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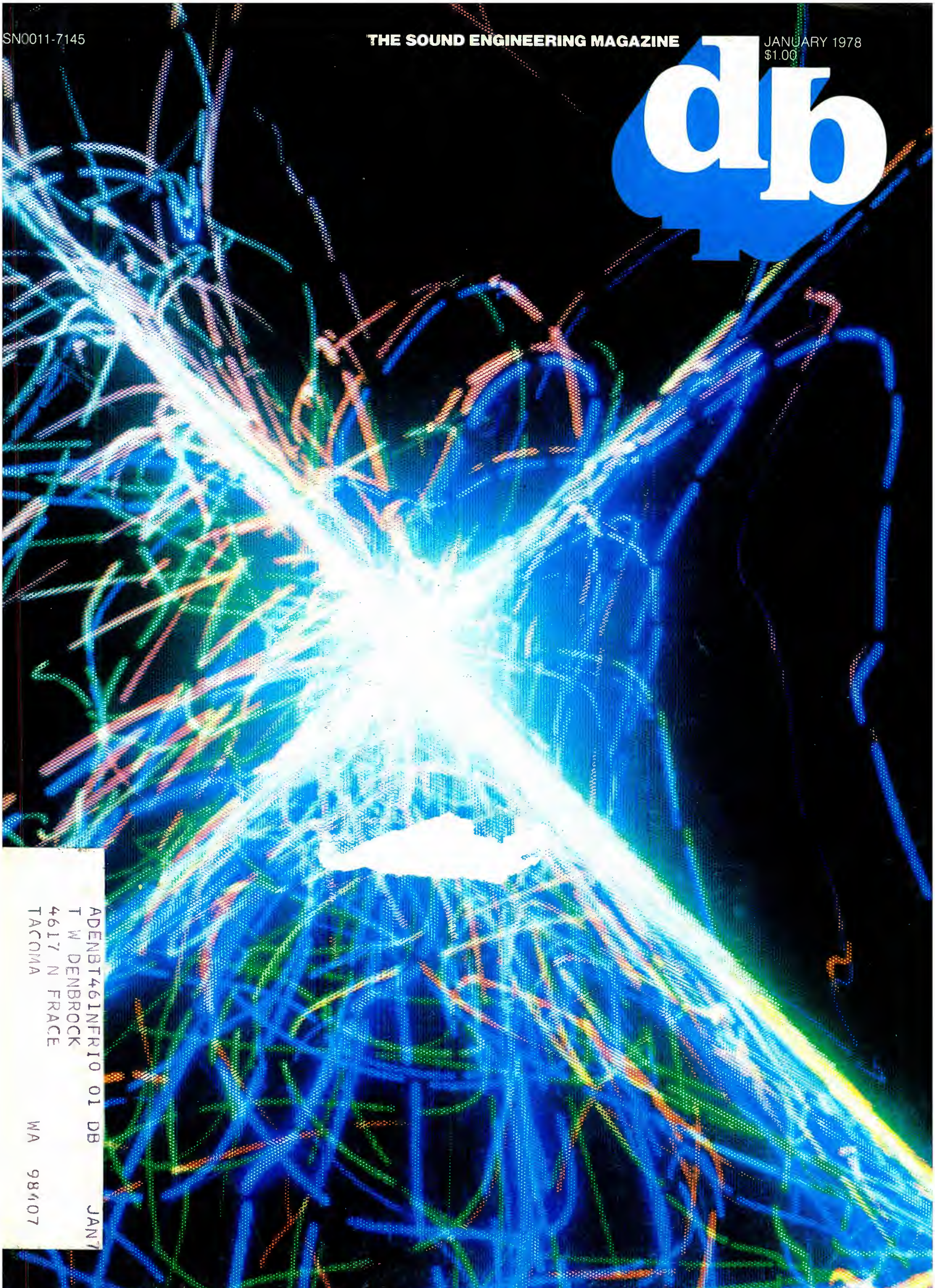

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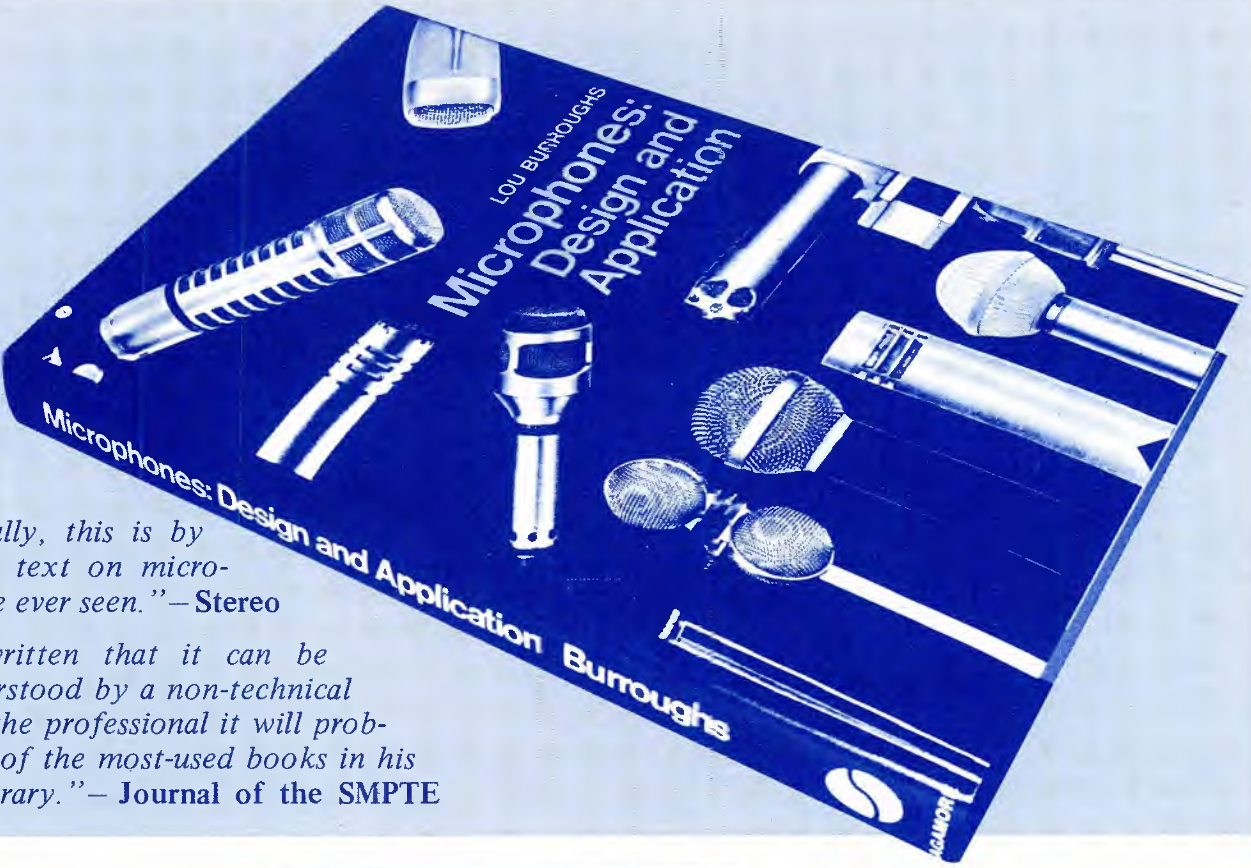

