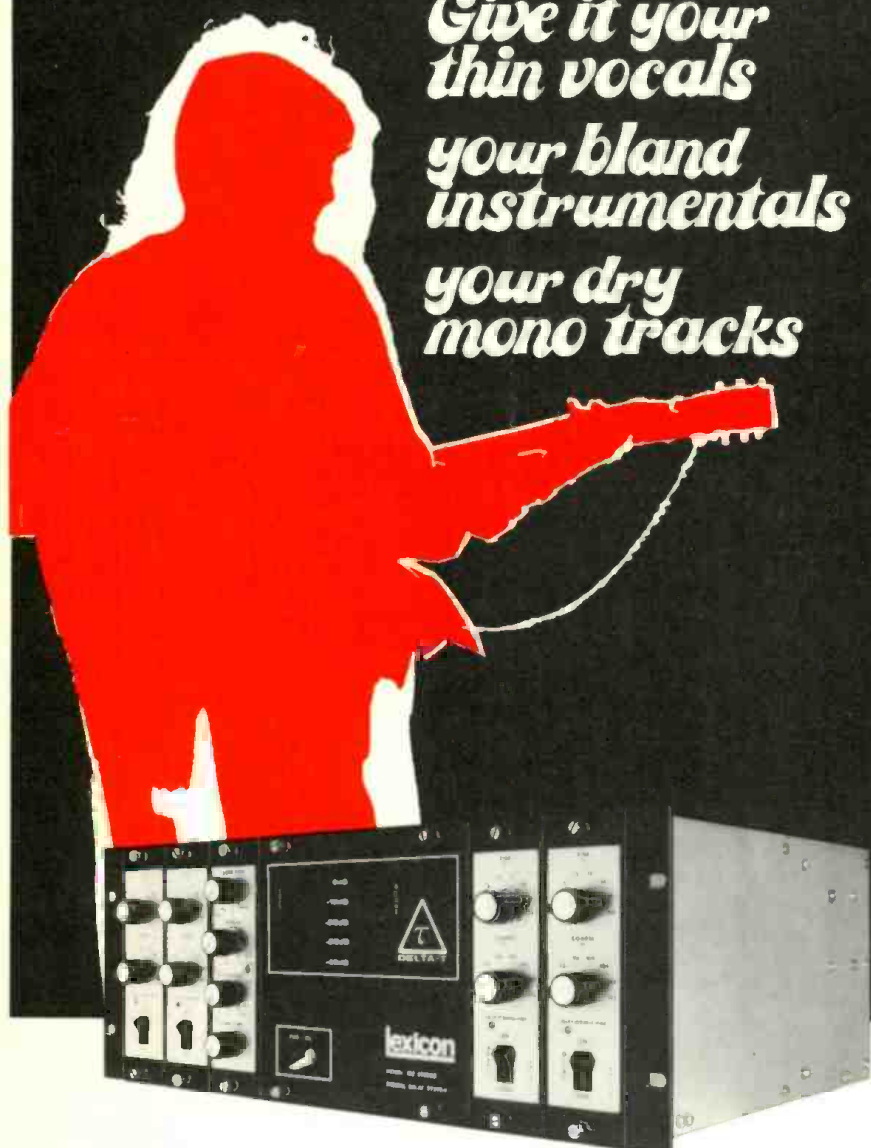
Audiotechniques Inc.  
142 Hamilton Ave.  
Stamford, Conn. 06902  
Tel: (203) 359 2312  
Contact: Adam Howell.



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# New Stereo Delta-T

Give it your  
thin vocals  
your bland  
instrumentals  
your dry  
mono tracks



Now relax, playfully invite your muse, and transform these tracks, adding body, stereo perspective, flanging, and a host of other time-base effects. Since Lexicon introduced digital delay over six years ago, most studios have come to depend on it at least for doubling and slap. Now, the stereo 102-S with the new VCO module\* produces many other effects, including more natural double tracking, flanging, vibrato, time delay panning, extreme pitch modulation, and signal transformation for special effects. Of course, you can also use the two channels for completely independent processing.

The Lexicon Delta-T has earned an enviable reputation for its 90 dB dynamic range, impeccable audio quality, high reliability, and functional modularity. All this is retained in the new 102-S, while two channel operation, finer delay steps (3 ms), and the VCO have been added. And the 102-S is economical. Its totally modular construction allows you to start with a bare bones mono system and expand later as needs and budget grow. We'll help you define the configuration you need to get started. Call or write Lexicon for further information.

Write on your letterhead for AN-3, *Studio Applications of Time Delay*. A 30-minute demo tape is also available for \$1 in cassette, or \$5 on 7 1/2 ips/2 track tape.

\*The new VCO module also fits any 102-B or C mainframe to enhance its time-base signal processing capability.

## lexicon

60 Turner Street  
Waltham, Massachusetts 02154  
(617) 891-6790

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## db letters

### THE EDITOR:

Would you please print the following message in your Letters column.

Dear Friends of Audio:

I am in charge of developing a student audio engineering library. If you have any literature concerning audio engineering, electrical engineering, music, physics, or other subjects appropriate to audio that you no longer use, their donation would be greatly appreciated.

Usable printed matter would include periodicals such as *db*, *A.E.S. Journals*, *Audio*, *RE/P*, *Studio Sound*; textbooks; service manuals; charts or photographs. Out-of-date or obsolete materials all have their value in student learning situations and most anything will be welcome.

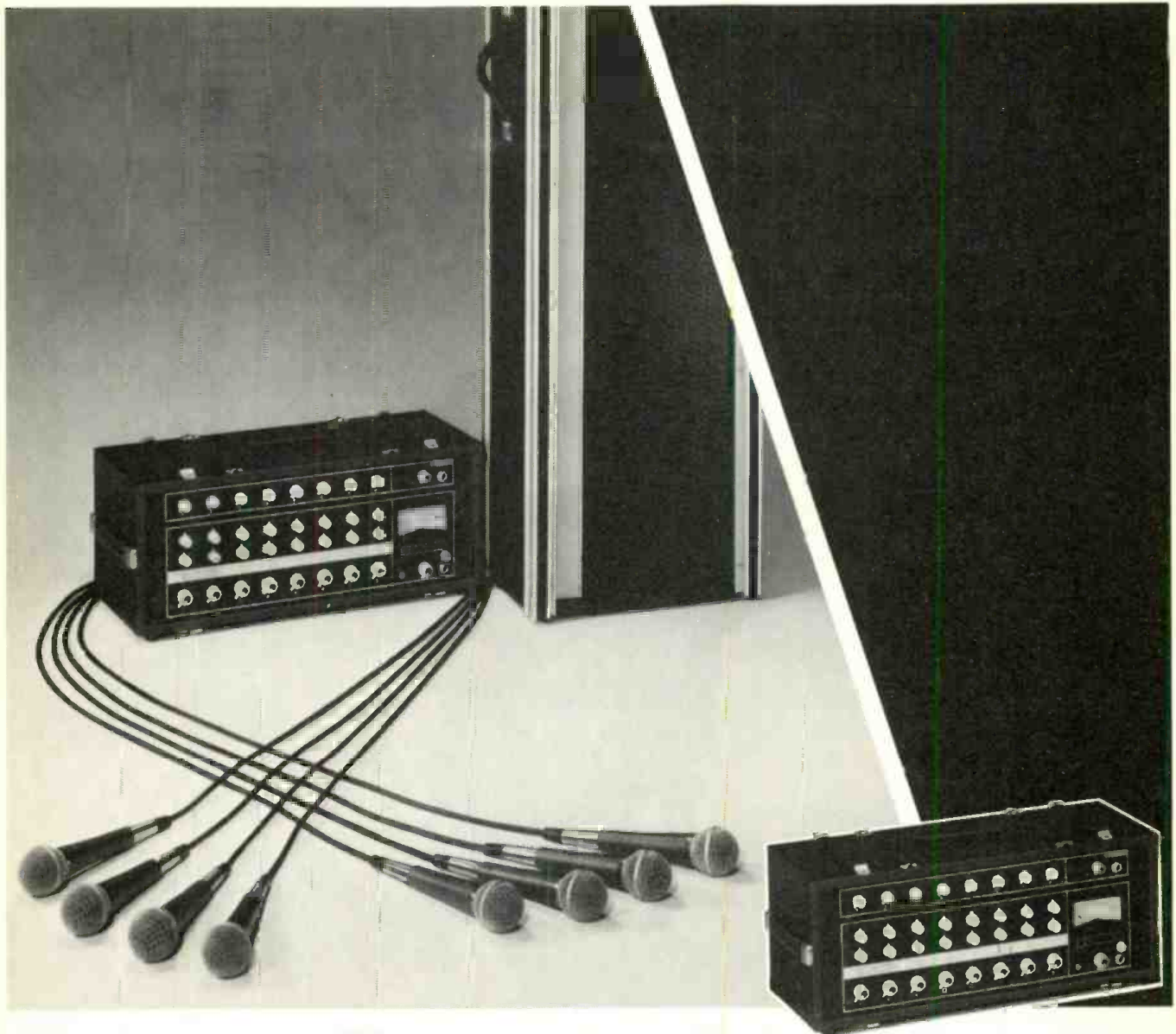
Thank you for your interest in promoting audio education.

The Student Library  
c/o T. W. WOYNICZ  
P.O. Box 7347  
Hollywood, Fla. 33021

## CALENDAR

### MARCH

- 1-4 **AES European Convention.** Hotel Meridien, Paris. Contact: Donald Plunkett, Audio Engineering Society, 60 E. 42nd St., New York, N.Y. 10017. (212) 661-8528.
- 14-17 **NOISEXPO '77**, the National Noise & Vibration Control Conference and Exhibition. Holiday Inn, O'Hare/Kennedy, Chicago. Contact: NOISEXPO '77, 27101 E. Oviatt Rd., Bay Village, Ohio 44140. (216) 835-0101.
- 22-24 **Ace '77 Advanced Consumer Electronics Show.** Pacific Terrace Convention Center, Long Beach, Ca. Contact: Cartridge & Associates, 415 Clyde Ave., Suite C, Mountain View, Ca. 94043. (415)-969-1556.



## The mixing links.

Now! Two new tools for even greater versatility, and economical expansion of SR Sound Systems: The compact SR109 Professional Mixer gives (or adds) up to eight microphone channels, each with individual gain control and high / low frequency equalization—without cramping your budget. Adjustable peak limiter with LED indicator prevents overload, and a peak responding LED indicates output clipping level. Built-in tone oscillator, headphone output and illuminated VU meter. Takes only 5¼" rack space. The SR109 can be connected to one or more SR110 Professional Monitor Mixers for monitor (foldback) mix, or for adding stereo output capability.

The SR110 features an eight-channel input /single output design—can be used as a single unit mixdown panel, or stacked for multi-channel recordings (use four for quadriphonic) or stereo broadcasts. Super space-saving—takes only 1¾" rack space. Both units are ideal for use with the SR101 Series 2 Console.

Shure Brothers Inc.  
222 Hartrey Ave.  
Evanston, IL 60204  
In Canada:  
A. C. Simmonds & Sons Limited

### TECHNICORNER

**SR109**  
Balanced low impedance microphone inputs. Program output circuit is 600-ohm balanced line level output with less than 1% distortion. Minimum clipping level of +19 dBm. Each channel has switchable 15 dB input attenuator. Maximum gain is 87 dB. Regulated power supply operates over a wide range of ac line voltages.

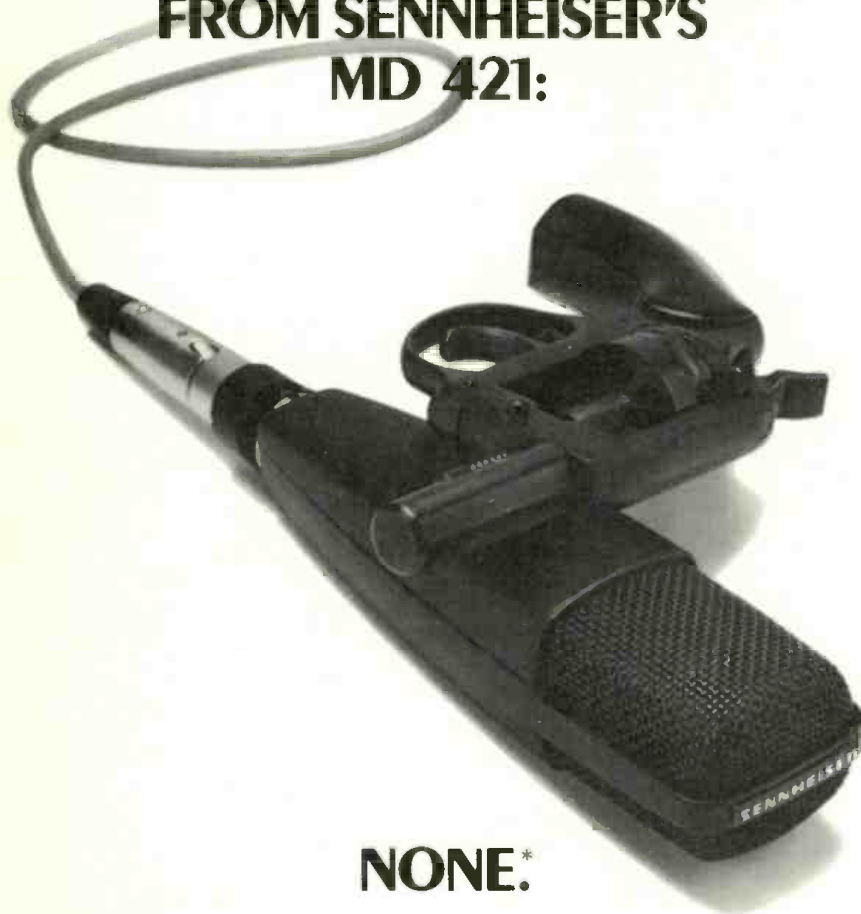
**SR110**  
All inputs made via single multi-pin connector. Mix Bus for 16 inputs. Provides a 600-ohm balanced line level output. Up to eight SR110's can be stacked to provide multiple monitor (foldback) or multi track mixes from an SR101 Series 2 or an SR109. Three-pin Male professional audio output connector and two ¼-inch three-circuit phone jacks connected in parallel.

**SHURE**®

Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

Circle 15 on Reader Service Card

# AND NOW, A WORD ABOUT OVERLOAD, FROM SENNHEISER'S MD 421:



## NONE.\*

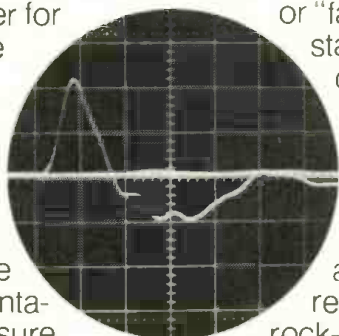
A lot of engineers are worried about overload these days. And no wonder: Rock groups. Country groups. Jetports. And other high program and ambient sources make it more necessary than ever for microphones to be overload-free as well as accurate.

Like our tough MD 421 cardioid dynamic.

In this test with a starter's pistol, we measured an instantaneous sound-pressure level of some 175 dB—well beyond what any musical instrument or voice can pro-

duce—while the oscillogram measured no clipping or ringing.

Whether you need a microphone to capture transient sound like this pistol shot,



or "face the music" on stage at 130+ dB in a disco or recording session, consider our MD 421. You'll discover its precise cardioid directionality, rugged design and wide, smooth response are ideal for rock-concert, recording and broadcast applications.

The price won't overload you either.

\*Outdoor test with Tektronix scope, set for 10V/division vertical, 0.1  $\mu$ sec/div. horizontal; .22 cal. starter's pistol mounted 15 cm from MD 421 measured pressure of 111,000 dynes/cm<sup>2</sup> (175 dB SPL). Smooth, rounded scope trace indicates total lack of distortion.

