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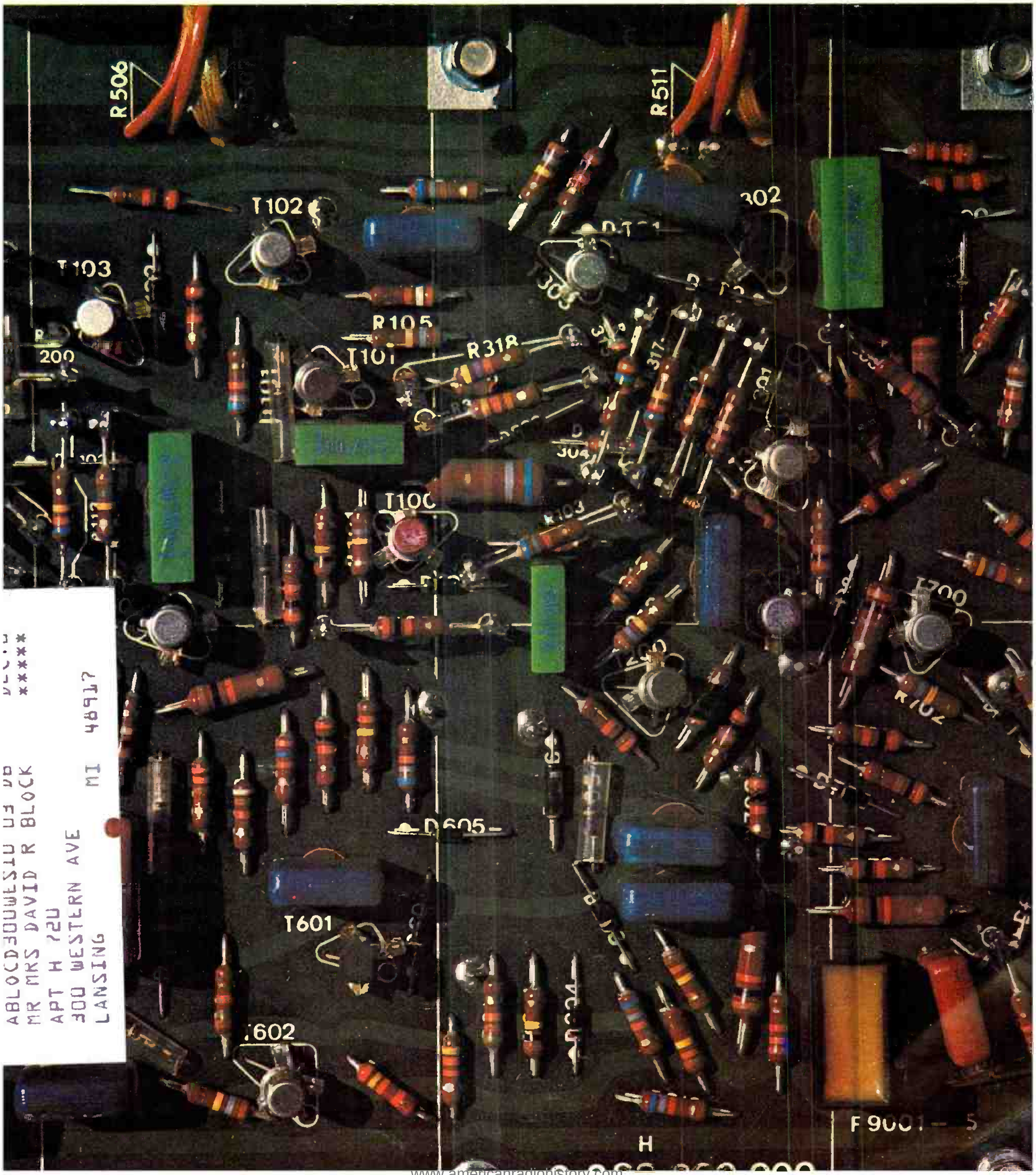
# db

THE SOUND ENGINEERING MAGAZINE

MARCH 1977 $1.00



# THE ADC CARTRIDGE CAUSES NO PERCEIVABLE WEAR OVER THE LIFE OF YOUR RECORDS.

Unbelievable? Believe it.

A series of tests conducted by a leading independent audio-testing laboratory prove it.

The tests show that the ADC XLM-MKII cartridge causes no perceivable wear until after 60 plays. Industry sources estimate the "life of a record" (the average number of times a record is played) to be 40 to 50 plays.

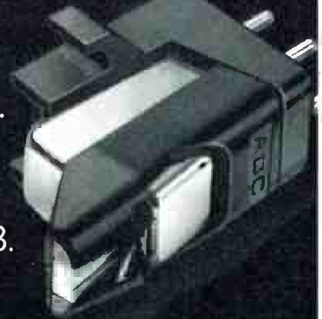
Other cartridge manufacturers may talk about less record wear, but ADC has proven *no wear over the life of your record.*

The reason for this is our unique patented design. It's patent #3294405.

We call it the "induced magnet" cartridge.

Most cartridges are designed so that a heavy magnet is part of the moving system.

The ADC XLM-MKII is different, because our engineers found a way to detach the magnet and reposition it above the stylus, so the stylus applies less pressure against the groove.



Less pressure means less wear.

The fact is, of all the leading brands, ADC cartridges have the lowest mass moving system you can buy. That means better sound and superior performance.

The XLM frequency response is exceptionally flat, from 15Hz to 24KHz ±1.5dB. And for the ultimate in stereo reproduction, it has a minimum of 28dB of channel separation.

Think about it. In the long run you'll probably spend more on your record collection than you will on your whole stereo system. So it makes sense to buy a cartridge with proof that it makes your records sound better and live longer.

The ADC low mass cartridge.

Unbelievable.

# THE ADC LOW MASS CARTRIDGE.

IT HELPS YOUR RECORDS LIVE LONGER.

A BSR COMPANY

ADC Phono Cartridges
A Division of
BSR Consumer Products Group
Rte. 303, Blauvelt, N.Y. 10913

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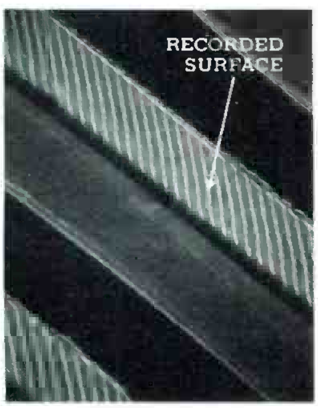


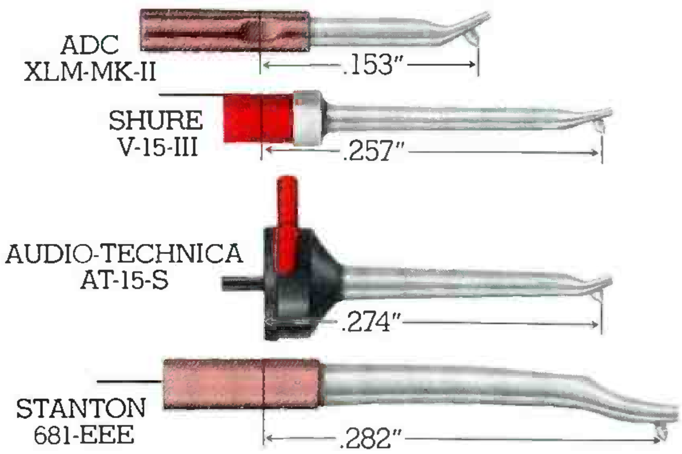

267X Magnification

This is a photomicrograph of a 20kHz record groove that has never been played before.


273X Magnification

This is a photomicrograph of a similar 20kHz record groove played 75 times with an ADC XLM-MKII cartridge. As you can see there is no difference.

## THE DIFFERENCE:




The way to get the most accurate reproduction of sound is to lower the total effective mass of the moving parts of the stylus. And that's exactly what our engineers did. In fact, of all the leading brands, ADC cartridges have the lowest mass moving system you can buy.

INDUCED MAGNET

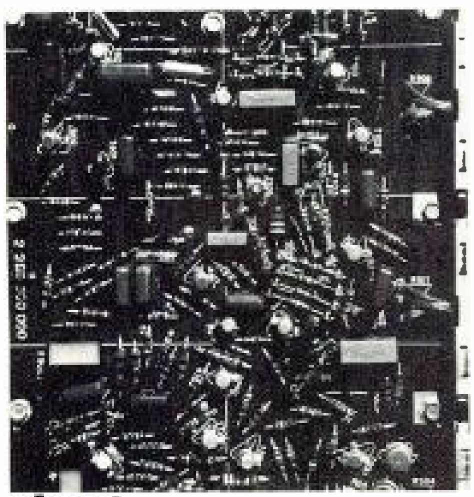
MAGNET

If you'd like your own personal copy of the test result, write to ADC at address shown above.

*Circle 10 on Reader Service Card*

## coming next month

- A Headset Communications System that can be used in concerts, recording sessions and the theater has been contributed by Peter D. Hiscocks.
- The knotty problem of establishing uniform acoustics in the control room is tackled by Michael Rettinger. His article is entitled appropriately Control Room Acoustics.
- Garry Margolis has written an article that offers specific instructions for Audio Transducer Power Handling.
- Coming in **db**, The Sound Engineering Magazine.



## about the cover

- The printed circuit plug-in card is a basic building block of audio systems.


# db

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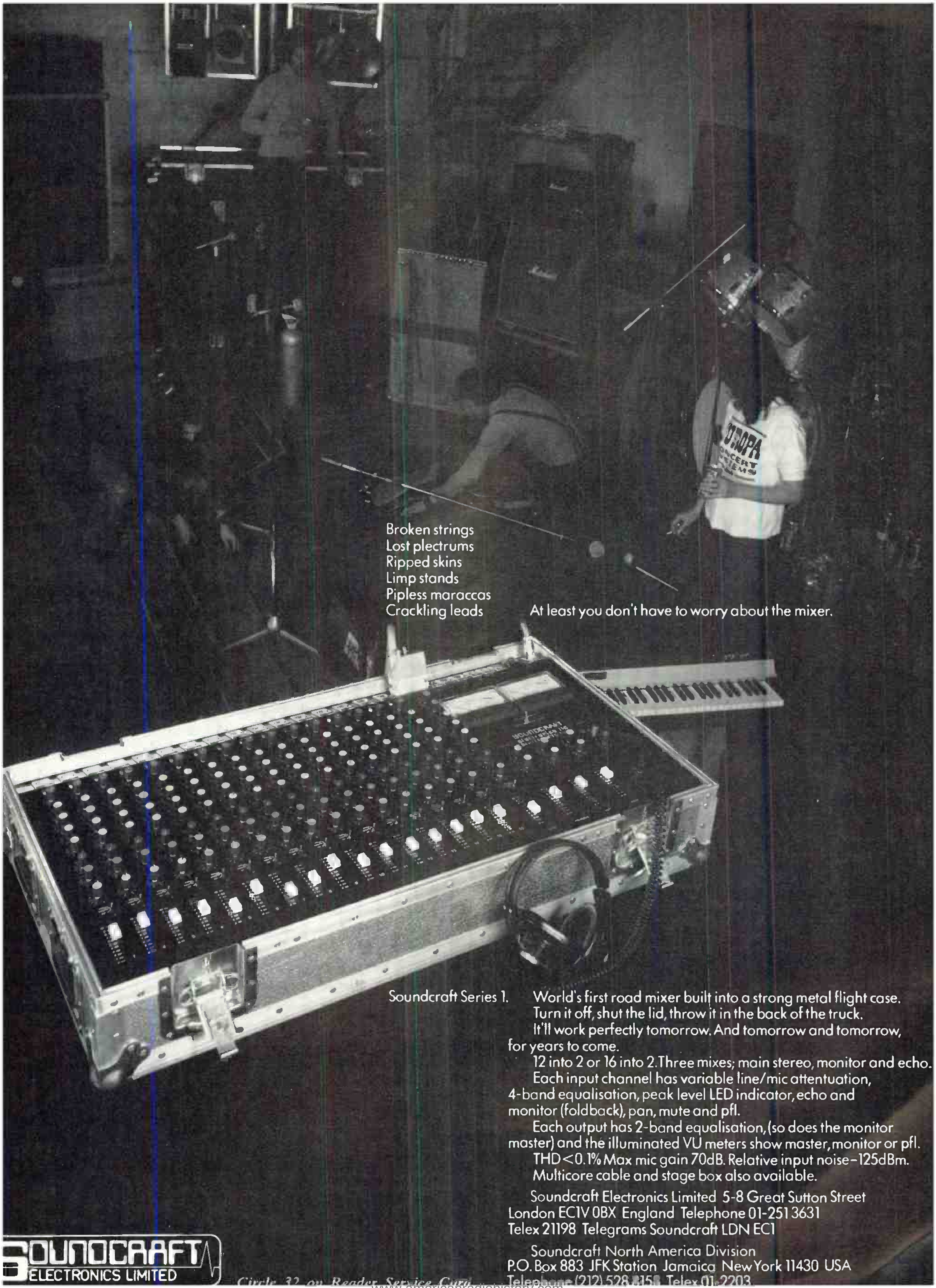



Circle 32 on Reader Service Card

## CALENDAR

### MARCH

22-24 **Ace '77 Advanced Consumer Electronics Show.** Pacific Terrace Convention Center. Long Beach, Ca. Contact: Cartlidge & Associates, 415 Clyde Ave.. Suite C, Mountain View, Ca. 94043. (415)-969-1556.

22-24 **Three-day course on Audiometry and Hearing Conservation in Industry,** Rennselaer 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.