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Coming Next Month

- Education is the special topic of the February issue. We've assembled material from Irv Diehl and John Woram that will explore the kinds of educational opportunities in the professional audio field. This will include both private schools and those major institutions that offer degree programs.

  Don't miss this issue.

- And there will be our regular columnists, Norman H. Crowhurst, Martin Dickstein, Patrick S. Finnegan, and John Woram. Coming in **db**, The Sound Engineering Magazine.

About The Cover

- The Technics by Panasonic people have been demonstrating quad to consumers wtih a large screen four-channel vectorscope made from a color c.r.t. that has been mis-converged. The resultant display was photographed for us by them to illustrate this special four channel issue.

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23-25 **Management Seminar.** Houston, Texas. Sponsored by New York University. Contact: Ms. Heidi E. Kaplan, Information Services Manager, New York Conference Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

24-27 **Modular VTR Workshop.** Contact: Smith, Mattingly Productions, Ltd., 515 Kerby Hill Rd., Oxon Hill, Md. 20022. (301) 567-9265. Workshop at above address.

FEBRUARY

3-4 **SMPTE Television Conf.** Sheraton-Atlanta Hotel, Atlanta, Ga. Contact: SMPTE T.V. Conference, 862 Scarsdale Ave., Scarsdale, New York 10583. (914) 472-6606.

6-8 **NYU Management Seminar, "Increasing Productivity in Manufacturing,"** Los Angeles. Ca. Contact: Heidi E. Kaplan, Dept. 14NR, New York Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

13-15 **NYU Management Seminar, "Project Management for Engineers,"** San Francisco. Contact: See above.

14-16 **Synergetic Seminar,** Seattle, Wa. Sea Tac Red Lion, 18740 Pacific Highway S. (206) 522-1533 or contact: Synergetic Audio Concepts, P.O. Box 1134, Tustin, Ca. 92680.

13-15 **NYU Management Seminar, "Management of New Technology Projects,"** Los Angeles. Contact: See above.

15-17 **Smith-Mattingly Workshop, "Electronic Editing,"** Smith-Mattingly Productions, 515 Kerby Hill Rd., Oxon Hill, Md. 20022 (Washington, D.C. area) (301) 567-9265.

17-19 **Midwest Film Conference.** Marriott O'Hare Hotel, Chicago, Ill. Contact: 10th Annual Midwest Film Conference, P.O. Box 1665. Evanston. Ill. 60204.

22-24 **Synergetic Audio Seminar,** Holiday Inn, 1101 Shoreway Dr., Belmont, Ca. 94002. (415) 846-0550 or contact: See above.

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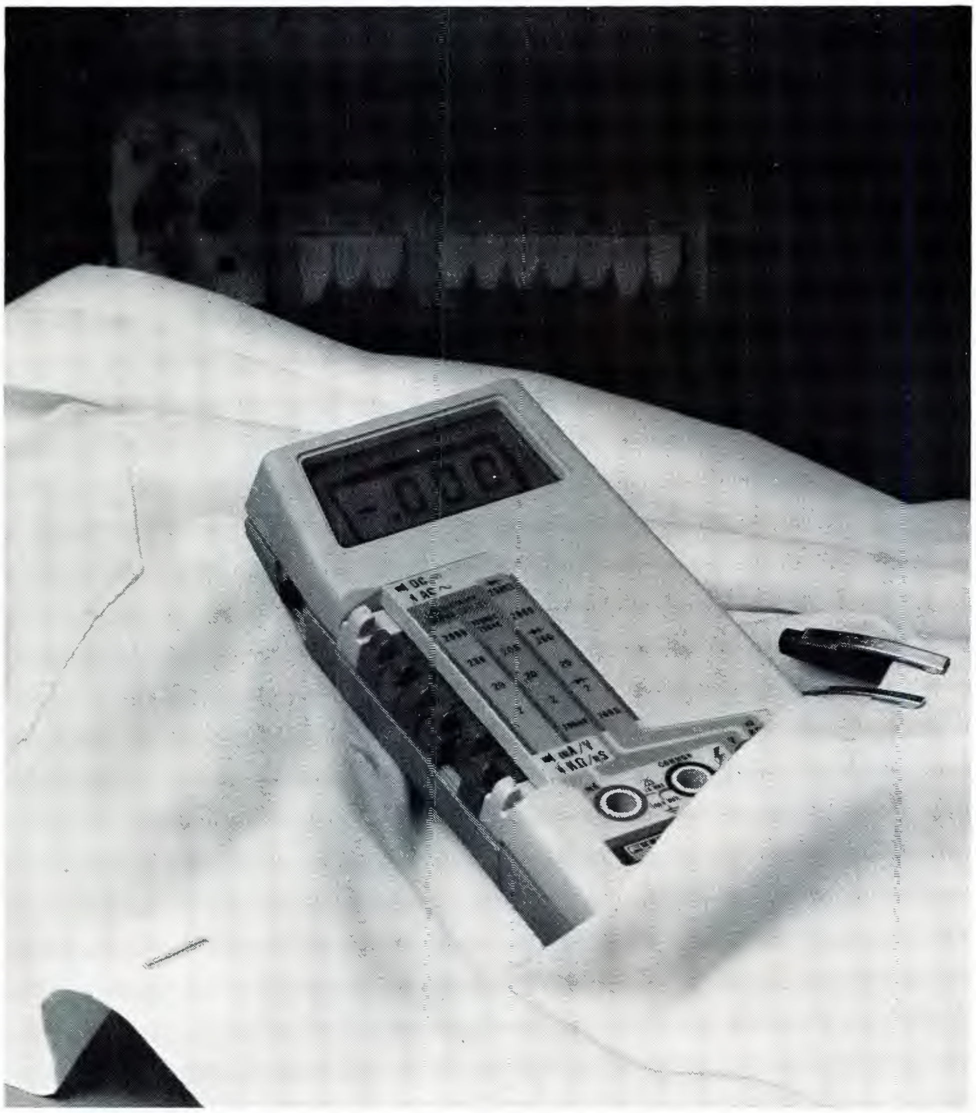