**SENNHEISER**  
ELECTRONIC CORPORATION  
10 West 37th Street, New York 10018 (212) 239-0190  
Manufacturing Plant: Bissendorf/Hannover West Germany

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calendar (cont.)

22-24 **Three-day course on Audiometry and Hearing Conservation in Industry**, Rensselaer Polytechnic Institute, Troy, N.Y. Contact: Office of Continuing Studies, Rensselaer Polytechnic Institute, Communications Center 209, Troy, New York 12181. (518) 270-6442.

27-30 **NAB Convention Washington, D.C.** Contact: National Association of Broadcasters, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500.

### APRIL

1-3 **Intercollegiate Broadcasting System Convention**, Hyatt Regency Hotel, Washington, DC. Contact: Rick Askoff, IBS, Vails Gate, N.Y. (914) 565-6710.

19-24 **High Fidelity '77 Exhibition**, Heathrow Hotel, London, England. Contact: British Information Services, 845 Third Ave., New York, N.Y. 10022 (212) 752-8400.

25-28 **AUDEX, the International Audio Exposition**, trade show, Las Vegas Convention Center. Contact: Charles Snitow, 331 Madison Ave., New York, N.Y. 10017. (212) 682-4802.

### MAY

9-11 **International Conference on Acoustics, Speech, and Signal Processing**, Sheraton-Hartford Hotel, Hartford, Conn. Contact: Clifford Weinstein, B-345, Lincoln Laboratory, P.O. Box 73, Lexington, Mass. 02173. (617) 862-5500 X5465.

17-20 **London Electronic Component Show**, Olympia, London, England. Contact: British Information Services, 845 Third Ave., New York, N.Y. 10022. (212) 752-8400.

18-22 **Consumer Hobby Fair**, Electronic kits and experiments, Philadelphia Civic Center, Philadelphia, Pa. Contact: Aaron Kozlov, Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606. (312) 263-4866.



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We've been manufacturing professional products since 1938. And, since we are both users of these products as well as manufacturers, we are best able to design them with you in mind.

We also offer the most complete line of recording products in the world. To find out more about us, contact one of our salesmen. You'll get first class service. And a first class product.

*Capitol* CAPITOL MAGNETIC PRODUCTS A DIVISION OF CAPITOL RECORDS INC. 1750 N. VINE STREET, LOS ANGELES, CALIFORNIA 90028

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[www.americanradiohistory.com](http://www.americanradiohistory.com)

## RF Tuned Circuits and Audio

• A considerable amount of audio is carried on rf transmission systems. Once the audio gets into the rf arena, it must contend with many factors that are not present in an audio-only situation. These rf factors can shape and distort the audio so that what is recovered at the receiving end of the system can be far different than what went into it. We will discuss one of these factors, the rf tuned circuit, and some of the effects it can have on the recovered audio.

### CARRIERS AND SIDEBANDS

The rf signal is a carrier only, usually called simply, the *carrier*. This is the rf frequency assigned to the station or for a particular use. The rf carrier is generated and amplified to the value necessary to radiate it from an antenna (in an open circuit situation, such as broadcast) or over a cable system (as in a closed circuit situation). The plain carrier by itself is of little practical value.

Intelligence signals are impressed on the carrier in one or the other modulation methods. In the amplitude modulation (a.m.) process, the audio signal all goes into the sidebands. In standard a.m. broadcasting, there are two full sidebands. There are also variations of the a.m. process, such as vestigial sideband transmission as used for the visual carrier in t.v., single sideband as used in communications systems, and double sideband-suppressed carrier as used in communications and stereo multiplex.

Audio which modulates the carrier's frequency or its phase is called *frequency modulation* or *phase modulation*. These modulation processes not only create many sidebands, but they also cause the carrier to deviate, or swing from its normal resting (assigned) frequency, in accordance with the audio modulation signal. This is a more complex situation since the carrier is constantly changing its frequency position.

A modulated carrier takes up more spectrum space than does an unmodulated carrier. Signals occupy space (in frequency) both above and below the carrier frequency. This space is called the *bandwidth* of the signal. Any circuit then, which carries this modulated signal or is to amplify it faithfully, must have adequate bandwidth. In

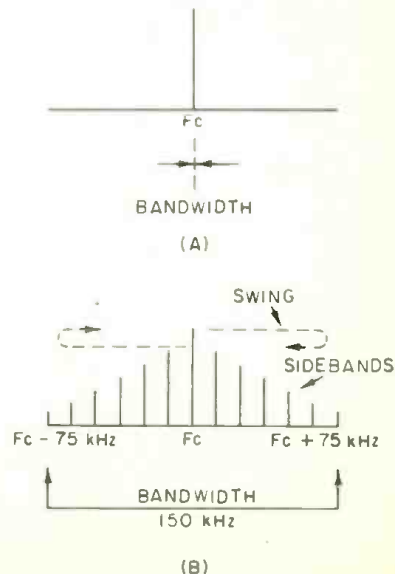
other words, the circuit must be broad-band enough to pass the signal and its sidebands.

### TUNED CIRCUIT

Circuit elements contain inductance, capacity, and resistance values that become more critical at rf frequencies. The higher the rf frequency, the more critical and important these elements become. Besides actual tuned circuits, these same elements are found in conductor lengths, transmission lines, and the antenna itself. The higher the rf frequency, the more peculiar these elements act. The inductive and capacitive reactances and the rf resistance will affect the signal, each in its own way.

In a given situation, the reactive components (which are opposite in sign) will equal each other and cancel out their *effects*—leaving only the resistance in the circuit. (The reactive components are still present, but they are counterbalanced by each other.) This is the natural *resonance* of the circuit. Circuit gain will increase tremendously, limited only by the resistance in the circuit. The bandwidth of this resonant point is also very, very narrow.

Figure 1. When modulation is applied to a carrier, sidebands are created which widen the spectrum space occupied by the carrier. (A) is an unmodulated carrier while (B) is f.m. modulated.



## Communications Headsets... ...for whatever the job

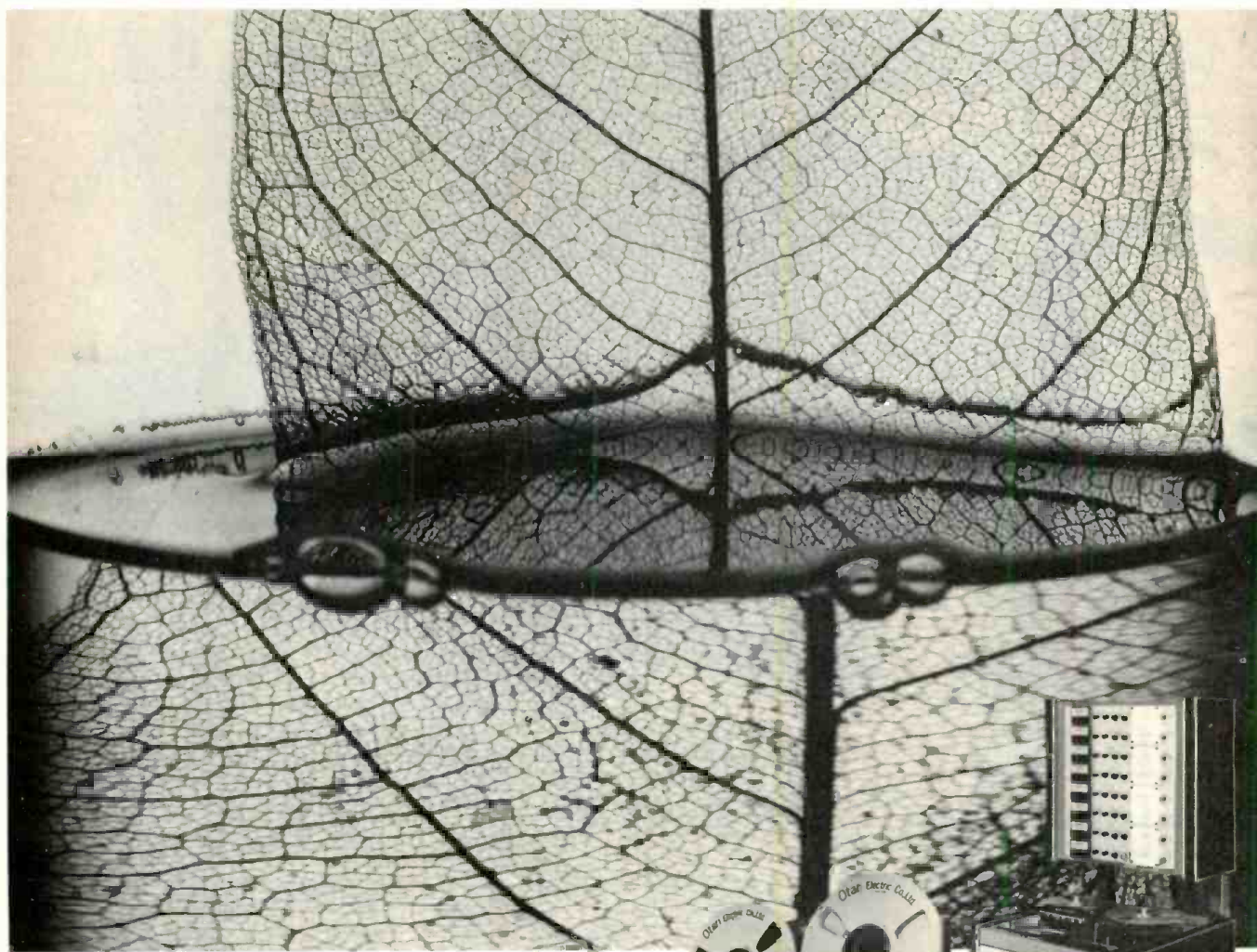
Telex 1320 series headsets offers you six models for all general communications requirements, indoor or out. Single or dual dynamic drivers are impervious to environmental humidity or temperature changes. With optional boom mikes, noise canceling dynamic or carbon. Designed for comfort. Dependably made for heavy duty use. Complemented by the compact Telex IC-10, amplified common talk intercom system for dynamic mike headsets. For "whatever the job," please write for free information:

PRODUCTS OF SOUND RESEARCH  
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COMMUNICATIONS, INC.

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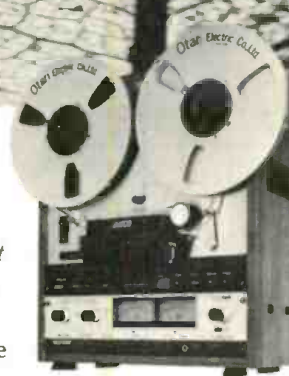
# once is enough!



*Water is pure and clear. Still, if we look at a leaf which is partially submerged in it, the leaf looks distorted. It is surprising how easy it is to introduce distortion, even by the simplest type of operation on the real thing. The bent leaf doesn't really bother us very much, but when distortion in sound results from the use of equipment, this bothers us a lot!*

Some OTARI specialists spend most of their day making sure that the equipment that we produce has the lowest possible wow and flutter, and the highest possible S/N ratio. Naturally, these are not the only features which create the top performance of OTARI products, but they reflect the care that results in a totally balanced OTARI product, and better service.

***Trust through experience — one encounter with OTARI equipment and from then on, You will trust the OTARI name.***



MX-5050-2S



Mx-7308

## **OTARI**

OTARI CORPORATION: 981 Industrial Road, San Carlos, California 94070, U.S.A. Phone: California 415-593-1648 Telex No. 259103764890 OTARICORP SCLS  
OTARI ELECTRIC CO., LTD. 4-29-18, Minami Ogikubo, Suginami-ku, Tokyo, 167 Japan Phone: (03) 333-9631 Cable: OTARIDENKI TOKYO Telex: J26604 OTRDENKI

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www.americanradiohistory.com

# The "Click and Pop" machine

only by

**SAE**



Ever since the invention of the recorded disc annoying "clicks" and "pops" caused by scratches, static and imperfections have consistently disturbed the listening pleasure of music lovers.

Now, SAE introduces the unique model 5000, an Impulse Noise Reduction System which eliminates those unwanted sounds with no adverse effect on the quality of the recorded material.

This breakthrough in electronic circuitry is so demonstrably effective that the SAE 5000 is destined to become an essential part of any sound system.

The SAE 5000 is compact and sleek, built to SAE's exacting standards, and ready to enhance the performance of any system, from the standard receiver/turntable combination, to the most sophisticated audiophile components.

SAE is proud to add the 5000 to their broad line of *Components for the Connoisseur*.

**SAE**db

Scientific Audio Electronics, Inc.  
P.O. Box 60271, Terminal Annex  
Los Angeles, Cal. 90060

Please send more information on the 5000.

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

Circle 49 on Reader Service Card

db the sync track

JOHN M. WORAM

• Some time ago (longer than I'll admit to here), I received a letter from Benjamin Homenick, who described himself as, "a semi-novice, not withstanding the implications of a half-empty or half-full glass of water, seeking the 'truths' about grounding and shielding, stereo and quad imaging, audio schools, etc."

Needless to say, each of these "truths" could take (and has taken) many pages to discuss. But before dealing with some of Mr. Homenick's specific questions, what about the "semi-novice" in general? It's just one more term to describe that intriguing phenomenon known variously as the "low-end professional," the "high-end consumer," the "crossover customer" and finally, the "semi-pro." To me, "semi-pro" seems to say it best; he's the customer (now *there's* an important word) who is not quite ready to spend some five kilo-bucks for a two-track tape recorder, yet who wants something more than he sees—or hears—in a \$500 machine. And for him (*and her*), an entire "crossover" marketplace is rising, and the word has nothing to do with loudspeakers. It refers to the fact that many manufacturers see this customer as one who is crossing over from a high-fi-type of interest to a more serious involvement with the hardware of recording.

Like the customer himself, many manufacturers are also crossing over from their traditional places in the market. For example, manufacturers of both professional and consumer-type equipment are expanding their product lines to include hardware that should appeal to the customer who finds himself with more enthusiasm than cash—that is, the semi-pro.

Which brings us more or less to one of the points raised in Mr. Homenick's letter: "*Much of this (semi-pro) equipment serves admirably, but lacks ease of patchability. I know you*

*'get what you pay for,' but does this sentence me to a lifetime of connecting and disconnecting phono-type jacks and plugs from the back of a console with a dentist's mirror?"*

## PHONO-CONNECTOR JACK BAY

Well, you may be condemned to a life of phono connectors, but thanks to TEAC, you can chuck your dentist's mirror. They've recently introduced a rack-mountable phono connector jack bay, with row upon row of RCA-type jacks, on both the front and rear of a 19 in. panel. The idea is for you to connect the rear jacks to your equipment and then, via the front jacks, do your creative patchwork.

But that's not exactly the end of the problem. Mr. Homenick—as well as others—is concerned about the practical significance of balanced and unbalanced lines, as well as about the matter of impedance and cable length. (And here's where the line between pro and consumer really gets stretched.)

Neither TEAC—nor the other manufacturers—can do much about the realities of electronics. To make a very long story overly short, you *do* get what you pay for, and balanced low impedance lines = \$\$\$\$. The advantages are greater noise immunity and less degradation of high frequency response, even with cable runs of hundreds of feet.