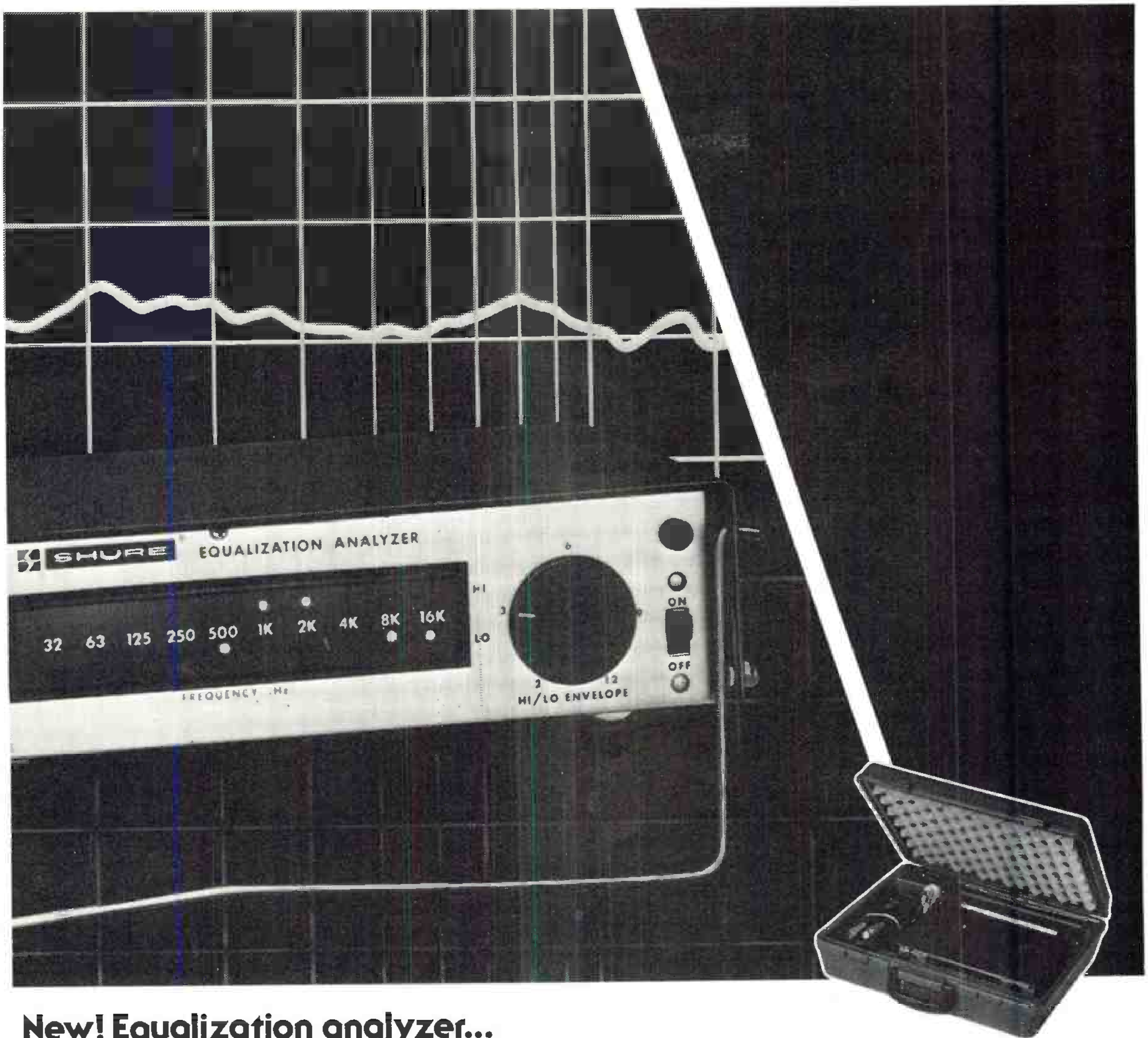
19-21 **IEEE Electro '77.** New York Coliseum. New York City.

### 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.

10-13 **A.E.S. Show.** Los Angeles, Ca. Hilton Hotel. Contact: A.E.S., 60 E. 42nd St., NYC 10017. (212) 661-8528.

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


SHURE
EQUALIZATION ANALYZER
32 63 125 250 500 1K 2K 4K 8K 16K
HI
LO
ON
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db broadcast sound
PATRICK S. FINNEGAN

# A. M. Modulation Monitor

• The audio which can be recovered in the home receiver is highly dependent upon the modulation that is taking place in the transmitter. It is important, therefore, that this modulation process be continuously monitored at the broadcasting station with an FCC approved modulation monitor. The monitor, essentially an operational test instrument that provides accurate data on the modulation taking place, permits adjustments to modulation levels during programming. The monitor contains a number of important functions and circuits, but we only have space to discuss a few of the most important ones.

## THE SIGNAL

When modulation is taking place in the transmitter, the output signal is a modulated rf wave that contains three components: the rf carrier, and two equal sidebands that are above and below the carrier. This is a full, double sideband signal. Each one of the sidebands will carry the entire program modulation intelligence. But even though the complete information is contained in each sideband and technically we can recover the full program audio from either one, because of the demodulation process, both sidebands should be identical in every respect or the recovered audio will suffer in some manner. The sidebands are not audio signals—they are rf wave components that vary at the audio modulation rate.

## DEMODULATION

Demodulation is the reverse process of modulation. The demodulator removes the modulation intelligence from the modulator rf wave and converts this back into the original audio signal. All other functions and metering circuits work with the audio signal that appears at the output of the demodulator, so consequently the demodulator is the most important circuit in the monitor. The accuracy of its performance will determine the accuracy of the entire monitor. Even if every other circuit and function of the monitor performed perfectly, none could yield any more accurate data than the accuracy of the signal presented to them.

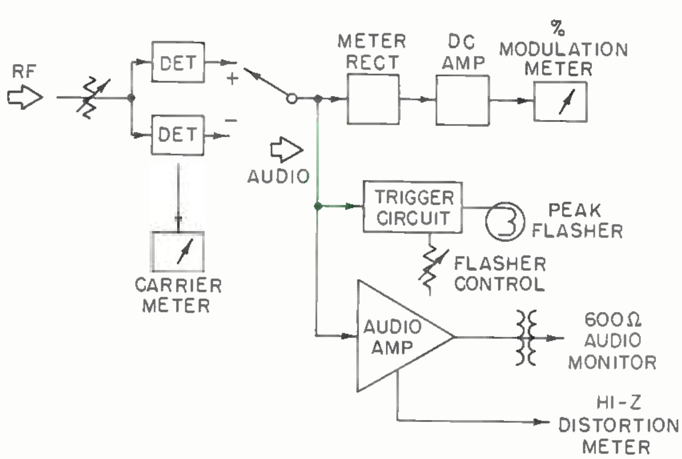
## THE DETECTOR

The circuit most commonly used for demodulation in an a.m. monitor is the diode detector. The diode does have some shortcomings, but when the circuit is well designed and operated within its parameters, it will produce the necessary accuracy in results.

The diode, its filter and load make up the detector circuit. The diode removes the sidebands from the modulated wave by rectification, the filter removes the rf components from the rectified carrier, and the output voltage is developed across the load resistor. This is a peak detector whose output is a d.c. voltage that varies at the audio modulation rate. The variation in amplitude of this d.c. voltage is a replica of the original audio signal.

The filter design is important to the detector's operation. The value selected for the capacitor must be such that it will remove only the rf component, leaving the audio envelope component intact. If the value is too large, it will remove the higher audio

*Figure 1. The basic monitor circuits.*



# 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

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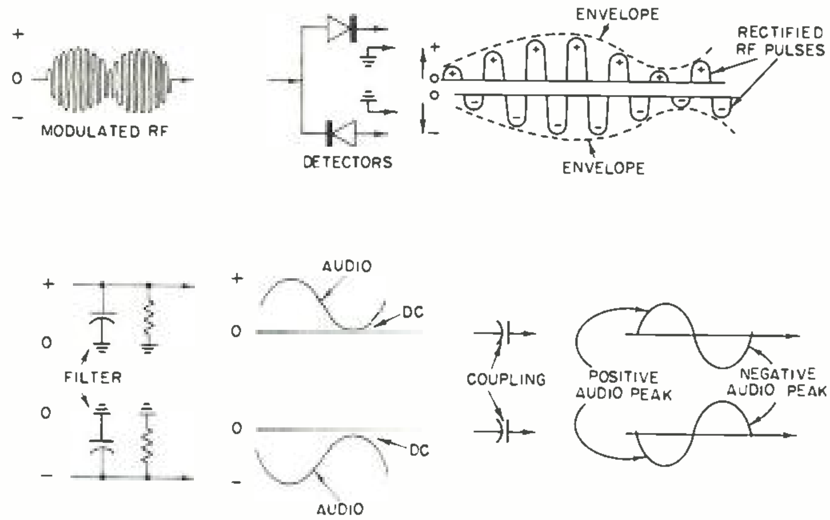



*Figure 2. Detection process. (Rf waveforms are shown exaggerated,*

frequency components and produce a poor audio bandpass for the detector. And if the value is made very large, then the circuit becomes a d.c. power supply instead of a detector. The load must be high in resistance value or it will affect the detector's efficiency and make it work at somewhat less than a peak detector.

## DETECTION

Two separate detector circuits are used in monitors to provide two independent output signals. These detectors are placed in opposite polarity to the rf wave so that one detector will rectify the positive going half of the wave, and the other detector will rectify the negative going half of the wave. Each of these detectors is recovering the same modulation information but the separate outputs are out of phase with each other. The output of each detector can be selected by a front panel (+) or (−) peak modulation switch. Whichever detector is selected by this switch will then feed all the other circuits of the monitor.

In a.m. modulation, it is important that the positive and negative audio modulation peaks are observed and measured, so this is why they are made selectable. The audio peaks could be split by a phase splitter but the common practice is the use of two detectors. This makes things less complicated, gives a better review of the modulated wave, and makes the following circuits more simple in design.

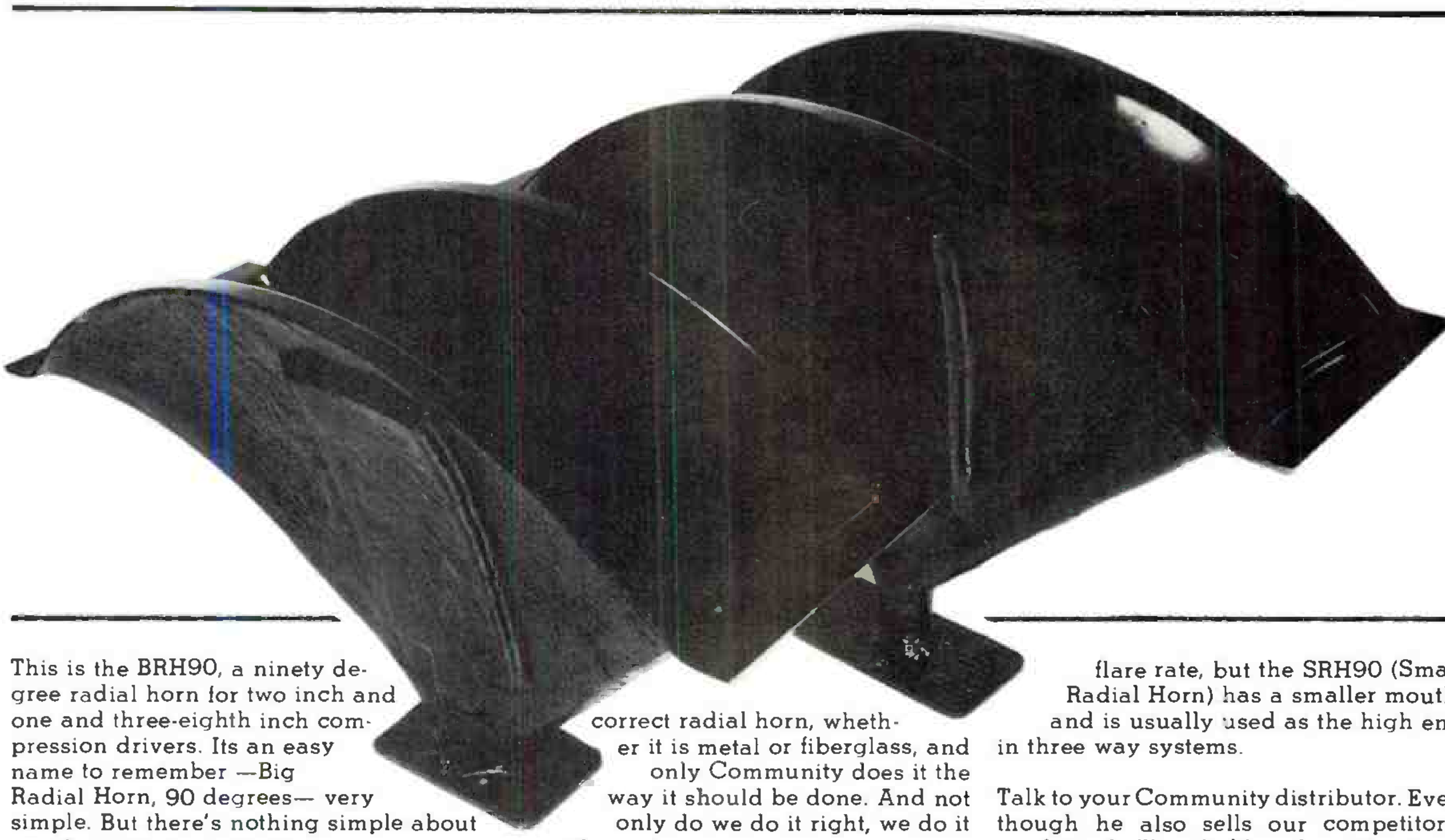
The output of the detector which rectifies the positive half of the rf wave is a varying d.c. voltage that is positive with respect to ground. When the d.c. component is removed by a coupling capacitor, the resulting audio signal positive peak is in phase with the original audio—that is, both positive audio peaks are in the positive direction. The output of the detector which rectifies the negative half of the rf wave is a varying d.c. voltage that is negative with respect to ground, and the recovered audio signal is out of phase with the original audio. Therefore, the original positive audio peak is now going negative while the original negative peak is now in a positive direction. As far as the monitor circuits are concerned, regardless of which audio peak is selected for observation, they see only positive going voltages at their inputs.

## SENSITIVITY

The diode detector is somewhat insensitive and requires a relatively large input signal or it will become non-linear and produce a distorted output. This lack of sensitivity is no real problem since the monitor is designed to couple directly to the transmitter output circuit by coaxial cable. In this arrangement, however, there is a danger that too much signal may be applied to the diode. This would overload the circuit and produce a distorted output, and it can damage the diode and circuit components.

The semi-conductor diode does not produce a "clean" baseline (a.c. signal zero axis line). Some reverse current will flow on the reverse half cycle of the a.c. signal and this will allow part of that half-cycle to appear in the output. The forward conduction curve of the diode exhibits a bend at the portion where the conduction begins. When the input a.c. signal is too small in amplitude, then operation is in this area of the curve and the output will be very non-linear. The input signal must be large enough so that the operation is on the straight line portion of the forward conduction curve. Some

# BRH90 RADIAL HORNS



This is the BRH90, a ninety degree radial horn for two inch and one and three-eighth inch compression drivers. Its an easy name to remember —Big Radial Horn, 90 degrees— very simple. But there's nothing simple about our design or construction.