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27-Mar 1 **NYU Management Seminar. "Effective Communications for Engineers,"** Chicago. Ill. Contact: See above.

28-Mar 3 **A.E.S. Convention,** Hamburg. Germany. Congress Center. Contact: A.E.S., 60 E. 42nd St., New York, N.Y. 10017. (212) 661-2355 or Dr. Joerg Sennheiser, Sennheiser Electronic KG. Postfach 3002. Wedemark 2. Germany.

MARCH

1-5 **Hobby Electronics Fair,** Anaheim Convention Center, Anaheim, Ca. Contact: A. Kozlov, 222 W. Adams St., Chicago. Ill. 60606. (312) 263-4866.

1-3 **NYU Management Seminar, "Managerial Skills for the Developing Manager,"** New York City. Contact: Heidi E. Kaplan. Dept. 14NR, New York Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

15-17 **Smith-Mattingly Seminar, "Multi-Camera."** Smith-Mattingly Productions, 515 Kerby Hill Rd.. Oxon Hill, Md. 20022. (301) 567-9265.

17-19 **Intercollegiate Broadcasting System Convention.** Biltmore Hotel, New York City. Contact: Convention Committee, c/o IBS, P.O. Box 592, Vails Gate, N.Y. 12584. (914) 565-6710.

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Audio Transients

• The program audio signal can meet with many mishaps which can distort the signal on its journey through the audio system. Some of these distortions also produce side effects that will further degrade the audio. One such side effect is transient distortion that can be added to the signal. Transients can be created by a number of conditions or by some operating practices, such as signal peak clipping. This month we will take a look at this type of transient and ways it can affect the operation.

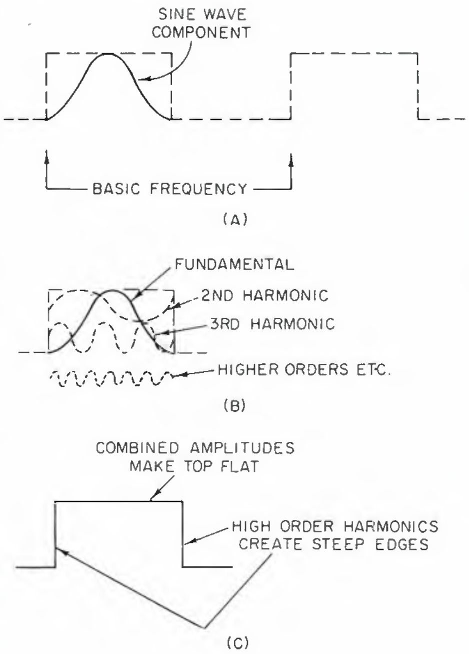
THE SQUARE WAVE

Perhaps we can better understand the audio transient if we consider it from the viewpoint of square waves and the behavior of these pulse signals in a system.

The square wave is a pulse signal that is very rich in many related signal components. These cover a wide frequency range from d.c. to many times the basic frequency of the pulse. The basic frequency of a pulse signal is its repetition rate, which can be reduced to a sine wave signal with the proper filtering.

The perfect pulse is a gold mine of harmonic signals that have the proper phase and amplitude relationship to the fundamental sine wave of the pulse. The great number of harmonics present give rise to the steep leading and trailing edges of the pulse. When phasing is correct, then so is the waveshape of each of these harmonics. All of the amplitudes will combine with the fundamental sine wave to produce a perfectly flat top to the pulse. Since the pulse amplitude does not change during the time of the flat top passage. this flat top represents a d.c. component in the signal.

Figure 1. The square wave is made up of many related signal components.



THE CIRCUIT PATH

If the pulse is to retain its shape and amplitude, each frequency component of the pulse must see the correct impedance, and there must be no phase shifts among the various components in the pulse. It is quite obvious that a pulse signal places tremendous demands upon every circuit or stage through which the pulse passes. How well the circuit can accomplish this is really a figure of merit for that circuit. This is why square wave testing of non-pulse type circuits, such as audio circuits, is popular in some quarters. The pulse signal as it appears at the output of an amplifier or a system can indicate many factors about that system. all at the same time.

But to be more specific, beginning at the very low end of the frequency spectrum, the circuit must be able to pass the d.c. component (flat top) or the pulse will be tilted. As we move up the spectrum to the lower frequency component. if the circuit response is poor, the top of the pulse may be either rounded or cupped—depending upon the circuit conditions. When we get to the upper limits of the system bandpass, this will determine how many of the harmonic components will pass. Removal of a number of these harmonics will round off the leading and trailing edge of the pulse. If phase shifts also occur. this leads to transients.