Although the unbalanced high impedance line is certainly no problem in the typical high-fi system, the trouble begins as the system expands into a semi-pro recording complex. Remember, unbalanced lines are potential noise makers, and high impedance lines must be kept short, if you care about frequency response. So, the unbalanced, high impedance patch bay can become a disaster area if you attempt to push it beyond its capabilities. It's really almost as simple (and depressing) as that. To help

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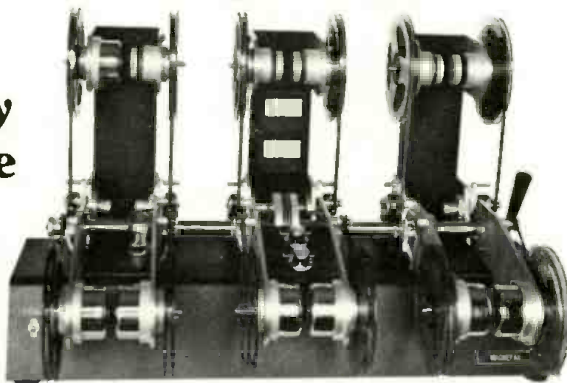
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the sync track (cont.)

keep your aggravation at a minimum, don't use the patch bay we are describing in low level (e.g., microphone) lines, for any noise generated therein will be amplified by the entire signal processing chain—often with spectacular results at the speaker. (By the way, don't wear headphones while patching, unless you are already stone deaf.)

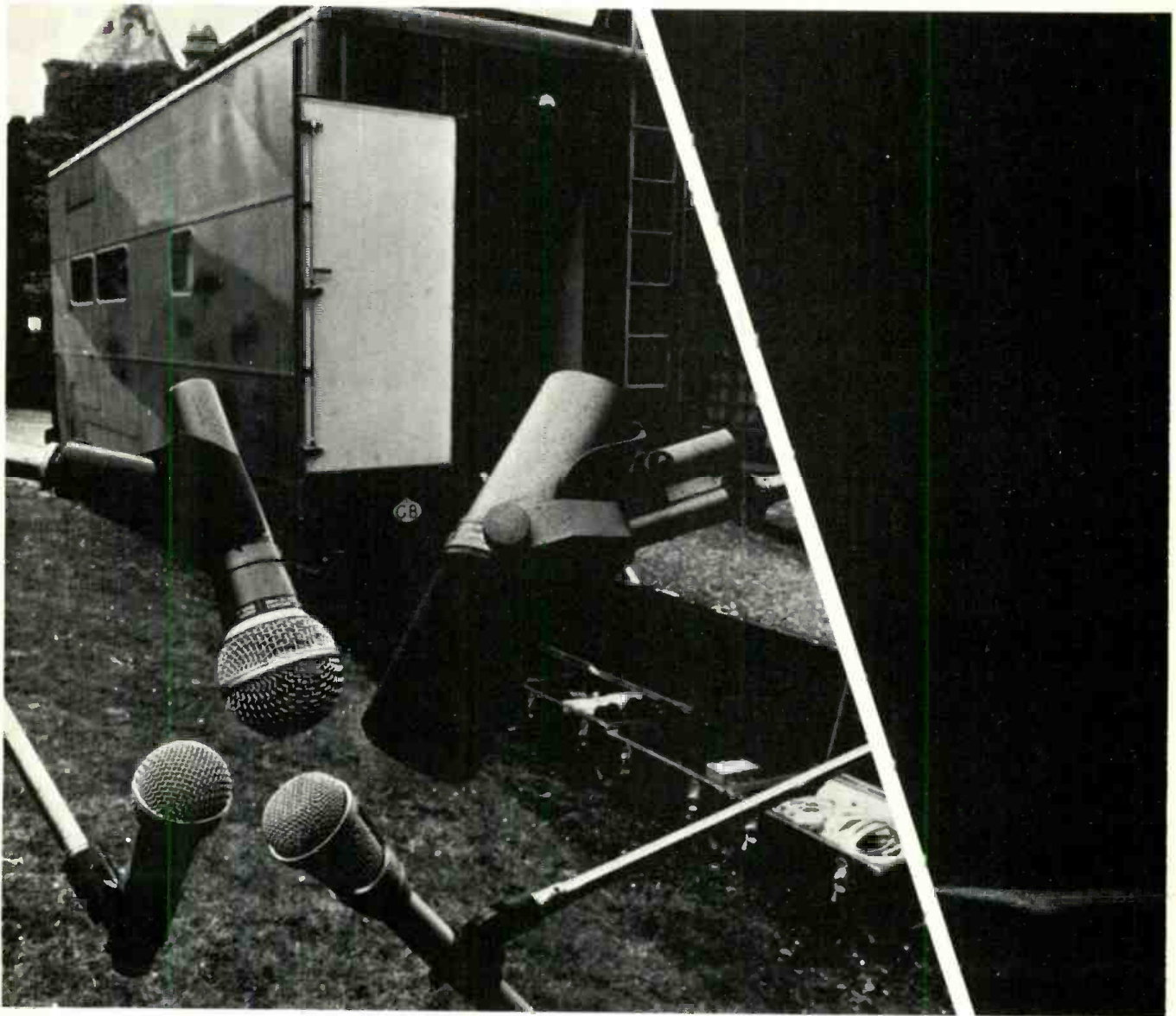
Remember, as you purchase, install and use semi-pro equipment, that prefix signifies two things; somewhat less cost, and somewhat less flexibility than full-professional hardware. If you operate the equipment within its limits, it will perform admirably. But if you try to push it, it may balk.

#### CABLE LENGTHS

The whys and why nots of balanced lines have been explained elsewhere many times, but maybe a word or two on the subject of cable lengths can stand repeating here. The reason for the high frequency fall-off in high impedance lines is reasonably straightforward. All cables have a certain amount of capacitance per unit of length. Therefore, the longer the cable, the greater the capacitance. Since the capacitance is, in effect, across the audio line, it acts as a high frequency roll-off filter. If the line impedance is low, the roll-off occurs far beyond the audio bandwidth. However, in a high impedance line, the effect of the high frequency fall-off becomes apparent well within the audio frequency range. Therefore, high impedance lines must be kept short, so that capacitance is kept to a minimum. (Don't overlook that point if you're trying to play CD-4 records. The 30 kHz carrier frequency may be done in by a relatively high capacitance phonograph cable. If you're using an older model turntable, you may need a replacement cable, as well as a new cartridge.)

If you're thinking about purchasing some semi-pro equipment, it's a good idea to consider the type of connectors used, in addition to the factors just mentioned. Especially on console microphone inputs, it's a great convenience to have Switchcraft three-pin plugs, regardless of what's going on inside the console. Most—if not all—decent microphones use a Switchcraft-type output plug, and professional-quality microphone cables are not only easy to use; they're relatively inexpensive. Be thankful for such small favors, and take full advantage of them.

And as for stereo and quad imaging, and audio schools, more later. ■



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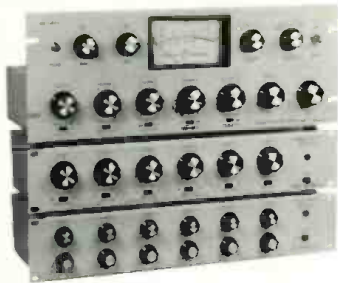
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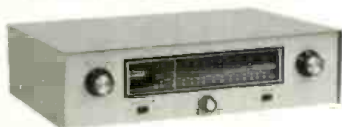
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# db theory & practice

NORMAN H. CROWHURST

• Last month we were discussing the need for, and problems in getting, initiative in the publishing field. This month brought to my attention a similar set of questions, in radio, a field closer to many readers of *db*. During the last year or so, a number of NBC affiliates across the country have been operating with a format they call the "news-only" station. In this format, the network provides updated newscasts for alternate quarter-hour periods, and the local station fills in the rest, from local happenings. For whatever reason, the network decided to discontinue this service, so now those stations are looking for something else to do to fill in the time formerly occupied with network program material.

### PROGRAM ALTERNATIVES

All across the country, stations fill time, mainly with recorded music that appeals to the local listeners. Right now, that is country and western, most places within miles of where I live. But when dozens of stations are transmitting the same type of program, and listeners are limited mostly to people driving to and from work, most of the stations eke out a meagre subsistence.

To really get ahead, a station must show some initiative. Where there is a larger population within a station's service area, one station can adopt a more unique format, such as a talk show where anyone "out there" can call in and talk about whatever interests him. Or they can run interview shows where interesting personalities of all kinds are interviewed at regular times.

### SPONSORSHIP DEPENDS ON LISTENER APPEAL

But whatever format is adopted, whether the station does essentially the same as everyone else but tries to do it better, or whether it does something different from its neighbors, what pays the bills is sponsorship. What interests every potential sponsor is how many people he can reach by means of whatever advertising medium he uses, and usually radio is only one of them.

An argument for the news-only format, as well as for anything other than what may be termed background music—something to drive by—is that they are something to which people

consciously listen. So, in an attentive mood, they will also listen to the sponsor's message rather than letting it go by as part of the background. It would seem to be a natural for a program that grabs listeners' attention to be something that sponsors would want to buy.

What a radio station expects will grab the listeners' attention does not always do it. When drivers put on the radio with the idea of providing background to relieve the boredom of driving, they do not necessarily want to have their attention grabbed. However, if something does grab it, it may provide a talking point, when they get to work, or home, or wherever they are going. And of course, it may also give them a resolve to listen again, to hear more of the same, if they like what they hear.

### GETTING INTO EDUCATION

Statistics from other fields, such as book publishing, t.v., and even theater, suggest that people want to be more than just entertained. Non-fiction has been outselling fiction for some time. Documentaries are more popular than they have ever been. So couldn't radio get into the business of education, somehow?

Whatever a station does, it must find a way to stay in business doing it. When we mention education, in almost any context, we soon hear someone talk about "funding," with perhaps a reference to "Classroom of the Air." In most people's minds, education means something that is tax-supported, and thus gets away from the "finding sponsors" hassle. But really, in making that switch, you merely substitute one hassle for another, both money. Now you are looking for funding.

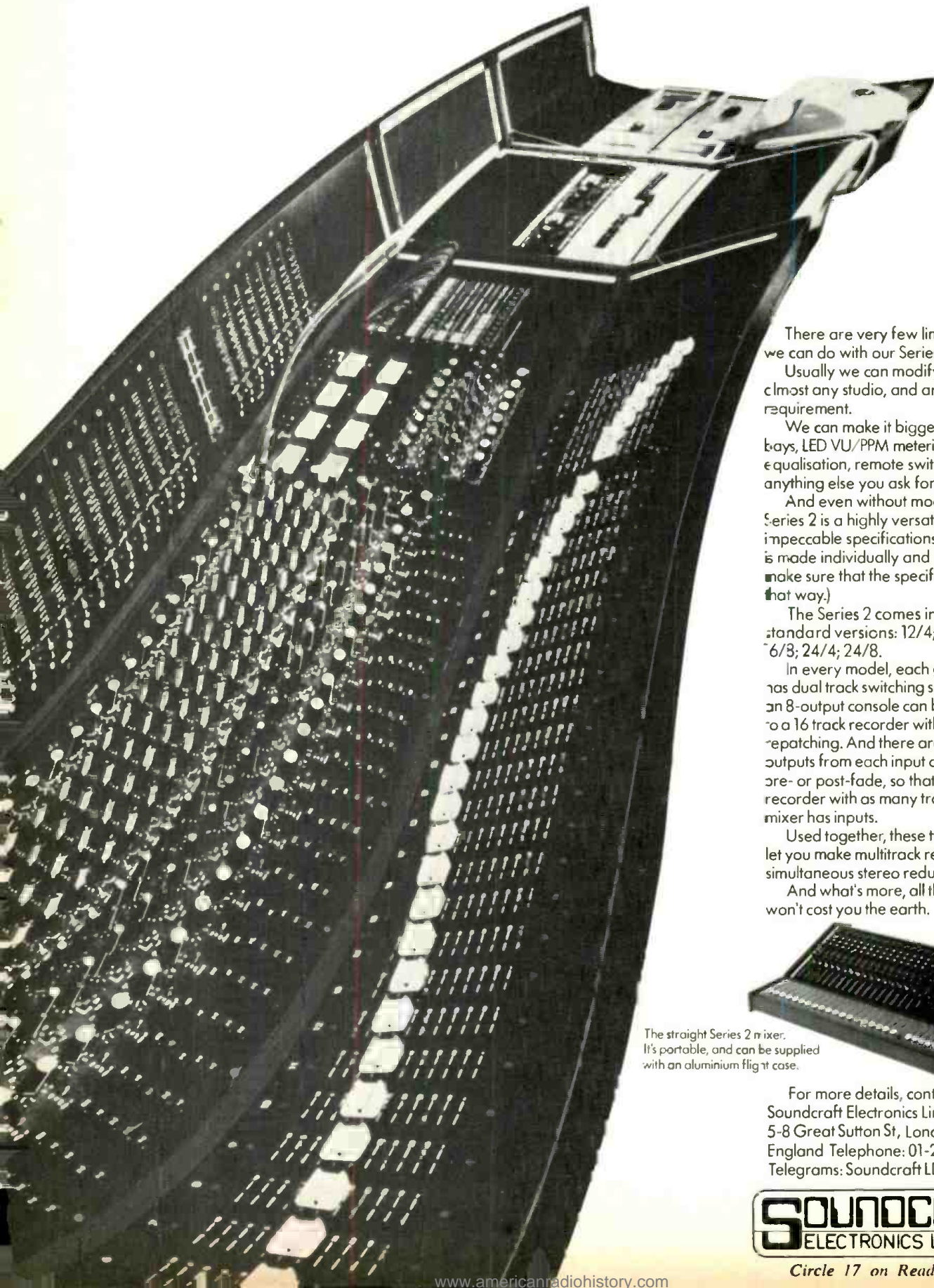
### FUNDING PROBLEMS

I do not really want to get into this, beyond showing what is wrong with it. As I said, sponsorship depends on listener appeal. Funding doesn't, at least not in the same way. So long as what you broadcast appeals to the agency that funds it, everybody is happy, for a while, at least. You do not have to please the listeners anymore.

And that is what really paves the way for the downfall of whatever educational program you happen to be



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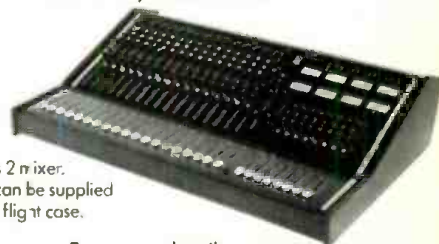
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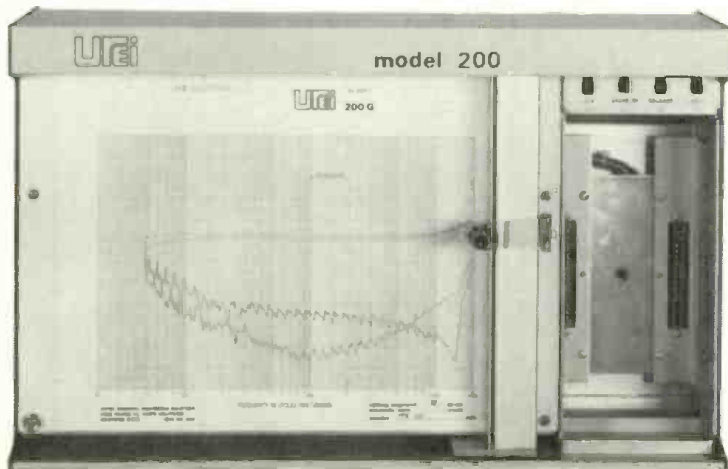
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Circle 53 on Reader Service Card

theory & practice (cont.)

engaged in. So long as the person who benefits from the funding can keep the funding source happy, the money keeps coming. But, sooner or later, something changes, and someone discovers that really nobody is listening to that junk. End of junket.

So let us ask ourselves whether educational programs really have to be funded, or whether we cannot find a way to base their continuance on the establishment of listener interest, like any other format, along with a way to get them paid for on that basis.

Well, one way, perhaps, would be to find sponsors who share your interest in education, and use a commercial format, with whatever educational content you agree upon. One advantage of this is that you can mix it in, part of the time, with some other format instead of changing your whole operation over.