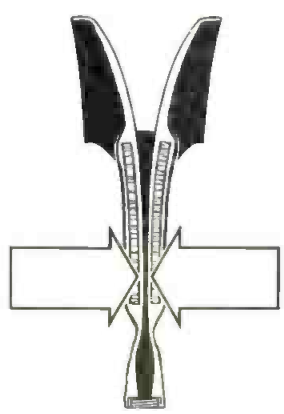
Community horns are made of fiberglass. Not sprayed-up cheaply-made fiberglass, but fiberglass hand-laminated by experts and constructed to our exact requirements for maximum acoustical accuracy, resonance-free rigidity and unparalleled strength. Our horns are absolutely weatherproof. They will *never* corrode or rust out. Nor are they ever likely to break. Not now and not forty years from now.

But the real mark of Community radial isn't apparent unless you cut it in half as we have done here. If you look closely at the cutaway, you will see that the corridor in the horn just past the throat gets extremely narrow before it flares out. That pinch in the horn is absolutely necessary to any mathmatically and acoustically correct radial horn, whether it is metal or fiberglass, and only Community does it the way it should be done. And not only do we do it right, we do it cheaper.

We also make two 90° radials for use with one inch and screw-on drivers —the RH90 and the SRH90. Both have the same flare rate, but the SRH90 (Small Radial Horn) has a smaller mouth, and is usually used as the high end in three way systems.

Talk to your Community distributor. Even though he also sells our competitor's products, he'll probably tell you that there is nothing available today that equals a Community horn.

He's right.



| | BRH90 | RH90 | SRH90 |
|---|---|---|---|
| Flare Rate | 240Hz | 345Hz | 345Hz |
| Operating Range | 500Hz up | 600Hz up | 1,000Hz up |
| Size: H. | 11 1/8" | 12 1/4" | 6 1/2" |
| W. | 33 5/8" | 30 3/8" | 24 3/4" |
| D. | 21" | 20 1/2" | 18 3/4" |
| Weight | 25 LB. | 20 LB. | 12 LB. |
| Finish | Black, High Gloss | " | " |

| | BRH90 | | | RH90 | | | SRH90 | | |
|---|---|---|---|---|---|---|---|---|---|
| Horizontal Dispersion | KHz | -3dB | -6dB | KHz | -3dB | -6dB | KHz | -3dB | -6dB |
| | .6 | 85 | 95 | .6 | 80 | 90 | 1.2 | 95 | 100 |
| | 2 | 90 | 90 | 2 | 90 | 100 | 3 | 90 | 95 |
| | 10 | 80 | 90 | 10 | 85 | 90 | 10 | 85 | 100 |
| Vertical Dispersion | KHz | -3dB | -6dB | KHz | -3dB | -6dB | KHz | -3dB | -6dB |
| | .6 | 50 | 90 | .6 | 55 | 100 | 1.2 | 50 | 70 |
| | 2 | 35 | 50 | 2 | 35 | 50 | 3 | 40 | 65 |
| | 10 | 20 | 35 | 10 | 20 | 35 | 10 | 20 | 30 |

# Community

COMMUNITY LIGHT & SOUND, INC. 5701 GRAYS AVE., PHILA., PA. 19143 (215) 727-0900

*Circle 36 on Reader Service Card*

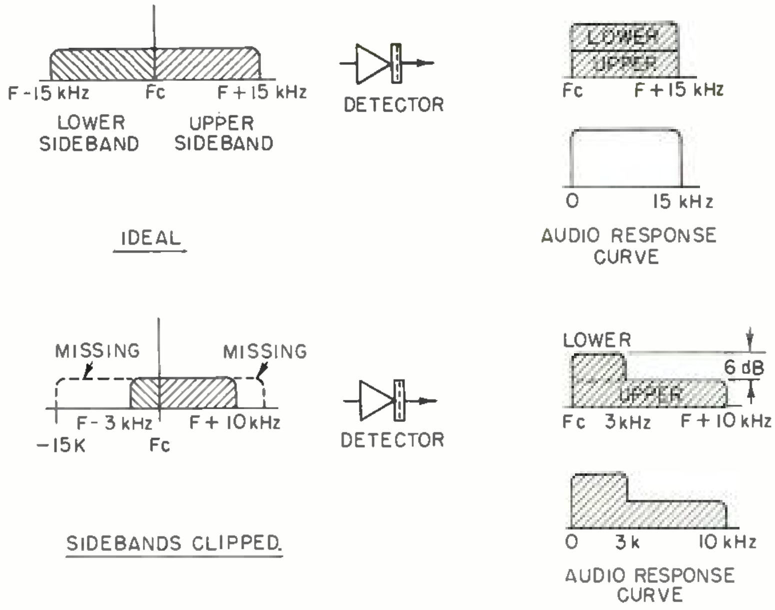



*Figure 3. Non-symmetrical sidebands affect the amplitude response curve of the recovered audio.*

monitors forward bias these detectors almost to the point of conduction in order to improve their linearity. But even with this design technique, the input level must be carefully adjusted.

## SELECTIVITY

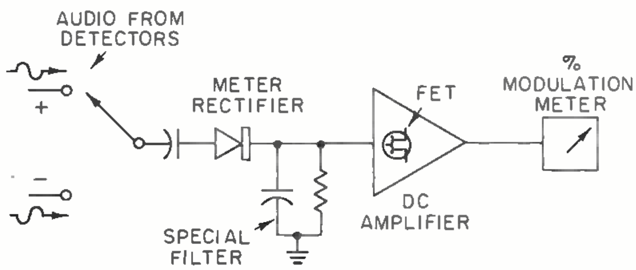
The diode is a non-selective device that will rectify any a.c. signal that appears at its input with enough amplitude to make the diode conduct. The diode cannot distinguish the various components of the modulated wave, but will rectify the instantaneous voltages of all the components present at its input at any instant. In so doing, the diode is recovering *both* sidebands at the same time and adds them together in its output (in phase). It is because of this detector action that both sidebands should be identical in every respect. When they are not, when they are added together in the detector output, the audio will suffer according to the differences of the sidebands.

For example, assume that sideband slipping has removed most of the lower sideband because of faulty tuning. If we used a sweep signal to modulate the transmitter, the waveform of the sweep envelope at the output of the detector would appear similar to the FCC's *Ideal Detector Curve* for t.v. picture transmission. In the band-pass area where both sidebands are present and equal in amplitude, these are added together in the detector output. But in the area where the lower sideband is missing, only the voltage of the upper sideband is present, so the voltage amplitude is down one-half, or 6 dB. Sideband clipping in this case has produced a very poor audio bandpass for the system. (The t.v. receiver, by the way, corrects for the unequal sideband transmission by having its IF response curve sloped.)

## CARRIER LEVEL

The average value of the carrier does not change during modulation. If any change does occur, this is termed *carrier shift*. FCC rules require that any carrier shift be kept within a 5 per cent tolerance. A number of conditions can cause carrier shift in the transmitter, but a measurement of this factor is also a measure of transmitter performance under modulation conditions. The output of the detector is a d.c. voltage that is derived from the rf carrier, so the current flowing in the

*Fig. 4. The modulation meter circuit is a high impedance fet meter with special*




# JBL's 4315.
# There's never been a wider range studio monitor. Of any size.

And, four more things:

It's a four way system. It has the most sophisticated cross-over network ever designed. It's compact, shallow, portable. Perfect for wall mounting, horizontally or vertically. It's yours for $771.

There's more. Much more. Go hear the rest.

JBL

James B. Lansing Sound, Inc., 8500 Balboa Blvd., Northridge, Calif. 91329.

detector output circuit is measured with a front panel meter which is labeled *Carrier Level* or similar terminology.

Metering the d.c. current of the detector in this manner serves two useful purposes. Since this meter measures the output of the detector, then it can be used to set the rf input to the detector properly. And since any change in the average carrier value will change the average current in the detector output, a proportional amount, we can read the carrier shift directly from this meter.

### MODULATION METERING

The modulation percentage caused by either the positive or negative audio peaks is measured with a high impedance voltmeter circuit that is the equivalent of a vtvm or fet meter. This is a quasi-peak indicating circuit and it must contain special damping and meter ballistics, according to the FCC rules.

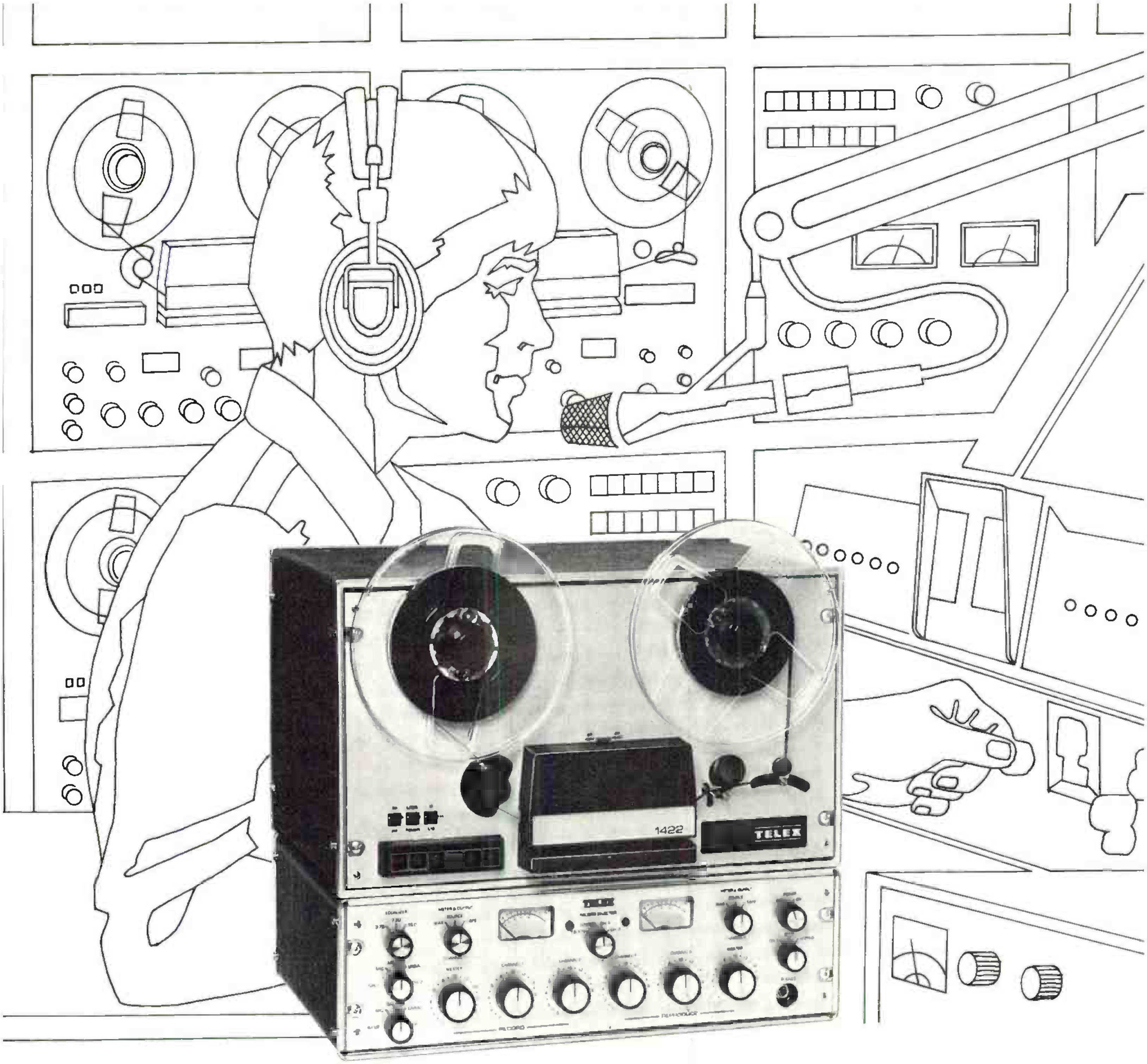
The positive or negative modulation peaks selected by the switch will feed the audio signal to a meter rectifier circuit. The output of this rectifier circuit is a varying d.c. voltage that now has the special damping, and this voltage is amplified by a d.c. amplifier which drives the front panel modulation meter. The r-c filter in the rectifier circuit provides the special damping characteristics. The meter face has two scales: one in percentage for modulation of program, the other in dB for tone modulation and testing.

### PEAK FLASHER

Since the modulation meter cannot follow peaks because of its characteristics, a true peak indicating circuit is provided. This is an electronic circuit, such as a Schmitt Trigger or similar circuit, which has its threshold sensitivity preset by the front panel flasher control. When an audio peak exceeds this threshold, the trigger will fire and turn on a lamp or other visual device to warn that a peak has exceeded its setting. This circuit will catch many peaks that do not show up on the modulation meter.

### OTHERS

The monitor will provide an audio output for aural monitoring and for making distortion measurements. Individual models also provide many other features. But regardless of the features, the monitor should be kept in calibration, good repair and operated properly. Next month we will discuss some of the problems that can occur in monitoring. ■


1422
TELEX

# db theory & practice

NORMAN H. CROWHURST

• Last month, I reached the point of preparing to discuss what part various media, such as radio or television, and prerecorded tapes, can play in developing an effective educational program. The best way to approach this is to "walk through" what a good teacher can do to promote learning, then see how this can be applied to mediation.

Curiously, during the month since I wrote that, I have had some interesting responses that are quite relevant. One of them refers back to 1973, and says the reader has retyped part of one of my columns of that time, and gives copies of it to "the better teachers."

In July, 1973, in a column that addressed some of the problems of designing good a/v materials, there was a paragraph that read:

*A good teacher is not required to know everything the students will learn in that teacher's class. I have seen some dramatic instances to support this statement. The good teacher's capability can be summed up as knowing how learning happens, in a variety of different human beings, and being competent at causing it to happen.*

When considering the matter of finding a continuing place for media in effective education, we still need to analyze how a good teacher can cause learning to happen effectively in every student making up that teacher's class. which is what any good teacher can do.

## MOTIVATION: FROM OUTSIDE AND INSIDE

An unmotivated person cannot be motivated from inside: the first motivation must come from outside. But it is not truly effective until the source has transferred to become internal. For example, you might have no interest in, say, number games. But if a good presentation on t.v. starts your interest and leaves you with a desire to explore some angles the t.v. presentation only touched on, you will go on working at it after the t.v. program is over.

Perhaps number games do not interest you anyway. In that case, you will switch off the t.v. when such a program comes on. That is not to say that, given the right lead in, number games may not interest you at some later date.

Motivation as applied by educators is always external.

To sign up for a paid course, a student must first be motivated enough to part with, or to persuade his parents to part with, the necessary tuition. After that the educators possibly don't care whether he learns or not because they have his money anyway. The correspondence schools, and many that use mediation too, are little better. The student must commit himself to take the whole course, or at least to pay for the whole course, before he begins. Then, because internal motivation does not follow through, a great many students drop out. Many who stay with it do not learn what they hoped to derive from the course.

