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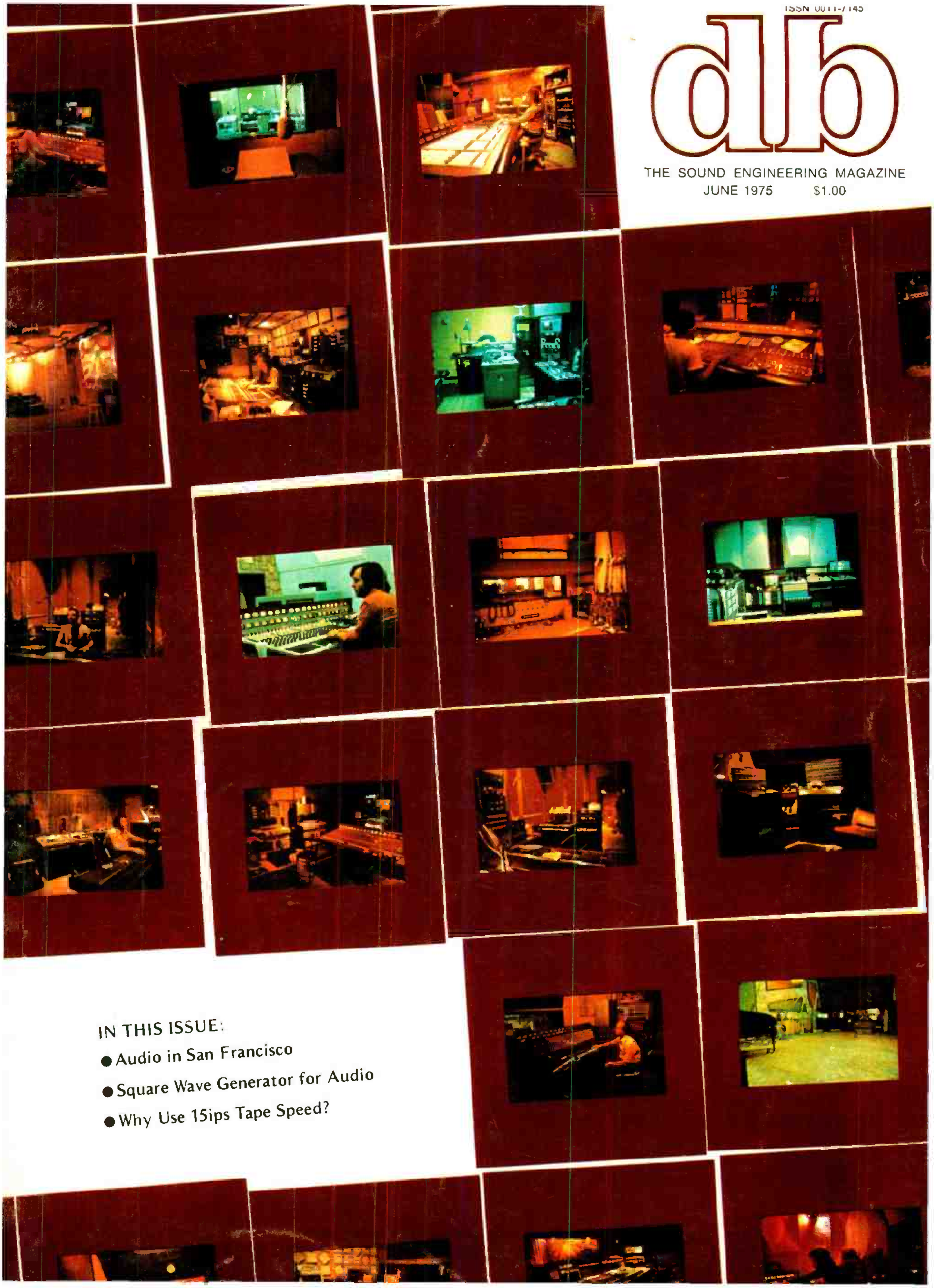
THE SOUND ENGINEERING MAGAZINE

JUNE 1975 $1.00



IN THIS ISSUE:

- Audio in San Francisco
- Square Wave Generator for Audio
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THE AUTHOR

Holder of twenty-three patents on electro-acoustic products, Lou Burroughs has been responsible for extensive contributions in the development of the microphone. During World War II, he developed the first noise cancelling (differential) microphone, known as the model T-45. Used by the Army Signal Corps, this achievement was cited by the Secretary of War. Burroughs was the creator of *acoustalloy*, a non-metallic sheet from which dynamic diaphragms are molded. This material made it possible to produce the first wide-range uniform-response dynamic microphone. Burroughs participated in the design and development of a number of the microphones which have made modern broadcasting possible – the first one-inch diameter wide-range dynamic for tv use; the first lavalier; the first cardiline microphone (which ultimately won a Motion Picture Academy award) and the first variable-D dynamic cardioid microphone. He also developed the first wind screens to use polyester foam. Burroughs was one of the two original founders of Electro-Voice, Inc. He is a charter member of the Society of Broadcast Engineers and a Fellow member of the Audio Engineering Society.

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• Sensurround, an illusion of motion through carefully contrived sound vibrations, made news in the motion picture, *Earthquake.* Meryl Altman's article EARTHQUAKE—A MOVING EXPERIENCE, tells the inside story.

• The engineer who always seems to have an answer to sudden ticklish problems, doesn't carry a magic wand. He owns one of Don Davis' HANDY BLACK BOXES. Mr. Davis describes the indispensible little items which every audio engineer should keep in his box, ready for instant use.

• A British look at the ELECTRET MICROPHONE is the contribution of Basil Lane, assistant editor of *Wireless World.* Mr. Lane describes the principle behind the permanently charged dielectric and other technical details of this miniaturized capacitor mic.

• Bonus **db** reprint brings back David L. Klepper's ARCHITECTURAL ACOUSTICS, PART 2, which many readers have requested for its clear instructions in designing studios to meet specific needs.

about the cover

• All of the recording studios shown here were photographed by Stephen Lampen for his article on audio in San Francisco (p. 26). Represented in this colorful montage are: Record Plant, His Master's Wheels, Columbia, Freeway Recording, Fantasy Records, Coast, Sierra Sound, Different Fur, and Wally Heider's.

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THE SOUND ENGINEERING MAGAZINE

JUNE 1975, VOLUME 9, NUMBER 6

16 LASERIUM—LIGHT WITH MUSIC
Martin Dickstein

26 HOW AUDIO IS DOING IN SAN FRANCISCO
Stephen Lampen

32 COVERS AUDIO BAND IN ONE SWEEP
James Davidson

34 ARCHITECTURAL ACOUSTICS—PART 1
David Klepper (Reprint)

40 WHY USE 15 IPS TAPE SPEED?
Josef Dorner

42 RECORDING STUDIO ACOUSTICS—PART 6
Michael Rettinger

2 LETTERS

4 INDEX OF ADVERTISERS

6 CALENDAR

9 FREE LITERATURE

10 THE SYNC TRACK
John Woram

12 THEORY AND PRACTICE
Norman H. Crowhurst

14 SOUND WITH IMAGES
Martin Dickstein

20 NEW PRODUCTS AND SERVICES

45 CLASSIFIED

48 PEOPLE, PLACES, HAPPENINGS

db is listed in **Current Contents: Engineering and Technology**

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db letters

THE EDITOR:

Reference the article appearing in your January issue, audio certainly *did* get a big boost at Syracuse, thanks to the Newhouse publishing interests and the attention lavished on the Newhouse Communications Center. How times have changed!

I was Student Chief Engineer at the University's WAER from 1950-1953. The station had just increased power from 2½ watts (that's right! This was the forerunner of the 10-watt educational stations) to 1 kW. Remote recordings were made—in mono, of course—on reluctant Pentrons, and bulky two-unit-plus-power-supply PT6H Magnecorders were considered state-of-the-art. The poor engineer headed off to do a remote sports or music broadcast had to haul fifty or sixty pounds of remote box, power cable, mikes and all the rest.

Home-built mixing consoles, "adapted" disc recording amplifiers and the like notwithstanding, the radio-tv center turned out some remarkable work and some first-class professional broadcasters. With all of that wealth of new equipment to play with, let's hope that the students of today remember that it's the product, and not the means, that counts.

GEORGE W. HAMILTON
(SYRACUSE UNIVERSITY, '53/54)
BEIRUT, LEBANON

THE EDITOR:

Martin Dickstein's February column was most enjoyable.

However, he incorrectly describes the method used for getting sound of Fibber McGee's closet.

Fibber McGee and Mollie was originated from WLW in Cincinnati. On a tour of the station as a high school student in the mid-50's, I was shown the actual "closet." It was a wooden box, about 7 or 8 feet tall by 3 or 4 feet square. Inside were hinged shelves on which items were placed. The sound man would trip the shelves, causing the items to drop. A mic was placed in front of the closet; it did not have a solid door, but one made of slats to allow the sound to get to the mic.

Thanks for constantly producing a very interesting magazine.

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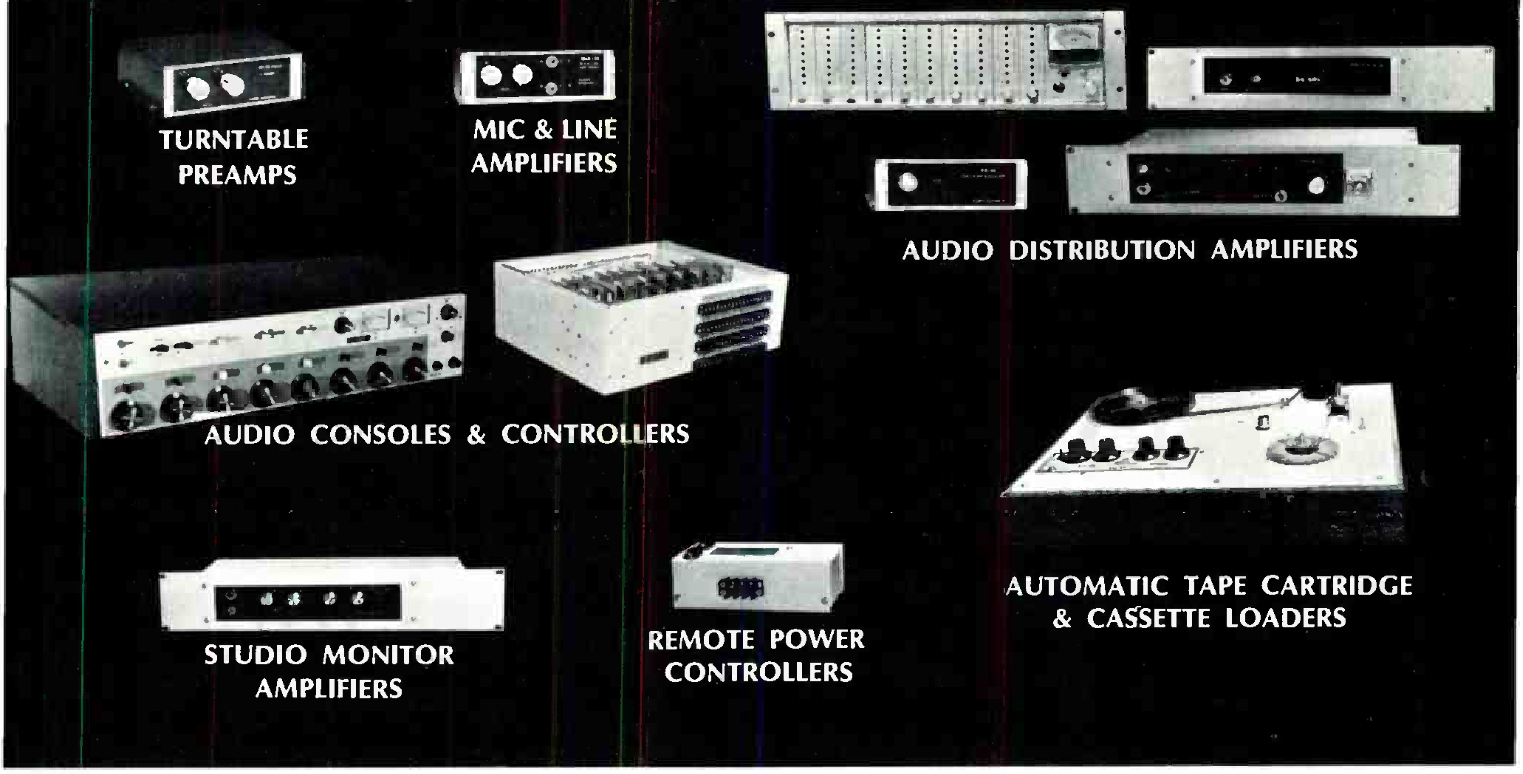

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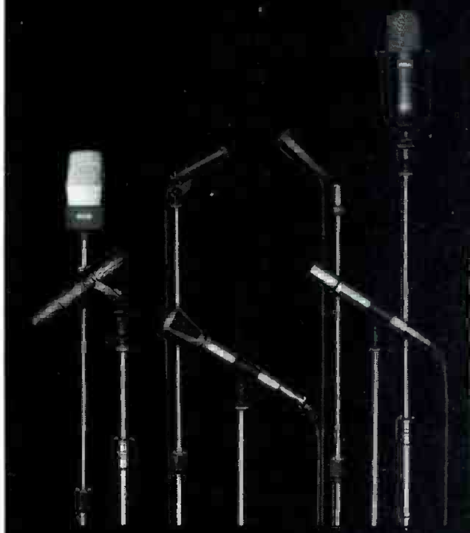

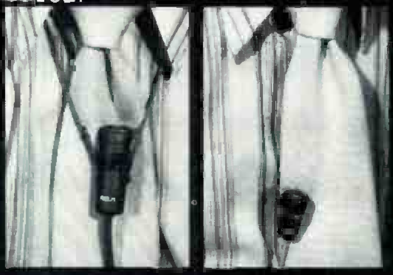

index of advertisers

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Audionics . . . 16
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BGW . . . 19
Bose Corporation . . . 39
Crown International . . . 18, 25
Electro-Voice . . . Cover 4
EMT . . . 9
ESE Digitals . . . 44
Everything Audio . . . Cover 2
Garner Industries . . . 18
Gotham Audio . . . 15
Lumiere . . . 6
MXR Innovations . . . 7
Neumann . . . 11
Rupert Neve . . . 30
Peavey Electronics . . . 21
Philips Audio (AKG) . . . 5
Polyline . . . 9
Precision Electronics . . . 6
Ramko Research . . . 3
Rauland-Borg . . . 17
RCA . . . 4
Revox . . . 4
RIA Tapes . . . 23
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Sound Genesis . . . 22
Southwest Technical Products . . . 24
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15-18 **AMTEC '75, Canadian Educational Communications Conference of the Association for Media and Technology in Education,** Calgary, Alberta, Canada. Contact: Garry Smith, ACCESS Television South, Calgary Health Sciences Centre, 1611 29th St. N.W., Calgary, Alberta T2N 4J8.

JULY

7-11 **Nashville Audio Exhibition** seminar. Contact: Nashville Audio Exhibition, P.O. Box 12123, Nashville, Tenn. 37212. (615) 327-3918.

8-11 **INTER NAVEX '75** (Audio Visual Aids in Education) London.

SEPTEMBER

15-17 **NOISE-CON '75** National Conference on Noise Control Engineering. Gaithersburg, Md. Pre-seminar at the Shoreham Hotel, Washington, D.C. Sept. 11-13. Contact (914) 462-6719.

28-Oct. 3 **SMPTE Technical Conference and Equipment Exhibit.** Century Plaza Hotel, Los Angeles. Contact: SMPTE Conference, 862 Scarsdale Ave., Scarsdale, N.Y. 10583.

29-30 **N.Y. Chapter of ERA, Commercial Sound & Communications Show,** Statler-Hilton Hotel, New York City. Contact: GIM Sales Corp., 375 N. Broadway, Jericho, N.Y. 11753 (516) 433-4080.

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the discernible difference

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The subjective effect of phasing is best at mid and low frequency ranges, as opposed to flanging, phasing's chronological predecessor.

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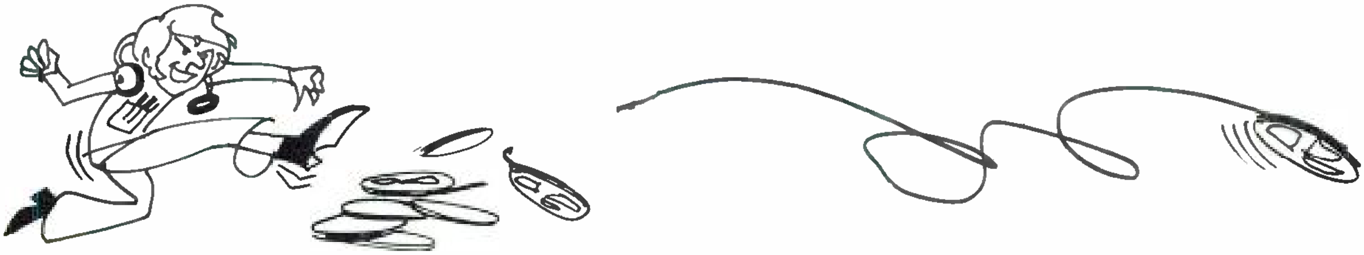

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Circle 23 on Reader Service Card

the sync track

JOHN M. WORAM

• Archeologists tell us that many years ago, recording engineers used a device known as a tape delay system. Usually, signals on their way to a reverberation chamber were first fed through this auxiliary machine, so that they were delayed a bit on their way to the chamber.

The system worked, but was inflexible, noisy, and a nuisance. The delay tape would run out in the middle of the ultimate mix, and the delay time was either too long or too short, depending on the speed of the machine. Today, all the beautiful people are using digital delay lines. You feed the signal into a black box where God knows what is going on inside. A little while later, the signal pops out the other end, none the worse for wear. On the front of the black box are some controls, and you simply dial up the amount of delay you need. That's all there is to it—no rewinding of tape, no fiddling with a capstan to get the delay you want. And no moving parts (except electrons).

The delay line is one of the first applications of digital techniques in audio. And now there are those new tape recorders that confuse so many of us with their logic systems. The logic system knows more about what you want to do than you do, and you must never make it angry! It's usually got a built-in fail/safe system, which is the first thing to crap out. This means that when you press "stop," the machine may perform the following functions:

1. Stop.
2. Go into record mode.
3. Go into fast forward.
4. All, or none, of the above.

Your maintenance department does not want to hear about it, for there are neither tubes to tap, nor pulleys to pluck. There may not even be a spring to snap. In short, the machine is unfixable. Unless you know something about

DIGITAL TECHNIQUES IN AUDIO

This was the subject discussed recently at the 1975 Midwest Acoustics Conference, a joint venture of the Audio Engineering Society's Chicago section, the Acoustical Society of America, the Institute of Electrical and Electronics Engineers, the Chicago Acoustical and Audio Group, and Northwestern University. This year's conference President—or Big Mac—was Bob Schulein of Shure Brothers, who got things under way with a talk by Dr. Barry Blesser on *Digital Processing of Audio Signals*. Dr. Blesser gave us some idea of what digital audio is all about.

Consider the problem of transmitting an infinite number of voltages, lying between, say, zero and 5V. If we have a 5V source available at a switch, S_a, we can transmit either 5V or zero V, depending on the condition of the switch. Not very promising, if we wish to transmit *any* voltage between these two levels. If we add a second switch, S_b, which will supply a voltage of $0.5S_a = 2.5V$, we now have four choices. (5 + 2.5, 5, 2.5, 0). With a third switch, $S_c = 0.5S_b = 1.25V$, we have 8 choices. (5 + 2.5 + 1.25, 5 + 2.5, 5 + 1.25, 5, 2.5 + 1.25, 2.5, 1.25, 0). The number of voltages available increases by the square of the number of switches, so the system's capability for transmitting any desired voltage increases rapidly as switches are added, while the error factor decreases just as quickly.