There is another possibility, selling materials to subscribing students, that needs more development, which we will come to later.

## RADIO IN A/V INSTRUCTION

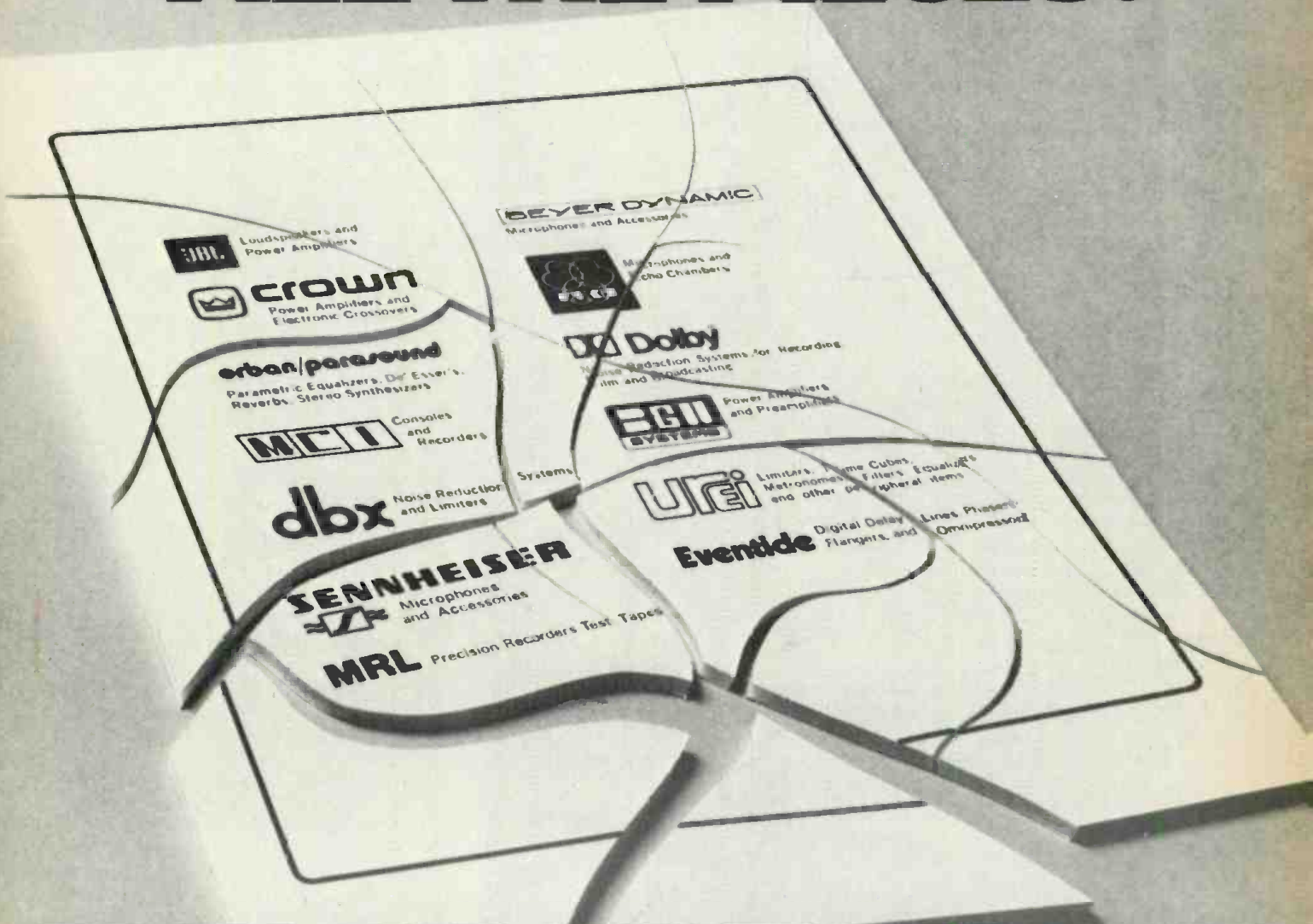
What part will your radio program play in the learning process, apart from the obvious one, that to pay by listener acceptance, it must interest them, rather than boring them?

For the last three or four years, I have been active in producing new kinds of mediated material. The best, from the results viewpoint, is often not the most costly. In fact it is often the least costly. Individualized instruction that uses workbooks and exercise books for the visual and student involvement part, with audio cassettes that provide the instruction, have been increasingly successful.

Before we leave mention of that, funded programs using the same media are invariably less successful. When the program designer gets paid for turning something out rather than for producing material that helps people to learn, this difference is really to be expected. If, as some people want us to believe, the profit motive is bad, all I can say is that the non-profit motive is worse!

Back to individualized instruction: the good feature about an audio cassette, with printed workbook and exercise materials, is that each student can take the audio at his own rate. If he comes to something he knows, he can press the "fast forward" button and save himself some time. If he comes to something that gives him difficulties, he can use the rewind button as many times as he needs to.

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## theory & practice (cont.)

The audio is best when designed to be repetitive, except with variation, to provide alternative ways of understanding, relying on the student to replay anything he wants to hear twice. We mention this, precisely because that procedure is *not* adaptable to audio by radio. What should we do then? Redesign the audio for radio?

The more you think about it in those terms, the more difficult it seems. You could be repetitive where the home-use individualized cassette relies on the student replaying material if he needs it. But then you repeat, whether the individual listener needs it or not. You just cannot suit all of the people all of the time.

### EDUCATIONAL PROBLEMS

If you think about it, these are precisely the same reasons that more orthodox forms of education are in trouble. Lecturing is not the best way to teach. Yet education insists on gearing material on a fixed program basis, so the only variable is the speed at which it is administered.

Schools have been struggling to get results this way, in a losing battle. The four-year colleges have shared the elementary and secondary schools' problems; the only bright spot on the edu-

ational horizon in recent years has been so-called vocational education. The junior colleges that offer it have been expanding where the other institutions have been in difficulties.

But at last we are hearing moans from even the vocational ed shops. Why? Because, while they were fresh, they did offer a new approach, different from the boring methods of conventional school. But now they are becoming "establishment" in this sense too.

Come to think of it, most correspondence schools have fallen into the same trap. All of these sources of education work in separate phases: first they try to sell you a course. On that they do a good selling job, to convince you that you need one of the courses they are offering. Once they get you signed up, their pay is sure.

Public institutions are assured of payment by funding; private, such as correspondence schools, are assured of payment because you sign a contract. So you'll pay, whether or not you take all the lessons. Once they have you signed up, they really do not care whether you learn, whatever their promotion may say.

### HOLDING INTEREST

Do you remember the old serial-type story that magazines and periodi-

cals used to publish back in the days before most of their readership was by subscription? That was a circulation-building gimmick. You read this week's, or month's installment. Then it left you hanging at a spot where you just couldn't wait to get the next installment.

Believe it or not, the same thing can be done in education. I know, because I've been on both ends of the situation, taught that way, and teaching that way. And believe me, a teacher who does that does not lose students. So how can we apply that technique to radio or to some other medium that may offer educational programs?

There are many tricks that can be incorporated. Perhaps tricks is not the word. Really they are techniques. But they work. The cassette audio can probably be used, either as is, or with little modification from the present, good individualized instruction material. The best study, for learning, is what each student does on his own. That is why that method is so successful.

But part of its need for success is competing against all the other things that clamor for the student's interest. This is where radio can provide, both the first incentive to get started, and the continuing incentive to see "what comes next."

The effort should not be to sell the listener a whole course all in one package, either in the learning materials, cassettes and printed work materials, or in a commitment to listen regularly. Get him interested, first, in something that other people are enjoying. Use the radio both to introduce something the listener can "find out" about, for a modest cost, and to provide an aid to continuity in learning. Continuity should not depend on the radio, but the radio should provide information of vital interest when the listener can tune in.

Space is gone, for this month. In later columns, I will discuss in more detail the role that radio can play in supplying this kind of initiative, so that, in return, it can give radio a new lease on life. ■

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Circle 46 on Reader Service Card

• When I received the December issue of this magazine, I immediately read with great interest the terrific article by Mort Goldberg on tape editing, which brought back many memories, fond ones as well as some of the exact opposite nature. Hopefully, you will permit a small side excursion from the more usual visual material found in this corner.

The last word in Mort's story on tape editing is also the last word anyone should remember if he or she intends to become a truly professional tape editor—*practice*—and that should really be written with a capital P. That's how he gained his well-earned reputation as "the fastest hands in the East" (and for all we knew it could have also included the rest of the

country, too). The techniques he discussed are some that he learned and developed to perfection along with a good ear, a precise sense of timing, and a fast pair of hands.

Recollection brought back times when Mort was working on tapes for the news department during innumerable crises, both the world-wide kind and those associated with broadcast time pressures. There were times when the small tape room adjacent to the master news studio was turned into the center for all incoming and outgoing material. One tape machine was recording incoming line and telephone reports while the second was being used for editing previously taped information while the third machine was playing the already taped and edited

program to air. The news man in the studio was getting copy ready to broadcast or put down on tape for editing into the program. The phone rang constantly, and the beeper was kept ever on the alert to mix with whatever came in on the phone line. And this was during a normal crisis. When it got really busy. . . .

During conventions, and campaigns, and space shots, and disasters, and elections, and wars (even if they were not officially called that), and whatever else happened which was worthy of reporting, a small team of expert tape editors was used to man the news tape room. Documentary material and delayed programs that were updated for the other time zones were de-fluffed and cleaned up and readied for either broadcast or future use. During slow times in between hectic periods there were some practice sessions, if you can call them that, when the "er" and "ah" sounds taken out of interviews and speeches by the thousands were spliced together in what resembled a long strip of splicing tape on one side. When played back, the tape sounded like a kid with a new toy machine gun.

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### EQUALIZATION AND FILTERING

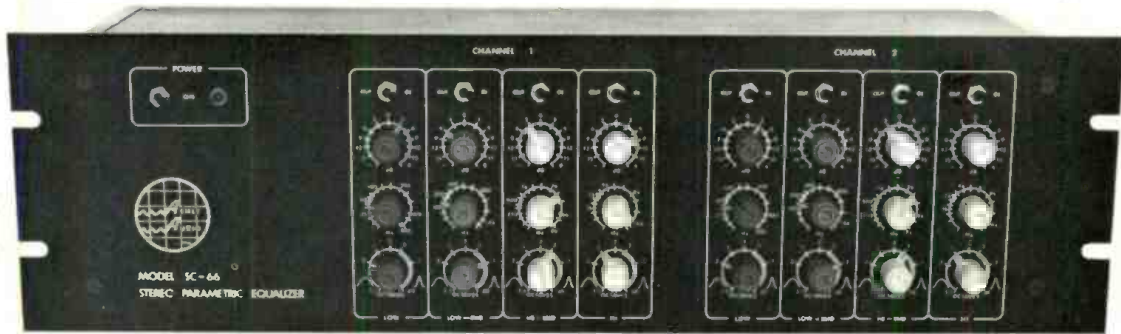
Equalization and filtering were very important in many instances. Phone lines are made very cleverly. They have a narrow frequency range around the 3,000 Hz point with some peaking in that area. This is the neighborhood in which the ear is most sensitive. It helps tremendously to use this knowledge when the recorded material is of poor quality. Although equalizing the voice can help clarity, it is also obvious that there is a similar quality change in the background sound. In most cases this may not matter much, but where the edited material has to fit into some other tape, the variation is important. As Mort indicated, a change in the background sound (including quality) is readily detectable, especially since the ears are doing all the work. (When some visuals such as film or even slides are used in conjunction with the sound, it probably matters less.)

One way to cover, or mask, the edit point is to insert one of those "er" or "ah" sounds, or a cough, or a car or fog horn, or a drum beat . . . something which is "natural" to the real background. It's amazing how the ear, or the brain, will accept this interruption and possibly not realize that the background has changed slightly.

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## sound with images (cont.)

Some masking is also possible with the continuous loop trick by adding an almost indistinguishable background sound to the whole section of tape.

On several occasions, the technique of "blending" or "mixing" two identical tapes to make an edit came in handy when working on music tapes sent in for broadcasting from N.Y. to the network. Shortening selections by removing a chorus was a neat trick in itself, but there were times when it was necessary to edit a solo quarter note to an eighth note. You might think it would be easy to step up the speed of the note (from  $7\frac{1}{2}$  to 15 in./sec., for example), measure the length of the note, cut it in half, then dub back down to normal speed.

On the face of it, this might seem acceptable. It's not, really. First, you must realize that the note has certain transients at the impact or start of the note and again at the end. There are also tonal quality changes, depending on the instrument and the natural harmonics. Just cutting out half the note from the center might sound okay to the untrained ear, but it's for the trained professional musician that the edit should really be made if it is to be acceptable to the professional tape

editor. Cutting the tape physically can result in an *almost* imperceptible change in tone, or level, in the note or an *almost* inaudible "pop." By using the "blending" trick, the tape is kept in motion at the time of the "edit," eliminating the chance of a "pop" and allowing the engineer to adjust correctly for even the minutest level difference.

### JOEL TALL

Back in those days there was another member of the tape editing team working with the News Department. In fact, he was the proverbial leader of the team in the sense that he outranked the others in terms of experience and seniority. He worked with scissors like other tape editors at that time and then decided to find a better way. He did. He invented the editing block. His name is on all of them. He called it the EDITall block. His name is Joel Tall. He's considered by many to be the father of audio tape editing. (He fathered the block in about the late '40s.)

A little of what he learned about tape recording, he put into a book that was published more than twenty years ago, and which went out of print less than ten years ago. In this book, some of the material he discussed relates to the characteristics of hearing and how it is possible to take advan-

tage of these to "fool" the ear, or "un-fool" it. (He has been asked several times to be the expert "friend-of-the-court" where tape was involved in a legal case.)

Joe found that aural persistence is about 0.04 seconds, much less than it is for the eyes. He also found that it varies with frequency, being greater at mid-range than at either lower or higher frequencies. Another phenomenon that came up in his work had to do with shocking the ear on hearing a sudden, new, or strange sound.

### VERTICAL CUT

When Joe edited tape with a vertical cut, he found that there was a definite click at both the in-cut and the out-cut at 100 Hz. At higher frequencies, the click sound seemed to decrease. At the 45 degree cut he put on his editing block, there was no click. A similar effect is also heard when an editor puts two words unnaturally close together. Actually, it could be shown that there was no click on the tape. It was a sound that the ear seemed to hear, but it could not be edited out by cutting. This had to be recognized before the tape was overcut. The way to eliminate the false sound is to add a bit of space with background sound. Opening the edit with about  $\frac{1}{2}$  in. of tape seems to let the ear "lose" the "click."

Joe has retired from day-to-day work, but he is still active in the audio field. He's working on a new book, and just applied for another patent on a modification to his editing block. The new item will now include a slot at 85 degrees. The 45-degree cut is fine for mono tapes or stereo, but with more than two tracks, a diagonal cut can make an edit on one of the tracks and will ruin the others. The front and back of the cut cannot be apart by more than about 0.03 seconds. At the 90 degree cut, which would be acceptable for sound, there is that "pop," or "click," either due to the magnetic oxide collected at the cut, or to the magnetization of the razor blade, or to the fact that the level of the background recording bias could jump severely from one side of the cut to the other side of the edit.