## FROM BOTH ENDS

To keep up newsstand circulation, a publisher must maintain reader interest. This month's issue, or this week's issue, must make the reader want to read the next one. What is wrong with building that kind of internal motivation into educational material so that lesson 7 maintains the student's interest and, at the end, makes him anxious to get into lesson 8? It can be done. Many of our courses prove this. That is what we need to address in our consideration of what media can do.

Why is the student turned off, and how can the good teacher turn him on? This is the kind of thing you need to "walk through," in finding what goes into a program that goes over the air, radio or t.v., and what goes into the part the student sits down with on his own.

When the student either pays for the course in advance, or signs up for it so he is obligated to pay, he has two

concerns: (1) how can he maintain interest, so as not to waste his money; (2) if he doesn't like the material or has difficulty with it, how can he escape from his obligation to pay?

Hampered by this kind of suspicious attitude, the student is not likely to approach learning with an open mind. Often those designing or presented the course are not motivated to do their best either because they have already been paid.

Why not design a course the way a publisher designs his publication, with one part stimulating enough to lead the student to want to continue? In other words, the student would pay for the materials necessary for each segment, say, a series of ten lessons, as he comes to it. He would not be obligated in any way other than by his own interest, to make the entire investment for the whole course. With their creativity on the line that way, the educators designing the course and the teachers delivering the audio part will be really challenged to show ingenuity and clarity, resulting in quality shows that enhance the reputation of the radio or t.v. station.

## TEACHING TECHNIQUES

One basic teaching technique that applies beautifully to instruction through mass media is the idea of individualization. Good teachers try to work on a one-to-one basis as much as possible. In a classroom situation they do as little lecturing as possible, getting the students to follow through either alone or in small groups. Obviously, this is the way an audio presentation will work, stimulating the student to continue on his own, using the materials he has purchased.

Teachers commonly categorize students into those who are self-starters and those who need to be spoonfed. There are other individual differences in the way people learn, of course, but I'm not discussing them in this context. What we want to keep in mind is the way we approach both the motivated and the unmotivated with the same material, reaching both groups. Actually, motivation is not an inherent quality; it is a phase people move through. Good learning is what self-starters achieve. One of our primary objectives is to move students out of the spoonfeeder phase into the self-starter category, moving a student from entire dependence to the first sign of individual initiative or from a little initiative to more confidence.

## PERSISTENT OR TRANSIENT MATERIALS

Let's take a look at the way these two groups approach learning materials, which is what we are actually selling. Such materials are persistent, semi-transient, or transient.

The commonest form of persistent material is the book. A self-starter will go off into a corner with a book and absorb what it has to offer with no help from anyone. The spoonfeeder, unless he is cajoled into it, approaches the book with trepidation. He can't seem to organize his thoughts well enough to merge with the author's presentation. (Training this capacity is a major concern of the elementary schools but the training doesn't always work.)

Audio cassettes are of a semi-persistent nature. The material is not solid the way it is on the printed page, but it is possible to punch the rewind button and hear the information again. The self-starter doesn't mind replaying any piece he has trouble with, but spoonfeeders just throw up their hands. They do not expect to understand what they hear; therefore they don't. "You see, I told you I was dumb!" They will not hit the rewind button because they figure hearing the tape twice will not make them any less stupid. It is this false self-evaluation that you have to change to convince them that they can do at least a few things they previously thought they could not do.

The classic transient presentation of information is that delivered over the radio or on t.v. Once it is over, the student has no way of retrieving the information. This is why the choice of material offered over the air has to be carefully selected. It needs to review material the student already knows or lead into further fixation of information by the student through the use of persistent (books and workbooks) or semi-persistent (tape cassettes) material. The ideal lesson will contain both review and motivation as well as lively entertainment value.

## BRIDGING GAPS

In designing a radio or t.v. educational program we need to keep these factors in mind. First of all, "out there" we have two kinds of students, the self-starters and the spoonfeeders. We want to encourage the spoonfeeders without boring the self-starters, avoiding "baby talk" or offering ma-

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terial of a ridiculously simple nature that is common knowledge anyway.

There is a point at which the needs of both groups converge. I call it "bridging gaps." As any elementary school teacher can tell you, there are dynamite readers who suddenly hit a brick wall when they come to complicated unfamiliar words that must be attacked phonetically. Such self-starter kids have galloped through reading at a great pace, memorizing words and grabbing context clues. But they have leapfrogged over phonics. If the teacher sets up a special "phonics group" to review phonics for the leapfroggers while teaching slower readers, the device not only gets the job done but encourages the slower students who are delighted to see that some of the "smart kids" have the same problems with sounds they are encountering.

This technique also works with grownup students, some of whom zoom over material, losing out on important details and others who need extra time to get those details. Your audio presentation can pick up loose ends, significant details the fast learners probably missed and the slow learners didn't understand. The self-starters will prick up their ears and say "I never thought of that" and the spoonfeeders will say in relief "Now I understand." Bridge gapping is a good source of material for the middle part of your lesson.

### FEEDBACK

Now that we've disposed of the middle part of the lesson, let's go back to the first part. How can we involve not only those students who have been with us for a while, but also intrigue the casual listener who has just happened onto our program?

Feedback . . . similar to the telephoned talk show and audience participation format, or more organized feedback taken from previously received written or telephoned comments and questions, brings a sense of immediacy to the listener, of being something more than a passive receptor of material droned at him by an instructor. A teacher who is good in the classroom can usually handle "live" feedback by telephone while the program is on the air. This can have its advantages and disadvantages, dependent to some extent on the nature and extent of the service area. An alternative is material received by phone or mail before the program goes on the air. This has the evident advantage, although lacking the spontaneity of unplanned voices, of permitting the instructor to sift through the material, choosing that which serves his purpose and of editing it to fit into his time slot.

We have talked about feedback, the

"magic genie" of audio. In education, as in audio, feedback can accomplish only so much. By skillful design feedback may accomplish more than one objective at once, maybe several. It just cannot achieve everything. In an audio circuit, you may use multiple loops so that eventually you do achieve a good deal. Such loops are applied simultaneously. But in teaching, feedback applications must be achieved with a time separation for each of the multiple effects. The instructor must be conscious of just what each piece intends to achieve and how.

The feedback of student participation does intrigue the listener, but there has to be a cutoff and other material offered if progress is to be made. The bridging information discussed previously might be used to introduce the meat of the lesson. Then there would be a follow-through with new material. This should be bright and dramatic, using the entertainment capacities of the media to its fullest.

The windup of the lesson should whet the appetite for MORE. "Tune in next week to see if the evil monster devours the beautiful young girl," as a stimulation to new listeners.

Those who are already involved and have purchased the materials for that part of the series will be motivated to hop to their books or cassettes to gather more information.

Hopefully, the students will be so excited about what they are learning. once the section for which they have paid is nearing completion, they will send for the following material in order not to miss anything.

These are but a few ideas of how to use the media for educational programs. Of course, as with feedback, the beautiful part is what's "out there" in your own imagination and skill. ■

***MOVING?***

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# db the sync track

JOHN M. WORAM

• Elsewhere in this issue, our editor reviews the Sound Technology Model 1710A Distortion Analyzer. Or perhaps you may want to pick up Amber Electro Design's Model 4400 Audio Test Set. On the other hand, you may be one of those "basement engineers" who have recently been under discussion here. In that case, big-buck gear such as this is probably out of the question for the time being. And then there's the star-crazed knob jockey who wouldn't know a lissajous pattern from a dBm—the type who regards all test gear as just so much irrelevance.

I don't know what to say to the latter type, but for the former, maybe some words on "getting started in test gear" wouldn't be such a bad idea.

Most routine testing is centered around the tape recorder, and a good test tape is an absolute necessity. Yes, they're expensive and you can't get along without one. Most readers know what to expect from a test tape by now, although one point may need a little clarification.

## FRINGING

At long wavelengths (i.e., low frequencies), a playback head tends to "read" a wider-than-normal path of the tape passing under it. When playing back a tape that was recorded on the same machine (or on any other machine with the same head configuration), this "fringing" phenomenon has no practical significance. However (there's always a *however*), test tapes are usually produced with uniform flux distribution across the entire tape width. That means even a 2-inch test tape is, in effect, a monster mono tape.

Because of the full track recording format, the test tape may be used on any head configuration within the width of the tape. But at low frequencies, each track of a multi-track (two or more) head responds not only to the fluxivity within the normal track width, but also reacts to the presence of information in what would ordinarily be the guard bands between each track. The result is an apparent boost in low frequency response of several dB. The exact amount of this boost depends on several factors which vary from one machine (and playback head) to another, and so an accurate correction factor cannot be stated.

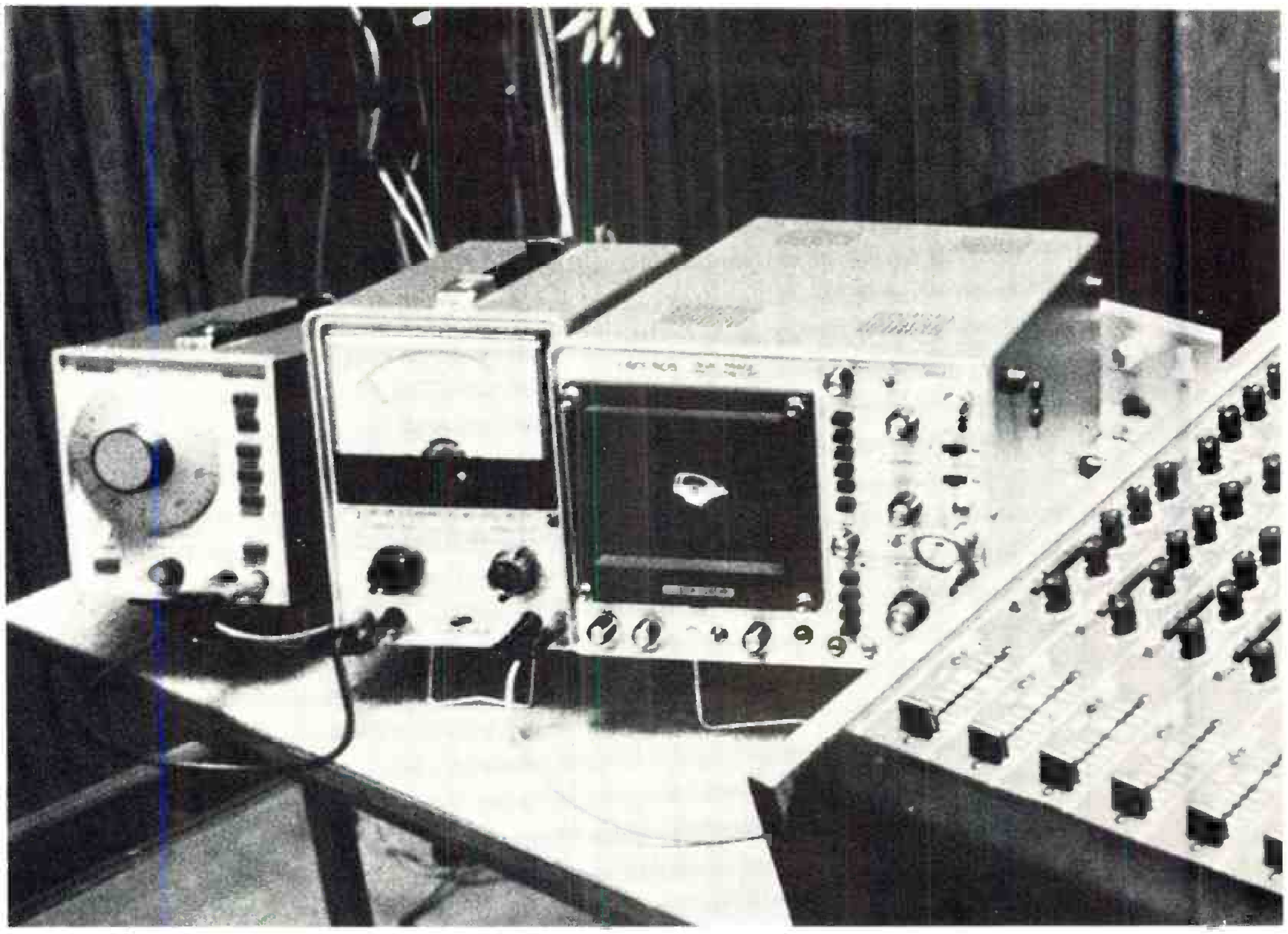
So, there's little point to making low frequency playback equalization adjustments while metering abnormally high levels. Save the equalization adjustments until you get around to recording a series of low frequency test tones. Since you will be recording these at the correct track width for your machine, the playback head will not be responding to additional flux on either side of the normal track width. Therefore, you may assume the tape recorder is functioning properly (there aren't any low frequency record controls anyway), and adjust the playback equalization controls for a flat response. Note that this procedure applies to low frequencies only. And, it introduces the subject of the audio frequency signal generator, or oscillator.

## OSCILLATORS

Some consoles have an oscillator built-in, but typically this will have just a few switchable frequencies available. This type of oscillator is sufficient for signal tracing purposes, or for making routine spot checks of tape recorder performance. However, it is not enough for a complete test of your tape recorder's performance. For in between each of the switch-selected frequencies, all sorts of strange dips and peaks may be occurring. So, you really need an oscillator that is capable of sweeping continuously through the entire audio bandwidth if you want to know what's really happening.

A good high impedance voltmeter is also worth having, especially for the basement operation. (Some otherwise-satisfactory recorders have unreliable meters; the ones on a certain fairly popular model are down about 4 dB at 10 kHz, although the machine's actual output level is reasonably flat.) Another point to keep in mind is that a zero reading on a semi-pro tape recorder may not signify a +4 dB output level. Sometimes it does, but just as often it doesn't, and if you are working with two or more machines, you may discover a level discrepancy of perhaps as much as 10 dB during an a/b comparison.

If you have a reliable meter on hand, it's a good idea to check the frequency response of the oscillator before and after plugging it into your console or tape recorder. If there's a signicant difference in response, it indicates a potential problem within the



system itself, and this should be corrected before proceeding.

For making azimuth adjustments, a cathode-ray oscilloscope is a valuable tool. However, if one is not available, the outputs of two tracks on the tape recorder may be combined, and shown on one meter, while adjusting the head azimuth for a maximum—or peak—meter deflection at some high frequency, say 7 to 15 kHz. In a typical situation, as azimuth is adjusted, a series of three closely spaced peaks may be observed. To make sure you have selected the correct one, check the response across the entire range of high frequencies. Sharp dips in response indicate an incorrect alignment. Go back and try again. On some test tapes, the tones are sequenced in ascending order, which is a great convenience for azimuth adjustment. For critical alignment, begin at about 1 kHz, and as the tones rise in frequency, make progressively finer adjustments.