THE PULSE TRANSIENT

Although the impedances the various components of the pulse "see" enter into the results, perhaps the largest factor in producing transients is phase shift.

When phase shifts are different for different harmonics, they move from their normal positions in the pulse and the individual shape of the harmonic also changes. The disturbed harmonics tend to pile up at the leading and trailing edges of the pulse and

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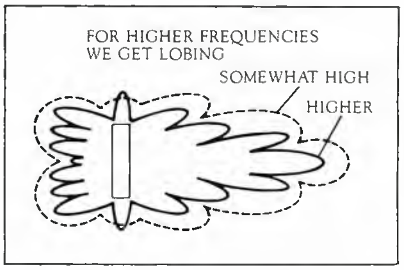

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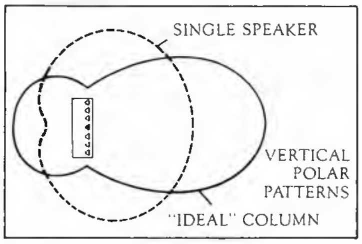

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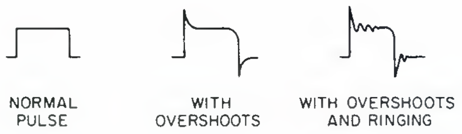


Figure 2. A transient appears as an overshoot, sometimes wtih ringing.

produce large overshoots at these two edges. The overshoots may be followed by an oscillatory waving of the pulse top that appears similar to a damped wave. This particular aspect is called *ringing*.

The amplitude of the overshoot can be rather high in relation to the normal pulse amplitude. Just how much greater the amplitude is depends upon the factors creating the transient. In some cases, the overshoot amplitude can be several times that of the pulse.

All the foregoing has been a rather simplified explanation of pulses and what can happen to them as they pass through a system. The actual process can be demonstrated more accurately by complicated mathematics. Suffice to say that it is difficult to pass pulse signal through *any* electronic system —even those designed for pulse! And needless to say, the audio system is designed for audio signals—not pulse.

AUDIO TRANSIENTS

Although the audio system is not designed for pulse, the system is often called upon to pass pulse-like signals. This can happen inadvertently when the system lacks headroom, for example, and the signal peaks become clipped. In some operational practices, signal peaks are deliberately clipped, for example, when peak limiters clip signal peaks to prevent the overmodulation of the transmitter.

Whatever the reason for the peak clipping, the clipped signal peak becomes a square wave-type signal. Once created, this clipped signal will have most of the same characteristics as the square wave and places the same demands upon the system.

TRANSIENT RESPONSE

A term appearing more often these days in equipment specifications is *transient* response. This term refers to the equipment unit's ability to pass a variety of audio signals, and more specifically, square wave signals, without creating transients.

To pass a square wave the equipment must have a superior response curve that starts at d.c. and extends far up the frequency spectrum—all without phase shift. Actually, the equipment designer has many other conditions to consider in the design besides transient response, keeping in mind that the finished unit must also be commercially competitive. So consequently, the finished unit will involve many compromises. This does not mean that it is a poor unit; it only means that it isn't perfect. As far as transient response is concerned, the unit may have either a good or a poor transient response characteristic, depending upon what compromises were made to arrive at the finished product.

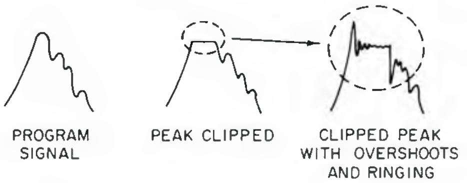


Figure 3. The clipped signal peak takes on the same characteristics as the square wave.

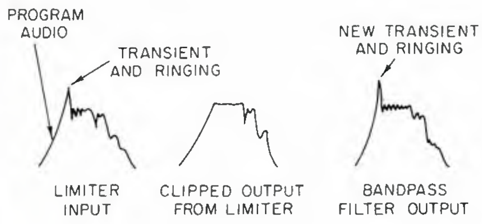
Aside from compromises in equipment design, the manner in which the equipment is operated in the broadcast chain will also have a direct bearing upon transients that may appear in the reproduced program signal. An equipment unit that does not have a good transient response characteristic, for example, will not produce transients if we don't try to force that unit to pass square wave type signals!

HOW IT HAPPENS

When signal peaks are clipped, the signal is automatically distorted since it no longer has its original shape, and intermodulation distortion can also occur. The clipping also creates many harmonics that are related to the frequency or frequencies of the signal peak that is clipped. Along with these harmonics, another component is added to the signal—a d.c. component. Aside from the initial distortions, every circuit from this stage onward must have excellent transient response if further degradation of the signal is to be avoided.

Much depends upon where the clipping is taking place in the system. If this is in an early unit of the system, then the transients can be amplified, intensified, or reshaped as each following unit contributes its share of

Figure 4. Limiter clippers can remove the positive overshoots, but filters can recreate them.



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Tape Speed: 15 ips

Line Input: −10 dB (0.3V) impedance: greater than 20K Ohms, unbalanced*

Line Output: −10 dB (0.3V) load impedance: greater than 10K Ohms, unbalanced*

Record Level Calibration: 0 VU referenced to 3 dB above 185nWb/m tape flux

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Overall Frequency Response, Sync Mode 40 Hz – 18 KHz, ± 3 dB

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Distortion 1% at 1KHz, 0 VU

Cross Talk greater than 45 dB at 1000 Hz

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*optional + 4/600 ohm balanced kit available

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phase shifts and impedance irregularities. By the time the signal arrives at the transmitter, the transient may be rather severe. Perhaps we may feel confident that the peak limiter and the system bandpass or bandpass filter will remove the transients and the harmonics, so there is little cause to worry. Not so! The bandpass filter (if used) can in itself further intensify the transient. To be sure, the peak clippers will lop off the transient overshoot and thus produce a nice, but very flat top, square signal peak again. When that squared peak hits the bandpass filter in the stereo generator, for example, that filter can *recreate* the very transients we thought were removed! These *new* transients will now cause overmodulation of the transmitter. Our "final filter" simply sowed the seeds of its own undoing.