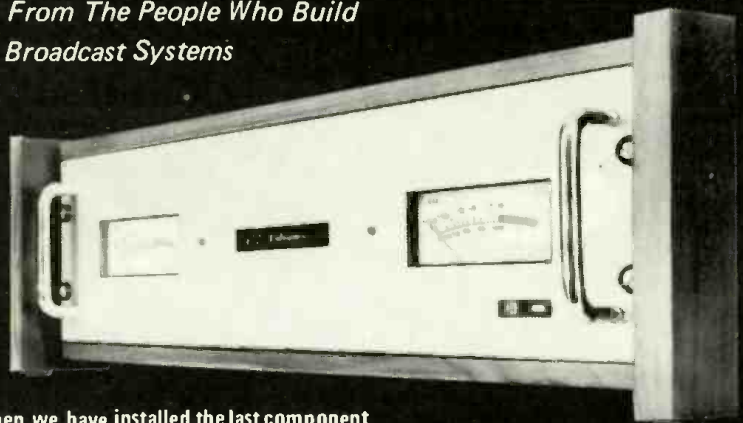
After extensive travel and discussion with engineers in various countries, Joe figured the 85-degree cut would solve the sound and the "click" problems. At that angle, tracks are cut within acceptable limits, and the bias current is averaged. With the time lag at 15 in./sec. being 0.01 sec. and at  $7\frac{1}{2}$  in./sec. being 0.02 sec., the audio tracks are not damaged.

### SEPARATE REEL

In his December article, Mort says

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that he puts his out-takes on a separate reel to save for future use. Take this recommendation seriously. It will come in handy for words, coughs, sounds, and background noise. Letting it run off on the floor during editing puts the out-takes under foot. Tape that has been jumbled up and wrinkled just doesn't sound right.

Joe, in his book, makes the recommendation that the tape editor not work under strain of any kind. The sound equipment should be the best, the surroundings as favorable as they can be, for the best editing results. Auditory fatigue can cause a shift in pitch perception, and the missing of short sounds, rendering a good editor incapable of proper judgment and resulting in faulty splices. Sometimes, during news crises, conditions for editing were not optimum, but Joe, and Mort, worked wonders—both during long and fatiguing hours. But Joe is right, when it is not necessary to edit under those circumstances—don't!

A few personal random thoughts ... Use 1.5 mil tape when there will be editing with a razor blade. The thinner material does not cut well, rolls, and stretches easily so that the sound can become very distorted at the edit points. Use a sharp razor (the single-edged type, please, or you'll get the nickname "Four Fingers"). One way to pick up a little bit of time in the playing time of any material is to wrap a layer or two of splicing tape around the capstan. This trick will not change the speed of the machine, but by making the capstan shaft bigger in diameter will cause the tape to be pulled through a bit faster. There is a limit to capability of this technique; be sure the sticky tape does not catch on the back of the audio tape or you could be in trouble.

If the edit cuts you're about to make seem almost futile or impossible to do, do not use the only copy you have of a one-and-only recording. This is nothing short of dumb if you can't re-fix the original tape. All you will be doing in this foolhardiness is proving the Murphy Law that if something can get loused up—it will! Finally, just remember that the edit block was invented to make editing easier (not for the benefit of the single edge blade industry) but it takes common sense, careful listening, and lots and lots of practice. Good tape editing is something like a good reinforcement system; you shouldn't be able to tell that it's there at all. You should learn not only the *tricks* of the trade, but the *trade* itself.

Thanks for letting me recollect a few memories. It sure was a pleasure working with those greats back when ...

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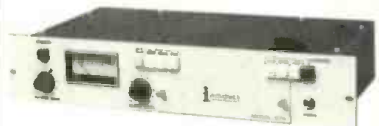
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Mfr: MicMix Audio Products, Inc.

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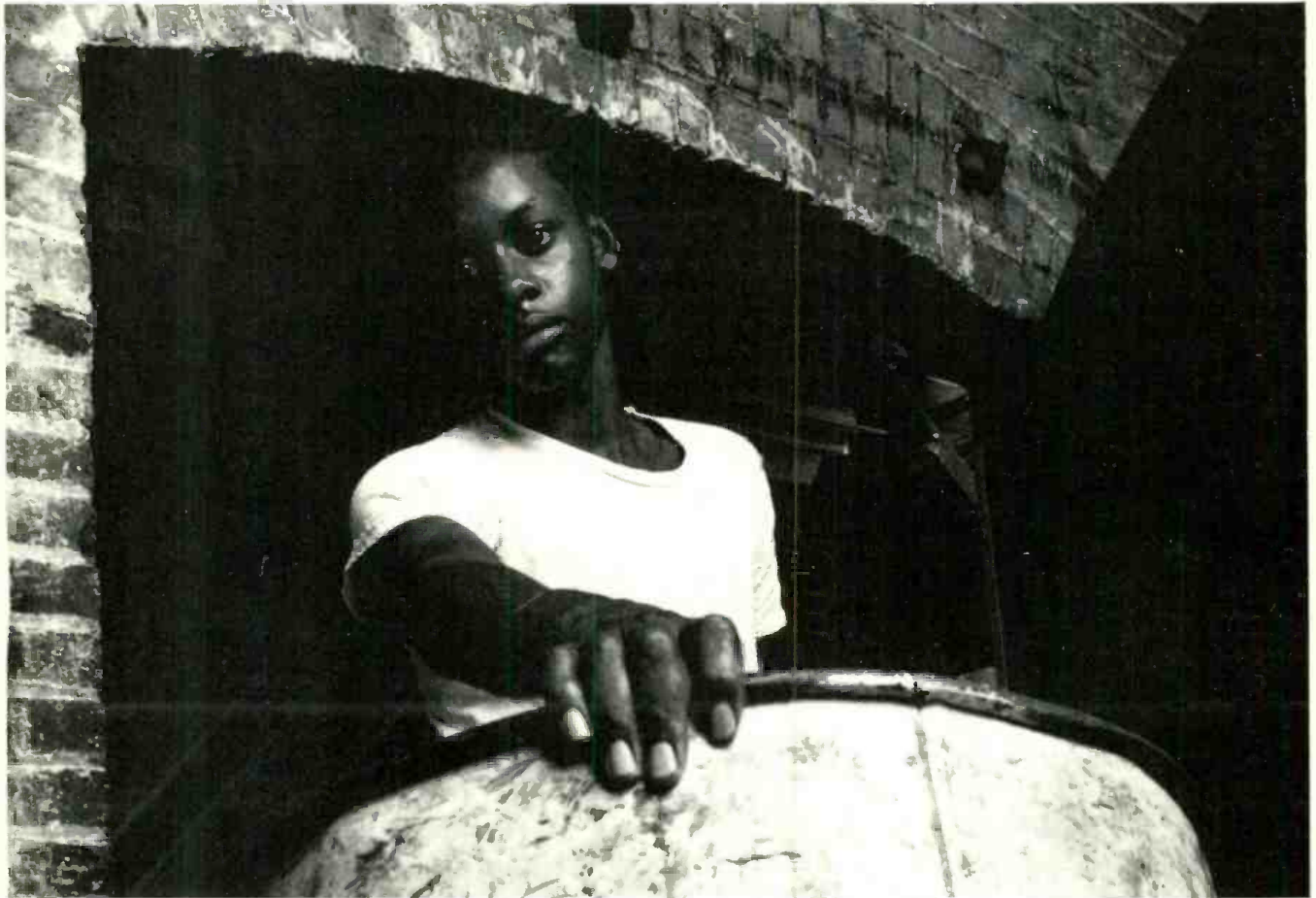
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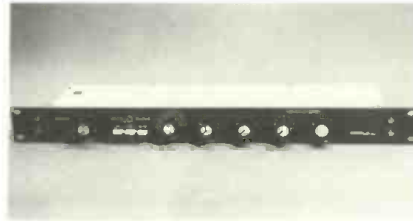
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*Mfr: Micmix Audio Products, Inc.*

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*Mfr: Analog Engineering Assoc.*

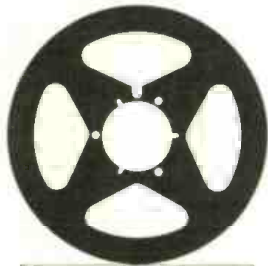
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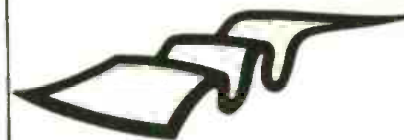
Performance data and other information on two new series of linear motion faders and joystick quadriphonic pan potentiometers. Mfr: Penny & Giles Conductive Plastics Ltd.

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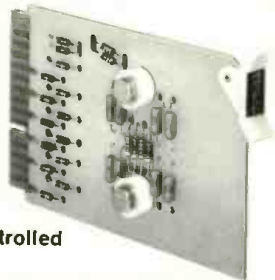
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## new products (cont.)

### PUBLIC ADDRESS SPEAKERS



● New series 403T, 405T, and 409T loudspeaker/70-volt transformer assemblies are designed for indoor p.a. and music reproduction systems. The 70-volt transformer has a maximum insertion loss of 1.0 dB and primary wattage taps of 0.5, 1, 2, and 4 watts. The compact speakers, which may be flush mounted in any type of wall or ceiling, feature wide distribution angles that enable large areas to be covered with few units.

Mfr: Altec Sound Products

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### MOVING COIL CARTRIDGES



● Certain unique features of design are present in this series of moving coil (electro dynamic) cartridges. The stylus cantilever is made of a specially-shaped aluminum alloy, which offers low mass as well as necessary stiffness. A patent is pending on a new damping mechanism as well as a squared pole piece with the shape of the magnetic structure devised to obtain improved linearity of the transducing elements. Models available include: SL 20E, for stereo and 4-channel matrix systems; MC 20, professional stereo and 4-channel unit, supplied with a fine-line stylus; SL 20Q very high quality unit developed for playing discrete 4-channel records. Designed for use with the cartridges, pre-amplifier MCA-76 has a subsonic filter which attenuates sound below 13 Hz and a switchable filter which changes the frequency response to 2-channel or 4-channel mode. A bypass switch makes it possible to bypass the amplifier when using magnetic cartridges.

Mfr: Ortofon (Harman Kardon, Inc.)

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### AUDIO DISTRIBUTION AMPLIFIER



● A transformerless bridging input, differential amplifier configuration, is claimed to deliver low distortion and noise from Model 7820 amplifier. The device provides eight balanced 600 ohm outputs, at up to +20 dBm level per output with a minimum of 80 dB of isolation between outputs, and from output to input. The amplifier is internally protected against short circuit and input overload. The unit may be rack mounted and contains its own power supply.

Mfr: Modular Audio Products

Price: \$330.00.

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### AUTOMATED MASTER CONTROL



● Automated computer controlled switching systems, for application in a.m. and/or f.m. radio master control areas provide control of signal routing, tape decks, transmitter, and radio plant supervision, while operating either from a real time program schedule, or sequentially, and logging all events as they occur. All systems in the series utilize one or more Data General Nova computers as the primary control element. Input/output devices provided include keyboard, teletype, and tape cassette. All audio switching is done by balanced solid-state crosspoints which are both transient free and noise immune. Switching by "cut," "fade-down/fade-up," and "cross-fade" are possible. Signal loss sensing and automatic fill are also available.

Mfr: Ward-Beck Systems Ltd.

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### GRAPHIC EQUALIZER

● Feedback suppression, room equalization, sound modification, and special effects are functions of the Model EQ/210 graphic equalizer. The dual-channel, 10-band unit uses no wound coils as inductors. Modified gyrator circuits are employed, with either conventional single-ended or transformerless balanced line for inputs and outputs incorporated. Claimed signal-to-noise ratio is -100 dB. Frequency response is  $\pm 1$  dB from 20 Hz to 25 kHz.

Mfr: *Biamp Systems, Inc.*

Price: \$229.

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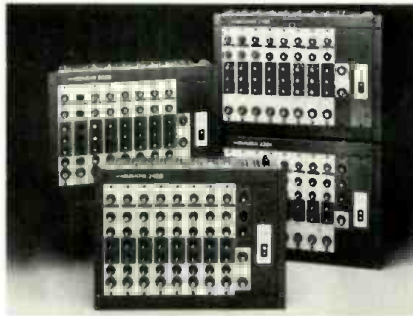


### RECORDING/LIVE MIXERS

● Application to both recording needs and to live performance is the intent of series 2000 mixers. All four mixers are rack-mountable and have eight modular channels. The integrated systems can be patched in a number of configurations. There are separate monitor controls for each channel. Models 2180 and 2380 are mono; models 2280 and 2480 are stereo.

Mfr: *Sunn Musical Equipment Co.*

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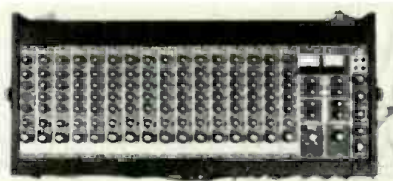


### MIXING CONSOLE

● Sixteen balanced and sixteen unbalanced low-Z inputs with four full range outputs are featured on HM 1600 mixing console. The unit also has a stereo two-way 800 Hz 12 dB/octave electronic crossover, low noise outboard power supply, individual input overload led, pan pots,  $\pm 20$  dB at 50 Hz and 7 kHz. Optional accessories include a four mix sub master module and a phaser module.

Mfr: *Heil Sound System*

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### TRAVELING MIXER

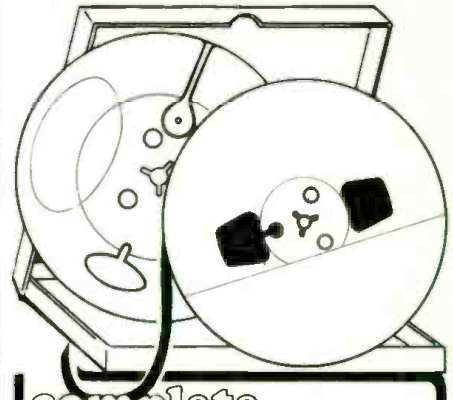
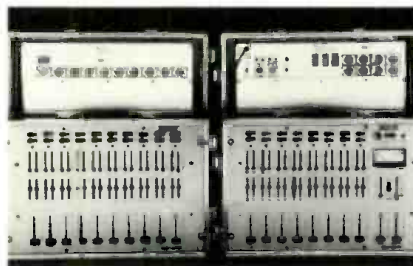
● Expandable and contractable Trouper II mixer has been designed for road use. It expands up to 38 inputs (8 inputs for the output control module and 10 inputs for each expander module). The unit contains separate monitor and echo send controls, echo receive, preview selector switch for listening to monitor or house outputs in the earphones, headphone jack and level control, phantom power supply for condenser microphone, house and monitor master level controls, vu meter with led peak indicator, high and low frequency eq., led peak indicators and mic pads. Each module weighs less than 30 pounds. A flight case is available.

Mfr: *Uni-Sync, Inc.*

Price: Output module: \$1,500

Input expander module: \$1,450.

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## Sabor corporation

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**TIME MARK GENERATOR**

● One main dial calibrates the sweep timing of the oscilloscopes in Model 6130A solid-state time mark generator. The single marker dial sets all 21 ranges from 0.1  $\mu$ S to 0.5 seconds, paralleling the 1, 2, and 5 sequence found on oscilloscopes. The dial's time/division setting can be multiplied by either 1, 2, 5, or 10. Marker frequencies are crystal controlled by a 10 MHz precision oscillator whose crystal is housed in a fast warmup, proportionally controlled, solid state oven. The frequency stability of the instrument is 3 ppm in 24 hours at 0.1  $\mu$ S (10 MHz) after 1.5 hours' operation (20 degrees to 30 degrees Celsius.) A special high stability ovenized oscillator with drift rates of three parts in  $10^9$  per day is optionally available. Applications of the device include calibrating the frequency and time modes of digital counters, the frequency dispersion of spectrum analyzers, and the best frequency calibration operation of signal generators and oscillators.