With an oscilloscope, set in the X-Y mode, a properly aligned azimuth setting will produce a straight line, running across the scope face at a 45 degree angle. Usually the line runs from lower left to upper right, but verify this by first feeding the same signal to both X and Y inputs, and noting the orientation of the display. If the line runs from upper left to lower right, make note that this is the proper direction for an on-azimuth signal on your 'scope.

## PHASE SHIFT

As a tape recorder head is rotated out of azimuth, the resulting phase shift will cause the angled line to widen into an oval, which eventually becomes a full circle when the phase shift reaches 90 degrees. Beyond 90 degrees, the display narrows into an oval again (tilted in the opposite direction) and at 180 degrees, a straight line is once again displayed. However, the line is tilted in the opposite direction from the on-azimuth display, and so the mis-alignment is obvious (providing you remember which way your 'scope is wired).

In observing the 'scope display, remember that phase shifts may be caused by equalization as well as azimuth mis-alignment. Therefore, as azimuth is adjusted, also note the meter readings on the tape recorder. If the high frequency response varies from one track to another, correct the equalization as you proceed.

Once the azimuth/equalization has been properly adjusted, it's a good idea to leave the 'scope across your left and right monitor outputs. A well-placed center soloist will produce a strong in-phase display on the 'scope. If the left-to-right balance is off a bit, the display will lean towards the vertical or horizontal, depending on the direction of the imbalance. (Usually, left = vertical, right = horizontal.) A good mono-compatible stereo program will produce a "brillo pad" display on the scope, but with practice you will recognize a general in-phase orientation to the display. And, when the display tilts in the out-of-phase direction, you get a visual warning that something is amiss in your setup. Especially when multi-miking drums, pianos or whatever, a strong out-of-phase component may sneak in and cause a lot of grief later during mono playback. Keep an eye on the 'scope, and you'll see the trouble before you hear it.

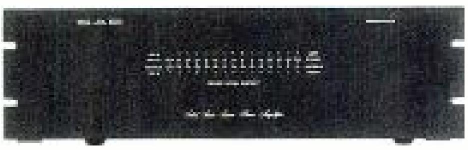
So far, we've talked about a signal generator, a good meter and a cathode ray oscilloscope (and the test tape of course). It's easy to spend a small fortune on these items. However there are several companies that manufacture a line of test equipment in the budget category. I've had excellent results with the Leader test equipment seen in the photo, and will try to come up with a product review in a future issue. ■

# db new products&services

### HEAVY DUTY TAPE


● Designed specifically to reduce print-through in critical studio and broadcast applications, reusable Formula Q15 tape features a long-wearing binder system. The bias-compatible tape can be placed on any machine and used without adjustments. The tape is available in 1, 1½, and 2 mil thicknesses in reel lengths from 525 ft. to 7,200 ft. in bulk.
*Mfr: Capitol Magnetic Products*
*Circle 50 on Reader Service Card*

### POWER AMPLIFIER



● 100 watt/channel model 2200 amplifier uses full complementary circuitry throughout, specified at 0.05 per cent thd and i.m., from 250 mW to full rated power over a frequency range of 20 Hz to 20 kHz. The circuitry includes dual-differential inputs, full complementary drivers and output stages. The unit is capable of a 40V/microsecond slew rate. Power output is monitored by an l.e.d. power display, indicating the average power (peak responding) of the amplifier over a range of 20mW to full rated power plus indicating amplifier overload. Plug-in circuit board construction permits unit-to-unit repeatability.
*Mfr: Scientific Audio Electronics Inc.*
*Price: $450.00.*
*Circle 51 on Reader Service Card*

### OPEN REEL TAPE DECK


● Half-track 2-channel stereo or mono format with 15 or 7½ in./sec. speed are available on A-3300SX-2T open reel tape deck. Using a three-motor transport system, the claimed s/n ratio is greater than 67 dB (wtd at 3 per cent thd). Frequency response is 30-26k (± 3 dB at 15 in./sec); wow and flutter is reported less than 0.04 per cent wrms at 15 in./sec. Independent left and right channel source/tape selectors determine the signal to be displayed on the vu level averaging meters. A manual cue lever is provided for searching and editing. Other features include separate bias and equalization selectors, independent left and right channel record mode selectors for making mono recordings and dubbing in sound effects from external equipment, individual input level controls enabling the operator to mix microphone and line level signals and a separate output level control for each channel.
*Mfr: TEAC Corporation*
*Circle 52 on Reader Service Card*

### DIRECT-DRIVE TURNTABLE

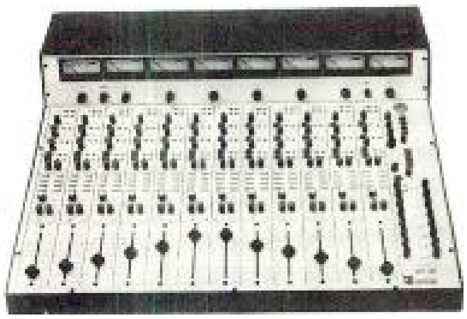
● Quartz-controlled SP-10Mk2 di-direct drive turntable features a phase-locked servo circuit. The oscillation of the quartz crystal supplies a reference frequency, adjusting the revolution speed to a constant norm, claimed to within ± 0.002 per cent. Extremely fast opening momentum is claimed; from standstill it takes the platter 0.25 second to reach 33⅓ r.p.m. It requires only 0.3 second to come to a standstill from rated speed. The stylus can be set down on a silent groove between two lp bands at standstill, and when started, the platter will reach rated r.p.m. before the first note is heard. At standstill, part of the braking force remains applied, preventing the platter from being inadvertently rotated and permitting precise cueing. The unit uses solenoid operating controls.
*Mfr: Technics by Panasonic*
*Price: $699.95*
*Circle 53 on Reader Service Card*

## SPLICING TAPE


● General purpose splicing tape Scotch #67 is intended to provide strong splice bonds despite extremes of dynamic stress in bin loop transports during manual splicing of magnetic tapes. It is claimed that splice bonds remain intact under environmental conditions ranging from —30 degrees F to +150 degrees F and at 80 degrees F with 80 per cent relative humidity. Splices are removable as required in bin loop applications. Available boxed or in bulk, in 100 ft. rolls in 7/32, 1/2, 3/4 and 1 in. widths.

*Mfr: 3M Company*
*Price: Varies (7/32 bulk single roll: $2.65.)*
*Circle 54 on Reader Service Card*

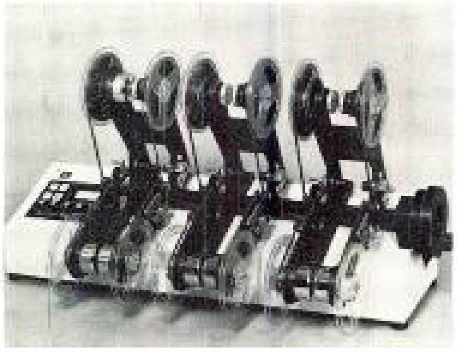
## 8-BUS CONSOLE



● Each input module on QM-128 8-bus console has solo, mute, two independent echo sends, and two independent cue sends, six frequencies for e.q. on three knobs with an equalizer in/out switch included and a mic/line switch with 15 dB padding on the mic. Also included are plastic faders and panning to the eight busses. The stereo monitor has push button selection of bus, line, or playback. A separate control for control room and studio monitor level is included with additional controls for cue masters and solo, talkback slates to all eight busses and two cue busses, and to the studio monitor feed.

*Mfr: Quantum Audio Labs. Inc.*
*Price: $4,300.00.*
*Circle 55 on Reader Service Card*

## HIGH SPEED TAPE DUPLICATOR



● Five copies can be turned out in four minutes by model 1056 reel-to-reel tap duplicator. The unit uses a single capstan drive and specially designed heads to provide uniform frequency response (± 0.5 dB of master from 50 Hz to 15 kHz). Pushbutton transport controls select 30 or 60in/sec. duplicating speed and a fast forward rewind capable of handling a 1200-foot master in 60 seconds. In addition to standard 7 in. reels, model 1056 can be specified for the processing of 10½ in. reels. Operating on 120V 60Hz, model 1056 uses a common capstan drive and standard shaded 4-pole torque motors for spooling.

*Mfr: Garner Industries, Inc.*
*Circle 56 on Reader Service Card*



*(continued)*

## REEL RETAINER

● Lock-down VIF 1000 reel retainer secures both NAB and RETMA reels in place, working with either ¼" or ½" reels on both rack and console-mounted recorders. When used with NAB reels, the retainer can be permanently locked on the shaft. For RETMA reels, the VIF 1000 is locked on the turntable shaft with the aluminum locking nut. Textured surfaces aid in gripping.
*Mfr: VIF International*
*Price: $13.50.*
*Circle 57 on Reader Service Card*

## LAVALIER MICROPHONE

● Tiny SM11 lavalier microphone measures only 1-5/16 in. in diameter, but delivers a frequency response of 50 to 15,000 Hz, optimized for lavalier use. The dynamic omnidirectional mic has an impedance of 150 ohms for connection to microphone inputs rated at 25 to 200 ohms. Accessories include a lavalier cord assembly, a clip-on clasp and a tie-tack assembly with a connector belt clip. The unit weighs 0.28 oz.
*Mfr: Shure Bros.*
*Price: $57.40.*
*Circle 58 on Reader Service Card*

## HEADPHONE/MICROPHONE

● Designed particularly for binaural recording and monitoring, Model HM-200E headphone features a matched electret condenser microphone with simulated auricles in the earpieces, permitting hands-free recording. A foam dummy head has screw sockets for tripods and mic stands. A three-plug connection for left and right input and monitor connections permits hookup to a stereo tape recorder. The unit is battery-powered, may be also used for stereo.
*Mfr: JVC America*
*Price: $80.00.*
*Circle 59 on Reader Service Card*



## FUNCTION GENERATOR

● Simultaneous sine. triangle, and square wave outputs are featured on Model 12 function generator. The unit handles f.m., frequency shift keying, and remote tone burst. It has external frequency control, vco, d.c. to 1 MHz and selectable function output with continuously adjustable amplitude and d.c. offset. Claimed accuracy is ± 5 per cent, with 200 ppm/°C stability.
*Mfr: Advanced Electronics Corp.*
*Price: Kit: $79.95 Wired: $124.95.*
*Circle 60 on Reader Service Card*

## STUDIO EQUALIZER

● Twin-Graphic balanced in/out 600 ohm studio equalizer displays zero-grain input-to-output signal ratios through four l.e.d.s on the front panel. Two separate ten-octave equalization panels, have ±12 dB boost and cut for each octave. Separate equalized signal zero-gain controls are used for each channel, enabling exact balancing of input to output with a +6 dB and −12 dB range. L.e.d.s are used in conjunction with the zero-gain level controls for visual balancing. Front panel pushbuttons select equalized or unequalized output, low and/or high shelving and zero-gain lights. The unit has balanced 600 ohm op-amp input, balanced 600 ohm op-amp output, and switch selection for low or high impedance input for output.
*Mfr: Soundcraftsmen*
*Price: $550.00.*
*Circle 61 on Reader Service Card*

### STEREO COMPRESSOR/LIMITER

• Model 162 compressor/limiter, with strapping for multi-channel tracking, offers true rms level detection with the threshold variable from 10 millivolts to 3 volts. L.e.d. indicators show above and below threshold operation. Compression ratios are variable from 1 to 1 up to infinity. By using the sum of the channel signals as the control voltage, the system maintains proper stereo image location. Four or more channels of operation are achieved through strapping so that a single voltage proportional to the sum of the channels controls all the outputs of two or more of the units. Meters are switchable to read input or output level or gain change over a 60 dB range and zero level may be set anywhere from —10 to +10 dBm. The unit accepts input levels up to +26 dBm and will drive a 600 ohm load at +24 dBm.

*Mfr: dbx.*
*Circle 62 on Reader Service Card*

### STEREO CARTRIDGE


• Optimization of tracking and transient ability are offered in the same unit, stereo cartridge model 2002-e. Lightweight, weighing four grams, the cartridge uses an electret transducer that is directly coupled to the beryllium stylus assembly, producing flat response from 5-20,000 Hz ± 1.5 dB with low distortion at tracking pressures of one gram or less. The unit is independent of tone arm cable capacity, as the result of a passive integrated circuit that eliminates the effect of cable capacity and matches the electret outputs directly to amplifier or receiver inputs.

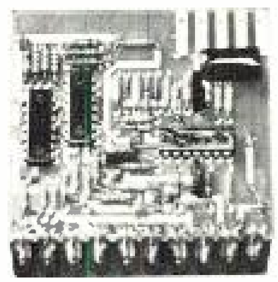
*Mfr: Micro-Acoustics Corp.*
*Price: $115.00.*
*Circle 63 on Reader Service Card*

### AUDIO TEST SET

• Consisting of a generator and a receiver, model 4400 test set has a multiplicity of functions. The generator section includes a multi-waveform function generator, pink noise source, log sine wave sweeper, and comb generator, with facilities for tone bursts, a +30 dBm balanced output capability and low distortion. The receiver section contains an autoranging digital level meter reading in dBm rms, an autoranging digital frequency counter, a spectrum analyzer, wave analyzer, band pass, band reject, high pass, low pass filter and a four-channel digital memory to store response plots. The instrument is used with any d.c. oscilloscope to measure level, gain, noise, crosstalk, distortion, frequency, and phase. Four digital memories permit plots of amplitude or phase versus time or frequency. Applications include equalizer and filter measurements, console verification, tape recorder line up, room equalization, production analysis, and transmission line testing.

*Mfr: Amber Electro Design, Ltd.*
*Price: Under $3,000.*
*Circle 64 on Reader Service Card*

### LED VOLUME METER



• Model LVU-1 consists of a row of ten red leds calibrated in 3 dB steps. The unit features fast response to positive and negative polarity transients and peak holding of 50 msec. to compensate for the integration of vision. Mounting is accomplished by drilling ¼ in. holes into a ⅛ in. panel and using the provided mounting clips. Options include: 10 or 12 leds; red, yellow, and green leds; mounting bezel: a ± 15 volt power supply.