Since each switch is either on or off, we can represent all possible combinations by a series of zeroes (off) and ones (on). So what?

Well, if we pick some convenient d.c. voltage that happens to be lying around, we can transmit a series of pulses, each of which represents a "switch on" condition. No pulse means either the system isn't working, or the switch is in the *off* condition. To eliminate this ambiguity, another voltage level is usually used to signify zero. Now, at one end of the transmission medium, the (analog) voltage to be transmitted is converted into a series of (digital) pulses. At the other end, the pulses are converted back to the analog voltage they represent, and the listener hears the original program, since the voltages we are talking about are of course, audio signals.

The reason for bothering with this analog/digital and digital/analog conversion process is that the digital data can be stored and retrieved with greater accuracy (and expense) than the equivalent audio, or analog, information. Since the digital information is a function of the audio signal only, noise within the transmission medium –tape hiss and all that—does not get converted into audio at the output end.

ECHO AND REVERB SYSTEMS

Following Dr. Blesser, Mahlon Burkhard of Industrial Research Products, Inc. discussed the specific application of digital technology to echo and reverberation systems. In either application, the audio signal is converted to digital pulses, which are stored in a memory system and reconverted to audio after a suitable delay. Although well suited for the creation of an audio echo or two, an orderly repetition of many delays, t, 2t, 3t, 4t, . . . may not sound altogether convincing as a simulation of reverberation. Natural reverberation consists of an incredibly large number of echoes, occurring at apparently random time intervals and at differing amplitudes. As Mr. Burkhard pointed out, a digital simulation of natural reverberation is still a costly process. However, there may come a time when the natural reverberation of an auditorium may be measured and artificially reproduced with digital techniques and at a realistic price tag. But not today.

DIGITAL FILTERING

Next, Thomas Curtis of Bell Telephone Laboratories spoke about digital filtering of audio signals. Or at least I think he did, but the math was way over my head, and I got lost almost at once. I think the point is that once the information is in digital form, it can be extensively modified before being converted back to analog audio. Earlier, Dr. Blesser alluded to various signal processing techniques that might be used digitally. Of course, neither conventional filters nor limiters will be usable in the digital world, so we may expect to see a new generation of devices presumably offering great flexibility at a very high price—at least at first.

Lexicon's Francis Lee demonstrated digital techniques applied to frequency shifting. Over the years, there have been many attempts at independently varying the frequency or timing of a program. Radio stations in particular would love a gadget that would allow them to speed up the last few minutes of a long running program, without raising the pitch. However, such devices still need a bit more development work. Speech remains intelligible, but music does not do well at all. Mr. Lee successfully demonstrated real time frequency shifting of his voice, as well as time compression and expansion of previously recorded material.

During the afternoon session, Thomas Stockham of the University of Utah had originally planned to compare 24th generation digital and analog recordings. However, by the 17th generation, the analog recording had just about self-destructed, while the 24th digital was still of master quality. The conference's analog tape recorder, on which the final generations had been recorded for comparison, got a little temperamental—frightened perhaps at its prospects for future survival. However, the conference committee managed to get it back in shape in time for Mr. Stockham to make his point on the viability of digital recording, editing, and duplication.

Derek Tilsley, from the Neve home office in England, gave us a behind-the-scenes glimpse of his company's research work with digital technology. Neve engineers seem to be on the left side of fanaticism when it comes to noise figures, and haven't been satisfied with current automated mixdown techniques.

Towards the end of the conference, Motorola's Scalatron was described and demonstrated. The Scalatron, a digitally programable keyboard instrument, may be quickly tuned to any scale with up to 24 steps per octave. For more traditional tastes, the Scalatron may be tuned to say, a just tempered scale, to hear how it all sounded before Bach. And, transpositions can be worked out with little pain.

COMPUTER-GENERATED MUSIC

In the final presentation, Joseph Olive of Bell Telephone Labs discussed computer-generated music. Mr. Olive has been quite active in the area of computer music, and brought along several examples of his work.

One of the limitations of some computer-generated music is that the feedback loop between man and machine is broken. The composer must prepare his computer program, which the machines will digest. Some time later, out comes the music. Spontaneity of expression and phrasing is lost —pretty much like on a vocal overdub session—unless the computer works in real time, which may not be possible when complex sounds are required.

Mr. Olive demonstrated some interesting effects, such as the tone that seems to be continuously falling in frequency, without actually doing so. (If you weren't there, don't ask *me* to explain it).

The grand finale was an excerpt from an opera for soprano and computer. Our scientist-soprano begins teaching the computer to speak. After a while, she tires of the exercise and turns the machine off. Or at least she thinks she does. Too late! The computer has been romantically aroused, and declares its affection for the scientist. Due no doubt to its digital heart, the computer's readout has determined that the scientist is a woman as well as a person. And she has discovered that it is a man as well as a machine. (I wonder what women's lib will do with this one?)

In a rousing duet that sounds suspiciously like the Brindisi from *La Traviata*, our hero and heroine pledge eternal devotion and other non-technical stuff. Perhaps their first generation reproduction will combine the best of analog and digital techniques. But that's another opera.

DEPARTMENT OF CORRECTIONS

For many years, the April sync track has been an april fool put on, as some very perceptive readers may have suspected. But last April's wasn't, except for one line that told about current going from water pipes to a.c. receptacle, via the grounding wire!! I wouldn't recommend that anybody try this very unique method, and if you'll just cross out the word "current," I hope the sentence will make better sense. ■

NORMAN H. CROWHURST

● A question that has recurred through the years appeared in my mail again during the past month. This particular reader asks, "Why are good conventional hi-fi speakers unsuitable for musical instrument reproduction or public address work? What are the major differences among them?"

ENVIRONMENTAL FACTORS

After having written that heading, I find that it covers more than the simple thought I had in mind when I set it down. I was thinking of the *listening* environment: what the place in which you listen contributes to what you hear. But it can also apply to how the same environment influences the way the loudspeakers installed in it reproduce their sound. So let us take those two influences separately.

EFFECT ON LISTENER

We listen to sounds for much of the time, and perhaps criticize them, without realizing that our surroundings influence what we hear, quite considerably. If you doubt that, cast your mind back to some time when you may have been moving. After all the furniture and perhaps the carpeting had been removed from your living room, did you notice what a hollow sound the room seemed to have when you spoke in it? Quite unlike the room you had grown accustomed to while you were living in it.

You may have been less conscious that the family room, or the utility room sounded quite different as an environment, than your living room, until you made that observation. As you moved from room to room, the sounds you heard in each seemed quite normal for that room, so much so that you were unaware that the room contributed anything to those sounds.

This is true, in a different way, of auditoria. The natural reverberation of an auditorium is something you come to accept as natural for that building, although it would seem strange indeed, suddenly transplanted into your living room. So one factor in why systems have different requirements is the fact that you *expect* to hear different kinds of sound, in different environments.

EFFECT ON LOUDSPEAKERS

In previous articles and columns, we have pointed out that different kinds of loudspeaker systems suit different kinds of rooms. In the well-furnished, more absorbent kind of room, loudspeakers with a wide, flat frequency response and uniform dispersion over the frequency range will sound good, giving what would be identified as high fidelity performance.

In the more reflective environment of a family room, a different type of loudspeaker system will sound good: one that utilizes the many reflecting surfaces to achieve the overall effect, rather than one for which multiple reflections would detract from the performance.

Either system, listened to in the environment that suits it, would sound good, be recognized as a high fidelity system. But now trade places. In the wrong environment, each system would cease to give the same impression of high fidelity. This proves that loudspeakers sound different, according to the environment you put them in.

PROGRAM FACTORS

Within limits, I suppose you can listen to any kind of program in any kind of environment—a pop concert in a church, or a symphony orchestra in a football stadium. This kind of thought again links back to the environment. But considering kinds of program also links to how you expect each kind to sound. You would not expect a full concert organ to sound like a harpsichord (although it may have a synthetic harpsichord as a feature). Nor would you expect a harpsichord to sound like a concert organ!

Accordingly, loudspeakers designed to reproduce an electronic organ, or an electronic harpsichord, will do their job best if each complements the instrument it is intended to reproduce. Similarly, a loudspeaker for use with an electric bass needs plenty of good, boomy bass and very little in the treble range. But if your symphony orchestra came out sounding like an electric bass, you would not like it too well, would you?

As opposed to that situation, where the loudspeaker will serve more effectively if its characteristics are similar to the instrument it is to reproduce, a high fidelity loudspeaker should have no character of its own. It should reproduce faithfully, whatever kind of sound is being fed to it at the moment. This is a far more rigorous requirement than will be expected of a unit that will be called on to reproduce just one kind of instrument.

And what about public address work? Doesn't that have to meet similar demands to those made of a high fidelity loudspeaker? In the sense that, in some public address installations, the loudspeaker has to handle a wide variety of program types, one might imagine so. But it has to handle those varied programs in a totally different environment from that met by the high fidelity loudspeaker.

The high fidelity loudspeaker operates in a relatively intimate environment—a living room, or a family room—and even those are different, as we have seen. In such an intimate environment, our hearing faculty is at its most critical. But the public address loudspeaker has to play its part in a much more public environment.

Because of the sheer size of such public places, the listening faculty of the auditors is much less critical, although they may not be conscious of the difference. We have met more than one enthusiast for a public address installation who thought the loudspeakers presented were the ultimate in fidelity, sounding better than his hi-fi set, in his own living room.

HEARING IS BELIEVING?

The old saying, "Seeing is believing," has been exploited through the centuries by sleight-of-hand artists who delude us with their magic acts. Under those circumstances, we know we are being fooled even if we don't know how. We may be aware that we can be fooled under other circumstances, but we are more reluctant to accept the fact that we may have been.

The same is true of the faculty that involves sound. Perhaps the most convincing demonstration of this that I remember concerns the first really high power loudspeaker unit I ever heard. I had been on vacation from the company that was developing it—a unit to handle 500 watts of sound, at an efficiency of better than 50 percent. That means it was capable of putting out more than 250 acoustic watts.

Most "high efficiency" units, even

today, seldom reach 20 percent efficiency. So that unit was really putting out a lot of power. I had left for my vacation while it was being built. When I returned, I thought I heard a sound car making announcements in the next street from my home. I wondered who it was, so drove around to see. No sound car. The sound must be coming from the next street over.

No sound car there, either. I kept going, toward the sound, until I found it. The company was testing the new unit, more than a mile from my home. In those days, London still had trolley cars, which made a noise that had always drowned the sound of loudspeakers.

I got right up to within a few feet of the loudspeaker, and remember being impressed with the fact that it did not seem all that loud. It happened that I was standing listening to it, on the opposite side of a sreet where the trolleys ran. Presently a trolley came by, and that was when I could not believe my ears. I could hardly hear the usual noise of the trolley: it did not interrupt my hearing of the sound at all, even when the trolley came betwen me and the loudspeaker!

In those days, a 5-watt speaker was fairly loud, and it would be fairly high efficiency at 5 percent, which would mean it delivered 250 milliwatts of acoustical power. When you think in watts, 250 watts is a thousand times as much as 250 milliwatts. But when you put that in dB, it is only 30 dB higher in level. And our hearing faculty can accommodate about a 120 dB range of levels. That explained it. But the experience proved it!

ROCK SOUND

So what makes modern rock groups sem so loud? Of course, the fact that they perform indoors, where reverberation builds up the energy, makes the situation a little different from the experience I just related, where sound could go on expanding for miles. And speaking of that, the fact that the sound did not seem appreciably louder as I moved from block to block nearer to its source was due to the fact that a block is only a fraction of a mile. The level only raised a dB or so for each block I got nearer.

But the bigger cause for difference is the fact that rock people always operate their system up where it runs into distortion. It is the presence of distortion that really makes it seem loud, not the power they have.

This explains why these rock groups keep demanding more power and never seem satisfied. In their minds, 200 watts should be twice as loud as 100 watts. Then 500 watts should be 2½ times as loud as 200 watts. And 1000 watts would be twice as loud as 500 watts. Actually, those steps in loudness are only 3 dB, 4 dB and 3 dB, respectively. What gives the impression is not how many watts you have, although more watts will make it seem a little louder.

What really makes the rock groups loud, is the fact that they run into however many percent distortion—sometimes nearly 100 percent. As we mature, we find distortion unpleasant. It jangles our nerves, not much less when a 10 watt amplifier is run into high distortion, than when a 1000 watt amplifier is used. The latter is just 20 dB louder.

Try keying 20 dB of attenuation, in and out. The difference, admittedly, is quite noticeable. For that matter, 10 dB is noticeable. But 2 or 3 dB requires careful listening, to tell the difference. Isn't it time we started giving our young people an education in physics that told them some of these single facts of life, because if they would suffer their extra "loudness" at 10 or 20 dB lower, it might get the resultant sound below the threshold of hearing, a block or so away, where we might happen to be! ■

MARTIN DICKSTEIN

● In the April issue, this column discussed the AAAS convention and the concurrent exhibit which took place at the Lincoln Center Library in New York City. In that video exhibit, the first cameras functioning without vidicons were on display. We briefly indicated that miniaturization had come to the camera as a result of a new development, the CCD or charge-coupled device. This made the solid-state video camera truly solid-state, with not even the vidicon to contend with. Let's take a look a how these new tubeless wonders work.

HISTORY OF TELEVISION

First, a peek at the chronology that led up to this momentous new position in the video field. Back in 1873, the light sensitivity of selenium was discovered. Just two years later, the first electronic television system was demonstrated. It could only detect and transmit the presence and absence of light, but this was the first time moving images were transmitted electronically. The method used to detect light was an array of 100 (10 x 10) selenium photo-cells.

In 1880, a principle for scanning was devised, and in 1884 the first camera using the rotating disc principle for scanning was developed. The method was to have a single spiral around the center. As the disc revolved, each hole closer to the center scanned a line lower on the subject. For a scan of 60 lines, it was necessary to have 60 holes. Equally spaced holes delivered equally spaced scan lines.

The next step came in 1897 when the cold cathode ray tube with magnetic deflections and fluorescent screen was demonstrated. Although a system of television using the CRT for both transmitter and receiver was first proposed in 1911, it wasn't until 1923 that the system was actually patented using the first electronic camera tube, the iconoscope.

Then, in 1940, the recommendations of the National Television Standards Committee for a television standard in this country was accepted by the FCC, and the NTSC system we use today came into existence. After that, most equipment and systems were designed around this standard for compatibility.

The next two steps made possible

"Eye" on a Tubeless TV Camera.

the development of the closed circuit television systems used in non-broadcast applications. In 1947, the first transistor was developed and the solid state of electronics was born, and just three years later the vidicon came into existence.

Next came the introduction of the charge-coupled device in early 1970, but it wasn't until this year that the camera was introduced which made use of an array in a general fashion similar to the one demonstrated exactly 100 years ago this year! Generally, the CCD will find application in fields making use of memory circuitry and analog delay, but most rapidly in the imaging area, the one with which we are most interested here.

CHARGE-COUPLED DEVICE

A CCD, requiring technology similar to that for producing other silicon devices such as the mos, is a wafer of a particular type of silicon covered by an oxide layer. Metallic electrodes are deposited on the layer. By charging the electrodes positively, electrons will collect at them selectively according to the intensity of the positive charge. By transferring the positive charge from electrode to electrode, the packets of electrons can be made to transfer accordingly. If an electrode were charged negatively, this would prevent the electrons from moving in the wrong direction and assure proper transfer. This, in essence, is the way the CCD functions.

In the case of the imaging device, the charge is introduced according to the light pattern of the subject picked by the device. Different methods can be used to collect the electron packets for conversion to impulses for transmission of the images. In the *frame transfer method*, for example, the entire device consists of three vertical layers, with common horizontal electrodes. During a frame period, the light hits the first layer and electron bundles are formed. During the vertical retrace time, the entire array is pulsed and the electrons are transferred to the middle layer, in time for another frame to begin forming.

The second layer stores the "image" and feeds it on in sequence and at a specific time. During a horizontal retrace blanking period, the bottom line in "B" layer is fed to "C" layer and then one element at a time horizontally to the video output diode and amplifiers. These signals then modulate the beam in the display system to recreate the image. It can be seen that the more elements used in the CCD, the higher the resolution of the image. However, for practicality, there are cerain limitations to the array arrangement. To provide broadcast quality, it might be necessary to have an array of somewhere near 500 x 500. If color were included, this would require, at present, triple such arrangement. To achieve requirements according to the NTSC RS-170 standard, RCA uses an array of 512 x 320 elements in the three-layer configuration.

This setup was arrived at by complying with the mathematical dictates of the standard. Considering the need for a 525-line scan, the 2:1 interlace requirement, the limitation of the usual closed circuit systems to 3 MHz in the luminance bandwidth, and the aspect ratio of 4:3, the 512 x 320 configuration can be calculated. Extra elements are included to account for variations in system blanking and timing and to provide greater uniformity around the edges of the picture.

RCA'S BIG SID

The CCD utilized by RCA is considered to be the biggest of its kind presently in use. Since they named their unit SID (Silicon Imaging Device), they actually call it Big SID. With its over 1633,000 elements, the resolution is higher than other similar units. In order to drive SID, a custom cmos has been developed which provides all the proper voltages and waveforms, takes the place of 35 conventional i.c.'s, and is already capable of driving three Big SIDs when color systems are introduced. (Incidentally, SID, at just under 1.5 in. in length, is 100 times greater in area than the conventional i.c., and has electrodes so small that eight of them are equivalent to a human hair.) It is estimated that the CCD applications will grow $300 million a year in the next ten years. SID will obviously be around for a while.

RCA is offering two grades of SID. For critical applications, a unit will cost $2,300. Where budget is primary, the cost will be $1,500 for the lower grade device. The primary difference "is with regard to the stringency of blemish screening criteria." Delivery of SID (and the two cameras being offered which include this device) is expected to be in the second quarter of this year. It is anticipated that the cost of devices similar to SID will be available around 1980 for about $30.

SOLID-STATE CAMERAS

The cameras (Models TC1150 and TC1155) are black/white units and can be purchased with either of the SIDs. With the higher priced device, the camera will cost $3,800, and with the lower grade one it will be $3,000. The TC1150 comes with a built-in lens, adjustable from 14mm to 45mm, with automatic light control, 1v p-p composite output (BNC connector), weighs 2.5 lbs., and is less than 6 in. long and less than 3 in. high. The TC1155 comes with a standard "C" mount to allow for choice of lens, and has a greater sensitivity to permit operation in lower light levels.

Another camera using the solid-state technology is Model Z7892 by General Electric. It uses a charge-injection device (CID) sensor. It contains 244 rows of 188 elements each, and is also capable of providing an output compatible with standard t.v. systems. The camera has a "C" mount and comes with a 25mm, f-1.4 lens. An optional lens system is available which provides automatic light compensation.

The smallest camera of this type is the Fairchild mv-101. This unit is 3 in. in diameter and only 1⅞ in. long. It weighs 11 oz. It uses a charge-coupled device with 10,000 photo-sensors. It has a "C" mount, comes with a 25mm lens, and provides a 2V p-p output. The vertical scan rate is 123 frames/sec. with 2:1 interlace, however, and since this does not conform to standard t.v. receivers, a special monitor is provided to accept the camera's output signal.

It's interesting to note that since the sensor used is responsive in the infra-red region of the light spectrum, it is suggested that the camera's performance is maximized in incandescent lighting and will operate satisfactorily in the 0.2 foot-candle range. With fluorescent lighting, minimum levels will run about two foot-candles. (Incidentally, although the camera plugs in to standard power, it operates on 15V and its consumption is only 1.5 watts.)

ADVANTAGES

The advantages of the new technology in the video camera are that the CCD avoids the lag that is common with the vidicon during the object movement, it does not bloom, eliminates vidicon replacement due to defects of breakage, face spots or burnout, is extremely low powered in operation, and avoids the need for critical alignment, necessary with vidicons in color applications.