AT THE TRANSMITTER

Transients can affect the actual transmitter modulation as well as the modulation monitor indications. When the limiter clips signal peaks, the stages which follow those clippers and the audio section of the a.m. transmitter or the stereo generator of the f.m. station must have excellent transient response. If they do not, transient overshoots that may be typically 2 or 3 dB higher than the signal peaks

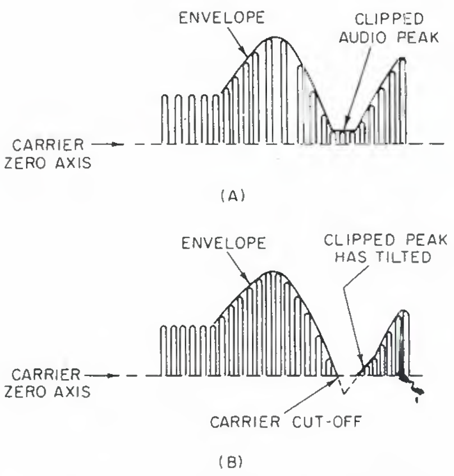


Figure 5. The flat top of a clipped peak can tilt and overmodulate the a.m. carrier in the negative modulation direction. (Only the upper half of the modulated waveform is shown.)

will occur. Two dB is approximately 20 to 25 per cent modulation. If the levels are such that the normal peak will produce 100 per cent modulation, this added 2 dB overshoot will push the true modulation to 125 per cent. But unless there are several of these peak overshoots in quick succession, the modulation meter will not indicate the true modulation because of its characteristics. The peak flasher however, will catch the overmodulating peaks. All this may have the operator wondering what is wrong with the monitor. To keep the flasher from indicating overmodulation, he might pull back the signal level to the transmitter so the peaks indicate about 80 per cent on the modulation meter. The transient in this case is actually robbing the system of 2 dB modulation capability for its program signal!

TILT

The clipped signal peak also contains a d.c. component that must pass through the audio stages and modulator in the a.m. transmitter, for example, or the flat top will tilt. To pass the d.c. component, the stages should all be d.c. coupled—but very few are. Although the operator may have the transmitter modulator set up for tight 99 per cent negative peak modulation, the clipped peak may tilt and push this past 100 per cent modulation and carrier cutoff. This can produce channel "splatter" and spurious radiations.

NEW EQUIPMENT

The new breed of transmitters and stereo generators today have a better transient response than their predecessors. Designers are now aware of the effects of transients in signal degradation and modulation. The Harris MW-1 all solid state a.m. transmitter, for example, uses d.c. coupling of the audio stages and no modulation transformer. On the f.m. front, the Orban stereo generator is actually a combined automatic gain control limiter/stereo generator in one unit, all designed as an integral unit—and thereby achieves superior transient response. Still other units contain "soft" clippers in limiters. These clippers produce less audible distortion on the air than "hard" clippers.