*Mfr: Lintech Electronics*
*Price: $35.00 to $50.00.*
*Circle 65 on Reader Service Card*

### LOW FREQUENCY HORNS

• Designed for the rugged high volume demands of large area live performances, SR-215 and SR-115 low frequency horns are suitable for applications requiring low frequency response to the 40 Hz region at extremely high levels. These are exponential straight horns with reflex loading for 15 in. woofer drivers; true exponential flare rate is claimed by the manufacturer. A 6 dB down point of 40 Hz or less is permitted. Response is maintained to above 1 kHz to permit crossover to the midrange horn anywhere in the 500 to 800 Hz range. The units are constructed of laminated birch with internal bracing to further control resonance. Inside surfaces are lined with fiberglass and corners are reinforced to withstand on-the-road handling.

*Mfr: Forsythe Audio Systems*
*Circle 66 on Reader Service Card.*

WILLIAM H. HALL

# Solving the Reverberation Dilemma

*The ear's sensitivity to reverberation makes paring equipment costs difficult, careful testing of equipment a must.*

LOOKING OVER the reverberation market, one views everything from "space expansion" devices to gold foil models, with equipment costs ranging from about $100 to more than fifty times that amount. You can't help but ask, is there really *that much* difference in performance between the various manufacturer's equipment at these two extremes? Reverberation equipment seems to group itself in the gnereal price ranges of (a) below $500, (b) $500—$1,000, (c) $1,000—$2,000, and (d) over $2,000. The higher range can easily exceed the cost of the primary recording equipment with which the reverb would be utilized.

Skillful usage can make recordings on budget equipment that are almost unnoticeably different in quality from those done on the most expensive equipment. But when dealing with reverberation equipment, one finds that the cost *vs.* quality required is not necessarily in proportion to the overall equipment budget, nor does skillful usage compensate for lack of quality. Five thousand dollars' worth of basic recording equipment can make excellent tapes, but reverberation equipment worthy of such tapes will add at least one-fourth more to the investment.

A lot of effort is being spent, even today, by individuals as well as manufacturers on ways to achieve high quality reverberation without spending this apparently disproportionate amount of money. Over the years we have heard of many novel and often rather extensive schemes to try and bypass the requirements for the more expensive reverberation devices, but only a very few of these attempts have been capable of passing the listening test.

## BASIS FOR CRITERIA

The primary problem with any approach is that the human ear is an extremely sophisticated device and is quite particular about the type of reverberation that it wants to hear. No special talent is required to make a listening test. With very little experience, almost anyone can pass judgment on a reverberation device and will probably find himself in general agreement with others.

This very fact determines the quality required in reverberation, regardless of the cost. It is almost as if poor

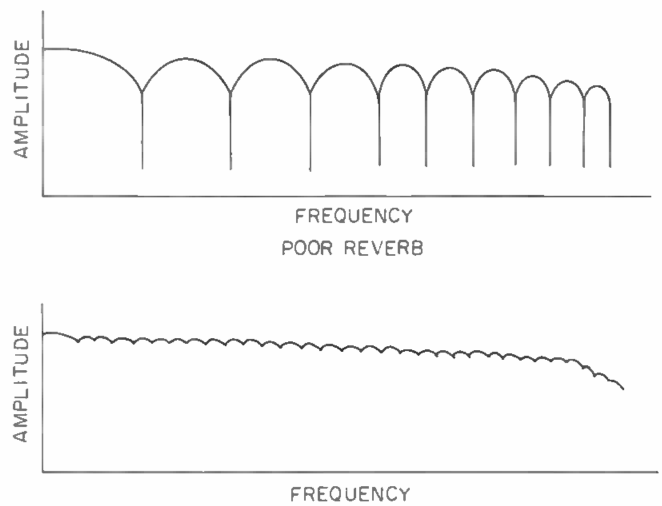



*Figure 1. Sine wave sweep frequency test shows comb filter effect.*

*William H. Hall is vice president of MICMIX Audio Products, Inc. in Dallas, Texas*

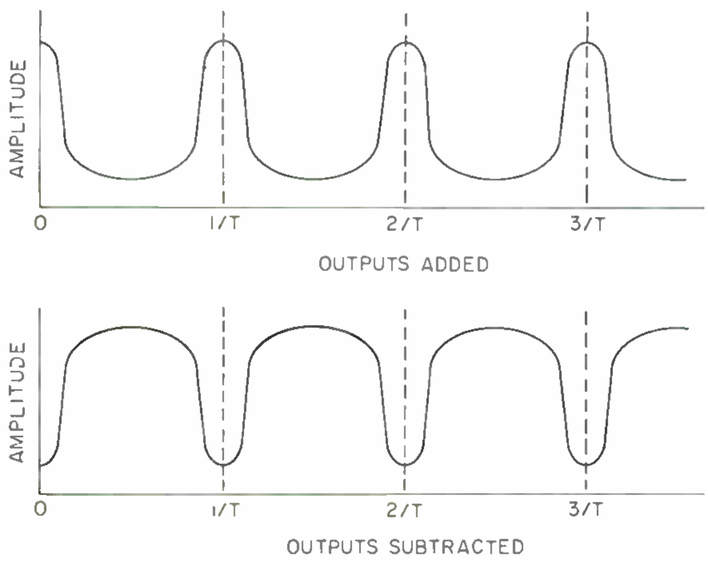



*Figure 2. Recycled electronic delay lines have precise periodic amplitude reinforcement or cancellations at harmonics of the fundamental resonant frequency. Fundamental frequency is determined by the reciprocal of the delay time.*

reverberation is worse than none at all. Poor reverberation is readily apparent when transient material is involved, or, to put it another way, transient material always requires good reverberation.

To the already diverse product lines of reverberation devices now on the market, there will soon be appearing a group of low priced delay lines which can be recycled and thus form another type of reverberator which is very similar in performance to the recycled tape loop, an elementary setup on the professional tape recorder. From this assortment of electro-mechanical, and now all-electronic, devices when taken in relationship to the sophistication of the human ear, what are the criteria for a reverberation device and how do they equate to money well-spent?

The primary consideration in reverberation is the somewhat elusive quality called *diffusion*. All reverberation devices contain standing waves in their output structure, with the difference being whether these standing waves represent a large or small portion of the total output energy. A poor quality machine will have a coarse comb filter effect, with almost complete cancellation of signal at the comb minima points, while a good reverberator will have a fine comb filter effect and only a very small amount of cancellation at the comb minima points.

## PLOTTING STANDING WAVES

The old technique for plotting out the standing waves in a room or auditorium is very valid for assessing the diffusion capability of an artificial reverberation chamber. It is also a very easy test to perform. To make such a test, slowly (very slowly) sweep the chamber with a sine wave oscillator from about 50 Hz to 5,000 Hz. Count the number of output amplitude variations which occur, as measured with a vu or dBm meter, or plotted on a graphic recorder.

The resulting quantity of maxima points divided by the frequency range covered (in Hz) is referred to as *resonances per hertz* and provides a strong indication of the chamber's performance qualities. A good reverb will produce close to one, or even more, resonances per Hz, while a poor quality machine will result in at least a magnitude *fewer* resonances per Hz.

FIGURE 1 expresses this concept. A low quality machine will have a very well defined comb filter effect caused by the cancellations due to standing waves in the transmission path(s), resulting in a low figure (usually 0.01 to 0.20) of resonances per Hz. This effect is very well known, although not in those terms, and is responsible for the sound so often discussed and associated with an inexpensive spring reverb. Most people refer to it as "boing," but it is a characteristic property of delay lines, and not necessarily that of the spring itself, which happens to be the transmission medium most often used in electro-mechanical reverberation systems.

Because of this fact, it has been possible to design at least two very good reverberation devices using the basic spring as the transmission medium. One of these spring systems is generally referred to as the *torsional* transmission line system. The other is the Master Room system which utilizes networks of specially designed "springs," with the outputs being essentially summations of numerous interconnected and digitally tuned sections.

## ELECTRONIC REVERBS

Because of its cost, the electronic delay line has not yet achieved the popularity of the more common reverberation device. However, there is probably not a person alive who, having the availability of a digital delay line, has not tried to duplicate some reverberation effect by making the line recycle itself. What is soon discovered, though, is that the recycled delay line is even more "boingy" than its electro-mechanical counterpart. The reason for this rather weird fact is that the electronic line is a precision comb filter and exhibits *no* diffusion. The electro-mechanical device is not as precise in its physical design and therefore has some inherent diffusion which tends to reduce the "boing" properties.

Since diffusion is the name of the game to a very great extent in reverberation, and it is this property which breaks up sound into the multiplicity of random echoes that please the ear, it will take a lot of design effort to make an electronic reverb that is as good as our present electro-mechanical systems. New concepts will have to be developed to provide diffusion in a digital system, since the obvious multi-tapped delay line can sound worse than even the automobile "reverberators" which were popular a few years ago.

There will soon be on the market a formidable array of analog delay line units based on the bucket brigade devices (BBD's). This type of delay line, like its digital counterpart and the electro-mechanical systems, will still have to follow the same set of laws, however, when set for a recycling mode of operation. In the recycling mode, the delay time determines the primary resonance, while the method of feedback determines whether the reflections are odd or even multiples of the primary resonance. Various configurations of these systems are responsible for the "flanger" and other electronic sound modifiers. The comb filter which is formed by a recycled delay line can have two basic modes, depending upon the sign of the output summation. FIGURE 2 illustrates this effect.

The primary resonant frequency is determined by F = 1/T, where T is the delay time. A delay time of one millisecond in a delay line would result in a primary resonant frequency of F = 1/0.001 = 1,000 Hz, with additional resonances occurring at all multiples of T (2T, 3T, etc.) to the bandwidth of the system. If the delay line was 50 milliseconds long, the primary resonance would be at 20 Hz.

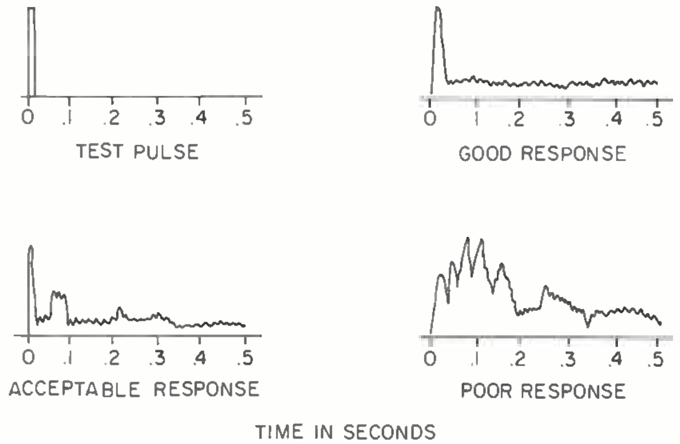



*Figure 3. A good reverberation system will have only small variations in amplitude due to standing waves created when tested with a sharp pulse signal. The first 500 msecs. of reverberation time are the most significant in this test.*

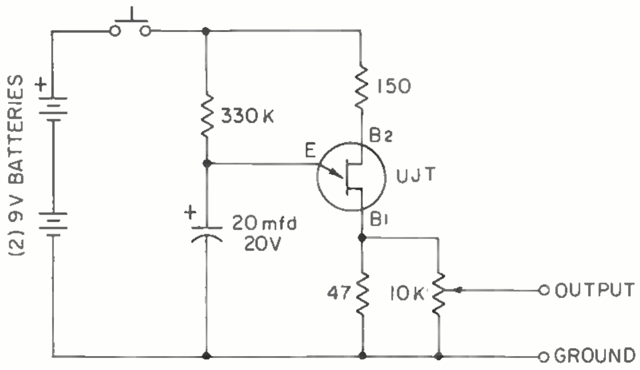



*Figure 4. A simple test circuit. Typical UJTs are 2N4851, HEP 210, or ECG 6401. A pair of standard 9-volt transistor batteries in series provides the power supply. The unit is operated by depressing the momentary switch until a pulse occurs. Set the output level low enough to avoid overloading the system being tested.*

## PULSE TESTING

Any transient in the recycled line can shock excite the system to ring at the primary and/or at harmonic resonance points. These resonances are interpreted as *boing* when the frequency is within the range of approximately 50 Hz to 3,000 Hz, and as *flutter echo* when the resonance is below the lowest frequency that the ear can resolve. It is this property of the basic delay time, not the material used, that has given the simple spring reverb its bad name and sound.

At MICMIX Audio Products, we developed (or at least significantly improved) another technique for room and reverberation device analysis which is similar to radar and sonar technology. With this system, a sharp narrow pulse is transmitted and the resulting echo pattern describes the time domain characteristics of the structure or device being tested.

Figure 3 illustrates this system as applied to an auditorium. The test pulse is transmitted and the resulting echoes are displayed on a storage type oscilloscope. The timing pattern displayed is capable of being interpreted as the result of a good or bad reverberation system; the frequency of any trouble points can be located by the 1/T formula. It was from this type of studies that the parameters for the Master Room reverberation chambers were determined.

One interesting aspect regarding these studies of both live rooms and artificial chambers is that all good reverberation systems have a common sound when pulse-tested and monitored aurally. While I cannot readily describe this type of sound in print, it is possible for anyone to become familiar with its character after just a little experience, and thereafter to be able to quickly spot a poor reverberation system. The pulse test also has the ability to shock excite any resonances in the reverberation system which color the resulting echo pattern.

Pulse testers for this purpose are extremely simple devices, Figure 4 is a schematic of one circuit using a unijunction transistor which can be built for just a few dollars' worth of parts and which delivers a very usable pulse with more than adequate amplitude. Care must be taken with this circuit in not using too much amplitude. Because the output has such a low duty cycle (manually operated pushbutton) and a very sharp pulse, it is quite easy to use too much output and overload the input amplifier of the system being tested, whether it is a speech input system or an artificial reverberation device.

Such overloading will totally defeat the purpose of the test. A little experimentation with the pulser will soon give an idea of the proper pulse amplitude. From use of the pulse test, one can learn a substantial amount about reverberation devices and become a good judge of quality rather quickly. As an additional benefit, the pulse tester is an excellent aid in tweaking up EMT and AKG units to obtain best performance.

## APPLYING CRITERIA

The purpose of this article is to try and clear up a little of the witchcraft that has surrounded reverberation devices for a number of years, and to provide a simple test method whereby one can have a standard for comparing not only artificial chambers, but acoustic systems as well.

In the near future there will be many models of electronic delay lines and space expansion type systems. Some no doubt will be very good while others will be of questionable value to the professional. With these, as with existing devices, I would like to reiterate one point; i.e., reverberation is considerably different than a speech input system and the human ear is very sophisticated in the type of reverberation it likes to hear. It pays to evaluate a reverb system before spending one's cold hard cash, and thereby eliminate the oft-repeated lament that what was bought was not satisfactory for the desired effect.