*Mfr: Ballantine Laboratories, Inc.*

*Price: \$845.00.*

*Circle 61 on Reader Service Card*



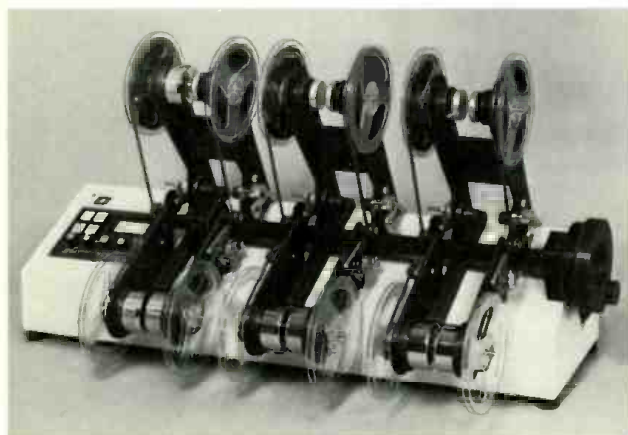
**AUDIO LIMITER**



● Precise modulation level control of f.m. transmission systems is offered by Model TFL-280 audio limiter. In addition to f.m. monaural, stereo, quadriphonic, SCA and t.v., audio can be processed by the frequency conscious limiter, particularly emphasizing the solution of problems in the transmission of pre-emphasized audio. The device utilizes existing stereo generating equipment, operated with optimum modulation; a field-removable audio low-pass filter located prior to the stereo and SCA spectrum. The unit remains in the audio chain for EBS two-tone transmission and proof of performance measurements. Multi-channel AGC interconnection terminals are provided for two or more channel operation.

*Mfr: Mosely Associates, Inc.*

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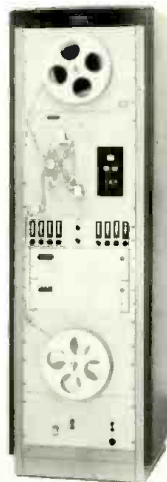
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*Circle 38 on Reader Service Card*

**PLAYBACK INSPECTION CONSOLE**



● All S-8 film formats can be handled by Model 880 super 8 playback inspection console. checking sound reproduction transfers on S-8 single strand, 16 mm/S-8 (1-3 & 1-4). or quad (5R) film formats at one and two times real time. The system is calibrated against SMPTE super 8 test films for frequency response, signal level, flutter and azimuth alignment prior to shipping. A dual drum, dual sprocket film transport provides a simple film threading path; all tracks are monitored simultaneously on vu meters with switch selectable audio for loudspeaker monitoring. Applications include quality-checking recordings before slitting, and use along with a transfer console or panel printers with sound recording capability.

*Mfr: Wide Range Electronics Corp.*

*Price: \$4,650.00.*

*Circle 63 on Reader Service Card*



## SOUND LEVEL METER

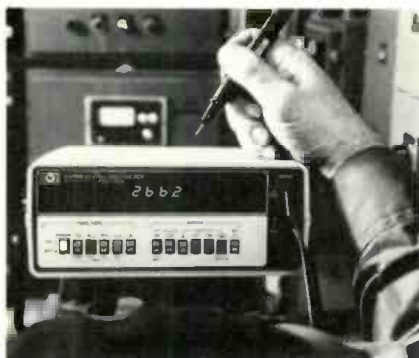


• Digital and analog displays are both inherent in the Model 1981-B sound-level meter. The device, with a measurement range of 30 to 120 dBA in two switch-selectable 50 dB ranges, meets ANSI S1A and IEC 179 standards. It is possible to hold and display the maximum level measured on the digital display while the analog meter continues to indicate lower levels; either fast or slow detector response may be selected for this measurement.

*Mfr: GenRad, Inc.*

*Circle 64 on Reader Service Card*

## DIGITAL MULTIMETER



• A convenient touch-hold probe available as an accessory for Model 3465B digital multimeter enables the user to freeze the reading on the led display. The battery/a.c. portable 4½ digit, five-function multimeter has a d.c. measurement range from one microvolt to one kilovolt with a mid-range accuracy of  $\pm$  (0.2 per cent of reading + 0.01 per cent of range) for one year. The a.c. measurement range is 10 microvolt to 500 volts with a mid-range accuracy of  $\pm$  (0.15 per cent of reading + 0.05 per cent of range) over a 40 Hz to 20 kHz bandwidth. A.c. and d.c. current measurement range is from 10 nanoamps to two amps. D.c. current accuracy for the 10 mA range is  $\pm$  (0.1 per cent of reading + 0.01 per cent of range). A.c. current measurements are made over a frequency band of 40 Hz to 20 kHz with a mid-band accuracy of  $\pm$  (0.25 per cent of reading + 0.25 per cent of range). Open circuit voltage on the ohms terminal, when set to its lowest range, does not exceed 5 volts. The use of a single instead of double reference makes possible a reduction in components, improved stability, and simplified calibration.

*Mfr: Hewlett-Packard Co.*

*Price: \$500.00.*

*Circle 66 on Reader Service Card*

## TAPE POSITION LOCATOR

• A microprocessor in a compact, self-contained calculator-style case, Selectake II is designed to be used remotely for programming cues. The process involves entering a "store" command and the digitally displayed time on a keyboard. Up to nine separate cues can be stored in the unit's memory; no information is placed on the tape. Cue recall is accomplished by touching the recall key, number key corresponding to the store position, and locate key, which moves the tape drive to the specified location at high speed, stopping within one count of the cue point. The control panel contains the usual control functions—rewind, forward, record, stop, play, and locate. Both digital time and locate readouts cover minutes from 0.00 through 99.99. The display is "frozen" upon tape run out, allowing rethreading without loss of location. High-low switching is automatic; 7½-15 or 15-30 in/sec. ranges can be achieved manually.

*Mfr: 3M Company*

*Price: \$1,750.*

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# The Making of the Ampex ATR-100, Part 2

*In this concluding segment, the Ampex engineers discuss the four tape speeds, the development of the electronics for superior headroom and phase coherence, timing accuracy for radio broadcasts, and finally future machines to come from this technology.*

**T**HE ROUNDTABLE consisted of Robert P. Harshberger, Jr., staff engineer who did the motors and control systems; Alastair M. Heaslett, senior staff engineer whose responsibility included the signal electronics; and Roger R. Sleger, senior engineer who created the mechanical systems (and whose name we misspelled in the picture captions in part one). Also present, and in whose office we sat, was Frank Santucci, the audio product manager for the project and its marketing.

The ATR-100 is a four speed tape machine, but in practice only two speeds at a time can be selected. The other two speeds are available and require circuit board changes to achieve. What I wanted to know was why this method had been selected rather than making it a simple four speed front panel selection alone.

"Mechanically, with the type of servos we are using, four speed operation was easy to implement. However, it must be realized that for every speed you have you must also have a full set of equalizers for both play and record. So, to have a four speed operation from the front panel you would need two more complete sets of equalizers. This, of course, would raise the price significantly.

"It was the considered opinion of both engineering and marketing that few potential users need four speed operation. Rather, most people tend to work at one dominant speed with another as secondary. In the broadcast field the primary speed is  $7\frac{1}{2}$  in/sec and sometimes 15 in/sec, with an equal amount at  $3\frac{3}{4}$  in/sec. In the recording field, the dominant speed in Europe is 15 in/sec, and in the U.S. 30 in/sec, with 15 in/sec as a secondary speed.

"All that is required to change to any other speed not already set up is more a jumper on each audio board. For each channel there are two jumpers which select the respective two speeds at which the machine will operate. You only have to reposition those on each channel. Then, of course, you will have to readjust equalization for the speeds you want to use. Incidentally, the machine will

only operate at the two speeds selected on the boards. Setting the front panel speed switch to another speed will cause the machine to refuse to function.

"There is no jumbling required for the servos. The audio signal boards control the speed at which the servos will run.

## THE ELECTRONICS DESIGN

My basic question to the group was what was done to the electronic design to get the ATR-100 to be so much better than the 440-C model.

"The short quick answer is that the electronics are designed with margins that accommodate the existing tapes. These tapes may be two or three generations old. The improvements of tape performance over the last five years have been such that these margins have been eroded to the extent that the headroom to electronic saturation above the tape operating level has got to the point where there's not much left anymore.

"In general, however, the ATR-100 improvements have consisted of just attention to detail in each individual element of the signal paths and ensuring that there is enough headroom for today's and tomorrow's tapes.

"Let's put some numbers on headroom. In the reproduce electronics of the ATR-100, the headroom approaches 40 dB and for the record electronics, there is the capability of driving the record head with a signal that is 30-35 dB above operating level (or what we assume as operating level today before any intrinsic internal clipping occurs).

"This headroom is not fully apparent if you take an ATR-100 and drive it to see what happens. Under that condition we would be talking about 20-25 dB of headroom—with modern tapes. That used to be a pretty good number and still is. The 440 had that number when applied to the tapes of its day, but modern tapes have considerably eroded it.

"There are other factors that give the electronics their

present qualities. We've made sure the system is linear from a distortion viewpoint, all the way to the overload point. From a purely design view, that meant circuits with output stages that are symmetrical.

"In short, it was an effort to ensure that there would be enough margin for today's tapes, while adding a bit more to provide for a few more years of tape development.

### PHASE COHERENCE

Intertrack phase relationships on most multi-track machines are pretty poor. Ampex made a special effort to achieve a high degree of intertrack phase coherence on the ATR-100. I wanted to know how this had been achieved.

"Intertrack phase coherence is affected by many factors. In part one we talked about the design and construction of the tape heads. With our heads, mechanical gap scatter is so small as to be difficult to measure even with visible light.

"The precision with which the head and the rest of the machine is aligned mechanically is also important.

"Now if a machine is set up without paying attention to these details, you will end up with a system that has inter-track gap scatter. If phase differences were caused by differing track head impedances, you could still do some correction by careful alignment of the heads. This is, of course, a mechanical correction for an electrical problem.

"Where the ATR-100 is different from other machines is that a great deal of attention has been given to making sure that the performance of the two channels, or any pair of channels, is as identical as possible to each other. Once these electrical differences are worked out, you are left with the mechanical ones. And these can be readily corrected.

"It is fundamental to the process of magnetic recording that there will be phase non-linearity in the channel. The direct effect of this is that if you put a pulse into the system, and reproduce it, and the apparent amplitude response to the system is flat over any desirable frequency range, the pulse comes out the other end distorted. The form of the distortion is not important, but the fact is that the pulse is not faithfully reproduced. One could ask if the amplitude response is flat, why doesn't the pulse response come flat?

"The answer is because the process has nonlinear phase things happening in it due to the process of magnetic recording. Having said that, now we can go back and say why the ATR is different. There have been attempts in the past on professional machines to put appropriate phase equalization circuits into the electronics with the aim of producing a machine which will reproduce pulses correctly as they are recorded: The drawback to these systems has been that the phase equalization has been accomplished principally during reproducing. The factors which influence the nonlinearity in terms of phase recording are intimately bound up with the particular record head (what was its physical gap length, what was the coating thickness of the tape, how did the user choose to bias the tape?) and a lot of other similar factors. Of course, on that particular machine you could adjust this phase equalizer and indeed come out with a very good replica of a square wave coming off the tape.

"The problem was that the recording that you produced is not compatible in the sense that now you take this recording and play it on another machine which is equalized to reproduce the sine wave response correctly, but it would not possess these good phase characteristics. In a similar sense, if you took a recording that was made on another machine, and play it on this machine which had the phase equalization present, it might help the phase response, but it might make it worse because it just depends on the par-



*The Ampex ATR-100.*

ticular set of circumstances under which that machine was aligned.

"There is another disadvantage in the fact that you're doing it in the reproduce process. There's sort of an engineering dictum that goes around here that says if there's a knob to be adjusted, someone will adjust it wrong.

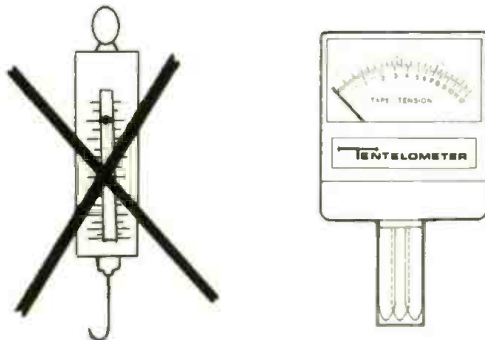
"The way the ATR-100 is different is, first of all, we looked at the possibility of putting phase equalization in the system in such a way that it reproduced a recording which had a compatible phase in the sense that if you made a recording correctly, you should be able to play it back on any other suitably designed machine with equally good phase performance. In other words, you're making a compatible recording which possesses proper linear phase characteristics when played back on a normally equalized system.

"Part of the design is a record equalizer which is capable of being adjusted with a potentiometer (opposed to a capacitor as are virtually all current record equalizers) over the entire range of speeds operating the systems from 3 $\frac{3}{4}$  in/sec all the way through to 30 in/sec. The rather novel circuit possesses the property of producing phase rotation in the required direction to improve the phase linearity

*A closeup of the ATR-100 control panel matrix.*



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*I had the rare privilege of a short interview with Alexander M. Poniatoff, founder of Ampex, still active in the company although in his eighties. He posed for my camera, seated at his desk.*

recording. The nice part of it is that the user is totally unaware of the fact that while he is adjusting his record equalizer to produce a flat amplitude response, he is also adjusting the phase equalization of the system so that the overall phase linearities of the system are considerably better than if the classical kind of record equalizer were used. If you adjust the record amplitude response of the system for a particular type of tape, you produce the correct phase response. By having the phase correction on the record side, the result is a tape that is more phase linear and you can benefit from it on any machine on which it is played."

**TIMING ACCURACY**

The ATR-100 is well suited to the needs of broadcasting. In this field, timing consistency and accuracy is important, and it was toward this that we talked.

"Let's look at the worst possible case—a one hour program recorded on one machine and played on another. Under such conditions the total error in one hour would be less than two seconds. More likely, it will be under one second. If, in fact the recording is made today, and played back on the same machine tomorrow, the maximum error will be less than one second."

**ONE AND TWO INCH MACHINES**

The present configuration of the ATR-100 is as a quarter- or half-inch only machine. In an attempt to look into the future, I asked about the probability of machines using the new technology for the larger format. The question was fielded by Frank Santucci.

"It must be understood that any larger format is a totally different machine from the ATR-100. The tape handling is different; the control system is different. If we were to start the design today, it would be at least three years before the machine saw the light of production day. Of course, we are looking at one and two inch machines with the performance characteristics of the ATR-100. But there are practical problems. Two inch ferrite heads are a whole new ball game at the very least.

"Of course, Ampex is looking at this project, but it certainly has a long way to go down the pike before it sees production."

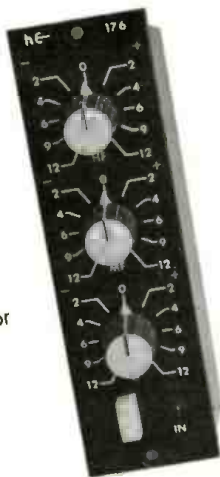
It is easy to become impressed with the product after an interview such as this. But the specifications of the ATR-100 really tell the full story. It's all the story that has to be told. ■

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ROBERT C. EHLE

# A Homebrew Multi-Media Show

*Using a couple of your surplus amplifiers, an oscilloscope, and an old t.v. set, you can combine sound with dancing visual patterns.*

**W**HAT MUST INTRIGUE many experimenters is the notion of how they might utilize the technology they already have available and produce an interesting and sophisticated result with relatively little effort. I was thinking one day of the variety of sophisticated electronic devices I have on hand and how I might interconnect them to produce various results. I have, for example, five television sets, five radios of various bands and types, ten or more amplifiers of various sorts, and four tape recorders. I might add that I do electronic music experimentation and like to connect such things as tape delays through several tape recorders, feedback loops through radio receivers using phone oscillators, and so forth.