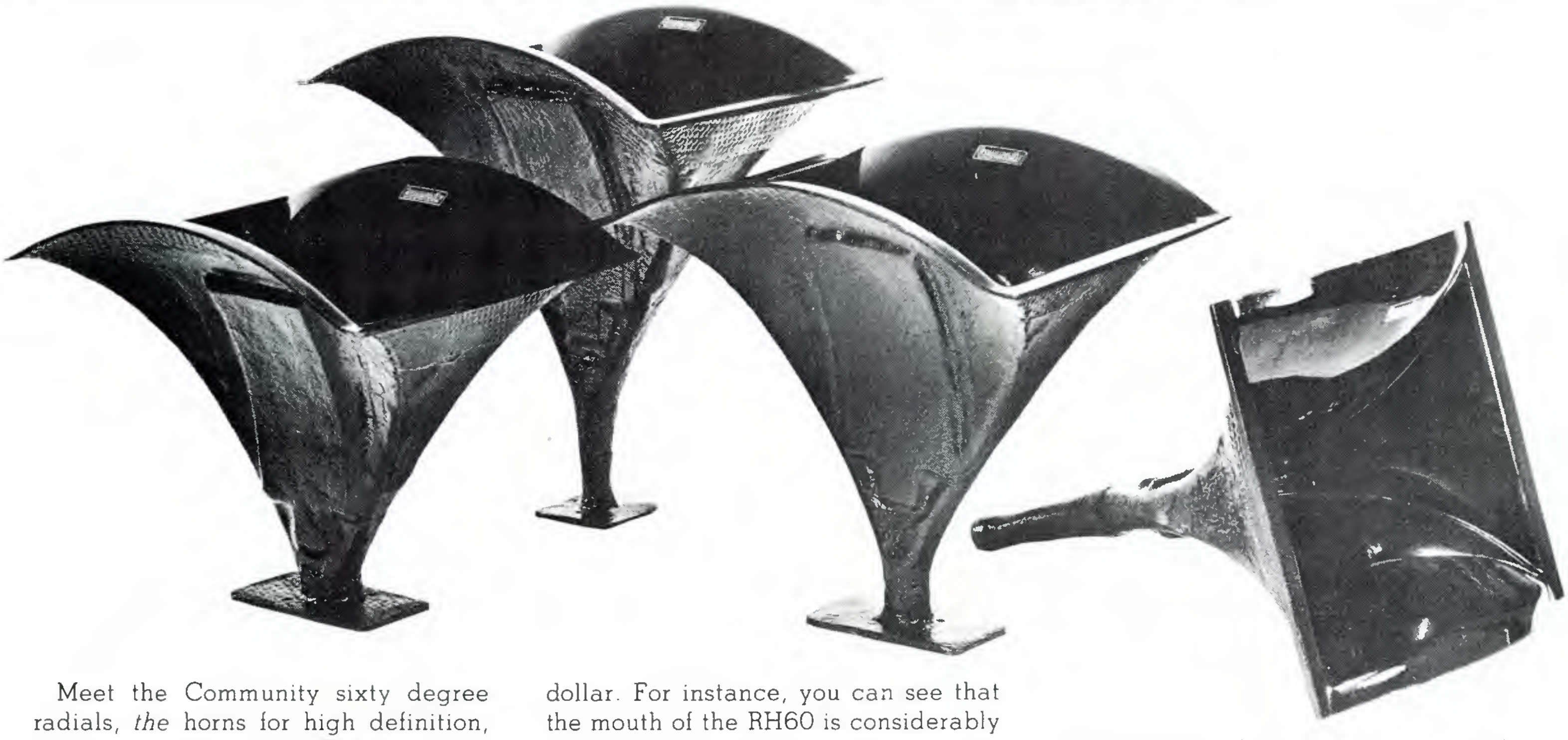
OTHER TRANSIENTS

I don't want to leave the reader with the impression that peak clipping is the only way in which transients can be created. Transients can be caused by parasitics, spurious oscillations, intermittent positive feedback, rfi feedback, and a host of other factors. But with signal clipping a very predominant part of many signal processors today, this is perhaps the largest cause of audio transients.

SUMMARY

The clipped signal peak has most of the characteristics of a square wave signal, and places the same demands upon system performance in terms of transient response. Transient overshoots can cause overmodulation or rob the system of program modulation capability. If you must clip—clip with care! ■

RH60 RADIAL HORNS



Meet the Community sixty degree radials, *the* horns for high definition, understandable sound. The horn pictured is our RH60, the midrange mainstay of the large system. We've recently added two new sixty degree horns to our line for HF and VHF projection, the SRH60 and the SQ60.

Some people still think that our horns and cabinets look a little strange, perhaps not realizing that at Community shape and construction are determined by the laws of physics, not marketing, packaging or the almighty dollar. For instance, you can see that the mouth of the RH60 is considerably taller than that of comparable sixty degree horns. Why? Well, if a horn is to act as a wave guide at its lower operative frequencies (which it is) it must have a tall mouth to support the larger wave forms generated near crossover. The idea of a thin, wide-mouthed radial may be pleasing in terms of packaging and handling, but it is a convenience that does not pay off in operation. Some conveniences that do pay off in operation are one-piece construction, low resonance, high strength-to-weight ratios and the meticulously executed design that characterizes a Community horn.

Would you like more information? We recently published a catalog which details the performance of all Community products. Already it has been called a must for anyone wishing to design a sound system on a professional level. Please write or call to order.

RESPONSE AND SPL

RH60-A DRIVER: **GAUSS HF4000** — BANDWIDTH PINKNOISE: **250Hz-16KHz**
1 Watt @ 1 Meter **107.24** dB-SPL — 1 Watt @ 4 Feet **107.28** dB-SPL

SRH60-B DRIVER: **ALTEC 288.16G** — BANDWIDTH PINKNOISE: **350HZ-16Hz**
1 Watt @ 1 Meter **108.99** db-SPL — 1 Watt @ 4 Feet **105.52** dB-SPL

SQ60-C DRIVER: **EMILAR EA. 175.16** — BANDWIDTH PINKNOISE: **800Hz-16KHz**
1 Watt @ 1 Meter **103.85** dB-SPL — 1 Watt @ 4 Feet **102.14** dB-SPL

Frequency	RH60-A	SRH60-B	SQ60-C
40 Hz			
50			
63			
80			
100			
125			
160			
200			
250	−12		
315	−7		
400	−6	−10	
500	−4	−6	
630	−3	−4	
800	−1	−2	−6
1K	0	0	−2
1.25	+1	0	−2
1.6	−1	0	0
2.0	−2	0	0
2.5	−1	0	+2
3.15	−3	−2	0
4.0	−5	−2	0
5.0	−5	−4	0
6.3	−9	−8	−2
8.0	−9	−8	−2
10.0	−9	−6	−5
12.5	−13	−10	−12
16.0 KHz	−17	−12	−16

Community

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NORMAN S. CROWHURST

Authentic Reproduction

• Last month, under the heading *Faithful Reproduction,* I discussed different views that have developed over the years about what that means. In this context, *faithful* conveys the thought of accurate, flawless. From the discussion last month, it becomes apparent that perfect accuracy of audio reproduction is an impossibility, using any method.

The word *authentic* means convincing, capable of being believed, or genuine. What reproduction has to do is to convince our ears, or more accurately, our hearing faculty, that we are listening to the real thing. Last month's discussion should have convinced you that you cannot ignore the environment in which you want the reproduction to do its convincing.

So let us now turn to how you can go about creating a pleasing result in different environments. In every instance, first you must consider how you normally listen in that situation. In some instances, you may wish to change the environment to some extent, but usually people just want to buy a hi-fi, a stereo or a quad that will do what they want, in their room as it exists.

Let us take the easy settings first. In a well furnished room that is acoustically relatively "dead," you listen in a relaxed manner. Unless you are hard of hearing, you never have to strain to hear, or understand, what someone says in such a room. The background is quiet and whatever you want to hear comes to you unconfused—directly. Listening is a pleasure.

This is the room in which the idealized "faithful" reproduction comes nearest to being fulfilled. So to serve this room, you want sound sources—loudspeakers—that serve you directly. All the frequencies present in each channel of sound should radiate uniformly from an appropriately placed loudspeaker so that a listener in any part of the room gets a correct perception of the stereophonic nature of the original source to which he is listening.

If the room happens to be extra absorptive of the higher frequencies, you may want to use tone control, or equalization, to give this part of the spectrum a little extra emphasis. But this type of room should not present any problems in producing what we could call authentic reproduction.

Now let us turn to the difficult environments. In the larger variety of rooms, usually called auditoria—but they are rooms just the same—the sound man has always had problems. Modern technology has enabled him to solve them a little better. But how does he do it?