As a final note on cameras, the world's smallest camera was introduced last April. It is a vidicon-type, using a tube only 0.5 in. in diameter (made by British EMI). The camera (produced by Reten Electronic of W. Germany) is 0.75 in diameter and 5.5 in. long.

It looks as if we have passed Buck Rogers by a long shot. Now all we have to do is to catch up to Dick Tracy. Wristwatch t.v. camera-receivers may not be far off after all. ■

MARTIN DICKSTEIN

Laserium...Light With Music

A fusion of music and the incredible colors produced by the laser—a different entertainment experience.

As you approach the entrance to the Hayden Planetarium, there is a crowd waiting to go in to see Laserium. Most of the visitors have already purchased their tickets from Ticketron, but some will form a line in hopes that this performance is not a sell-out. Maybe there will be some tickets still available at the box office.

A few minutes before the program is to begin, the audience is allowed to go upstairs and find seats in the dimly lit circular amphitheater under the planetarium dome. In the center, stands the Zeiss star projector. There is music, and there is a feeling of excitement and anticipation which always seems to be engendered in the domed room, with its mysterious access to the universe.

A member of the Planetarium staff welcomes the audience (right on time) and explains briefly that the show will take place on the dome overhead, that the images will be produced by a laser (which is completely safe, should anyone wonder) operated by a laserist who will create the program completely live. Brian Bassett, the operator of the laser console is introduced, and the lights begin to dim. The stars come out and the skyline of New York can be seen around the horizon.

As the music begins, the lights fade out completely and the room is in total darkness except for the stars overhead. (The audience reacts vocally with surprise and pleasure at the beauty of the scene.) The music swells and the stars begin to move as they normally do. The skyline has disappeared and the tension builds.

Martin Dickstein is well known to readers of **db**. *Special thanks to Ron Bassett, Brian Bassett, and Michael Gershman of Laser Images, Inc.*

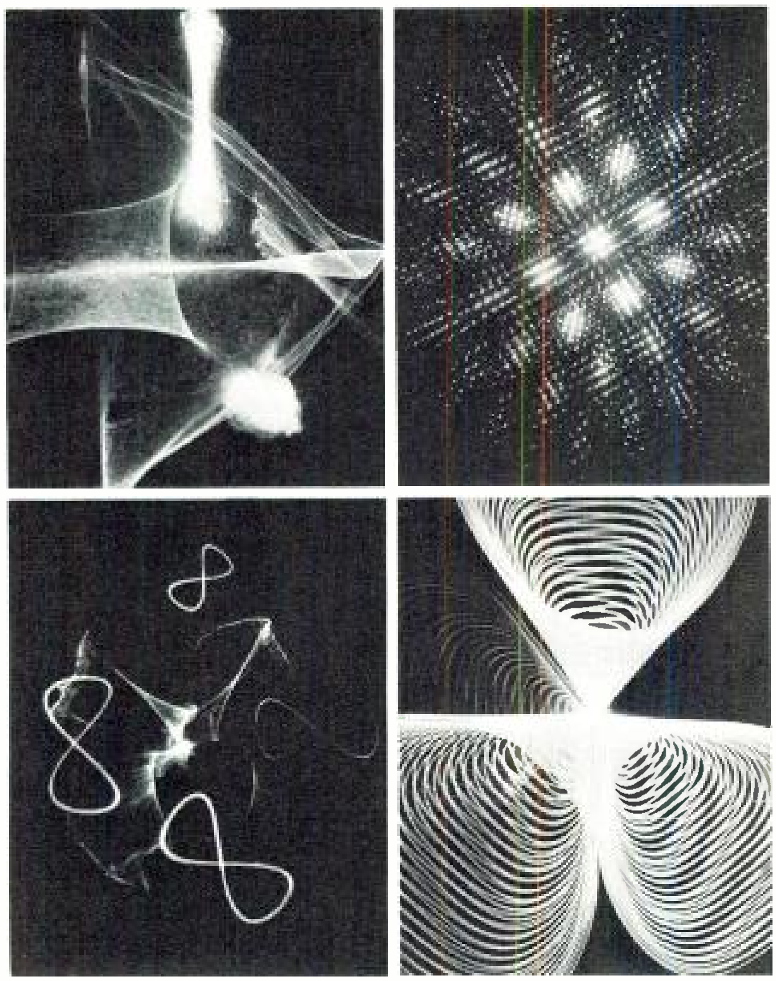
1. Composite photo showing a laser pattern above the dome of the Griffith Observatory in Los Angeles.

A cloud begins to appear, seemingly in space—not really on the dome. It moves gently, changes form and color, increases in size and follows the quiet serene music. The colors are bright, very bright, and again the audience reacts with pleasure. As the music flows, so do the clouds. The music ends and the clouds vanish. The stars, which have been a background to the entire selection, continue to move.

VARYING SELECTIONS

The next selection begins. The music builds in rising pitch. Wild images follow the music—this portion of the show is totally different from the first. The selections follow in this manner—some slow and gentle, some rock music, some contemporary music. Each is different from any of the others, and the images on the dome take form in movement and shape as the laserist feels the music.

During the selections, the audience reacts to the images and the rhythm. There is laughter, applause, "oohs"



2. Typical laser light patterns, stimulated by music.

and "ahs," and a big round of applause at the conclusion of each portion of the show. A creative bond between the lasarist and the audience grows; one senses this sharing in the increased vigor of the performer. He sets up the patterns and shapes with the pushbuttons, controls size with rotary knobs, and moves the images around the roof with the joy-stick control which permits slow glides or quick leaps of any of the figures he has built up. He knows each note of the music, and the musical group seems to follow each move he makes (or is it the other way around?).

The music begins with *Fanfare for the Common Man* by Copeland, includes *The Planets* by Holst and *The Blue Danube* by Strauss, as well as a selection from *Clockwork Orange*, then changes completely in texture and rhythm and driving power with *Tank* and *Abaddon's Bolero* by Emerson, Lake and Palmer and *Space Race* by Preston. *The Pines of Rome* completes the performance. The multi-colored clouds, vibrating shapes, and undulating patterns diminish as the music ceases, soften, and end the show quietly.

When the audience has finally left, after asking all kinds of questions of the laserist and the operator of the star projector, the star projector is again positioned to show the stars as they appear in the New York sky on the date of the presentation. The laser system is again set up with mirrors and beam splitters in proper positions for the first musical selection. The tape is recued. The power supply is checked, the console buttons and controls are put in proper position. The laserist, really the star of the show (besides the overhead display) takes a break and collects his energies for the next show.

LASERIUM—HOW DID IT ALL BEGIN?

Laser—a word coined a little over 10 years ago to describe a newly invented device . . . has since become a household word.

Laserium—a word devised just a few years ago as a name for a new application for the laser and a novel human experience . . . *soon* to become a household word!

The laser came into being in 1960 and got its name from the method by which it gives off its light—*L*ight *A*mplification by *S*timulated *E*mission of *R*adiation. A laser makes use of the principal of physics that energy is emitted when outer electrons of specific atoms move from one energy level to another in the right direction. Part of that energy is in the visible frequency range, and light results. The color of the light is determined by the wavelength of the energy. By stimulating this emission of radiation, amplifying it, and projecting the beam, the laser has been made to do what it does best, project an intense light.

Lasers can be made with a solid, liquid or gas medium in a tube with highly reflective spherical mirrors at both ends. Gas lasers emit continuous light and have been found most satisfactory for work with three colors. Once the energy is released by use of either an electric charge or rf frequencies, the light particles are pulsed to travel between the mirrors until they are released through a tiny "window" at one end of the tube. Output energy is about 1 percent of the total in the tube.

The light from a laser is very unique, and differs greatly from ordinary light. When the sun or any kind of light bulb gives off light, it radiates equally in all directions and the beams are non-coherent. The laser emits a beam which is coherent, extremely narrow (a half-inch at the tube spreads to a diameter of only about 3 inches in a mile) and the frequency band is also extremely narrow for the emitted rays, resulting in the brightest and sharpest colors ever seen. Nevertheless, the power required for a laser can be very small. These factors make the laser a natural for a Laserium presentation.

THE LASER IN ACTION

The laser has found application in medicine and surgery (eye operations without incision, for example), space measurement (checking distance from earth to moon to within inches from reflectors left by the moon-walkers), industry (checking for microscopic defects in parts and machines) and even as a potential weapon, mentioned often in science fiction. (It can burn a hole, when concentrated, through solid steel.)

Experimentation has been going on in the creation of holograms and 3-D motion pictures. Extensive use was made of the laser in the Pepsi Cola Pavilion at Expo '70 in Osaka, Japan, for environmental displays. But for the first time in public entertainment, in the Laserium display, the laser, with music, makes possible the whole show.

Laser Images, Inc. of Van Nuys, California, was incorporated in early 1971 "primarily to engage in the use of lasers for design and theatrical purposes, including, but not limited to the production of designs, photographs, films, light shows, and light show devices." After several commissions to create films for motion pictures and television, experimentation led to the most dramatic form of laser imagery—Laserium. L.I.I. is still experimenting, considering offers for new shows for various institutions and

• It is with deep personal regret that we report the death, on April 13, of **Herman H. Scott,** founder and former president of **H. H. Scott, Inc.** of Maynard, Mass. Mr. Scott was the inventor of the dynamic noise suppressor, R-C oscillator, and selective circuits. He received the Distinguished Service Award from President Kennedy's Committee on the Employment of the Physically Handicapped.

Mr. Scott was a development and executive engineer with the **General Radio Corporation** from 1931 to 1946, president of the **Technological Instrument Corporation** in 1946-7. He founded H. H. Scott, Inc. in 1947 and retired in 1972.

a rock group, and planning further installations of the Laserium presentation.

LASERIUM

Lasèrium, emphasis on the second syllable, is a word derived from "laser," and "planetarium," the location where the shows take place. It played its first show under the dome of the Griffith Observatory in Los Angeles and is still running there.

In New York, the show began its performances in October, 1974 at the American Museum of Natural History, Hayden Planetarium. Images, created in four colors—red, blue, green and yellow are cast on the 81-foot dome by a 1 watt laser, in association with music. Each performance has the same music, but the visual aspects of every show are totally different. Each presentation is unique, a one-and-only done live by a laserist, who operates a console with illuminated pushbuttons, rotary controls, and a joy-stick. The rack next to him houses the laser, its power supply, and the water cooling system (35 degrees C maximum) to keep the laser's temperature at its normal level. The rack also holds the 4-track audio tape recorder which provides the music for the show and some control cues. (Total system, costs about $100,000.)

The laser itself is approximately 4 ft. long and 6 in. wide and weighs 50 lbs. (It costs approximately $10,000, acording to Spectra-Physics of Mountain View, California, who made this unit.) Although similar models are made with argon or argon/krypton, this one is made with krypton. The beams of light, with special optics, and front surface mirrors (with 50 coatings) can be projected onto the ceiling in dots (only about 4 in. in diameter) expanded to circles to almost the diameter of the dome, take the shape of geometric figures, or become nebulous clouds which seemingly float in open space.

Shapes change, positions vary slowly and smoothly or in bursts and jumps. Sizes, also controlled to follow the music, can change gently or very rapidly. Every change is made manually by the laserist, with only a very few exceptions which are controlled by the tape cues.

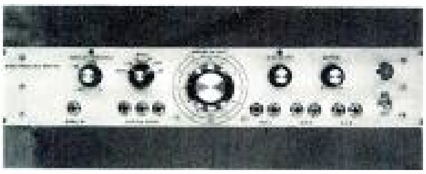
The sound portion of the presentation comes from two of the four tracks on the tape. Stereo music plays through two Crown dual 300-watt amplifiers and is distributed by four Altec A-7 speakers located behind (actually above) the perforated dome. There are also six surround speakers in the amphitheater for fuller sound and special effects. (This equipment is part of the Planetarium's regular sound system.)

Laserium really must be seen and heard to be believed. The programs are presented on Friday, Saturday and Sunday evenings. Since the first showing less than two years ago, over a quarter of a million people have come and experienced the shows in various cities. About 50,000 of them have come to the display at the Hayden. There are also showings at the Gates Planetarium in Denver, the Morrison in San Francisco, the Reuben H. Fleet Space Theater in San Diego (and the Griffith in Los Angeles, of course). There is now a traveling show (with a screen instead of a dome) going to colleges across the country. All installations seem to be doing well and will continue indefinitely.

Make Laserium a part of your enjoyment this summer—wherever you are. Experience! Enjoy! ■

db new products&services

FREQUENCY SHIFTER



● New sounds are created by model 735 frequency shifter through a change in the harmonic structure of any natural or synthesized sound received at the input. The device creates shifts by as much as +5 kHz through zero to −5 kHz (and simultaneously the inverse) through turning of a master dial. Three pairs of output jacks provide the up and down shifted signals, as well as a variable mixture of both. The amount of frequency shift is voltage controllable in a linear as well as exponential mode. In the exponential mode, the device is compatible with keyboard controllers of synthesizers. In the quiescent state, a threshold-sensitive squelch circuit eliminates any carrier feedthrough. Frequency response is 30 Hz to 16 kHz. Comes on a 19 in. rack mount.
Mfr: Bode Sound Co.
Price: $995.00.
Circle 50 on Reader Service Card

TWO-TRACK MASTERING RECORDER

● A switchable playback head and 10½-inch reel adaptors are featured in model A-6100, a ½-track recorder with four heads, one of which is a ¼-track playback head that is switchable on the head bridge. The three motors are powered with a hysteresis synchronous capstan drive. The dual-functioning metering system, consisting of two vu meters to indicate average levels and two peak reading led's to indicate transients allows the user to record 3 dB hotter when using high-energy tape. There is also a pad for 15 dB or 30 dB of attenuation. High-density heads have a flip-up hinged head cover. The unit has two-position bias and eq. switches, and microswitch pushbutton transport control. Cue control allows cueing in either the fast wind or pause modes and for manual reel rotation during editing. There is an automatic stop function from the rewind mode and a zero vu click stop on the output level control. Adaptors automatically compensate for the height difference between 7-inch and 10½-inch reels.
Mfr: TEAC
Price: $999.50
Circle 51 on Reader Service Card

BACKGROUND MUSIC SYSTEM

● Background music system TRAK-4, utilizing two playback decks, can provide music that will intersperse with commercial announcements, or play two musical formats. This is done by interfacing two TRAK-4 playback units and a mixer switch. The system is also capable of playing 32 hours of music before repeating. The unit is a continuous-duty type of machine with built-in amplification, microphone input, volume and tone controls. The 16-hour tape magazine can be quickly loaded or unloaded without threading. The mixer switch may be set to play the two decks alternately or in a 3:1 sequence.
Mfr: Tape-Athon Corp.
Circle 52 on Reader Service Card

DISCOTHEQUE CONSOLE

● Compact package system ATS DC-202, designed for the confines of discotheque use, offers the following: stereo operation; auxiliary stereo input; complete cueing system with volume presents; program send to cue buss; separate hi and low EQ. on program and mic channels; built-in 30 watt cue amplifier with speakers and headphone output; gooseneck d.j. microphone with built-in variable echo; footswitch operation of microphone. Clearly visible vu meters enable the operator to keep track of proceedings.
Mfr: Audio Transport Systems
Circle 53 on Reader Service Card

PORTABLE PARABOLIC REFLECTOR

● Depending on climatic conditions and surroundings, PBR-400 parabolic reflector can pick up high quality sound from a distance of up to several hundred yards. The manufacturer claims that the PBR-400 will improve the sound sensitivity of most omni-directional microphones 10 to 20 dB over rated sensitivity. Angle of acceptance is approximately 26 degrees. The unit, weighing less than three pounds, is hand operable or can be used on a tripod. Included with the reflector are a microphone stand adaptor, tripod stand adaptor, and carrying case.
Mfr: Superscope (Sony)
Price: $79.95.
Circle 54 on Reader Service Card

CUE CLOCK

● "Cue Clock" is an up/down digital timer which counts up to or down from any thumbwheel preset time; a cue light shows the end of count. A "set" light indicates that the unit is programmed and ready. The clock, which operates manually or through remote control, has a timing capacity up to 99 min. 59 sec. It uses TTL logic throughout, with a seven-segment display. The clock starts automatically when any switched voltage is applied, without relays. Data outputs are provided for custom interfacing with automation systems.
Mfr: Electroneering, Inc.
Circle 55 on Reader Service Card

THE PEAVEY 1200 MIXER

In response to the market demand, we present the 1200 Mixer,
the first truly professional mixer for less than $1,000.

- **12 transformer balanced, low impedance mike inputs**
- **12 unbalanced, high impedance line inputs**
- **Input attenuation & mike/line selection**
- **High and low equalization on each channel**
- **Stereo pan on each channel**
- **Three send controls on each channel, all having pre or post capability**
- **Output slide attenuators on each channel**
- **Master control area consisting of left & right main slide attenuators with associated low, middle & high equalization and monitor slide attenuator.**
- **Effects master, return & pan controls**
- **Reverb master, return, & pan controls**
- **600 Ohm transformer balanced outputs on left & right main and monitor**
- **Lighted VU meter on left & right mains, externally adjustable.**

Suggested Retail Price

$949.50

PEAVEY®

FOR MORE ABOUT THE 1200 MIXER WRITE: PEAVEY ELECTRONICS, BOX 2898, MERIDIAN, MS. 39301

Circle 33 on Reader Service Card

HIGH VOLTAGE PROBE FOR TV

• Self-contained, direct reading, high voltage and current measuring probe model HVP-5 provides for the safe measurements of voltage up to 40,000 volts d.c., and for separate current measurements up to 200 mA d.c. It measures accurately the high anode voltage of a color picture tube and, through the use of a switch monitor, the cathode current drawn by the horizontal output tube or the output stage. The two circuits are completely separate, enabling the technician to switch from the mA position to the HV position without disrupting the operation of the set under test.

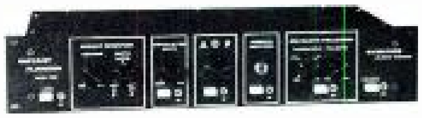
Mfr: EICO Electronic Instrument Co.
Price: $29.95.
Circle 56 on Reader Service Card

SERVO FEEDBACK SPEAKER SYSTEM

• The servo system controlling the SmartSpeaker line utilizes a sensing network that compares the mechanical analog of the speaker output with the applied electrical inputs and then generates a correcting voltage. This voltage is fed back to the amplifier to adjust the input to the speaker's voice coil and thereby compensate for errors normally introduced by conventional loudspeakers. Other benefits claimed include improved transient response, reduced phase distortion, and increased dynamic range. The line consists of three models, model 15, a floor-standing three-way system, model 12, a large bookshelf unit, and smaller bookshelf system model 10.

Mfr: C/M Audio Components
Circle 57 on Reader Service Card

INSTANT FLANGER



• An effect modifier block on Instant Flanger™ model FL201 allows "bounce" circuit to simulate true tape flanging by imitating motor or servo hunting. Depth control regulates the percentage of direct vs. delayed signal, and relative phase. Other features include internal regulated power supply, remote control capability, dual outputs for pseudo-stereo, internal envelope follower, line in/out control and indicator, high level input and output, optional balanced line in/out, full frequency response to 15 kHz, automatic operation with oscillator, mode indicating lamps. The control configuration—oscillator, manual, remote—envelope may be used in any combination. The Instant Flanger uses a true time delay circuit, which the manufacturer claims will produce many more nulls and thus a deeper effect than previously available with an all-electronic unit. Construction is all solid-state, with l.e.d. front panel indicators. Internal circuit boards plug in.