The electronic reverb is somewhat in the future and it is probably safe to say that all of us in the manufacturing business have several systems running in development for evaluation. Other than as a novelty, however, the professional quality all-electronic reverb at a somewhat reasonable price may be quite some time in the future because it is so much more difficult to achieve our present quality in reverberation electronically than it is electro-mechanically. The electro-mechanical (passive) delay line is not a "noise" generator and can be more easily produced on a cost-effective basis to achieve the diffusion that is so necessary for good reverberation quality.

New technology usually wins out in the end, but during the interim it is always wise to let quality be the determining factor in making a decision, rather than novelty or price. ■

# Sound Technology 1710A Distortion Measurement System

*The Sound Technology 1710A analyzer with the intermodulation distortion and auto level set options installed. As shown the total price would be $3495.00. The breakdown is $2635 for the basic 1710A, $210 for the set level option, and $650 for the intermodulation distortion option.*

ESSENTIALLY, the Sound Technology 1710A is an all-purpose total harmonic analyzer combined with a pushbutton low-distortion sine wave generator. There are two options available, both of which were on the unit tested: one adds an intermodulation distortion analyzer using the SMPTE method, and the other is an automatic level system.

It's quite easy to become totally dependent on this unit once it is installed in the lab. My lab was falling into obsolescence with distortion analyzers that could not reliably indicate below 0.1 per cent. These days much audio equipment, both consumer and professional, is more than an order of magnitude better.

*(continued)*

## WHAT THE 1710A DOES

As a lab tool, the unit is interfaced via banana plug jacks that are fully balanced and floating (with ground available and no loss of output involved if an unbalanced signal is sent out). The audio generator section is operated by pushbuttons. Three rows cover the full range from 10 Hz to 110 kHz. Those buttons do something else. They shift the filter tracking of the distortion analyzer to the selected frequency so there is no balancing required and a distortion indication on the meter is a matter of seconds.

A separate switch chooses between *fast response* (of the filter system's tracking) and *low distortion*. In the fast response mode, the auto tracking will not achieve the lowest distortion indication, but the results are virtually instantaneously achieved. For testing tape machines, this is as good as needed.

The low distortion setting of the switch takes a bit under five seconds to settle down, but it will achieve the full low distortion the system is capable of. How good is that? The 1710A will reliably indicate distortion within the 10-20,000 Hz range as low as 0.002 per cent. Above that frequency range distortion remains low—to wit: 0.015 per cent at 50 kHz, and at the limit of 110 kHz, total floor distortion was 0.22 per cent. Just how much of this residual is part of the distortion analyzer and how much is part of the generator is hard to say, but most is, I suspect, the generator. In other words, a better generator, if it exists, might show up even better on the analyzer.

The distortion measurement capability is not limited to the use of the internal generator. Any generator or test tape/disc could be measured. To adjust the filter, you must punch up the frequency being fed into the unit. There are two led's under the nomenclature *notch* that will light if the filter frequency is set too high or low. The objective, when using an outside source, is to get both lights out. Then the notch is correctly set for the frequency at hand.

The unit submitted for test had the option of automatic level set built in. This feature is immensely useful in tape recorder testing where different levels used to determine the saturation point, 3 per cent distortion point, etc., are achieved with no further adjustment of input gain. If the input signal is raised too much, another led will ignite to tell you to reduce the input level switch of the unit.

You can also set input level of the analyzer manually, but there is hardly a reason to do so.

## OTHER FEATURES

The analyzer is also a wide range a.c. voltmeter. As such it can range from full scale indications of 100 μV to 100 volts. Accuracy is spaced at 2 per cent full scale.

That scaling on the input switch will also measure noise from full scale indications of −80 dB to +40 dB. In use, the 1710A is patched to the unit under test and its several features make it easier to make quick tests. A push button just to the left of the meter switches the meter between *input* and *generator output*. Just one quick push and you know the voltage of the signal going into the unit under test. Release the button by pushing it again (the button has a position indicator built in) and you are measuring the output of the unit under test.

Another nice feature are two input filters that operate only for distortion or dB ratio testing. A 400 Hz filter cuts everything below that frequency at an 18 dB/octave rate so that 60 Hz hum is over 40 dB down. The second and independent noise switch cuts frequencies above 30 kHz at the same rate. My tests indicate that the filters are exactly correct in their action.

The generator output is derived through a three knob attenuator that will make 10 dB, 1 dB, and 0.1 dB level changes respectively. Source impedance of the generator can be switched between 150 or 600 ohms. With the 600 ohm load on, the attenuators directly indicate dBm.

A vernier knob with a −1, 0, +1 range can be used to further trip the generator output. And finally, a push button will shut off the generator, while maintaining the load impedance, thus making signal-to-noise measurements a matter of quick achievement.

## INTERMODULATION DISTORTION

An available option at the time of ordering adds SMPTE—method i.m. distortion capability to the unit. Merely switching in the section by pushing the correct button will automatically convert the unit. Now, the predetermined signal is at the generator output. It will be the standard 60 and 7000 Hz, which can be mixed in fixed ratios (switch selected) of 4:1, or 1:1. In addition, variable ratios of the two frequencies can be set manually with a knob anywhere between 1:1 and 100:1.

Tests indicate that reliable intermodulation distortion measurement can be made to a residual floor of 0.0015 per cent when the 4:1 ratio is used.

## SUMMARY

The foregoing covers the bare bones of operation of this system. What is not fully conveyed is the simplicity and utter reliability of the day-to-day use of this system. In particular, I found the automatic level set something that once used, can not be dispensed with. The ability to monitor input and distortion products output separately on meters and 'scopes (via bnc-type connectors) is a further advantage. In fact, I know of no other analyzer that can indicate lower, and operate with such total convenience, and in so compact a package as can the 1710A. L. Z. ■

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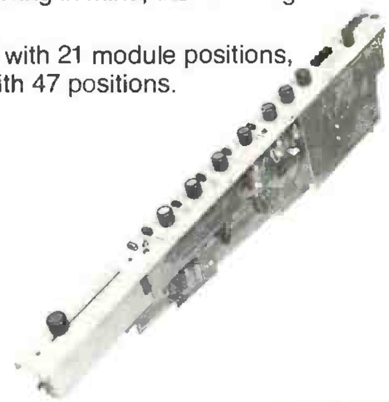

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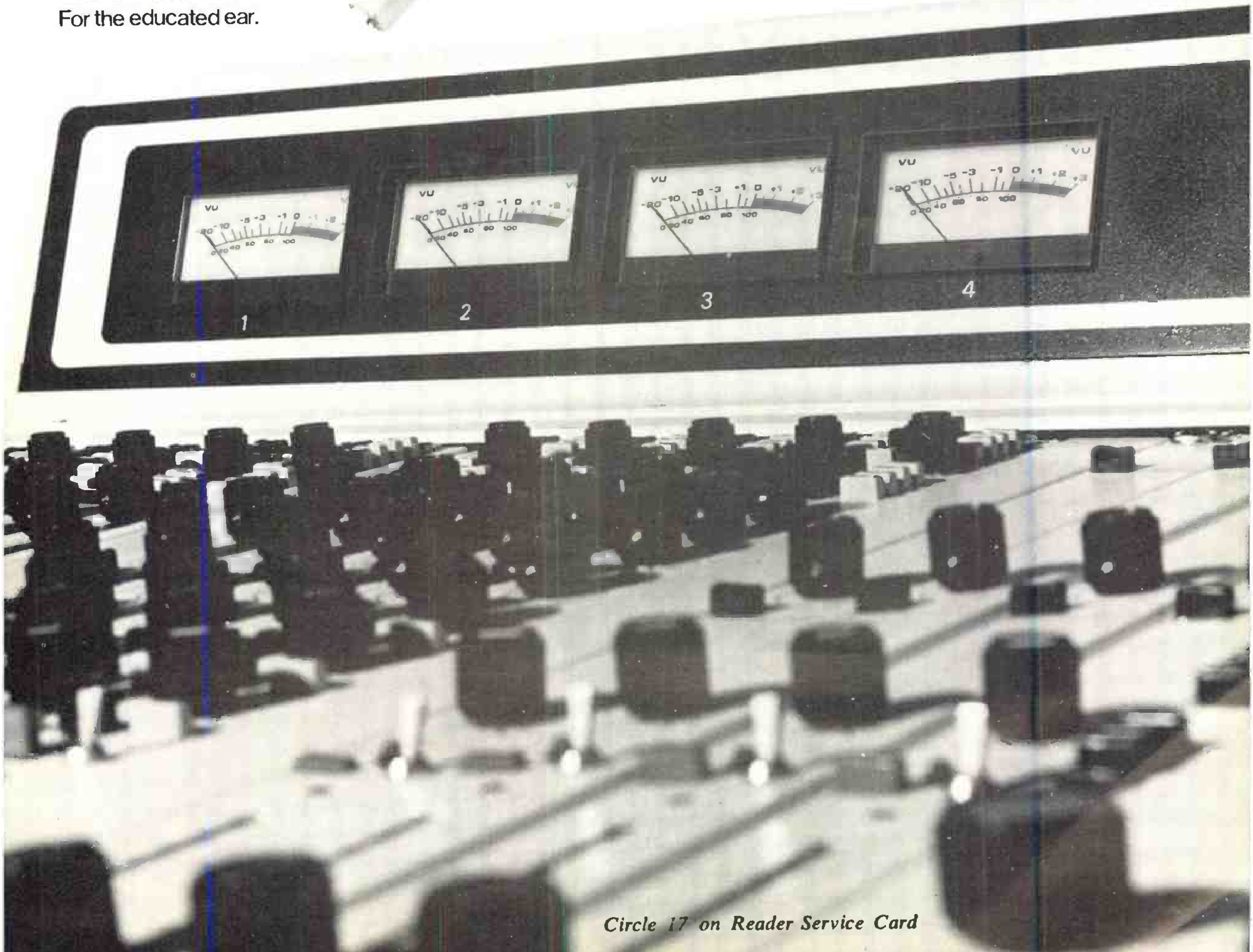


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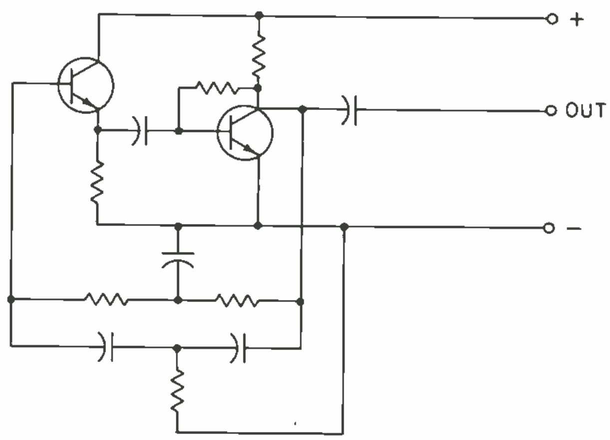
In designing the device, the parallel tee phase shift oscillator depicted in FIGURE 1 looked like a good place

*Figure 1. Basic phase shift (parallel tee) oscillator approx. 15 per cent distortion, must see high Z load. (See Figure 4 for values.)*




*Evert Fruitman is an engineer at KOOL Radio & T.V., in Phoenix, Arizona.*

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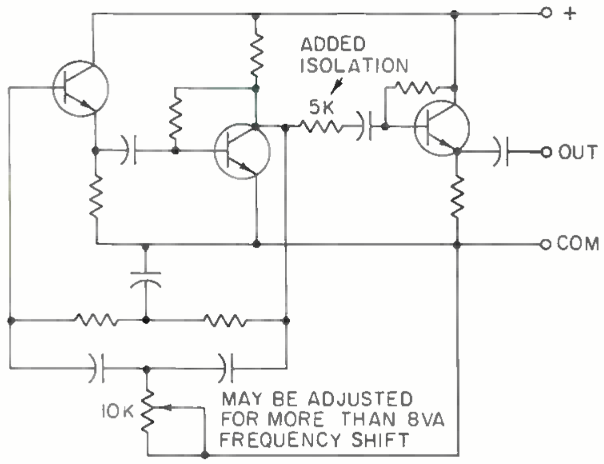



*Figure 2. Basic phase shift oscillator with emitter follower. Will drive medium Z load. May be adjusted for more than 8 VA frequency shift.*

to begin since it was supposed to be fairly stable and have a reasonable level of distortion. Before the stability or distortion could be measured, it was necessary to reduce the output impedence to a usable level because any change in load resistance at the collector of $Q_2$ shifted the frequency. This was neatly resolved by using an emitter follower for isolation. (A J fet would have been better, but wasn't handy when this was put together.)

The next thing that became evident was the fact that there was about 18 per cent distortion in the 3-stage system. The usual quick cure-all consisting or bias and voltage juggling didn't do enough, and a mathematical analysis



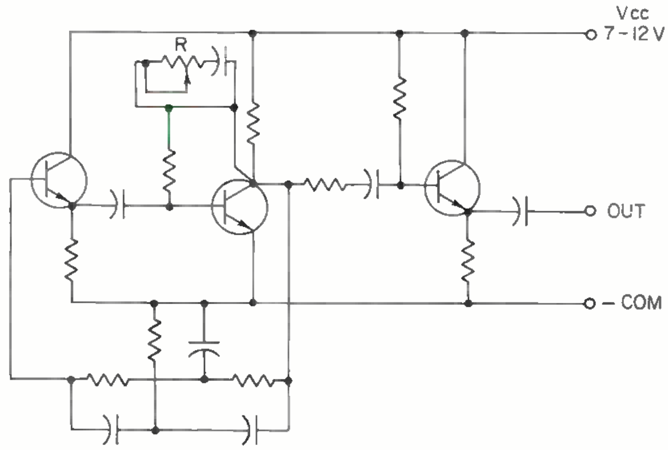



*Figure 3. Low distortion oscillator with negative feedback, suitable for use with fixed voltage supply. R is adjusted for low distortion.*

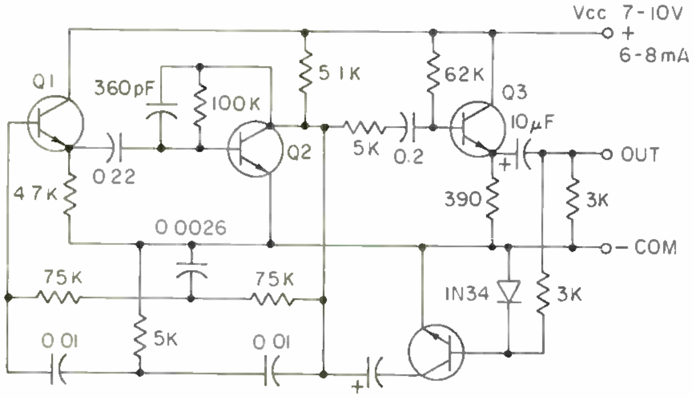
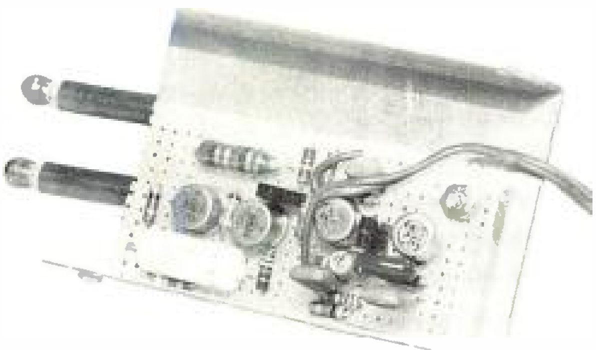



*Figure 4. Low distortion oscillator with negative feedback and agc approx. 1 kHz. For balanced output use MT 26FB. 2N2926 may be used for $Q_{1-4}$. 2N1171, 2N2102, 2N3053.*

wasn't all that practical or helpful either

If a balanced output is required, it is a simple matter to add a small 1:1 transformer. However, there have been no difficulties encountered in using the units without a transformer at studio or transmitter.