My rumination turned to using some of those television receivers for an interesting experiment. Basically, the proposed technique was to use several of those amplifiers I mentioned to control the beam of a large screen television so that sounds would produce the pictures and one could watch his recordings in operation, or whatever else appealed to him.

As there are many ways that this project might be carried out, I will describe the equipment I used and how I did it and others can adapt this to whatever they have on hand. I have a 23-inch General Electric black/white television set with a weak picture tube. The picture is too dim for viewing comfortably. The set has a power transformer power supply. I also have a stereo radio/phonograph with transistor output, balance control, tone control and volume control. The phono input takes ceramic cartridges.

I used the stereo phonograph amplifiers to drive the

deflection yoke of the 23-inch television set. Basically, this simply involved disconnecting the speakers from the amplifier, the deflection yoke from its outputs, and connecting the amplifier to the yoke. I used the left channel for vertical deflection and the right amplifier channel for horizontal deflection. Then I connected the stereo amplifier in parallel with the pre-amp output of my sound system.

## VOLUME CONTROL

In operation, the volume control on the stereo amplifier controls the size of the display, the balance control determines the percentage of vertical to horizontal deflection, and the tone control handles detail in the display. A signal appearing in the right channel only produces a horizontal line, while one in the left channel produces a vertical line. Separate signals in the two channels produce lissajous patterns while stereo signals of varying phase create rotating patterns of various sorts. These are generally the most interesting of all and make very clear the difference between true stereo and synthetic stereo, which has different material on each channel.

The impedance of a high-fidelity amplifier intended to drive dynamic loudspeakers is close to that needed to drive deflection yokes, which are, after all, simply coils of wire similar to voice coils. Five to ten watts of amplifier power seems to be sufficient for even a 23-inch set; less would be required for smaller sets having less deflection. Although my television set was weak and did not produce sufficient brightness for pictures, I discovered that this was not a serious drawback in the application to sound displays because the beam does not move as fast nor cover so great an area as it does in television applications. The result is apparently greater brightness and contrast.

## Z MODULATION

In a normal television picture, the detail is produced against the raster by intensity-modulating the beam of the picture tube. This detail is normally inverted so that no

*Robert C. Ehle teaches at the School of Music, University of Northern Colorado, Greeley, Colorado.*

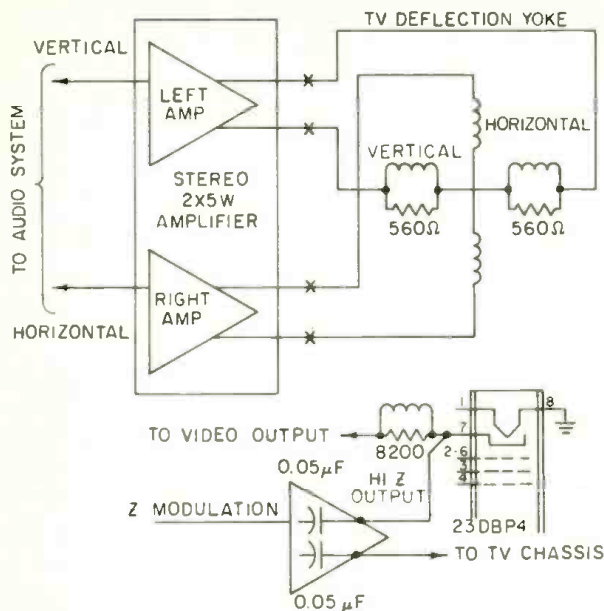


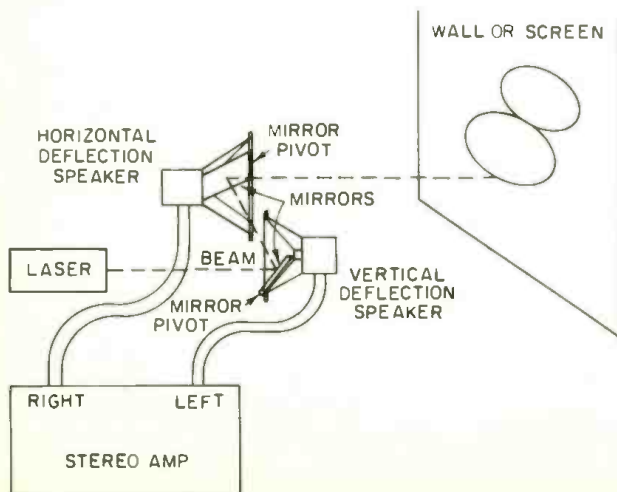
Figure 1. Circuit to modify a television set to display lissajous patterns from stereo sound.

signal produces a light screen and the presence of dark elements in the signal drive the tube toward cut-off. This intensity modulation is called *Z axis modulation* when applied to oscilloscopes and it can be incorporated into the setup described above.

In my own situation, I employed an old Admiral vacuum-tube radio amplifier for Z axis modulation. The advantage of using a vacuum-tube amplifier is that high impedance and a high voltage swing are required and can be easily obtained from such a unit. The output from the amplifier is taken from the primary side of the output transformer through two 0.05 microfarad capacitors to the cathode and chassis of the television set (which should have a transformer in the power supply). If no transformer was included in the set you choose to use, you should add an isolation transformer to eliminate shock hazard.

In using Z-axis modulation, full brightness will be obtained from a display on the left and right channels when the Z-mod. channel amplitude is zero. As a signal is inserted on the Z-mod. channel it will cause blanking to oc-

Figure 2. Diagram of a laser modulation system, useful for projecting oscilloscopic displays.



cur in areas of greatest signal amplitude. The effect of this on a display is to turn normal lissajous patterns into a series of dotted lines. It should be noted that even if you do not connect a Z-modulation circuit, the normal video output circuits may be used and a television signal received from a station may be used to Z-modulate the patterns in a random manner.

### MORE EXPENSIVE ADDITIONS

In addition to the circuit described, other variations may be employed. These include using a color t.v. set, use of dot, bar and test pattern generators, use of color dot and bar pattern generators with color sets, employment of projection television systems, causing a pre-recorded video tape recorder to play back special patterns, and use of laser deflection systems. However, most of these ideas require expensive equipment, not generally available in surplus to the experimenter. Still, it is worth considering a few points in connection with a few of the above additions.

### USE OF A COLOR TV

Not too many of us have a surplus color t.v. set around just for experimenting but in case you do, there are a few additional things you can add to the system. In the first place, a color set has only one set of deflection coils, so you can only drive one signal to the vertical and one to the horizontal, just as in the case of the monochrome set. The color set has three guns, however, and each one of these may be individually intensity-modulated.

The three guns are deflected together by the coils and focused on a triangle of dots in the three colors on the phosphor screen so, assuming that convergence, purity, etc. have been correctly set up before the sweep circuits were modified, each gun will tend to keep its place in the triangle with the other two. Note, though, that the amount of deflection is a variable, depending on the input signals, so there is no way that each gun can project only on its own color of phosphor. Thus, there is no way to predict which color each gun will energize.

Therefore, the color-patterns will be random. In intensity-modulating each of the three color guns, a separate amplifier is required, just as a single amplifier is used for a monochrome set.

### USE OF COLOR AND MONOCHROME PATTERN GENERATORS

These generators have circuitry that generates signals which coordinate with the vertical and horizontal oscillators in a television system. Therefore, once the internal oscillators have been disconnected, there is no way to project the intended patterns. The effect will be random intensity modulation.

### PROJECTION SYSTEM

A few expensive projection systems have been built. If one is lucky enough to have a theater with a projection video system for television, this may be used. Most color projection systems are not particularly intense. The most successful projection system for oscilloscopic display is a laser type, using two deflection mirrors attached to loudspeakers, driven from audio sources and a low power laser. Color systems have been built using several different colors of laser beams. Morton Subotnick, the electronic music composer and performer, uses such a laser projection system, along with movies, lights, synthesizers and pre-recorded tapes in his multi-media presentations. The effect is quite spectacular.

### SOUND DISPLAY UNIT

To get back to practicalities, I want to describe ways I've used my display system and the effects I've achieved. First, let me point out that I do electronic music demon-

strations in a rather small room and have often used oscilloscopes so that the audience can watch the waveforms of the sounds as I generate them with a synthesizer. The problem is the typical size of an oscilloscope screen (3-5 inches), but my 23-inch television set provides a satisfactory display. Also, using internal sweep on an oscilloscope means that synchronization is achieved only rarely and that the display is often a confused jumble. With my television display, I have a separate signal from my synthesizer for the left and right channels to the television display and I can actually play the display by selecting sounds from the synthesizer oscillators that produce the most interesting patterns.

I watch the display as I play the synthesizer and work for interesting visual results as well as interesting aural ones. The combination of the two stimuli makes the result much more interesting to the audience, I find, as the two reinforce each other. An interesting visual pattern will attract attention to the sound and *vice versa*. Playing on such an audio-video synthesizing system is an experience as well—both senses are titillated with effects that are deliberately controlled by the performer. In the usual "light show" such combinations are left to chance because the music or other sound is prepared in advance without consideration of visual effects.

By connecting three different oscillators and other generators to the X, Y and Z channels of the television set, it is possible to generate some very spectacular animated displays. It seems that low-frequency oscillators create this sense of animation best. They may be mixed with higher frequencies, or, better yet, frequency-modulate higher frequency oscillators so that the result is a switching of patterns at fixed rates. Such circuits as voltage-controlled os-

cillators, ring modulators and electronic metronomes may be used to advantage to create interesting patterns and motion. Anyone having a synthesizer will find that such a display adds a considerable new dimension to its enjoyment.

#### WATCHING RECORDS

It may make a good joke, but with such a system you can tell your friends that you are going home to "watch a few sides!" Seriously, many records produce spectacular visual results and you may find yourself going through your record collection to see what sorts of effects you can discover. As pointed out earlier, changing phase relationships between the channels cause patterns to rotate on the screen at the speed of the phase shift. Also, since the ear responds to the logarithm of the amplitude (the decibel scale) in its perception of loudness, while the video display responds to the amplitude directly (in the form of voltage), a very small change in loudness can produce a large change in the size of the display. The display can be a very vivid replica of the sound as a result, calling attention to the smallest details.

Since one channel produces vertical deflection and the other channel, horizontal, a combination of two channels carrying the same signal, in phase, produces one diagonal and, out of phase, the opposite diagonal. Thus the device serves as a good indicator of channel separation. It would be possible with some differential amplifiers and a resistor matrix to convert the display to a four-channel display of the sort employed in some audio equipment. It would also be possible to display matrix quad records to see the in-phase information and out-of-phase information. But that's another project, beyond my intentions at this time. ■

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# Sheet Lead Insulation in Recording Studios

*Consideration of lead sheets for noise insulation includes a hard look at extra cost as well as the efficiency of the material.*

**I**N DISCUSSIONS concerning the sound proofing of a partition between two adjacent rock recording studios intended to be employed for simultaneous recording sessions, the use of sheet lead is almost always mentioned. It seems to carry a magic connotation, as if the material had sound insulating qualities far above the more common building products, assuring excellence in sound insulation. It is the purpose of the following to examine the advantages and disadvantages of sheet lead for the sound attenuation of barriers.

## ACOUSTIC MASS LAW

To break the "spell" of lead immediately, it may be said that at 500 hertz it is no better than any other product of equal surface density, that is, mass per square foot. This may be quantitatively conveyed by stating the *acoustic mass law*:

$$TL_{500} = 23 + 14.5 \log M$$

$$= 13 + 14.5 \log M^1$$

where  $TL_{500}$  = sound transmission loss of a homogenous barrier

$M$  = surface density of barrier, lbs./sq. ft.  
 $M^1$  = surface density of barrier, kg/m<sup>2</sup>

The above equation pertains to random sound incidence, and was derived empirically. It agrees well with theory, except for the fact that it does not quite provide an increase of 6 dB for double the surface density, but one of only 4.5 dB. Except for the low- and high-frequency resonances associated with such panels, the sound transmission loss between these resonances increases 6 decibels per octave above 500 hertz and decreases a similar amount per octave below 500 hertz.

One advantage of lead lies in the fact that its coincidence frequency is higher than that of any other building material with the same surface density. This latter condition in such comparison evaluations, because, as shown above, near 500 hertz, materials of equal surface density offer the same amount of sound attenuation. Wave coincidence occurs when the wavelength of the bending wave in the panel equals that of the incident sound in air; this causes the amplitude of the transmitted signal on the far side of

the barrier to be almost equal to that on the source side. The frequency at which wave coincidence occurs in a simple partition is given by

$$f_c = \frac{2 \times 10^6}{d} \sqrt{\frac{D}{E}}$$

where  $D$  = density of panel material, kg/m<sup>3</sup>  
 $E$  = modulus of elasticity, kg/m<sup>2</sup>  
 $d$  = thickness of panel, cm

## PANEL THICKNESS

The table below gives the panel thickness in both centimeters and inches of various building materials which have the equal surface density of 48.82 kg/m<sup>2</sup> (10 lbs./sq. ft.).

Material	cm <sup>d</sup>	inch	D/E	f <sub>c</sub> (Hz)
Lead	0.431	0.17	6.65x10 <sup>-6</sup>	12,000
Plywood	3.180	1.25	0.5x10 <sup>-6</sup>	422
Concrete	2.12	0.833	1.04x10 <sup>-6</sup>	1000

The surface density of 10 lbs./sq. ft. in the above table was chosen because it conforms well with the surface density of *one* wall of a double-stud partition separated several inches from the other, as is often the construction of a partition between two recording studios.

FIGURE 1 shows the sound transmission loss characteristics of the three materials listed in the above table when they have the same surface density. It is seen that the 0.431 cm (0.17 in.) thick sheet lead is really a far better sound insulator above 5,000 hertz than required. The TL at this frequency for *one* stud wall is 57.5 dB, whereas at 125 hertz it is only 27 dB, the same as it is at the other materials. But it is exactly at the low frequencies where most recording studios' partitions are insulation-deficient, since the sound pressure levels of low musical notes is generally much greater than in those of the treble range.

The high coincidence frequency on the part of lead exists for all thicknesses of sheets as long as they are compared with other building materials having equal surface density. It is only by going to thicker sheets of lead (thicker than the 0.17 in. considered in the table) that this frequency can be lowered. Thus, by employing a 0.34 in. thick lead panel, weighing 20 lbs./sq. ft. the frequency can be halved to 6,000 hertz. Obviously by employing a sheet of lead thinner than 0.17 in., the frequency will be raised, as is evident from the equation for the coincidence frequency.

Michael Rettinger, a frequent contributor to *db*, is an acoustical consultant from Encino, California.



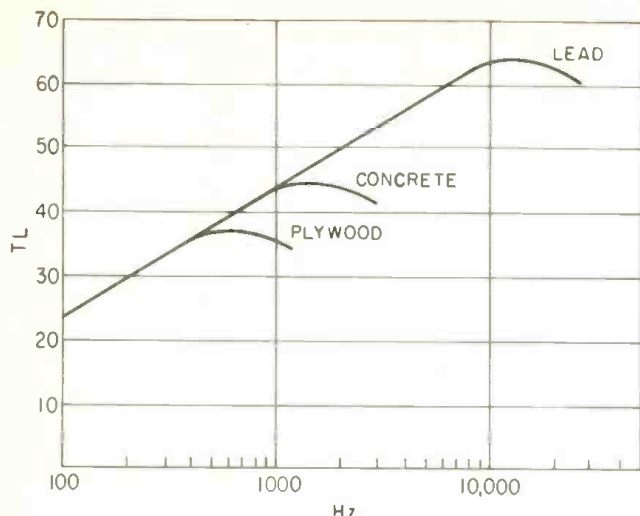


Figure 1. Sound transmission loss characteristics of plywood, concrete, and lead.