Mfr: Eventide Clockworks
Circle 58 on Reader Service Card

PRECISION SOUND-LEVEL METER

• The capability to "hold and display" the maximum level measured on a digital display while an analog meter continues to indicate lower levels is a feature of the model 1981 sound-level meter. The meter features both a digital display and a large, linear analog meter, meets ANSI S1A and IEC 179 specifications, and has a measurement range of 70 to 120 dBA. The analog scale spans the entire 70 to 120 dBA range linearly in 1dB increments. While measuring, either fast or slow detector response may be selected. The unit is available alone or in sets or systems.

Mfr: General Radio
Circle 59 on Reader Service Card

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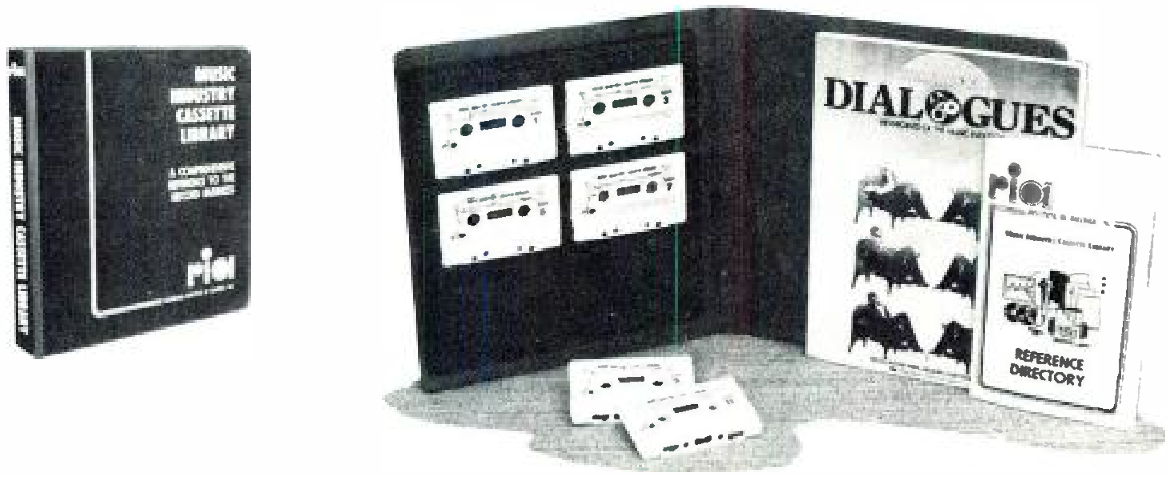

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Sid Bernstein	Personal Manager and Promoter
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Kip Cohen	V.P., A&R, A&M Records
Al Coury	V.P., Production, Capitol Records
Al DeMarino	V.P., Music Department, CMA
Tom Draper	Dir., R&B, RCA Records
Kenny Gamble	Pres. & Producer, Phila. Int. Rec. Co.
David Glew	V.P., Marketing, Atlantic Records
Barbara Harris	Dir. Artist Relations, Atlantic Records
Emil LaViola	Prof. Mgt., Chappell Publishers
Michael Martineau	Booking Agent, Premier Talent
Mark Meyerson	A&R, Atlantic Records
Barry Oslander	West Coast Prof. Dir., Jobete Music Co.
Richard H. Roemer	Law Firm of Roemer & Nadler
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CARTRIDGE TAPE SPLICE FINDER

● 240 volt/50 Hz automatic cartridge tape splice finder and bulk eraser, model SFE-3, has been developed to cut broadcast cartridge handling time by automatically locating a splice on a cartridge and kicking out the cartridge with the tape stopped just beyond the splice point, without the need for human surveillance. Recording begins immediately after the splice, precluding the possibility of an audible blip. The pressure-sensitvie device does not require a prerecorded signal. It will also detect tape fractures and exercise the tapes for better performance. An optional built-in bulk eraser allows cartridges to be erased and searched on the same machine.
Mfr: UMC Electronics Co.
Circle 60 on Reader Service Card

FRICTIONLESS TURNTABLE

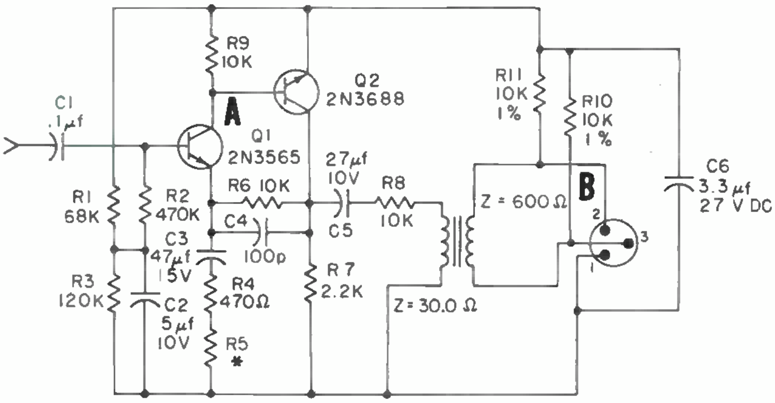
● Model 8004 turntable features gyropoise® frictionless magnetic suspension of the platter and single point tone arm suspension. Powered by a 24-pole synchronous high torque motor, it has belt drive. The tone arm has a magnetic hold bar and anti-skate control adaptable to all types of styli. The turntable is equipped with a state-of-the-art cartridge, either the 681 triple-E calibrated to the tone arm for stereo playback or 780/4DQ for discrete.
Mfr: Stanton Magnetics
Price: Stereo: $199.95
4-channel: $224.95.
Circle 61 on Reader Service Card

ENGINEERING CALCULATOR

● Trigonometric and logarithmic functions are handled by 6-ounce HP-21 scientific calculator. In addition, the user can calculate in either degrees or radians; convert from polar to rectangular coordinates and vice versa; format and round the display in either fixed or scicntific notation; and perform conventional arithmetical functions with the contents of its single addressable memory. Since several keys serve multi-functions, the number of operations possible has been compressed into a small size. The device, which operates on two rechargeable batteries, features an RPN logic system with a four-memory stack that holds intermediate answers and automatically brings them back when needed in calculation.
Mfr: Hewlett-Packard
Price: $125.00.
Circle 62 on Reader Service Card

FUNCTION GENERATOR

● Available in either kit or assembled form, model 1271 function generator generates sine, square or triangle waveforms from 0.1 Hz to 1 mHz. A short-circuit-proof output amplifier supplies a 10-volt peak-to-peak signal into a 50-ohm load. A calibrated step attenuator adjusts from zero to 50dB (10V p-p/30mV p-p) in 10 dB steps. 20 dB additional attentuation for each step for a total of 70 dB is achieved through the variable attenuator control. The manufacturer claims attenuator accuracy is ± 1 dB.
Mfr: Heath Company
Price: Kit: $99.95
Assembled: $140.00.
Circle 63 on Reader Service Card



* GAIN ADJUST
MAX 10K
MIN 0Ω

CORRECTION

In the above direct-box diagram (which appeared in **db**, April 1975, p. 18) the circuitry at two points, A and B, was incomplete. The circuitry shown here is correct.

INSTALL IT AND FORGET IT!

WE BUILD AND TEST EACH AMPLIFIER WITH THE CONVICTION THAT WE'LL NEVER SEE IT AGAIN

That's why 25% of our people work in inspection and verification. And we have this confidence in our amplifiers because our people make sure you receive a better amplifier than you ordered. You'll find the Crown line of power amplifiers unique in both specifications and operation. And that kind of confidence you can pass on to your clients.

Output Power: 30 watts per channel minimum RMS (both channels operating) into an 8 ohm load over a bandwidth of 35 Hz—15 KHz at a rated RMS sum total harmonic distortion of 0.05%.
Dimensions: 19'' wide by 8¾'' deep by 1¾'' high.
Weight: 10 lbs.

The Crown D-60 stereo amplifier, small in size, big in value and adaptability. Its uses include headphone power supply for system monitoring; ideal power for high-efficiency speakers; can be easily used in bi-amping and tri-amping situations and can be field modified to produce 25 volt monaural output power for industrial sound distribution systems.

Output Power: 75 watts per channel minimum RMS (both channels operating) into an 8 ohm load over a bandwidth of 1 Hz—20 KHz at a rated RMS sum total harmonic distortion of 0.05%.
Dimensions 17'' wide by 8¾'' deep by 5¼'' high.
Weight: 24 lbs.

The D-150 medium power amplifier, is by design an ideal audio amplifier with the kind of rugged reliability needed in portable sound systems. Especially where one to one amp/speaker ratios are used. Well known Crown protection circuits are an integral part of the D-150. Protection from mismatched or shorted loads is provided, and a series limiting resistor protects against excessive input signals. Controlled slewing-rate voltage amplifiers protect against RF burnouts. And a thermal switch cuts AC line power if overheating occurs from improper ventilation.

Output Power: 155 watts per channel minimum RMS (both channels operating) into an 8 ohm load over a bandwidth of 1 Hz—20 KHz at a rated RMS sum total harmonic distortion of 0.05%.
Dimensions: 19'' wide by 9¾'' deep by 7'' high.
Weight: 45 lbs.

The Crown DC-300A. High power is first thought of when referring to a "super" amplifier. However, this Crown amplifier is also super in its reliability; super in its capability to deliver sound without distortion, and super in its ability to power any type of load, from 2.5 to 16 ohms, resistive or reactive! And whether it powers a multi-speaker theatre system or is on line with a group of twenty or thirty DC-300A's for an outdoor rock session, this amplifier delivers 100%. And we know that in whatever application you use it, the DC-300A will give you the kind of reliability you're looking for.

Output Power: 600 watts minimum RMS into an 8 ohms load over a bandwidth of 1 Hz—20 KHz at a rated RMS sum total harmonic distortion of 0.05%.
Dimensions: 19'' wide by 16½'' deep by 8¾'' high.
Weight: 92 lbs.

The Crown M-600 power amplifier was designed specifically for applications requiring relatively high power levels. The M-600 maintains all the exacting Crown laboratory performance standards, plus featuring built-in cooling for continuous full power operation.

The M-600 also features Crown's patented protection circuitry allowing it to drive highly reactive and low impedance loads without adverse effects. A newly patented output bridge circuit permits extremely high power levels to be sustained safely.

If by this time you do not have enough power to do the job, consider the M-2000, DC-1200 or the DC-4000. These configurations are combinations of the M-600 and are specifically designed for applications where huge amounts of power (2 kilowatts plus) are needed.

Crown amps are widely known for superior performance and reliability, and like every Crown product are covered by a comprehensive warranty which includes parts, labor and round-trip shipping for three years.

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Jim Nielsen at the console at Freeway Recording.

Wally Heider's Studio C, just completed, set for a John Coaltrane album.

STEPHEN H. LAMPEN

How Audio Is Doing In San Francisco

Major recording studios seem to be holding their own, with many garage-types doing a lot of budget work. Manufacturers feel the pinch of tight money.

HARD TIMES have hit all sections of the audio industry. But, in the San Francisco area at least, the response to a tightening money situation and a drop in customers has been most unorthodox: Build now!

Among the ten 16- or 24-track recording studios surveyed, seven were in the process of expanding or improving their facilities. "It was a question of expanding while we still had the money and fewer customers to bother, or waiting until it was too late," I was told. Still, all admitted that the hecic, profitable days of the late sixties when the Grateful Dead, the Jefferson Airplane and Santana dominated the rock industry are gone now and may never return. At that time, some studios were booked a year or more in advance. Now, a week's notice—or less in some cases—is all that's necessary. And, while two large studios have folded in the last couple of years, neither termination was due to the present financial conditions. Perhaps current circumstances now can be best described as solidification.

TIGHT MONEY EVERYWHERE

The same cannot be said of the manufacturers, however, to whom tight money means strangulation. Almost all manufacturers who were around five years ago are still here, but the picture still looks grim for some. I was told of one major manufacturer's chief executive appearing before the stockholders in makeup, to indicate subconsciously that the company was as healthy as his ruddy appearance. Don't know if it worked!

Distributors and representatives are a quick-moving, fast-talking breed, almost impossible to keep track of over the years. Over thirty pro dealers cover the Bay Area with practically every line of recording, broadcasting, duplication, and public-address equipment. Some are borderline-pro, offering what could easily be called good hi-fi equipment but also selling to small studios and independent producers who cannot afford major studio prices.

Thereby hangs another change in the sound scene: the tremendous rise in the number of studios-in-garages. Any estimates as to their number would be difficult because

Stephen H. Lampen is the owner of 3P Recording in San Francisco.

Record Plant's psychedelic Studio B.

The cutting room at Fantasy Records.

many do not advertise for customers. But there must certainly be over a hundred of them cranking out marginally acceptable quality programs for budget labels or broadcast.

FREEWAY RECORDING

Minorities and women were not very much in evidence in any of the studios visited, the one exception being Freeway Recording in Oakland, which is owned by Bernie Reveira. Because of his minority status, he received a substantial SBA loan to start his studio and other ventures. From what we saw, the money was spent intelligently. A custom Opamp board feeds their 3M 16-track machine which can be mixed to two 3M 2-trackers. A dbx 216 noise-reduction system is used.

Other support equipment includes UREI 527A graphic equalizers and 1176 limiters, Spectrasonics 610 complimiters, McIntosh and Crown power amps. Besides the Altec 604E's which almost every studio offers, Freeway had a double-pair of Quad electrostatics. While clean, and even with the surprising low-end which a pair produces, they lack the power-handling abilities of standard speaker designs such as the Altecs. When we visited, they were just completing the installation of the studio and were looking forward to major business in the near future.

WALLY HEIDER'S

Wally Heider's, in San Francisco, is a different story. Although not the oldest studio in the city, they are one of the first which come to mind because of their work with the rock stars of the last ten years, turning out one million-seller after another. Studio C, upstairs, had just been completed and, even with plaster still on the floor, was set up for Van Coaltrane, who was doing some work later in the day. Hot Tuna was also in the building in Studio D. All studios, in fact, most of the Heider chain, standardize their equipment: Dimidio custom board, modified by Miter Productions; 3M 24- or 16-track recorder; 3M 2-track machines; Altec 604E monitors; McIntosh 275 amps; UREI LA3A and 1176 limiters; Dolby 361As in one room; APL 550 EQs on all board inputs in Studio C; Pultec PEQ-2 equalizers. Studio A had a Quad-8 board modified to 24-channel use and also had the Altec 891A mini monitors for limited range mixes.

RECORD PLANT

Meanwhile, Record Plant in Sausalito, the "beautiful" studio in the Bay Area, is also expanding its facility. In keeping with its "subdued freak" decor, the new studio, dubbed The Pit, will be recording-in-the-round—with a twist!

"Where's the console going to go?" I asked the secretary.

"Why, right here," she said pointing to a large opening in the circle of what will be plush seating.

"What about recorders?" I continued.

"Over here," she indicated, pointing to smaller gaps in the seating.

"Well then," I asked, "where's the studio if this is the control room?"

"This *is* the studio," she insisted.

Sierra Sound's recorders.

Everything's portable at His Master's Wheels, even the Neve console.

Engineer & producer working on commercial at Different Fur.

Columbia's cutting room. Their patchbay is the largest the author has seen.

At this point I gave up. But I can't wait until it's finished and I get to see what they did. These two existing studios, often the hangout of Sly and the Family Stone, are plush-plush-plush designed with the richer labels in mind by Westlake Audio. API boards feed 3M 24-track and 2-track machines, with extra Ampex 2-tracks, and 4-tracks. Dolby M-16 or M-16-8X units provide noise reduction with UREI LA3A and 1176 limiters, Eventide phasers, Pultec equalizers, Cooper Time Cube, United Audio's Little Dipper and Westlake monitors filling out the scene.

I strolled among the studios. "And this," continued my guide, pointing to a deep fold in the tapestry wall, "is where Sly puts his baby when he's recording." I look puzzled. She continued. "They put a mic on the kid and, every so often, the engineer hits the solo button to see if the little one is crying." A customer breakthrough: nursery service!

In the other direction, down the peninsula, we find Pacific Recording finishing up Studio 2. The main studio is supplied with an Ampex MM-1000-16, 2 Ampex MR-70-2, and 440-1, all fed from a custom board. The Grateful Dead cut their first hits here.

SIERRA SOUND

Across the bay in Berkeley, Sierra Sound is working hard with mixing TV tracks for the Serendipity Singers, many gospel groups and some commercials. Sierra will be reworked completely this year, owner-chief engineer Bob de Sousa told me. "We can't stay in business without doing it. Customers require absolute separation." Quite a tall order, I would think, and if he succeeds, I want to know who the architect was.

FANTASY RECORDS

Only a few minutes away from Sierra lies the massive concrete blockhouse of Fantasy Records. I was amazed to see a customer actually turned away! I asked why, and manager Jim Stern's reply was, "We do only in-house production; we don't need any outside business."

With three well-equipped studios—Studio A had just been completed—they must have a solid core of return customers. He assured me they did. Still, in spite of their entry hall lined with all the Gold Records earned by Creedence Clearwater Revival, times have calmed down for them as well. This is the only concern in the Bay Area that does recording, cutting, record promotion, and distribution under one roof. All they're missing is a pressing plant of their own, something Mr. Stern said they were not planning on establishing. Farming out the work worked fine. Studio A, one of the largest rooms in the area, had been re-fitted for film scoring, complete with Magnatech mag-film machines and complete projection equipment. The film version of "One Flew over the Cuckoo's Nest" was waiting to move in.

HIS MASTER'S WHEELS

One of the newest studios in the area is San Francisco's His Master's Wheels which, as the name suggests, does a lot of on-location recording. However, they also maintain a studio equipped with their totally removable gear. Everything is either carryable or on wheels. Part of a wall collapses to let their Neve console and two MM-1000-16 Ampex machines roll out and into the truck. They had just finished recording the Grateful Dead's last concerts, which I had photographed, by coincidence, and they were enmeshed in the re-mixing for record release and for the feature film which had been shot.

The studio, the best acoustically I found in my survey, has a skylight—but no outside leakage. Still can't figure out how they did it. Their equipment also features Studer A-80-2 and Ampex 351-2 machines, the latter modified with MCI electronics, Phase Linear amps feeding JBL or Klipsch monitors, Pultec equalizers, Eventide phaser, Multi-Track equalizers and UREI graphic equalizers.

DIFFERENT FUR

Not far away lay Different Fur, a small, but prospering studio, also in San Francisco. Pat Gleason told me they had just had their 12th consecutive quarter of growth. With their custom-built Spectrasonics console, Scully 100-16- and 4-track, they could offer pro quality at a competitive price. But, the outlook was not that good, Mr. Gleason emphasized. "There's less business coming in the near future for all studios, but we're not going in for price cutting. Any studio would be crazy to cost cut now. It's better to compete on service. There's no sense to lose money working full-time."

COLUMBIA-COAST

The San Francisco scene is rounded out with the two oldest studios in the area: the Coast-Columbia complex and Golden State Recorders. Coast and Columbia both seem to represent the conservative aspects of the industry; they don't have the latest gadges–just the best. No doubt part of the reason for this is that as part of the Columbia chain, all equipment changes must be authorized through the head office. Even I had to be cleared through the head office! Still, being under a mother's wing has its advantages in hard times.

All artists on the Columbia and related labels use the studio so that one has, in effect, a built-in clientele. Equipment available includes two Ampex MM-1000-16- with an EECO synchronizer for 30-track recording if required, 4 digital delays, UREI LA3A limiters, and the largest patch bay I have ever seen. "We can patch anything to *anything*," Chief Engineer George Horn told me. There are also Pultec equalizers, RCA limiters, Ampex 440-4 and 440-2 machines and monitoring on Altec 9845 speakers modified with J.B.L. 2420 drivers. A custom 38-in console feeds the system with rotary switching which can bring any track from any machine up on any fader. Versatility, right?

The next room, Studio B, was busy with the mix for Michael Schreve's new album, (Schreve is late of Santana.) Across the hall, Coast Recorders, a smaller studio, held the last vestige from the umbrella days of a few years ago: a large beach parasol over the drum set. They had a 3M 8-track and Ampex 300-4, 440-2, 300-1 machines. Down the hall, the Columbia master room held their Scully lathe with Westrex 3D-2 cutter and 440 Ampex playback machine.