COLUMN LOUDSPEAKER

One of his best tools is the column loudspeaker unit. What does that do? Its main function is to put sound where you want it, which is where people are listening, and to avoid putting it where it is not wanted, which is where it would create undesirable reflections and their attendant confusion.

So you have the high school gym or the local armory hall with its lofty ceiling from which echoes of the original sound come bouncing down, after noticeable delay, to cause confusion. Of course, that's what makes the room sound like a gym, or an armory. But it also makes listening, especially to speech, very difficult.

If you listen to Stan Kenton playing at the local armory, then the sound is real: Stan Kenton's band, playing at the local armory. It does not need reinforcing, because Stan's band has plenty of acoustic output without artificial help. But when Stan steps forward to tell the audience something about the last number or the next number, the audience wants to hear what Stan says. They do not want to

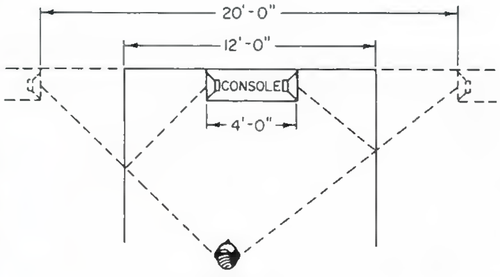

Figure 1. Reflective wall surfaces can be utilized rather than having to fight them. The actual distance between the left and right speakers is only 4 feet. The apparent distance between them, as perceived by the listener, is 20 feet.

hear his voice bouncing unintelligibly round the walls.

This is where the column speaker units are useful. By installing them where they direct sound at the audience seating and avoid shooting it at that lofty ceiling, they make possible a much more intelligible sound, at least. People like Stan, who perform on the road in a different auditorium every night or two, carry their own system with them.

They use column speakers, not because they are more convenient to tote, but because they do the job better, in the average difficult room. Stan's sound boys set them up, looking at the audience area to see that the audience gets served, and that the ceiling does not.

SMALLER ROOM

How does this apply to your much smaller room at home? If it is highly reflective, maybe column speakers could help you too. But there are other tricks of the trade that can sometimes help in the smaller, over-reflective, type of room.

What we have been emphasizing is that however you introduce the sound into the room by means of your loudspeaker installation, your hearing is already conscious of the room environment. As the old saying goes, "If you can't beat 'em, join 'em." And this certainly applies to acoustic environment.

One of the early console stereo arrangements did this, perhaps without realizing it, as far as the designer was concerned. The designer put the loudspeakers in the ends of the cabinet, so as to make a package that gave the "biggest possible" stereo—in terms of separation—in the smallest possible package.

But put this package in the middle of one of the shorter sides of a rectangular, highly reflecting room, and what do you have? Sound from the speakers on the ends goes out, hits the longer side walls and is bounced back in toward the listeners. What this does is to create image sources for the sound, beyond the walls. If the wall against which you put the console is 12 feet long, and the console is 4 feet, then the speakers are each 4 feet from the wall they face.

This means the image sources are 20 feet apart, along this 12 foot wall. This arrangement suits such a room because the reflections normal to that room make it seem bigger than it really is, anyway. Our hearing faculty judges the size of a room by its reverberation time. Reflecting surfaces increase reverberation, and thus reverberation time, making the room seem larger than it really is.

So that method uses a characteristic of the room, its reflections, instead of trying to fight them. The result is natural for that room, far more natural in fact than putting separate loudspeakers in the corners, although that may not have been what the designer had in mind when he put together that design.

That is one way to go. Another approach uses a different characteristic of such a room, its size. The way we just described uses the reflections that

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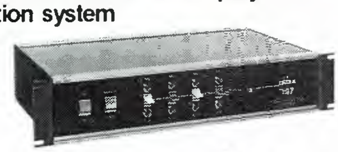

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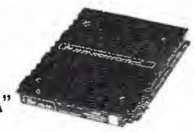

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make it seem bigger than it really is, to expand the apparent sound source. The alternative is to work on the directness of the wave—or rather, its apparent directness.

This emphasizes that, whatever we do, we are creating an "authentic" illusion. The problem in any room that has too much reflection is that indirect sounds confuse the direct sound. So if only we can direct the sounds at the listener and avoid the reflections, or at least minimize them, we will have it made—right?

Perhaps, if the listener would oblige by sitting in that one "ideal" spot that early stereo experimenters insisted upon. But most people want to sit where they like, not to be dictated to by an inanimate object. If we try to direct sound at every possible position where a person might sit, we find ourselves fighting reflections again because sounds that do not "find" a listener to absorb them, continue to be bounced around by the reflecting surfaces.

ISOPHONIC STEREO

Back in the early days of stereo, CBS Labs developed a system that they called "isophonic." That particular system used a single channel for the lowest frequencies, up to about 250 hertz, and separate channels for frequencies above that. The stereo illusion was due to the way those separate channels were used.

Instead of employing ordinary loudspeakers, the ones used had open backs, and their positioning was important. The technical papers that CBS presented on the subject explained how such a system produced a "correct" sound field for proper stereo separation around each listener's head. Let us explain that a little more fully; the reason this system never caught on more than it did, I believe, is because people just did not understand it.

Any sound man knows about ordinary phasing problems. If you apply monophonic program to two loudspeakers, spaced apart, and you occupy a suitable position, the sound will appear to come from midway between them. If you move your position, the apparent source will change. That fact was an early criticism of stereo. But let us not stop there.

If, while you stay in the position where the sound seems to come from midway, you reverse the phase of the sound fed to one of the loudspeakers, something peculiar happens. Now the sound no longer comes from in front, but its source seems to "get lost." If you now move around, as you get closer to one or the other speaker, the sound will seem to come from the nearest one.