One advantage of lead is that it can readily take curvilinear shapes, because it is so soft, unlike plasterboard and plywood.

One decided disadvantage of lead is its cost when compared to other materials of equal surface density. Thus, presently, (1976), the price of sheet lead is 40¢/lb. Since ½ in. plasterboard, weighing 2 lbs./sq. ft. costs 8¢/sq. ft., it is seen that lead sheets comparable in sound insulation to plasterboard cost ten times as much.

#### PARTITION THINNESS

To overcome the structural weakness of sheet lead, and to take advantage of its high surface density to achieve a thin partition when the resulting increased floor space provides a return on the money, the material is advantageously employed in laminate form, whereby it is sandwiched between two sheets of plasterboard, plywood, Transite, etc.

We see, therefore, that the chief advantage of sheet lead in recording studios lies in the relative thinness of the partition required to achieve a desired sound transmission loss over most of the common audio frequency range, compared to other building materials of equal surface density. Its chief disadvantage lies in the high material cost per pound, compared to that of other building products of equal weight. This disadvantage can only be compensated for by the extra floor space resulting from the thinner partition—actually by the greater monetary return gained from the extra floor space. In the case of a 30 ft. long partition between two recording studios, where the sheet lead partition results in a 4 in. thinner partition (2 in. thinner measured from the center line of the partition) the extra floor space in each studio comes to  $30 \times 2 / 12 = 5$  square feet, representing possibly the floor space for one additional instrument in each studio.

Assume now that the above partition is 20 ft. high and is to have a surface density of 20 lbs./sq.ft. With sheet lead priced at 40¢/lb., the lead partition material will cost  $30 \times 20 \times 20 \times .4 = \$4,800$ , compared to the cost of an equally heavy plasterboard partition of \$960. Will the extra 10 square feet of floor area gained by the thinner lead partition return  $\$4,800 - \$960 = \$3,840$  within a few years?

The decision whether or not to use lead must incorporate the cost return on the gained space as well as lead's noise insulation capacity in relation to cheaper, but bulkier materials. ■

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PROFESSIONAL SOUND COMPONENTS from Crown, TAPCO, Soundcraft, Eventide, Community, dbx, Gauss, Soundcraftsmen, Spider/Peavey, Sound Workshop, Neumann, and many more. Hear it all at **Gary Gand Music, 172 Skokie Valley Rd., Highland Park, Illinois 60035. (312) 831-3080.**

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AMPEX AG-300-4 with sel-sync, in console, excellent condition. Also, equipment for complete home studio—will sell as package or will separate. TEAC Model 5's, Revox 2-track, MasterRoom reverb, JBL monitors, Beyer mics, etc. Hardly used and under warranty. Call (317) 849-0905 for details.

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CONSOLE, 12-IN/8-OUT, API 550 eq. and API 440 faders; 2 API 525 limiters; API 575 oscillator, full monitor mix, 2 cue busses, 4 echo busses, patch bay; Crown D-60; 2 producer's desks; much more. Tioga Recording, P.O. Box 205, Allegany, Oregon, 97407. (503) 267-2330.

ELECTRO-VOICE SENTRY III monitors, \$1,150.00/pair. Two MB 520 condenser mics, \$300.00. (214) 226-7179.

AMPEX 354. \$950.00. (305) 299-1299.

LOW \$\$'S. Ampex 440B (2), Scully 280-2 14 in., T.T.'s QRK (2) + SP 1300 (2), Marti limiter CLA-40H (3), Sparta mixer AS-30B, Belar SCM-1 & MORE!!! Contact "Media," G.C.S. Box 2776, N.Y.C. 10017 or (212) 661-4664.

STAGE & STUDIO AUDIO EQUIPMENT. Turn-key design, permanent, mobile, wiring/switching networks, flight cases, component sales. AKG, BGW, dbx, Eventide, JBL, Orban/Parasound, Otari, SAE, Sennheiser, Shure, Soundcraft, Sound Workshop, Tascam, and UREI. Midwest Sound, 4346 W. 63rd St., Chicago, Ill. 60629. (312) 767-7272.

STUDIO SOUND—Europe's leading professional magazine. Back issues available from July '73 through June '75. \$1 each, postpaid. 3P Recording, P.O. Box 99569, San Francisco, Ca. 94109.

RACK LABS STEREO active crossovers and 40 Hz hi-pass filters for hi fi or p.a. Write Rack Laboratories, 136 Park St., New Haven, Conn. 06511.

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WANTED: TASCAM 4- or 8-track 1/2" recorder with 501 or 701 electronics (and Model 10 consoles, modules & small Neve boards). V. Bond, Box 1946, Winnipeg, Manitoba, Canada R3C 3R2. (204) 888-6099.

WANTED: Three Neumann U-87 microphones; AKG BX-20E reverb. Call (201) 359-5520 after 6:00 p.m.; ask for Bernie.

#### BUSINESS OPPORTUNITIES

WANTED: INVESTMENT CAPITAL for sound equipment rental company. Pays 20% interest; minimum investment, \$5,000. Return principal and interest monthly within two years. Serco, 6820 Santa Monica Blvd., Los Angeles, Ca. 90038. (213) 461-2961.

WE ARE LOOKING for suitable distributors in the USA, for equipment including portable and studio mixing equipment for broadcast and multitrack recording applications, compressor/limiters, power amplifiers, distribution amplifiers, telephone hookups, equalizers, etc. Apply to Sales Manager:



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POSITION WANTED. Recent B.S.B.A. Magna Cum Laude, former pro musician (Berklee alumnus). Syn-Aud-Con grad, currently running small studio (4 & 8-track) desires work in large metropolitan area. Resume available upon request. Contact: Rick Devaney, 1200 Baxter St., Johnson City, Tenn. 37601. (615) 929-8715.

AUDIO/BROADCAST ENGINEER needed for public f.m. station with classical music emphasis. Duties include planning, design, installation, maintenance, and renovation of transmission and production technical facilities. FCC first class license, f.m. broadcast experience, and high interest in audio quality essential. Send resume, including salary requirements, to Engineer Search Committee, WGUC, U. of Cincinnati, Cincinnati, Ohio 45221. An equal opportunity employer.

INTERVIEWS now being scheduled for engineer/mixer positions at Suntrader. Persons must meet the unusual qualifications of technical expertise and level-headedness. Generous compensation commensurate with experience, etc. Maintenance capability not a strong factor. We're first class—24-track Studer—and we expect you to be. Send resume and salary history/requirements to J. Bergstrom, Manager, Suntrader, Beaver Meadow Rd., Sharon, Vermont 05065.

YOUNG GENERAL ELECTRONIC TECH, Recording Institute of America I & II, studio experience; desires studio work; very willing to work hard. Kevin R. Clock, 1263 Meade, Denver, Colorado. (303) 825-0743.

POET/ARTIST/AUDIO ENGINEER seeking work—graduate IAR, member AES, research experience; multidisciplinary: audio, language, visual, plastic, theater arts — in communications, language, music, and theater arts; wherein multitrack recording techniques, theory/experimentation are utilized in research/production/performance situations. Resume & references. Richard Chandler, Director, Ginnungagap Audio-X Group, 356 Maple Ave., Hartford, Ct., 06114. (203) 524-5504.

EXPERIENCED MUSIC MIXER  
For major N.Y.C. studio, expanding staff. Send resume to Dept. 72, db Magazine, 1120 Old Country Rd., Plainview, NY 11803.

- Announcement has been made of the election of **John E. Hammel** to the newly created position of assistant vice president, investor relations of the **General Telephone & Electronics Corporation**, of Stamford, Conn. Mr. Hammel has been with GTE since 1953, at which time he joined GTE's **Sylvania, Inc.** in an accounting capacity.

- Stepping up from the post of vice president of marketing/sales, **Larry Lynn** has been named as president of the **Sunn Musical Equipment Company**, of Tualatin, Oregon, a subsidiary of the **Hartzell Corporation**. Mr. Lynn will be responsible for the Sunn Musical Equipment group, including Sunn/Magna Professional Audio Products.

- Promotion to the post of national sales manager for **Hal Loman** has been announced by **Superscope, Inc.** of Chatsworth, Ca. Mr. Loman moves up from the position of vice president of Superscope Chicago, the firm's mid-west subsidiary.

- A second manufacturing facility, occupying about 26,000 square feet and costing \$4 million, is being constructed by the **Sony Corporation** in Dothan, Alabama. The new plant, manufacturing shells for the Betamax videocassette, is scheduled to be completed in October, 1977.

- Plant III, a new building which houses the main offices of the **Studer-Revox** organization, as well as their research and development, data processing and production facilities, has been opened at Regensdorf, Switzerland. The address is CH-8105 Regensdorf, Switzerland. Althardstrasse 30.

- Replacing **George DeRado**, **Masaji Takahashi** has assumed the position of president of **TEAC Corporation of America**. Mr. Takahashi had been executive vice president of TEAC Japan. Mr. DeRado, who is chairman of the board of **Damark Industries**, will maintain his connection with TEAC while concentrating on his duties at Damark.

- A 24-track studio has been opened in New York City by **Sigma Sound**, of Philadelphia. The facility contains a 25 x 40 foot studio with a 65 square foot glass isolation booth, a 17 x 20 control room and a listening lounge. The address is at 1697 Broadway.

- Two new sales engineers have been added to the staff at **Martin Audio Video Corporation**, of New York City. **Courtney Spencer** has a background of writing music and producing radio and t.v. commercials. **Tony Hawkins** comes from England, and has been associated with the **Revox Corp.**

- **International Rectifier** has opened a new facility at 348 Kansas St., El Segundo, Ca. to produce solar energy cells, photocell arrays for digital punched card and tape sensors, as well as silicon photocells for photometer and other sensing equipment. **Gerhard Fischer** has been appointed manager of the opto-electronics activity.

- **Russ Ide** has been appointed Rocky Mountains area sales engineer for the audio-video systems division of the **Ampex Corporation**, of Redwood City, Ca. Mr. Ide will cover the territory of Arizona, Colorado, Montana, New Mexico, Utah, Wyoming, and southern Idaho from the firm's Salt Lake City headquarters. He comes to Ampex from **TeleMation, Inc.**

- **Jensen Tools** of Phoenix, Arizona has named **Dave Hackenbruch** as national accounts manager. Mr. Hackenbruch's particular bailiwick will be consulting with firms requiring special or custom-designed tool kits.

- Studio attenuator and open-frame rotary switch product lines recently acquired from the **McGraw-Edison Company**, are being manufactured by **Shalco, Inc.** at their Smithfield, N.C. plant under the supervision of **Mike Sutton**. The products, which have been sold under the Daven name, retain the same part numbers and designs.

- Four telephone pioneers, **John A. Balch**, **Carl D. Brorein, Sr.**, **Chester H. Loveland**, and **Talbot G. Martin**, have been elected to the **Independent Telephone Hall of Fame**, a museum in Washington, D.C. Mr. Balch was active in the telephone's development in Hawaii. Mr. Brorein, starting his career in Florida, was a director of **General Telephone & Electronics**. New Yorker **Chester Loveland** was instrumental in purchasing utilities companies, which merged with **General Telephone & Electronics**. Inventor **Talbot G. Martin** installed the first private automatic telephone system in the White House for President McKinley in 1898. He was responsible for much of the research and development progress of the independent telephone industry.

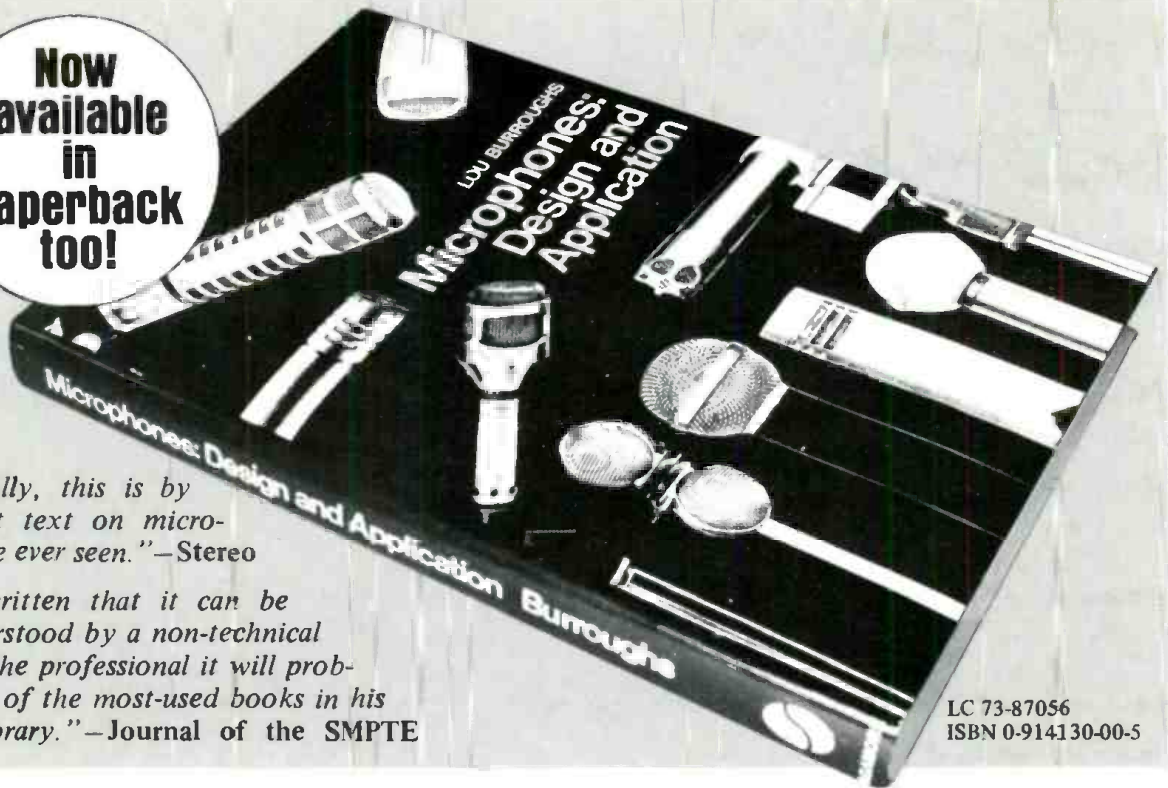
- Details are being finalized for the acquisition of **Switchcraft, Inc.** of Chicago by the **Raytheon Company**, of Lexington, Mass. Switchcraft will continue with its present management and other personnel and plant facilities in Chicago and Paxton, Ill. **Wilfred L. Larson** will continue as president. **Fred Dumke** as secretary-treasurer, and **William Dumke** as vice president for manufacturing and engineering.

- The new post of assistant sales manager at **Otari**, of San Carlos, Ca., has been filled by **Lewis Barrett**, coming from **Sound Genesis**. Mr. Barrett will service dealers and distributors of the firm's professional recorders and duplicators.

- Of interest to educators and others who buy audio-visual materials and equipment is a publication compiled by the **National Audio Visual Association** entitled **THE A-V CONNECTION: THE GUIDE TO FEDERAL FUNDS FOR AUDIO-VISUAL PROGRAMS**. Selling for \$15.00, the books are available from **NAVA**, 3150 Spring St., Fairfax, Va. 22030.

- A new 500 oersted video tape will be one of the products in the bailiwick of **Mike Skelton**, new product manager at the **Memorex Corp.** of Santa Clara, Ca. Mr. Skelton was previously based in the Great Lakes area.

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- Acoustic Phase Cancellation and the Single Microphone
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- Wide-Range vs. Controlled-Range Frequency Response
- Choosing Between an Omni-Directional and a Cardioid Microphone
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- Assembling a Superior Bi-Directional Microphone
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