GOLDEN STATE

And then we have Golden State, where hits they produced in the early fifties are still on the walls. This is also the home of the College for Recording Arts, the only recording school in the area. Both are ably run by Leo deGar Kulka, who, at first glance, looks sure to throw you out for the slightest infringement, but who turns out to be one of the nicest people I met on my journeys. With their Stephens 16-track, custom board and an ancient (but rock-solid) Ampex 200 full-track complement, as well as Altec 604C monitors and support gear, they offer not only a well-equipped atmosphere but a good place to learn.

So, everyone seems to be surviving. In some cases, one might almost say, prospering. I still think of one of the defunct studios. I heard through the grapevine that the owner had to choose between his wife and the studio. Maybe he made the wrong choice. ■

BAY AREA DIRECTORY

As an aid to those working in the Bay Area we list herewith a directory of DISTRIBUTORS and REPRESENTATIVES that handle professional equipment. Also listed are MANUFACTURERS of pro-audio equipment. We have made every attempt to make this little directory as complete as possible, but since that seems to be an impossible feat, we will bring it up to date as soon as we receive the usual indignant "you-left-me-out" letters. Maybe we can blame it on our computer!

DISTRIBUTORS/REPRESENTATIVES:

All Area Code 415

DALY CITY:
QRI Corp. 465-1312
Cetec
Gauss

LAFAYETTE:
Wilkins-Mason Associates 284-9200
Acoustic Research
Ampex Tape
Phase Linear
Koss

MENLO PARK:
H&K Sales. 369-6244
Sony
Marantz

OAKLAND:
General Electronics Systems, Inc. 658-9490
Neumann
Electro-Voice
Sennheiser
Turner
Shure
AKG
Phillips
Altec
R-Columbia
Memorex
BASF
3M Tape
Switchcraft
Rauland
Fairchild
Sony
Atlas
Argus
Ampex
Teac
Tascam
Vega

Norleen Sound Service. 652-2631
3M Tape
Editall
Electro-Voice
Atlas

Hank Gabriel. 465-5361
Fairchild
Sescom
Telex/Magnecord
University
Edcor
Mohawk

Professional Audio Electronics 654-6630
Electro-Sound
Electro-Voice
Shure
Klipsch
Sony
Crown
Accuphase
Thorens
Soundcraftsman
DBX
Teac

True Recordings. 652-8863
Revox
McIntosh
Beyer
AKG
Crown
Tandberg

Paul Seaman Co. 562-9241
Teac
Tascam
TDK
Audio Technica
Soundcraftsman
Royal
Accuphase

Cass Electronics. 834-4225
DBX
Cetec
Gauss
Electro-Voice
Shure
Turner
Audio Tape
Audio Pak carts
Switchcraft
Dyna
SAE
Teac
Telex
Winlab

Mike Stobin Co. 836-2937
SAE
ADS-Braun
Hervic
Winlab
Grace
Supex

PALO ALTO:
Western Audio Imports. 321-0664
Crown
McIntosh
Revox
Sennheiser
MB
AKG
Vega
Sony
Shure
Lamb
Teac
Uher
Tandberg
Beyer

REDWOOD CITY:
Accurate Sound. 365-2843
AKG
Ampex
Audiotek
Asco
DBX
Innovonics
3M
Revox
Countryman
Russco
Stevenson
Tascam
Sennheiser
JBL
Audio Tape
Electro-Sound
Sony
Parasound
Shure
Tascam
UREI
VIF
JVC
Switchcraft
Marantz
Nortronics
Spectrasonics
MRL
Electro-Voice
LPB
Altec
Cetec
Crown
Scully
Nagra
Otari
Editall
Neumann
Telex
Recortec
Taber
Liberty

Magnetic Tape Distributors 326-3540
3M Tape

The Woodworth Company 365-0252
Waters
CMS

SAN CARLOS:
Dobbs-Stanford. 592-5958
Crown
DBX
Uher
Yamaha
Group 128
Schweitzer
Vaco-Rac

(continued)

SAN LEANDRO:

Taber Manufacturing & Engineering. 635-3831
Ampex
Scully
Electro-Sound
Gotham
Revox
Tascam
UREI
STL
Burwen
Inovonics
Electro-Voice
AKG
Russco
Altec
Wireless
Vega
Nortronics
Cetec
Teac
University
Soundoliere
Telex
Crown

SAN FRANCISCO:

McCune Sound. 777-2700
Altec
Jensen
Atlas
Vega
Switchcraft
Clear-Com
Shure
3M Tape
Crown
Toa
Koss
Electro-Voice
AKG
Edcor
Telex
Orrtronics

Alembic Inc. 864-3800
JBL
Parasound

Adolph Gasser Enterprises 495-3852
Nagra
Stellavox
Sony
Arrivox
Sennheiser
Shure
AKG
Vega
Electro-Voice

San Francisco Radio: 863-6000
Teac
Shure
Telex
Koss
Sony
Sennheiser
McIntosh
Electro-Voice
AKG
Altec
Thorens
Bogen

Brooks Camera. 392-1900
Sony
Marantz
Uher
Jensen
Teac
Acoustic Research

Skinner Studios. 986-5040
Sennheiser
Shure
Audio Devices
Nagra
Crown
Atlas
Electro-Voice
Sony
Stellavox
D&M
Uher
AKG
Teac
Tapco
Ampex
Countryman

Edisco. 756-0300
Shure
Atlas
Lowell
Nortronics
Bogen
Utah
BASF
Electro-Voice
University
Memorex

Sound Genesis. 391-8776
Advent
Atlas
Crown
Electro-Voice
Langevin
Metrotec
Ramko
Scully
Sony
UREI
AKG
Ampex
DBX
MB
Parasound
Revox
Sennheiser
Soundcraftsmen
Otari
Allison
Beyer
Editall
Gauss
Maxell
Scotch
Russco
Sescom
Tascam
Altec
Countryman
Electro-Sound
JBL
McIntosh
Quad-8
Scott Instruments
Shure
Teac

Technical Sales Associates 467-1434
Oxford
E-V/Game
Permapower
McMartin
Fourjay

Audio-Video Associates. 626-2038
Lowell
Sennheiser
Frasier
Belden
Cornish
Atlas
Electro-Voice
AKG
Bogen
Columbia
Cannon
Soundoliere
Bozak
Magnecord
University
Alpha
Shure

Lumiere Productions. 989-1130
- Altec
- Crown
- JBL
- Shure
- Atlas
- Electro-Voice
- McIntosh
- Stevenson
- Cerwin-Vega
- Community Light & Sound
- Sennheiser

SAN MATEO:

Protronics Co. 574-8511
- Altec
- Teac
- Sennheiser
- Shure
- MB
- Ampex
- McIntosh
- Sony
- Electro-Voice
- UREI
- AKG
- Countryman
- Crown
- Neumann
- Quad-8
- Parasound
- Tascam
- Quantum
- Gately
- JBL
- ARP

TERRA LINDA:

Catania Sound. 479-7043
- McIntosh
- Fisher
- Superscope
- Altec
- Teac
- Shure
- B&O
- Kenwood
- ESS
- Thorens
- Tandberg
- Sherwood
- Marantz
- JBL
- Phillips
- Sony

TIBURON:

Corporate Media Systems. 435-2020
- Altec
- Gauss
- Shure
- Telex
- Vega
- AKG
- McKenzie
- Sony
- Tape-A-Thon
- Wireless
- Edcor
- Marantz
- Spectrasonics
- UREI
- Fairchild
- Sennheiser
- Toa
- University

WALNUT CREEK:

MacPherson Sales Corp. 937-1482
- Bose
- OEM
- Rotel
- AKG
- Vega
- Tapco
- Phillips
- Dather
- Innermedia

MANUFACTURERS

Alembic
60 Brady St.
San Francisco CA 94103
864-3800

Ampex
401 Broadway
Redwood City CA 94063
367-2011

Audio-Tek
2970 Scott Blvd.
Santa Clara Ca 95050
408-244-1776

Electro-Sound
725 Kifer Rd.
Sunnyvale CA 94086
408-245-6600

Clear-Com
759 Harrison St.
San Francisco CA 94107
415-989-1130

Electronic Music Associated
3400 Wyman St.
Oakland CA 946159
532-5034

FRAP
PO Box 40097
San Francisco CA 94140
824-2223

Kinetic Technology
3393 De La Cruz Blvd.
Santa Clara CA 95050
408-296-9305

Memorex Corporation
1200 Memorex Dr.
Santa Clara CA 95052
408-987-1325

Parasound
680 Beach St. #495
San Francisco CA 94109
776-2808

Recortec
777 Palomar
Sunnyvale CA 94086
408-735-8821

Sound Genesis
445 Bryant
San Francisco CA 94107
391-8776

Taber Manufacturing & Engrg.
2081 Edison Ave.
San Leandro CA 94577
635-3831

Tentel
1210 Camden
Campbell CA 95008
408-377-6588

Scully-Metrotech
475 Ellis St.
Mountain View CA 94040
968-8389

Countryman Associates
424 University Ave.
Palto Alto CA 94302
326-6980

MRL
999 Commercial St.
Palo Alto CA 94303
327-6724

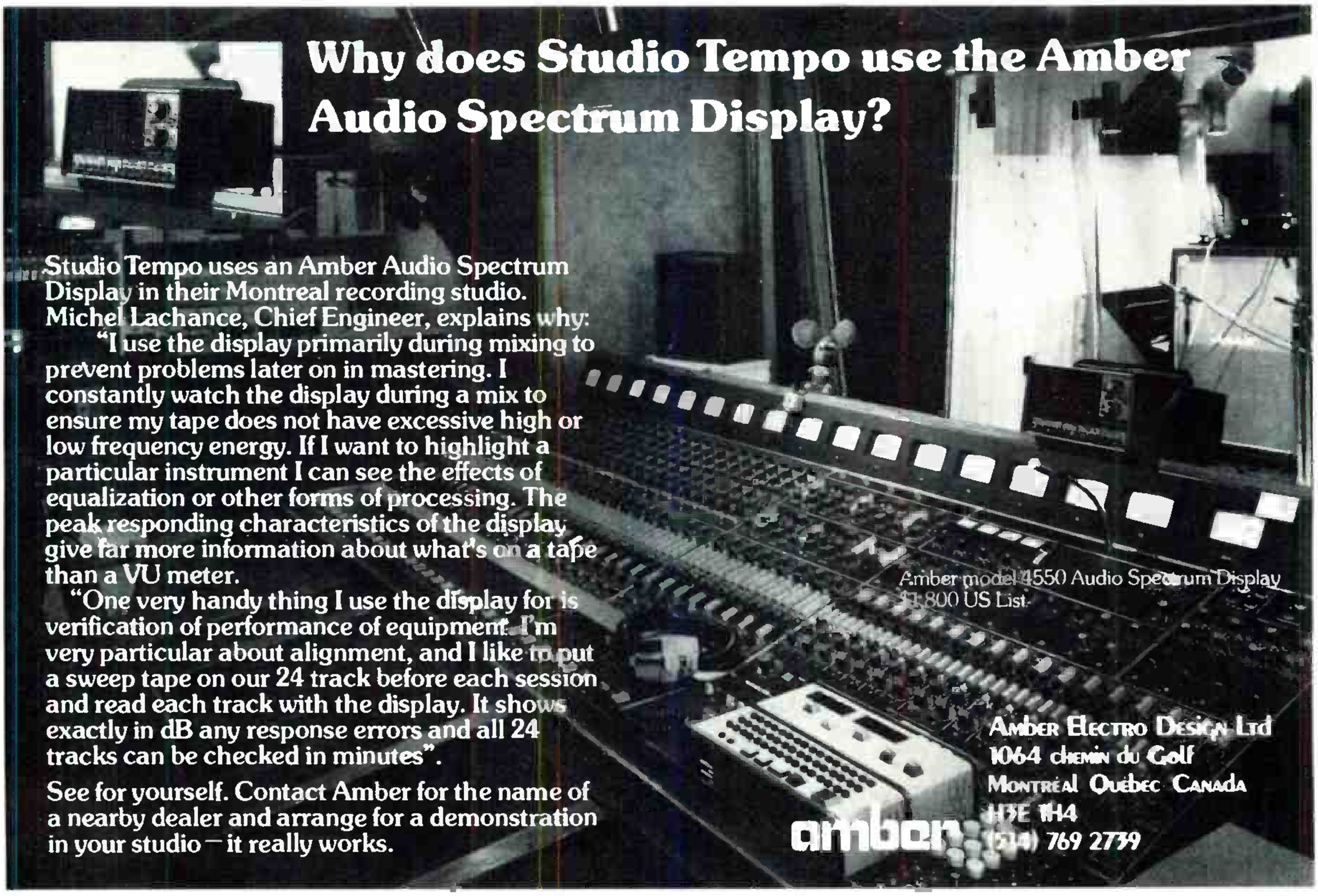
BRANCH OFFICES:

Agfa
1 W. Mill Dr.
Brisbane CA 94005

B&K
1611 Borel Pl. #236
San Mateo CA

CBS Laboratories
1 Embarcadero Center
San Francisco CA 94111

3M Tape
320 Shaw
South San Francisco CA ■



Circle 38 on Reader Service Card

JAMES J. DAVIDSON

Covers Audio Band In One Sweep

A 555 timer can be adapted to create a square-wave generator which covers the 20-20,000 Hz range in one sweep with no band switching.

SOMETIMES, IN AUDIO WORK, it's handy to have a generator which covers the entire 20-20,000 Hz range in one sweep, with no band switching. The ubiquitous 555 timer can be adapted to this function, producing 50 percent duty cycle square waves whose frequency is controlled over a 1000:1 range by a single potentiometer.

The complete circuit is shown in FIGURE 1. Note two items: 1. The capacitor is charged and discharged by the output stage (pin 3), rather than the discharge transistor (pin 7) as is usually done. That simplifies the frequency control. 2. A symmetry resistor, R_S, goes from pin 5 to ground. This resistor adjusts the duty cycle and the prober value yields exactly 50 percent, as will be explained.

Recall that, for the connections shown in FIGURE 1, the maximum voltage on the capacitor is the same as that on pin 5 (V_5), and the minimum is half that on pin 5 ($\frac{1}{2}V_5$). If we assume that the low voltage from the output stage (V_{3L}) is approximately zero and leave the high output voltage (V_{3H}) temporarily unspecified, then the charging time for the capacitor is:

$$t_c = R_F C \ln \frac{V_{3H} - \frac{1}{2}V_5}{V_{3H} - V_5}$$

and the discharge time is:

$$t_d = R_F C \ln 2.$$

For 50 percent duty cycle, $t_c = t_d$, or $V_5 = \frac{2}{3}V_{3H}$

Now if it were the case that $V_{3H} = V_{cc}$, R_S would not be needed since the internal divider string puts pin 5 at $\frac{2}{3}V_{cc}$. But as the data sheets for the 555 show, V_{3H} is about 1.4 volts below V_{cc}. Using this value, the formula for R_S is

$$R_S = R\frac{V_5}{V_{cc} - 1.5V_5} = R(.476V_{cc} - .667)$$

where R is specified as 5000 ohms per resistor. For a 5-volt supply, R_S = 8.6k to give a symmetrical square wave.

James J. Davidson is a consultant with Davidson Consultants, in Overland Park, Kansas.

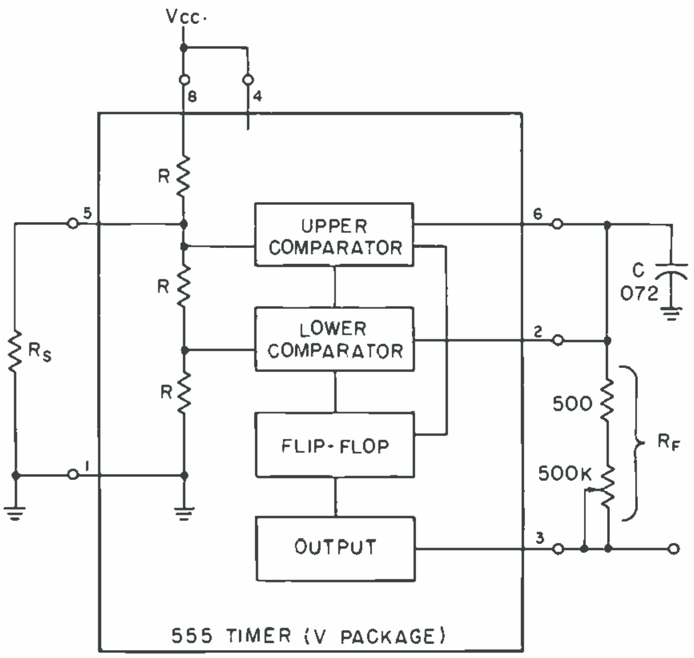


Figure 1. 20-20,000 Hz square-wave generator.

The frequency of oscillation, very simply, is

$$f = \frac{1}{t_c + t_d} = \frac{1}{2R_F C \ln 2} = \frac{.721}{R_F C}$$

If C = 0.0721 uf, $f = 10^7/R_F$.

The frequency determining resistor, R_F, consists of a fixed part of 500 ohms and a variable part of 0.5 megohm. A log-taper audio volume control gives a much smoother distribution of frequencies with rotation than a linear taper would. For a proper sense of rotation, put the frequency calibration marks on a skirted dial rather than on the panel. (If that sounds puzzling, try it.) The 500-ohm fixed resistor sets the 20,000 Hz frequency. However, check the minimum resistance of the pot (terminals 1 and 2) and subtract this from the fixed resistor. ■

DAVID L. KLEPPER

Architectural Acoustics, part 1

By following certain rules, you can design and build, or modify, studios to meet specific acoustic needs.

*Reprinted from **db** March 1968*

THE professional worker in audio is involved with acoustics, regardless of his specialty within his field. Indeed, the fields of audio and acoustics overlap more than they are separate and distinct. The acoustics of recording and broadcast studios, theaters, concert halls, and other performing spaces affect the work of the recording and broadcast engineer—while the acoustics of any space requiring an electronic sound amplification system will affect the performance of the system and the work of the system designer, installer, and operator.

A theater, concert hall, auditorium, or a radio or television studio should be designed acoustically: first to form a good *room-acoustic* link between the live sources of speech and/or music, and the live listeners and/or microphone(s); and second to exclude noise. Both the room-acoustics and noise-control aspects of architectural acoustics have been under continuous development for many years. The goals of the room-acoustics design may be stated as:

- Insuring an even distribution of sound energy throughout the space.
- Controlling discrete echoes, rapidly repeating echoes (flutter-echoes) and bunching of the normal modes of vibration of the rooms which might emphasize certain frequencies.
- Providing the proper reverberation time characteristics.
- Assuring the proper ratio of reverberant-to-early sound, related to the shape of the reverberation decay curve and particularly important in spaces where live music is heard by live listeners.
- Providing a short enough initial time-delay gap, for early reflections, again important in *live-music* spaces.

Diffusivity and Echo Control

Even sound distribution and satisfactory control of echoes and normal modes is achieved where there are no extreme variations in sound pressure either as the frequency of the signal or the position in the room is varied. Diffusivity can be accomplished by avoidance of parallelism in the basic shape of the room, as in FIGURE 1, or large-scale modulations of basically rectangular shapes, as in FIGURE 2. The popular polycylindrical diffusers (FIGURE 3) are one form of "break-up" that can be added to basically rectangular-shaped rooms.

Where large, concave or flat surfaces are essential because of architectural or other planning considerations, echoes may be controlled by sound-absorbing treatment. Usually, however, diffusion by surface break-up and shaping should be considered first and the sound-absorbing treatment limited to that required for reverberation control.