The values shown in the diagrams are those that were



actually used; standard values will work equally well. It will probably cost less than $10.00 to build one of these if all of the parts (except the transformer) are purchased new.

The net result of this effort has been a small, inexpensive utility oscillator with long battery life, reasonable frequency stability, and low distortion. ■

**REFERENCE**

1. Terman, F. E. *Radio Engineers' Handbook*, McGraw-Hill, New York, 1943.

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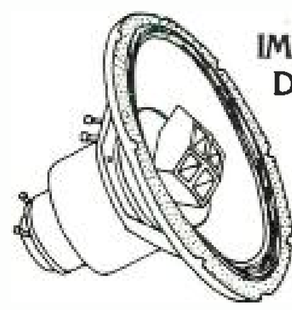

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• The question of whether the Betamax videocassette player/recorder violates the federal copyright law or is merely a device to make existing programs available to a larger audience is being tested in a lawsuit brought by **Universal City Studios** and **Walt Disney Productions, Inc.** against the **Sony Corporation.** Sony takes the position that the Betamax is a time-shift machine, which simply permits consumers to see programs they might have missed on their television sets.

• Announcement has been made of the appointment of **L. R. Dongelewicz** as manager for eastern European sales for **RCA** broadcast equipment. Mr. Dongelewicz is based in Sunbury-on-Thames, Middlesex, England. He has been with RCA since 1952.

• Four new reorganizational appointments have been announced by the **Memorex Audio Division. Al Pepper** and **Jim Aldrich** have been named product managers for the division. Former managers **Jim McBurney** and **Carl Yankowski** have undertaken new responsibilities, Mr. McBurney moving to London to direct marketing efforts in Europe, Africa, and the Middle East, and Mr. Yankowski to take charge of new products and acquisitions.

• A new service center facility has been opened at Rockland Rd., S. Norwalk, Conn. by the **Philips Audio Video Systems Corp.** The new facility will include warehousing, shipping, and receiving for **AKG Acoustics, Philips Audiocom,** and **Philips CCTV** products, formerly serviced in Long Island City.

• **Edmond A. May** has been appointed to the position of vice president, speaker engineering for **Superscope, Inc.** of Chatsworth, Ca. Mr. May will be responsible for both the Marantz and Superscope speaker lines. He comes to Superscope from **James B. Lansing Sound.**

• **Wayne Freeman** has been appointed national sales manager at **BGW Systems,** of Sherman Oaks, California. Mr. Freeman, who comes to BGW from the **Telesco International Corporation,** has a background in electronics and marketing management.

• Supervision of the national sales force of the **Fanon/Courier** line of CB radios, accessories and personal communication products is in the hands of newly appointed **Dick Lask.** Mr. Lask was previously with **Boman Industries** and his own company, **Evergreen Electronics.**

• Stepping up from the position of general manager of **Superscope's** international division, **Steve Rand** has been named as vice president and general manager of Superscope Canada, Ltd. In his previous capacity, Mr. Rand devoted a good deal of time to Canadian outlets and is well known to Canadian audio people.

• Occupying the entire second floor of New York City's famed Brill Building, **Soundmixers, Inc.,** a **Sound One Corp.** subsidiary, will provide facilities for major recording sessions in its three 24-track studios, large control rooms, and experimental 16-track studio. In addition to sound recording, the complex will provide videotape screening facilities for feature motion pictures and t.v. commercial scoring. President of the new enterprise is **Harry Hirsch,** who produced gold records for prominent entertainers and recorded for several prime commercial accounts during his period with his own studio, **Media Sound.**

• **Robert J. Anderman** has been appointed broadcast sales manager at **McMartin Industries, Inc.** of Omaha, Nebraska. Mr. Anderman comes to McMartin from the **Harris Corporation.**

• **Howard Webster Town,** audio engineering section manager for the **Ampex Corporation** of Redwood City, California, died on November 21. Mr. Town had been with Ampex since 1969. He was responsible for the ACR-25, the world's first quadruplex cassette vtr. While working as director of engineering of **WTTW,** Chicago, he was instrumental in installing WTTW's television transmitting station on the Sears Tower.

• Expansion of its plant facilities to include a new factory building in Sullivan, Illinois, has been announced by **Switchcraft, Inc.** of Chicago. The plant will be used for the production of switch assemblies, telephone components, and audio connectors. The firm recently took over two switch lines from **Chicago Dynamic Industries,** a factor that has led to the expansion.

• Burgeoning interest in direct-to-disc phonograph recordings, which bypass the tape recording stage of production, is evidenced by the decision of **Audio-Technica,** of Fairlawn, Ohio to import the discs from **Nimbus 9 Products,** of Toronto, Canada. Under the label "Umbrella" the discs will retail for $12.95. The hefty price stems from the fact that discs produced this way cannot be pressed on a mass basis; in fact, each album will be a limited edition with its own serial number.

• **William J. Overhauser,** founder of **Sparta Electronic Corporation,** has formed a new company, **Corinthian Marketing,** at Incline Village, Nevada. The firm will function as sales representatives and as consultants to firms needing broadcast expertise. Of particular interest is the representation of firms offering products or services to the broadcast industry.

• **Sonab Audio** of Sweden has been purchased by loudspeaker designer **Olle Mirsch. Roland Olvinger,** formerly with **Philips,** has been appointed managing director. In the U.S., **Brian Firestone** has been appointed eastern regional sales manager for **Sonab Electronics, U.S.,** based at Foster City, Ca.

• Newly appointed vice president/general manager of the audio video systems division of the **Ampex Corporation, Donald V. Kleffman,** will be handling the professional market. Mr. Kleffman has been with Ampex since 1959, serving as an applications engineer, and lately as marketing manager.

• Responsibility for **Sharp Electronics'** two factory service branches has been assigned to **Thomas F. Rossiter,** new manager of national service administration. Mr. Rossiter comes from **RCA.**

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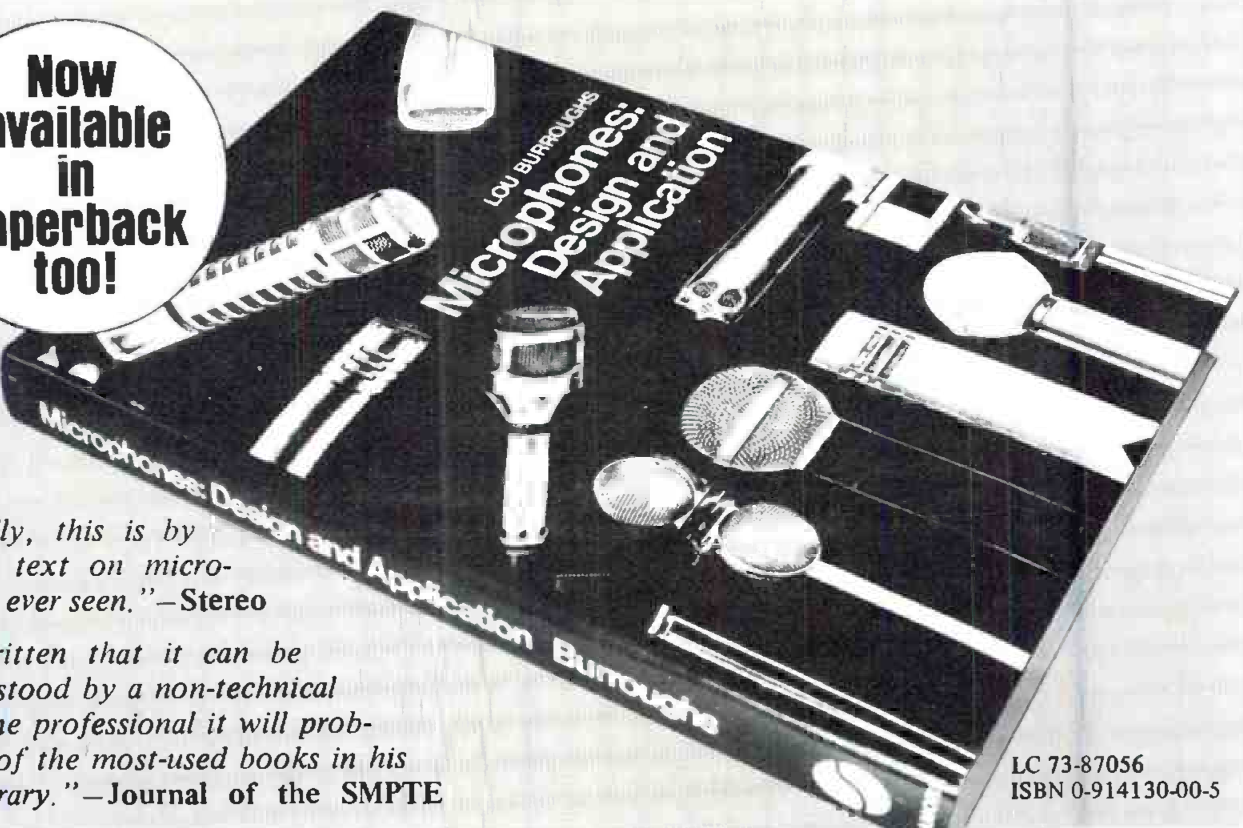


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**Microphone Interference**
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**Microphone Maintenance (this chapter alone "is worth the price of the book" said D.F. Mikes in *Audiovisual Instruction*)**
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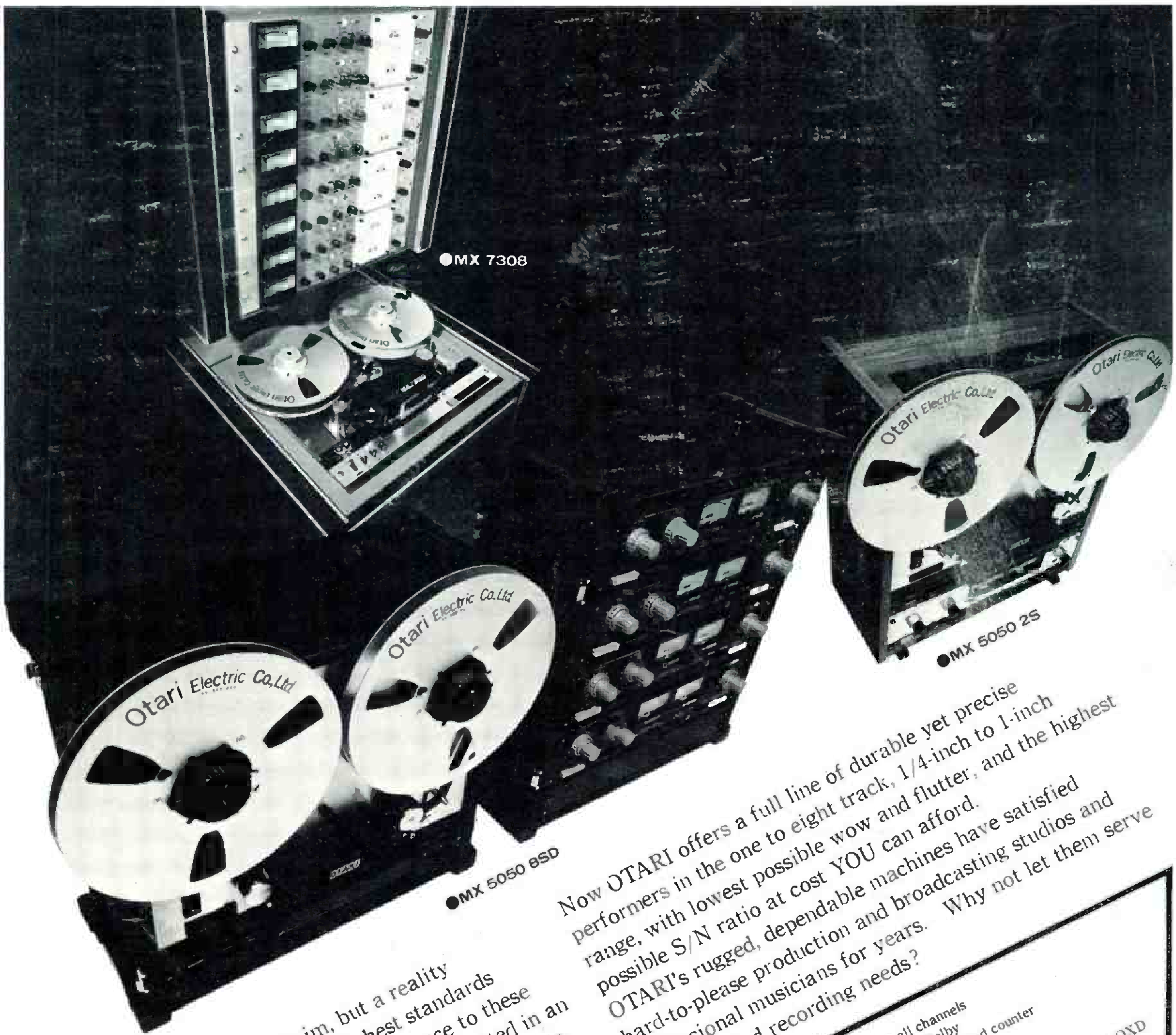


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●**France**: Reditec 62-66, Rue Louis Ampère(Zone Industrielle des Chanoux), 93360 Neuilly-Plaisance, Phone: 935—9786
●**Belgium**: Trans European Music S. A. Koeivijverstraat 105, 1710 Dilbeek, Phone: (02) 569 1823
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