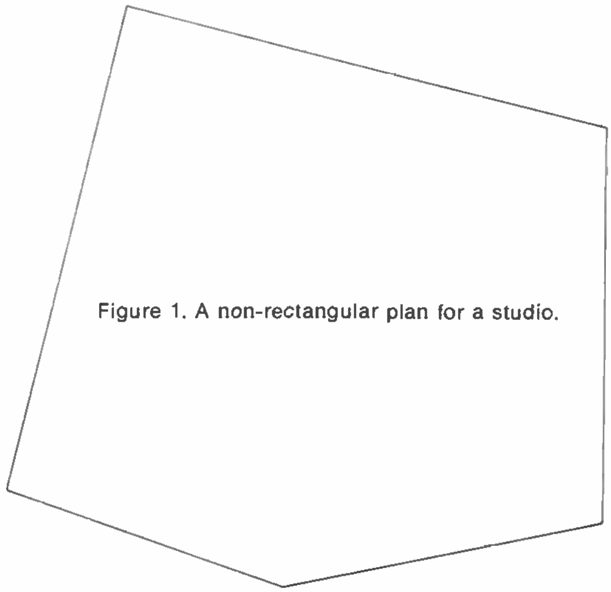


Figure 1. A non-rectangular plan for a studio.

Elements added to basically rectangular rooms for sound diffusion must be approximately equal or larger in scale compared with the wavelengths of sound energy being controlled. (The wavelength of a 100 Hz signal is 11.3 feet.) For speech studios a designer might restrict diffusion to the range above 200 Hz (5.65 ft.), but for music studios the range down to 50 Hz (22.6 ft.) or even lower – to the 20 Hz lower limit of human hearing – may be important.

In many auditoriums and concert halls, balconies or applied decoration in the form of statues, etc. are "natural" sound-diffusing elements.

Reverberation Time

We define reverberation time as the time required for sound to decay to one-millionth of its value (60 dB) after cessation of the sound source. In any real room it usually varies as a function of frequency and may be predicted accurately by the ratio of the volume of the room to the total sound-absorption present, according to the following formula[1]:

1 This equation is called the Sabine equation after Wallace Clement Sabine, father of modern architectural acoustics. It appears generally applicable for must diffuse-large spaces, although the Norris Eyring equation or other modifications of Sabine's original equation are perhaps more appropriate for small or very dead rooms.

$$R_t \text{ (reverberation time)} = \frac{0.049\ V}{S\alpha}$$

Where V = room volume
S = room surface area
α = average absorption coefficient
$S\alpha$ = total sound absorption

Although early studios were uniformly dead, there has been a trend from the early days of broadcasting to the present for more reverberant studios, particularly for music performance.

Beranek's suggested criteria for speech, general, and music studios still appear to be generally applicable and are illustrated in FIGURE 4. Large music studios should have much the same reverberation time characteristic as a fine concert hall. Speech studios should have essentially no audible reverberation with less or equal reverbation time at frequency extremes (low-frequencies and high-frequencies) as compared with mid-frequencies.

General studios may be a compromise between speech studios and music studios. Regarding auditoriums for "live" listeners, experience suggests the following mid-frequency reverberation times for different uses:

	Optimum	*Possible*[2]
Lectures	0.9 – 1.1	0.5 – 1.4
Drama (theaters)	0.9 – 1.4	0.5 – 1.6
Musical Comedy	1.2 – 1.5	1.0 – 1.7
Opera	1.5 – 1.8	1.4 – 2.0
Instrumental Recitals and Chamber Music	1.4 – 1.8	1.0 – 2.0
Orchestral Concerts	1.8 – 2.0	1.4 – 2.5
Vocal Recitals	1.5 – 1.8	1.4 – 2.0
Choral and Organ concerts (liturgical music – the upper limit depends on the type of music)	2.0 minimum	1.7 minimum

2 Good results possible provided other parameters are optimized.

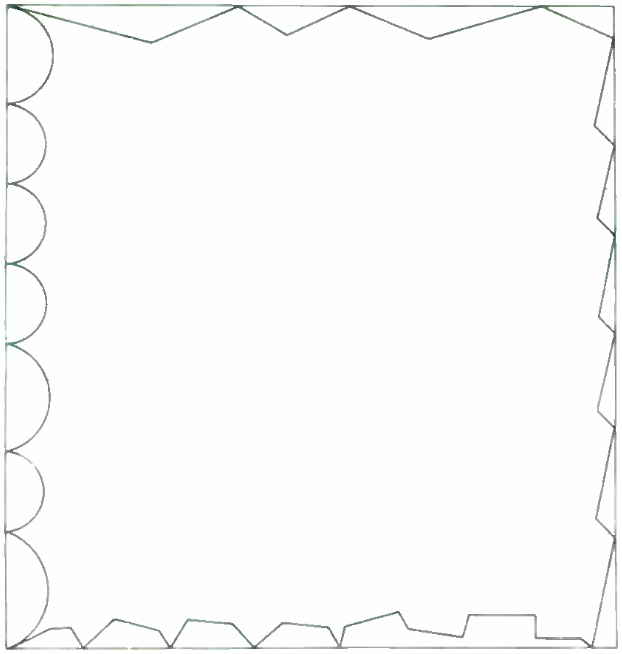


Figure 2. Sound diffusing wall modulations of several types applied to a rectangular room.

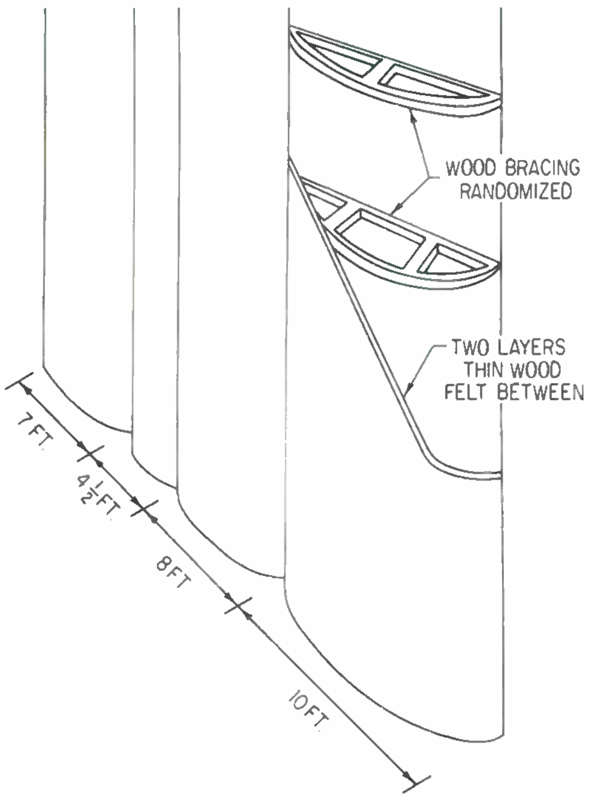


Figure 3. Typical polycylindrical diffuser construction. The diffusing effect of a cylinder is maximum when diameter equals one-half wavelength, and a combination of different radii will provide optimum diffusion over a wide range. The construction shown also provides low-frequency absorption.

Occasionally a reverberation time calculation will reveal a studio or auditorium on the "dead" side (too low a reverberation time), even without any applied sound-absorbing treatment. For example, the calculated reverberation time for a studio planned for music broadcasting may be under 1.5 seconds at mid-frequencies, even with all interior finish materials hard and sound-reflecting. The reason may be a relatively low cubic volume (interior volume less than say 40,000 cubic feet), with the predicted sound-absorption of the 100 members of a full symphony orchestra present.

Economics may dictate the design of studios or halls below optimum size. Under these conditions the wise designer or acoustical engineer will often refrain from attempting to make the hall or studio as live or reverberant as possible within the available volume, because under certain conditions in small halls or studios, he would be concerned that the space would simply be too loud for proper performance conditions. Instead, particularly in studio situations, he might choose to provide a relatively dry acoustical environment to be supplemented by electronic reverberation devices, either within the hall itself (for performers, listeners, *and* recordings) or for recordings alone.

We have been discussing mid-frequency reverberation time goals for various spaces. These are reverberation times measured in the 500 – 1000 Hz range. The variation in reverberation as a function of frequency is also very important; and it is a good measure of the "frequency response" of the room. For example, a concert hall with a reverberation time of 2.8 seconds at 125 Hz, 2.0 seconds at 500 and

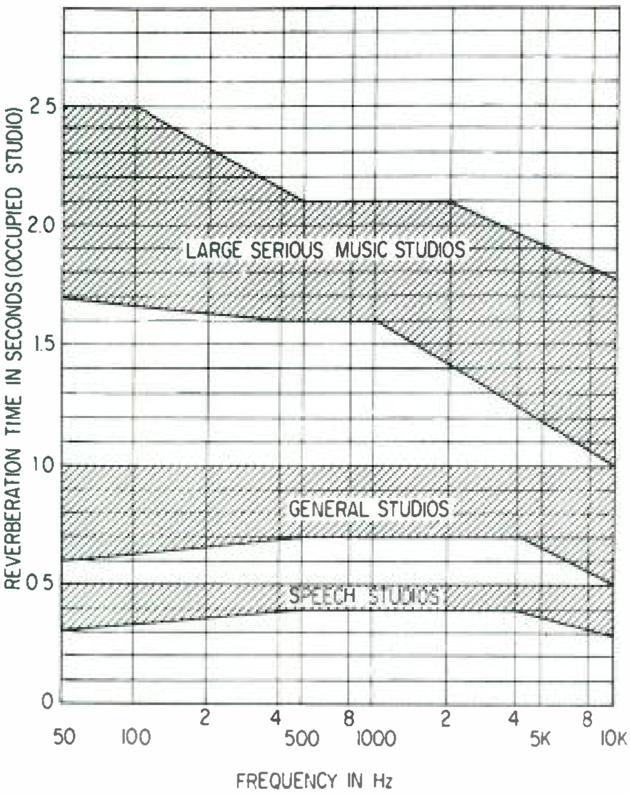


Figure 4. Suggested studio reverberation criteria.

1000 Hz and 1.6 seconds at 2000 Hz would be characterized as *warm*. On the other hand, a similar hall with reverberation times of 1.5 seconds, 2.0 seconds, and 2.0 seconds at 125, 500-1000, and 2000 Hz, respectively, would probably be characterized as *harsh*, or *bright*. Today, acoustical engineers plan large halls or studios for music performance to have rising low-frequency reverberation time characteristics: that is longer reverberation times at low frequencies than at middle or high frequencies.

In a speech studio, particularly a small one, a longer reverberation time characteristic at low frequencies would be characterized as a *boomy* acoustical environment. Speech-acoustics spaces should generally have flat reverberation time characteristics. Studios and auditoriums planned for both speech and music may be planned as a compromise, or — as discussed earlier — adjustable treatment or electronics may be employed to bridge the gap between optimum speech and optimum music conditions.

Initial Time Delay Gap and Ratio of Early-to-Reverberant Sound

These quantities have been analyzed primarily with respect to concert hall acoustics — although there is every indication that we should consider them important in large speech halls also.

In a large concert hall having an "ideal" reverberation time characteristic (a long one, say 2.0 seconds) there can be a tendency for the sound heard by a live audience to be *muddy* or lack sufficient clarity, particularly for classic (Mozart — Haydn) and contemporary (Stravinsky) music. Rather than shorten the reverberation time to obtain the added clarity, today's acoustical engineer would rather supplement the direct sound with additional sound energy that arrives at the listeners' ears soon enough to reinforce the direct sound, adding to clarity without destroying the richness of a long reverberation time. The goal is a "have your cake and eat it too" solution, which combines clarity and reverberation. Such a hall can have a large-hall liveness of sound with a small-hall intimacy. The time of arrival of these early reflections and their strength is important. If too late (after the initial sound) or too low in strength, they will be ineffective in aiding clarity: if they are too strong — and early enough — they will so dominate the sound heard by listeners that the liveness of the hall simply will not be heard, and the hall will have a reputation for *dryness* despite an adequately long reverberation time.

These early reflections may be compared to a pinch of pepper in a well-prepared soup. Just the right amount is needed. Too much and we'll taste only the pepper (too *much* clarity); not enough and the pepper may as well be absent (too *little* clarity); and the pepper should be added at the right time for best effect (the proper initial time delay gap).

The amount of energy in the early reflections, together with the energy of the direct sound, determines the ratio of early-to-reverberant sound, while the timing determines the "initial time delay gap". The ratio of early-to-reverberant sound is, for our purposes, defined as the ratio of sound energy received at a listener's position for the first 50 milliseconds during and after the receipt of the initial pulse of sound to the total sound energy received after the first 50 milliseconds.[3] Often, the inverse ratio — the ratio of rever-

3 We assume use of a short-duration (5 milliseconds or less) pulse or impulsive sound source to obtain measurements of the quantities here discussed. Such sound sources would be analogous to transient sound in speech and music — the attack of a musical instrument or consonants in speech — rather than the stead-state or vowel sounds. Proper hearing of transients is necessary for adequate clarity.

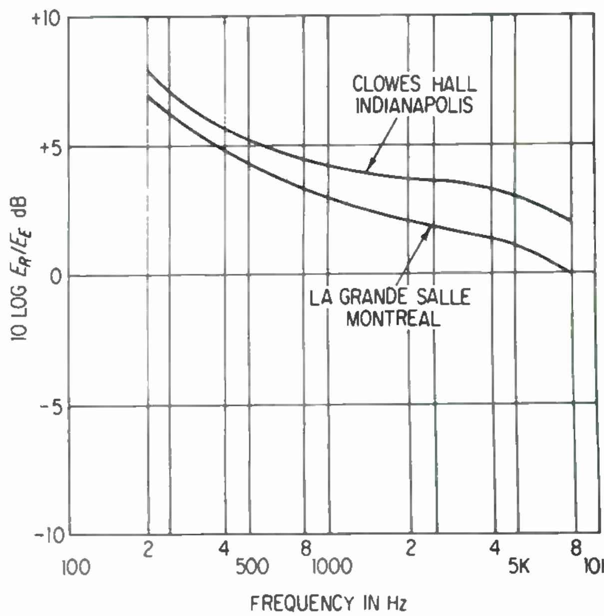


Figure 5. Ratio of reverberant sound energy to early sound energy of modern halls, expressed in dB (10 $\log_{10}$) as a function of frequency.

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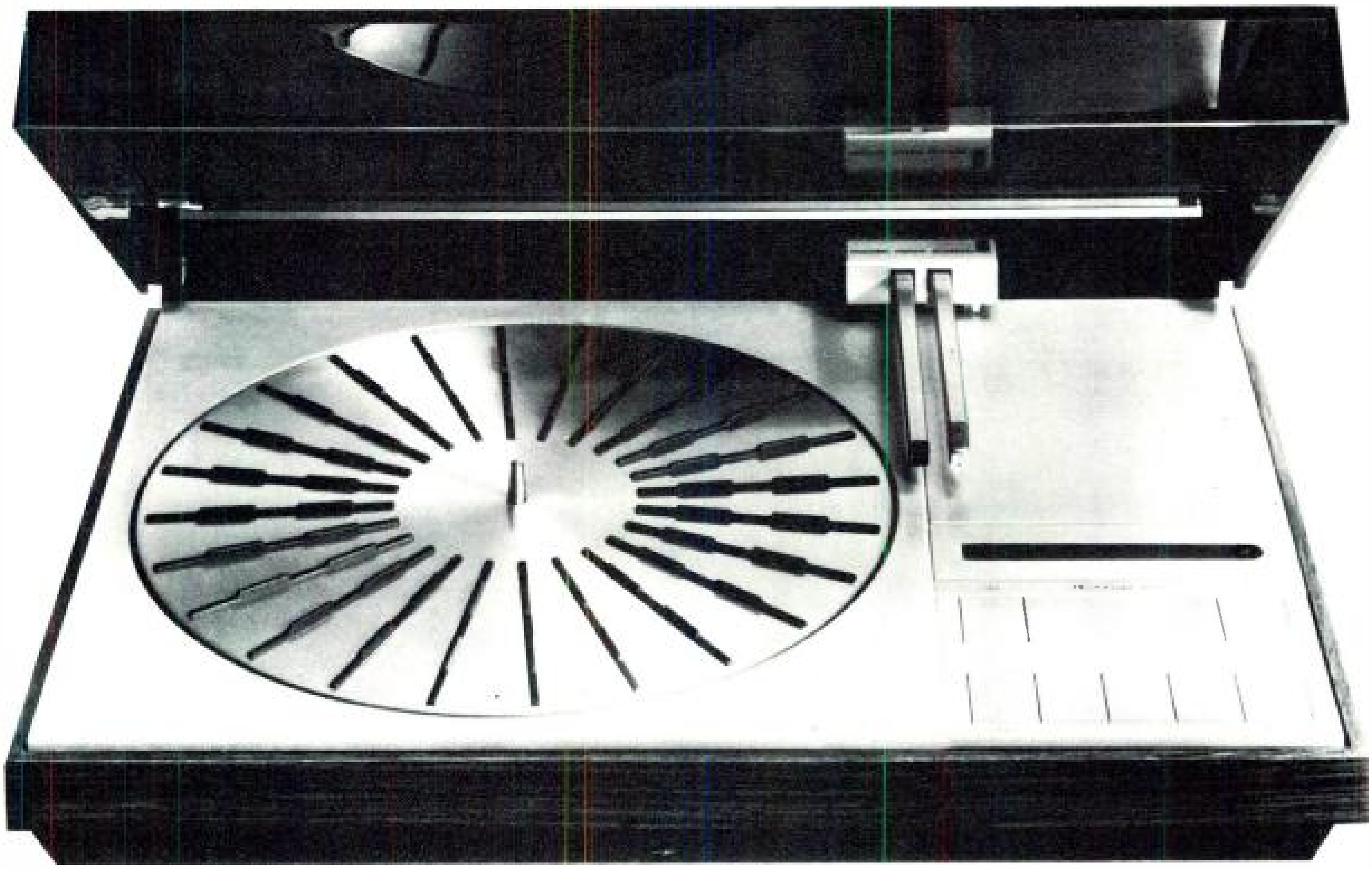

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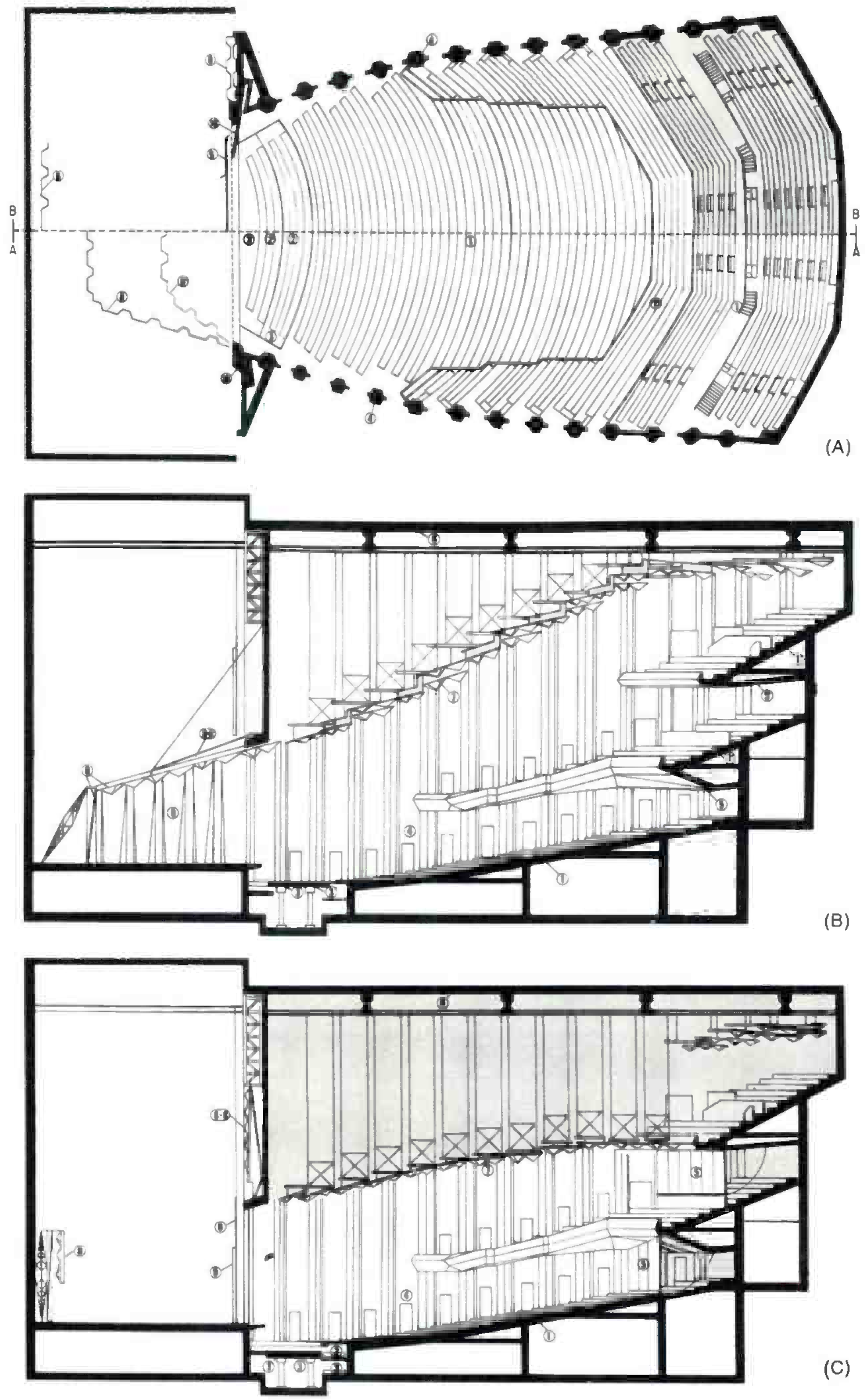

Figure 6. A 3000-seat Concert Hall-Opera House and 1700-seat Recital Hall-Theatre Combined in One Hall. (A)—Plan—left stage enclosure in position for 3000-seat concert hall, right, 1700-seat theatre, stage enclosure stored. (B)—Longitudinal section, stage enclosure in position for 3000-seat concert hall. (C)—Longitudinal section, stage enclosure stored for 1700-seat theatre.

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Shaded areas are spaces closed off by movable ceiling and rear walls.

berant-to-early sound energy is used. The ratios are usually expressed in decibels rather than fractions. FIGURE 5 shows the ratios for two modern halls as a function of frequency.

The initial time delay gap is the delay between receipt of the initial sound and the receipt of the first reflection. Beranek's study (see Ref. 4) has indicated 0 to 20 milliseconds as ideal for the initial time delay gap, and up to 30 milliseconds as good.

The proper early-to-reverberant sound ratio and the initial time delay gap were inherent in the design of the older, narrow, rectangular "shoe box" concert halls. The designs included broken-up or diffuse side walls, spaced sufficiently close together (and to the halls' center-lines) to provide the required early reflections. However, the newer, larger and sometimes more radically shaped wide halls seem to require supplementary sound-reflecting *clouds* (Tanglewood; Clowes Hall in Indianapolis; Jones Hall in Houston; La Grand Salle, Place des Arts, Montreal; DeDolan Hall, Rotterdam; for example) or one large sound reflector per hall in the form of a "lip" (Saratoga Springs; Chandler Pavillion, Los Angeles; Opera House, Seattle) to assure the right balance between clarity and liveness.

The recording engineer may not be overly concerned with these balances. Given a sufficiently live hall, he can increase clarity by closer microphoning or use of more directional microphones; or increase liveness by use of more omnidirectional microphones or greater distance from source to microphones.

The sound-system designer may broaden his understanding of room acoustics problems to have a better grasp of the combined room-sound system results. In special cases, where architectural means are impractical, an electronic sound reinforcement system may be called upon to simulate early reflections by amplified sound.

Stage Enclosures

Auditoriums used for opera and plays usually have generous fly-space over the stage and side-stage areas to permit movement of scenery and curtains. These voids can act as traps for sound energy during live music performances; the proscenium (stage opening) acts as a barrier between the musicians on the stage and the audience. A music studio or concert hall surrounds an orchestra with many hard, sound-reflecting surfaces. Movable stage enclosures accomplish the same results in multi-purpose auditoriums, they help in the "quick-change act" between theater and concert hall. When in place, the enclosure assures that the audience and performers are in the "same room".

To be fully efficient, such enclosures should usually be constructed of fairly heavy material, usually weighing 2 lbs./sq. ft. or more, to reflect low-frequency sound energy which can pass through thin, lightweight material. Half-inch or three-quarter-inch plywood is a popular material for stage enclosures, both custom-built for particular halls and available from stock from several manufacturers.

Good critical reviews have greeted concerts performed within relatively lightweight enclosures. These enclosures employ a process which has been described as *selective absorption* to achieve optimum frequency response and instrumental balance. Gaps are left in certain areas of the enclosure to absorb middle and high-frequency energy, balancing the absorption of bass energy by thinner than usual material.

The usual system for the erection of a movable stage enclosure is for the ceiling pieces to be suspended on the theatrical rigging system, with the walls in the form of interlocking self-supporting pieces or rolling towers. There is a trend, however, to mechanized stage enclosures that reduce dependence upon normal stage-hand labor for erection and striking while freeing the rigging system completely for its prime purpose of storing scenery. In the Jesse H. Jones Hall for the Performing Arts, Houston, Texas, the forward ceiling panels of the stage enclosure fold down as one unit from the stage house wall above the proscenium, the side-walls fold out from the stagehouse walls on each side of the stagehouse, and the rear wall and rear ceiling fold out from the lower up-stage (rear stagehouse) walls. All this is accomplished with the help of push-buttons and electric motors. Such a theater design can free the acoustical designer toward the use of adequately heavy materials, regardless of their weight. In this case, 12 gauge steel, backed with damping material and faced with thin wood veneer was employed. The surface weight of the combined structure is close to 7 lb./sq. ft., assuring good sound reflection down to 25 Hz.

The improvement of an existing mutlipurpose theater-concert hall by provision of a properly designed stage enclosure, whether wood, plastic, or damped metal, is a familiar event today. Often the improvement in hearing conditions for the live audience is matched by improvements in liveness and balance in the sound as picked up by microphones; however, more often than not complete re-engineering of the microphone pickup arrangements are required if best results are to be obtained. ■

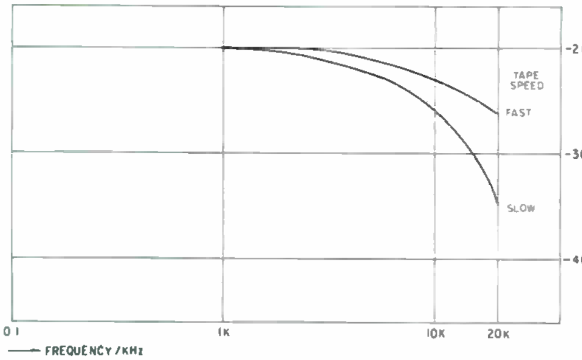

Figure 1. Typical high frequency losses of a constant current recording (no record pre-emphasis) well below tape saturation.

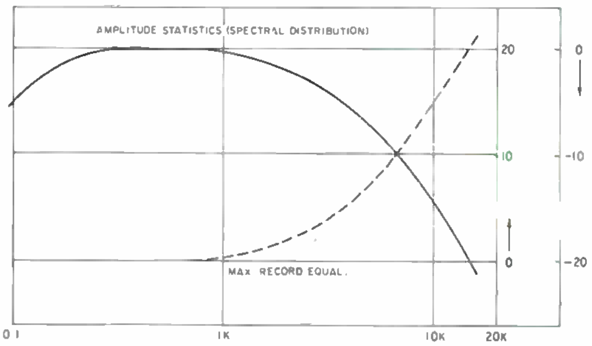

Figure 2. Amplitude statistics (spectral distribution).

JOSEF W. DORNER

Why Use 15-ips Tape Speed?

Is 15 in./sec. tape sometimes an extravagance when measuring frequency response? Points in favor may help you make a logical, and most economical, decision.

As in Tevye the dairyman's world, audio procedures, young as they are, have already established their traditions. One of these is the practice of measuring a tape record's frequency response some 20 dB below full modulation, in order to avoid the possibility of tape saturation at high frequencies as the result of the high-frequency boost required in the recording process. Iconoclastic audio engineers might ask, if the specification sheets for recorders running at 7½ and 15 in./sec. show almost identical performance data, why use twice as much tape at 15 in./sec. if the same results can be obtained at 7½ in./sec. anyway?

The answer is not, as Tevye melodiously put it. "Tradition." It's not even as your mother might have said, "Because." This particular practice is based on sound reasons (pun unintentional).

First, we may ask, "Is there really a difference in quality between a 7½ and a 15 in./sec. recording, and if so, why?"

Josef Dorner is an audio engineer in Zurich, Switzerland

Let's consider record and playback equalization, the electrical transfer characteristics of the amplifier, which, if properly adjusted, will produce a linear over-all frequency response with a given recording tape. If such equalization were not used and a recording made with constant audio current passing through the recording head over the whole audible frequency range, the output would remain constant at first. But as higher frequencies were approached, a drooping response would become evident. This fall-off of high frequencies would be more severe at a slow tape speed than at higher ones. This effect is shown in Figure 1. The amount of high-frequency loss depends on a number of variables, including the tape; therefore, the curves represent only the general trend and are not to be taken as absolute figures.

COMPENSATING FOR LOSS

This loss at high frequencies is a wavelength-dependent effect. The wave length of a given frequency becomes shorter on tape as tape speed is reduced. Record equalization is used to compensate for this loss of highs. An increasing amount of current is pushed through the head with rising frequency and decreasing tape speed. That is possible, to a certain degree, because high-frequency

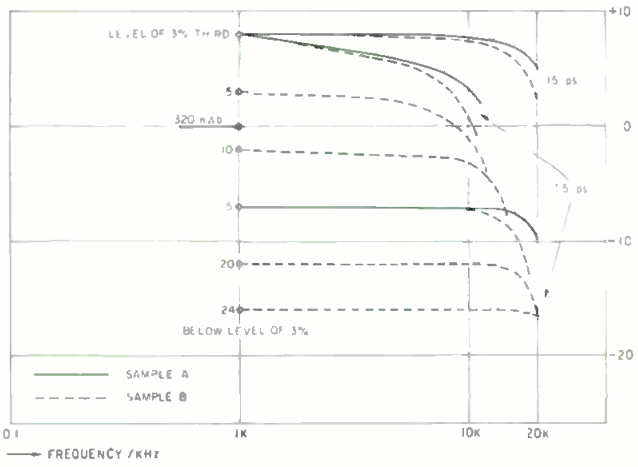

Figure 3. Frequency response at different speeds and different levels.

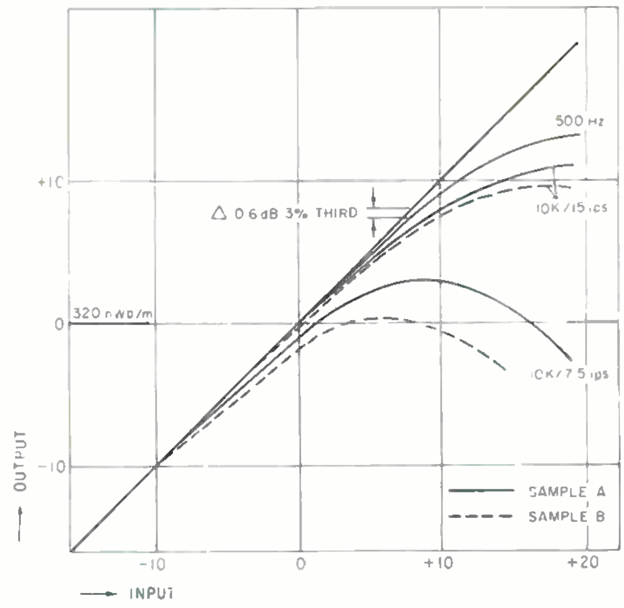

Figure 4. Saturation characteristics at high and low frequencies for different speeds and different modern high-output low noise oxides.

sounds in voice and music have rather low energy levels. They may be lifted up to produce on tape a level of magnetization which is stronger than their presence in a live performance. Compensation becomes effective for the losses which occur in the magnetic recording and playback process, maintaining the same spectral energy distribution as an over-all effect. To avoid tape saturation, the emphasis must not exceed the amount by which the high frequencies are present at a lower level in the original sound.

Based on various measurements, a curve (FIGURE 2) has become widely accepted and is considered representative of the average intensity levels in a wide variety of live sounds (spectral distribution.) The inverse of that curve is taken to be the maximum permissible record equalization for any recording process.

However, various researchers[1,2] have shown that spectral energy distribution may vary widely, in some cases being flat up to 16 kHz, within 3 to 5 dB. Obviously, the record equalization that must be used for music with such a high energy content at the treble frequencies will drive the magnetic oxide into saturation.

We can simulate this by trying to run a frequency response on a recorder, not at the conventional level of −20 dB but at a peak recording level instead. The results will reveal an interesting insight into what actually happens to the frequency response of a recording at different speeds and at different levels of magnetization.

STUDYING OUTPUTS

In FIGURE 3, we see the graphic presentation of a typical performance obtained with modern high-output tapes on a high-quality tape recorder. From these graphs, one can conclude the following: A slow speed recorder will drive the tape into saturation at comparatively low levels; musical selections with high intensity of high-frequency sounds cannot be recorded without severe losses at the upper spectrum. A recording tape may have reduced saturation characteristics at short wavelengths, causing high-frequency saturation to occur much sooner than on other magnetic oxides. (See FIGURE 3, samples (A) and (B) at −15dB.)

Not only the frequency response has to be considered in such an evaluation, but some difficult-to-measure distortion products are generated when saturation is reached at high frequencies, causing the recorded sound to take on a fuzzy quality as a result of the different intermodulation products which are generated.

COMPRESSION EFFECT

By investigating a tape's transfer characteristic at long wavelengths, we see that a compression effect (about 0.6 dB) becomes evident at a level which corresponds to the universally tolerated maximum of 3 percent of third harmonic. At the point where 1 dB of compression is reached, distortion already measures 12 percent. At the high frequencies (e.g. 10 kHz) distortion products are difficult or impossible to measure because the limited frequency response of the replay electronics does not normally allow the determination of their third harmonic content. That leaves only one alternative, to consider the point of 0.6 dB compression at 10 kHz as the highest tolerable modulation level. On the two tapes under investigation, that point was only a few dB below the 3 percent distortion mark for 500 Hz when using the speed of 15 ips. At 7½ ips, however, the tapes began to show compression (distortion) at 10 kHz at a much lower level, as can been seen in FIGURE 4.

Attempts are being made by at least one national standards organization to express a recording system's high-frequency saturation performance in terms of a decibel value for its signal-to-noise performance at a specified frequency. More accurate tests, such as the recording of two closely spaced high frequencies at different levels of magnetization while measuring their third-order product, will also yield very useful information.

In any event, it is apparent that the special characteristics offered by modern magnetic oxides should be carefully weighed against such desirable features as improved signal-to-noise ratio and extended frequency response, if the risk of high-frequency overmodulation is to be kept as low as possible. The purpose of using 15-ips tape is not just a caprice, or because someone else does it. It is necessary for that margin of excellence necessary to preserve on tape all the sparkle of a live performance. ■

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1. McKnight, John G., "The Distribution of Peak Energy," *Journal of the Audio Engineering Society*, April 1969, p. 65.
2. Bauer, Benjamin, "Octave Band Spectral Distribution," *AES Journal*, April 1970, p. 165.

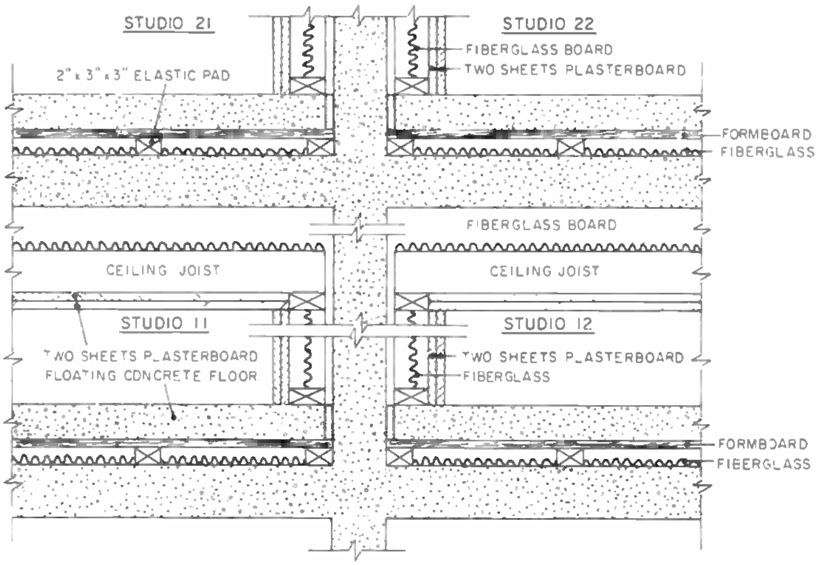

Figure 1. Cross-section of a studio complex, showing a floating concrete floor.

Recording Studio Acoustics, Part 6

Attenuation of noise from exterior sources, such as air-conditioning equipment, overhead noise, and traffic requires careful structural modifications.

MICHAEL RETTINGER

EXCEPT WHERE SPACE is severely limited, two or three recording studios of different volumes are preferable to one large studio with variable volume. Reasonably acceptable proportions for height, width, and length cannot be maintained for all possible studio volumes by moving one wall or by lowering the ceiling of the room. When massive movable walls or a massive ceiling are employed to achieve a low noise level in the enclosure, the cost of the moving mechanism becomes very high. The acoustic treatment cannot be optimally distributed for all possible volumes unless a second mechanism is employed to change the acoustic treatment along with the volume.

Multiple studios may be horizontally or vertically disposed. In either case, each studio should have a floating floor, that is, a resiliently supported concrete slab, for efficient sound and vibration control.

FLOATING FLOORS

FIGURE 1 shows a cross-section of an elaborate studio complex for a government project in Ryadh, Saudi Arabia.

A floating concrete floor, besides acting as a second bar-

Part 6 concludes db's series, Michael Rettinger's "Recording Studio Acoustics." Mr. Rettinger is an acoustical consultant in Encino, California.

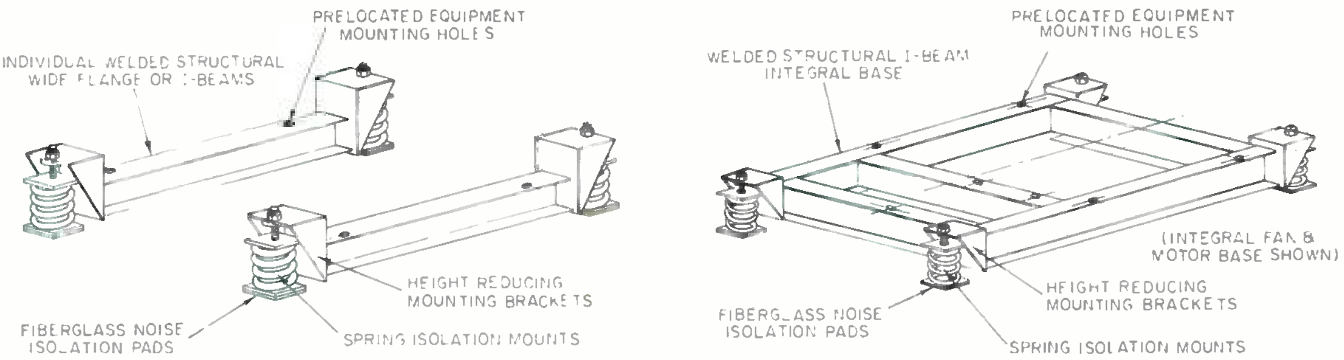

Figure 2. Structural rail equipment bases.

rier for airborne sound, also represents a type of inertia block which absorbs the mechanical vibrations of impulsive disturbances like footfalls, the moving of furniture or instruments, etc. Because of the elastic support below the floor, such a floating slab behaves as a low-pass mechanical filter whose cut-off frequency is given by $f_0 = 3.13/(d)^{1/2}$, where d is the static deflection, in inches, of the compliant mount below the floating floor upon application of the concrete slab load.

In the case of a studio 30 ft. wide and 50 ft. long, 1,500 sq.ft., a 4-in. thick concrete floor will weigh 75,000 lb., or 50 lb./sq.ft. A 2-in. thick, 3 x 3-in. Neoprene, cork, or precompressed plastic-jacketed fiberglass pad may be loaded to 20 lb./sq.in., or 180 lb./pad. Hence 75,000/180 = 416 pads will be required. They may be spaced 2 ft. on center, with 16 pads along the width and 26 pads along the length of the floor. Considerable steel reinforcing rods will be necessary to prevent cracking of the concrete floor, which may also necessitate several expansion joints. The concrete should be poured on a sturdy formboard, such as a ¾-in. thick exterior plywood on which a waterproof plastic sheet has been placed to prevent water-infiltration into the wood.

RESILIENTLY HUNG CEILING

Another structurally isolated sound barrier is represented by a resiliently hung ceiling. Much in the manner of elastic pads spaced at 2-ft. centers under a floating concrete floor, a gridwork of channel iron and metal lath is hung by means of spring or Neoprene hangers from the overhead structural building slab. The lath is then plastered, generally after some fiberglass material has been placed above the lath for sound absorption in the space between slab and ceiling.

The cheapest footfall attenuator from an upper to a lower studio is undoubtedly a thick carpet with an equally thick underlay. The disadvantage of such a floor treatment lies in the fact that no strong first reflections from musical instruments can be had from such a covering. To lay plywood panels on the carpet near an orchestra shell is merely a makeshift procedure. Such a device is simply an improvised floating floor, without aesthetic appeal and of dubious quality acoustically because of the high damping.

MULTI-STUDIO CONSTRUCTION

In multi-studio construction, corridors often can be placed advantageously to act as highly effective sound attenuators. In one instance, a corridor between a 12-in. thick concrete block outside boundary and a studio with double-stud walls reduced the noise from a near jet-aircraft run-up operation to complete inaudibility in the studio.

The construction must be carried out properly. Not to plaster a concrete-block wall is to invite unexpected high sound transmission through it. Even painting such a wall has increased its sound insulation by as much as 6 dB over the entire audio frequency range, and plastering it on both sides has increased it by 12 dB over the same range. Concrete blocks are rarely sufficiently dry when they are delivered to the job. Shrinkage is bound to occur with consequent openings in the wall, particularly at the joints, which by themselves are often so porous it is possible to blow cigaret smoke through them. Every core in every block, not only every second or third core, must be filled with concrete to obtain the necessary surface density for the wall, together with the required seals.

Corridors should be constructed in the same way as studios if they are to act as effective sound attenuators. Thus, their floors should be floated on elastic pads, their ceilings should be resiliently hung from overhead structural slabs, and a generous amount of sound-absorbent material applied to both the ceiling and the walls. Rubber pads should be placed on the floor to attenuate the sound of footfalls and the trundling of carts. *(continued)*

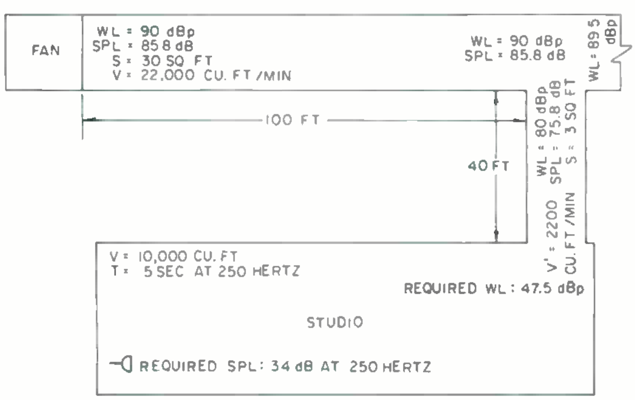

Figure 3. Duct-silencer.

AIR-CONDITIONER VIBRATIONS

In large studio installations, the location of the air-conditioning system equipment often becomes a critical problem. This situation is made more difficult because of the almost conspiratorial silence regarding machinery vibration levels on the part of equipment manufacturers. On more than one occasion, I have had to check the disturbances of an existing installation employing the compressors or chillers for the planned studio to be able to arrive at the necessary vibration isolation measures. When no such investigation is possible, it is advisable to over-engineer the attenuation. That may save extraordinary expense at a later date, if it is found that the equipment is audible in the studio.

My experience is that for most installations, the air-conditioning system machinery near the studio must be placed on inertia blocks. These should be mounted either on very tall springs (to achieve, sometimes a required 3-in. static deflection) or else on pneumatic mounts with an automatic feedback of air into the bags in case "bleeding" should occur over a prolonged period. Never place tall springs directly under equipment; that causes a wobbly motion on part of the machinery. They should be placed under a cradle, a heavy metal bar with upturned ends under which the springs can be located to produce a low center of gravity (FIGURE 2).

Needless to say, the use of an inertia block which may weigh several times as much as the machinery on which it is to be mounted requires consultation with the structural engineer of the studio project so that he may specify sufficient steel in the floor support.

SOUND POWER LEVELS

As good practice, one describes the noise of air-conditioning equipment in terms of octave-band sound power levels to make the rating independent of distance and thereby to facilitate the acoustic design of the installation. Because both the sound-pressure level *SPL* and the power level *WL* are expressed in decibels, the latter are noted as *dBp's*, the *p* standing for *picowatts* (10^{-2} watts) as the reference level. A numerical example will illustrate the use of this system.

Assume a fan with a WL of 90 dBp in the octave whose mid-frequency is 250 hertz. This fan has a 30-sq.ft. S-port, S, capable of delivering 22,000 cu.ft. of air per minute. A 100-ft.-long unlined duct of the same cross-sectional area is to be connected to the fan. At the other end of this main feeder, the duct branches off into a 40-ft.-long, 3-sq.ft. duct to deliver 2,200 cu.ft. of air/min. at a WL of 47.5 dBp into a studio with a volume V, of 10,000 cu.ft. and a reverberation time, T, of 0.5 sec. at 250 hertz. What are the SPLs and WLs at the various points, why the 47.5 dBp, and how can this specification be achieved?

At the port, where WL is 90 dBp, the SPL is:

$$SPL = WL - 10 \log S + 10.6$$
$$= 90 - 10 \log 30 + 10.6 - 85.8 \text{ dB}$$

At 100 ft. from the port, the WL and SPL are still 90 dBp and 85.8 dB, respectively, because there is no spreading of the sound in the duct. At the branch, the WL in the 3-sq.ft. section will be 10 log(3/10) = −10 dB less, or 80 dBp. The SPL will also be 10 dB less, or 75.8 dB. At the end of the 40-ft. long line, the WL and SPL are the same as at the branch end, since the studio is to have a noise level spectrum of NC-20, with an SPL of 34 dB at 250 hertz, the WL at the ceiling has to be:

$$WL = SPL + 10 \log V - 10 \log T - 29.5$$
$$= 34 + 10 \log 10^4 - 10 \log .5 - 29.5$$
$$= 47.5 \text{ dBp.}$$

Hence, in the 40-ft.-long line a duct-silencer with a dynamic insertion loss of 80 − 47.5 = 32.5 dBp at 250 hertz is required to achieve NC-20 in the studio (see FIGURE 3). ■

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ONE WAY NOISE REDUCTION for cutting rooms/tape copies; retains highs, rids hiss/surface noise & clicks/pops by a full 10-14 dB and costs $150 up per channel! **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**

FOR SALE: TWO (NEW) ELECTRO-SOUND ES-505C two-track, $2,650.00 each; one Spectra Sonics 502 w/amp, $180.00; one SS model 403RS power supply ±24V, $130.00; one SS model 400RS 24V, $125.00. **RM Sound & Co. Inc., P.O. Box 72, New Berlin, Wisconsin 53151.**

FOR SALE: DOLBY M-16, $7,800.00; 3M 206 2500' 2" w/reel & box, $20.00; 1", $10.00 (min. order, 10 reels). **Sound 80, Inc., 2709 E. 25th St., Minneapolis, Minn. 55406. (612) 721-6341.**

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FOR SALE: TASCAM 4-track 701, $1,900; Tascam 2-track 701, $1,500; dbx RM157, $950; Advent Dolby B, $175; custom consoles, $100 each; dbx 161 compressor, $215; other equipment available. Call: **301-933-9221 or write: Willow Mill Recorders, 2807 University Blvd. W., Kensington, Md. 20795.**

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- ★ SERIES "B" MIXING CONSOLE
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KING MODEL 800S TAPE WINDER (hub); pre-recorded tape winder, will wind either ¼ in. or 150 mil. widths; as new condition. Also used Rangertone resolver, as is. **Gary E. Taylor, Continental Film Productions Corp., P.O. Box 6543, Chattanooga, Tenn. 37408.**

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Inventors/Engineers

AMPEX AG-440 2-track w/console, $2,300; Scully 280-2 w/console, $2,600; Scully 280B-2 w/console, $2,995; Neumann VG-2 cutting rack containing: LV-60 power amp. GV-2A feedback amp, SI-1 circuit breaker, WV-1 monitor amp, plus new ES-59 head, all for $1,400. Contact Ron or Grant at: **Sound Recorders, 206 S. 44th St., Omaha, Nebraska 68131.**

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A FEW competitively priced used Revox A77 decks available. Completely reconditioned by Revox, virtually indistinguishable from new and have the standard Revox 90-day warranty for rebuilt machines. Satisfaction guaranteed. Example, A77 with Dolby, $675, plus shipping. Write requirements to **ESSI, Box 854, Hicksville, N.Y. 11802. (516) 921-2620.**

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WANTED: AUDIO CONSOLE (MCI, Spectrasonics, Electrodyne) 8/8 or larger). Must be in complete working order, factory-assembled. **Gaff Productions, 1725 S.W. 17th St., Ocala, Fla. 32670. (904) 732-4585.**

EMPLOYMENT

POSITION DESIRED: Recording experienced on A.P.I. and Ampex. Career position desired; wiling to relocate if offer secure. References. **Mario J. Salvati, 271 Third Ave., West Babylon, N.Y. 11704. (516) 893-0266.**

FOR SALE

FOR SALE: STEREO DISC MASTERING SYSTEM, Neumann transistor VG66 amplifier rack; SX68 cutterhead; AM32b variable pitch and depth lathe, with Leitz microscope, playback arm, suction system and stylus microscope; 2 racks with 2 Pultec EQPI-A; Fairchild 670 limiter, 2 in. oscilloscope, complete TRS jackfield, control panel with program and preview metering and controls; 2 Fairchild 688 amplifiers and 2 KLH4 speaker. Console with Ampex 300 deck, advance heads and 4 solid-state playback preamps. Best price over $25,000. **Caedmon Records, 505 Eighth Ave., New York, N.Y. 10018. (212) 594-3122. Attn: Dan Wolfert.**

AMPEX SERVICE COMPANY: Complete factory service for Ampex equipment; professional audio; one-inch helical scan video; video closed circuit cameras; video systems; instrumentation and consumer audio. Service available at **2609 Greenleaf Avenue, Elk Grove Village, Ill. 60007; 500 Rodier Dr., Glendale, Ca. 91201; 75 Commerce Way, Hackensack, N.J. 07601.**

BODE FREQUENCY SHIFTERS since 1963 . . . Advanced designs for electronic music studios and high quality P.A. systems. New real time performance, synthesizer compatible model (patented features): $995.00. Anti-feedback and special effects model with variable frequency shifts, down to 0.5 Hz.: $575.00. Prices f.o.b. North Tonawanda. Delivery: stock to 6 weeks. For details and information on other models, write to: **Bode Sound Co., Harald Bode, 1344 Abington Place, N. Tonawanda, N.Y. 14120. (716) 692-1670.**

INFINITY SS-1 SPEAKER SYSTEM, $1,200.00; Audio Research amplifiers: D76, $700.00, D51, $450.00. **(516) 889-3777.**

DYNACO RACK MOUNTS for all Dynaco preamps, tuners, integrated amps. $24.95 postpaid in U.S., $22.50 in lots of three. **Audio by Zimet, 1038 Northern Blvd., Roslyn, N.Y. 11576. (516) 621-0138.**

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DYMA builds roll-around consoles for any reel-to-reel tape recorder. **Dyma Engineering, Route 1, Box 51, Taos, New Mexico 87571.**

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TASCAM REVERBS—$500; Tascam mixing consoles—$2,350; Tascam ½-inch recorders—$2,750; Tascam 8-track recorders—$4,600. All shipped prepaid/insured, including *free* alignment/equalization/bias/calibration. **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**

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TO-1 SPECIFICATIONS

Switch selectable frequencies:
30 Hz, 400 Hz, 1 kHz, 15 kHz
Balanced outputs:
+4 dBm and -56 VU into 200 ohms
Frequency response: ±0.1 dB
THD (total harmonic distortion):
less than 0.05%
Frequency accuracy: ±5%
Frequency stability:
2% for temp. 32-104 degrees F.
Source (output) impedances:
600 ohms ±5% at +4 dBm,
200 ohms ±5% at -56 VU
Current drain: 5 mA with 9V supply
Size: 7¼" x 2" x 1"
Weight: 6 oz. (169 gm)

Designed to feed a 600 ohm line at ±4 dBm, the TO-1 balanced output can feed any patch bay using a simple patch cord. A calibration curve supplied with the unit indicates the output level for other load impedances as well. An internal trim pot provides an additional variation of oscillator output.

For testing purposes, the TO-1 can be used as any other type of high quality audio oscillator with the additional ability to truly resemble a floating balanced signal source, with distortion and noise levels matching the best available microphone. It is a perfect substitute for any unbalanced signal source as well.

Since it is battery operated, it can be used as a portable test oscillator in practically any field situation. At its low price, it can be an indispensible tool in any studio, shop or station.

The TO-1 carries a 1-year warranty.

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• **Harold L. Kassens,** former assistant chief of the **FCC Broadcast Bureau,** has become a partner in the consulting engineering firm of **A. D. Ring & Associates** of Washington, D.C. Other partners in the firm, which was established in 1941, are **A. D. Ring, Dr. Frank G. Kear, Howard T. Head, Marvin Blumberg,** nad **Ogden Prestholdt.** Mr. Kassens is well known in the broadcast industry because of his activity in f.m. stereophonic and quadriphonic broadcasting, as well as his work in broadcast re-regulation and broadcast allocations.

• Hi fi veteran **Paul Miller** has joined **Maxell Corporation of America,** of Moonachie, N.J. as product/advertising manager. Mr. Miller comes from **Altec,** where he was product manager, and formerly served with Ampex and **Reeves Soundcraft.**

• **Arthur A. Schubert, Jr.** has joined **Ward-Beck Systems, Ltd.** of Scarborough, Ontario as director of engineering. Mr. Schubert served in the **CBS** television engineering department before coming to Ward-Beck. Previously to that, he worked in England as chief development engineer for **Neve Electronic Laboratories, Ltd.** In his new position, he will be responsible for engineering management in the design and production of Ward-Beck audio consoles and related products.

• The 117th Technical Conference and Equipment Exhibit of the **Society of Motion Picture and Television Engineers (SMPTE)** will be held at the Century Plaza hotel in Los Angeles, September 28 to October 3. This will be the first year in which SMPTE will hold only one conference instead of two in order to consolidate costs to exhibitors. For information, write to SMPTE Conference, 862 Scarsdale Ave., Scarsdale, N.Y. 10583.

• **RCA International, Ltd.** has established a new regional office in the London, England area to service the European and African markets. The office will be headquarters of Commercial Communications Systems—Europe, Middle East, and Africa. It will be located at Lincoln Way, Windmill Rd., in Sunbury-on-Thames. **Patrick J. Murrin** has been designated vice president in charge of the new facility.

• A new northeastern regional office, based in Boston, has been established by **Electro Sound, Inc.** The office will be headed by sales manager **Joseph C. Ciccone.** His territory will include all states from Virginia on the south to Canada on the north, and west from the Atlantic seaboard through Pennsylvania. He will also service Canada west to Toronto. Mr. Ciccone comes to Electro Sound from the **Data Packaging Corporation** and was also associated with **RCA.**

• **Charles Trausch** has been named midwest manager for **Capitol Magnetic Products,** a division of **Capitol Records.** His responsibilities include the sale of music tape and professional products manufactured under the Audio label. Mr. Trausch has been with Capitol since 1970 and previously was associated with **Totel Systems.**

• **CCA Electronics Corporation** of Gloucester City, N.J. has announced the appointment of **A. W. Trueman** to the position of director of engineering. Mr. Trueman came to CCA from his own consulting firm. Prior to that he was with **RCA.**

• Three educational companies have been purchased by **International Audio Visual** of Van Nuys, Ca. from **Alco Standard** of Pennsylvania. The companies include **Standard Projector and Equipment Company, Electronic Systems for Education,** and **Educational Projections Company.** The combination of resources from the new companies will be utilized to produce new equipment for educational audio, such as a new l.e.d. device for transmitting video and audio information and new miniaturized audio systems.

• A decision has been reached by prestigious **A & M Records** to assign their long-term quad commitment to the CD-4 discrete record system. This came about after considerable experimenting with all three of the major quad systems. The nod to CD-4 by A & M is regarded by many in the industry as a major triumph for the discrete form as opposed to matrix quad.

• A ten week course in the art of multi-track recording is being offered by the **Recording Institute of America,** 6565 Sunset Boulevard, Los Angeles, Ca. 90028 at forty locations throughout the country. Students learn to operate equipment such as the control console, multi-track recorders, equalizers, limiters, noise reduction units, etc. and receive instruction in techniques of microphone selection and placement, patching, overdubbing, mixing and editing. The course features a two-week experience with live 16-track recording and mix down sessions.

• Focalizing customer services, **Bill Hamilton** has been appointed regional sales manager of the **Auditronics Systems Division,** of Memphis, Tenn. Mr. Hamilton will be based in Philadelphia. His duties will include providing assistance to recording studios with equipment, system design, acoustic design, and financing.

• Two subsidiaries of **Filmways, Inc.** of Los Angeles have been consolidated to form a new Broadcast and Sound Services group. **Broadcast Electronics, Inc.** of Silver Spring, Maryland and **Wally Heider Recording Studios** of Hollywood and San Francisco, Ca. will be unified under the same executive direction. The group will be headed by **Andrew Szegda,** president of Broadcast Electronics.

• **H. N. Larkin** has been appointed to the newly created position of vice president for marketing at the **Ampro Corporation,** of Willow Grove, Pa. Mr. Larkin comes from the **Control Design Corporation. Edward N. Mullin,** who has been with the firm since its inception, has been promoted to the position of vice president for engineering at Ampro.

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We pioneered the quarter-track format in multi-channel recorders and we've probably built more of them than all our competitors combined. We introduced the design philosophy of low level, high impedance signal processing in mixing consoles (the first first from TASCAM). And it worked.

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The true test of what goes on a tape is what comes off; quality is as much a matter of talent as tools. If you want professional quality and you're willing to work with a tape recorder to get it, take half the tape width for about half the price of a one-inch machine and see the Series 70 8-Track at your TASCAM dealer soon. For your nearest dealer just call (800) 447-4700. In Illinois: (800) 322-4400. We'll pay for the call.

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