That is using two loudspeakers, radiating out of phase. The open back loudspeaker is a single unit, radiating out of phase from front and back. So the sound field it creates in the vicinity of a listener's head is somewhat like that produced by two loudspeakers out of phase. But it is different because now the out-of-phase sources are close together, not widely separated, which means that the effect the double source produces is not confined to the special spot we discussed, relative to the widely separated case.

That is half the story. The other half is putting another such unit on the other stereo channel. Now the combined field from both of these dipole units creates a sound field around the listener's head that is a composite of that radiated by the individual units. It can and does create stereo separation at the listener's head.

It plays down reflected sound because this complex sound field is far stronger, to the listener, than all the confusion that develops a few milliseconds later. It is a completely different way of getting the desired authentic effect.

One argument used against the CBS system was that stereo separation disappeared below 250 hertz, or whatever crossover frequency was used for that purpose. That was a purely theoretical argument, with no foundation in practice. The fact is, in any room of the size in which such a system would be used, stereo separation of those low frequencies is impossible anyway.

The sense of location for instruments that include those low frequencies is not due to those frequencies at all. Try it, with string bass reproduction, for example. CBS demonstrated it with that kind of program, but not enough people listened to the demonstration. The overtones gave the sense of location and the low frequency part was convincingly—authentically—conveyed as being where the rest of the sound appeared to come from.

You do not have to get a CBS isophonic to do that job. Any open-backed loudspeaker can be used in the same way—or rather, a pair of them.

And what about quad? This would be interesting to pursue. The main purpose of the "rear" speakers is to reproduce ambience. This changes our expectations of them. Before quad was introduced, some experimented with creating artificial ambience, by feeding delayed signal to the front units (since that is all there was) out of phase. It was more convincing than you would expect. ■

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MARTIN DICKSTEIN

db Sound With Images

• Although the Season of Lights has come to an end, the field of lighting has expanded to an enormous extent through their application in discos and similar establishments, and the same can be said of sound. At a recent conference in New York, Disco III, run by *Billboard Magazine,* equipment to boggle the mind through both eye and ear was demonstrated. Just a look at random, with no special order of appearance, might give an idea of what's available for whatever situation anyone might have in mind. Please be aware that mention here in no way indicates personal or **db** preference of one over another, nor is this any advertisement for the described systems.

LIGHTS FANTASTIC

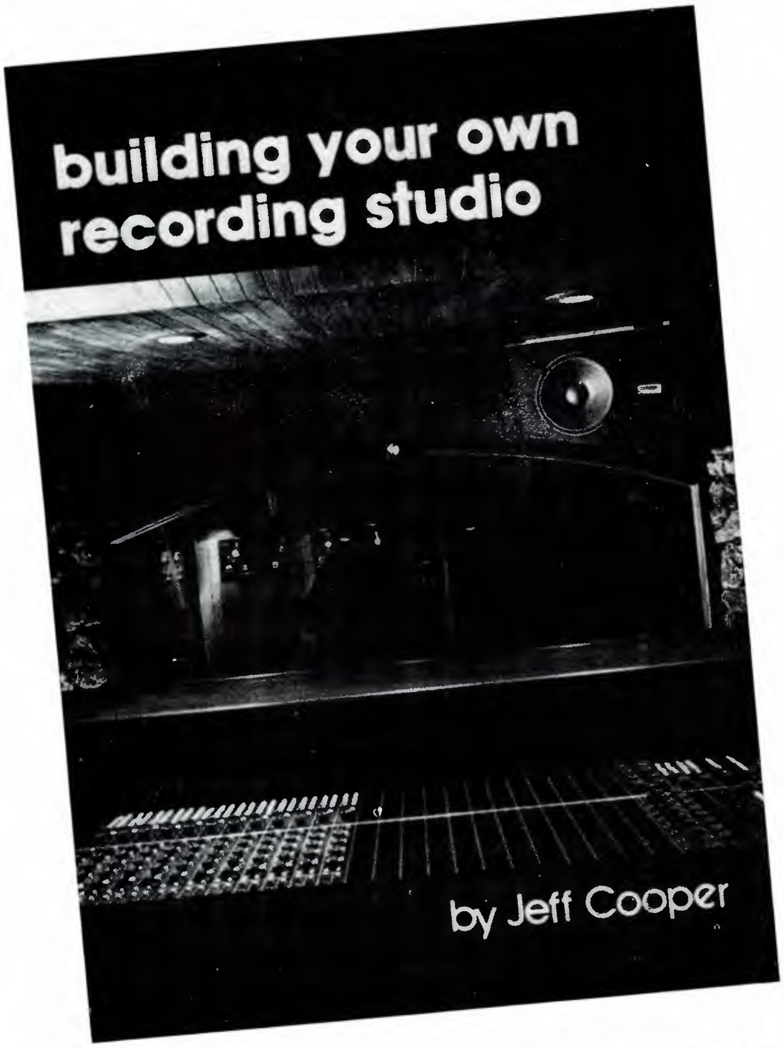
Starting in the light, a company called Lights Fantastic showed a projector using a 250-watt tungsten-halogen lamp with an output of 600-plus lumens per square foot. The unit itself acts as a light source, and the mounting on the front permits setting up a range of lenses and effect-creating attachments. For example, a liquid and animation wheel can be rotated at ½ rpm to make slowly moving blending effects appear on the walls or ceiling. A color splode, a two-cell tank with two different colored liquids, can also be attached. A small pump agitates the liquids and creates color patterns, pulsating with the music but with no direct link to the sound. Combinations of blue, red, and yellow are available. Whirling bands of color can be created by another attachment consisting of a set of color cogs which are intermeshed and rotated by a high speed motor. There's also an attachment to allow three effects to be mounted at the same time with a built-in electronic timer controlling the time lapse between effect changes. Each of the effects can also be set for any time desired between 20 seconds and 15 minutes. Additionally, a prism lens is available for multiple overlapping images made to rotate within themselves and around a central axis.

MOIREMATIC

A British company called Moirematic makes use of a similar projector and provides the front end devices for additional effects. A ColourFlash attachment adds alternating movement of flashing colors, and the Colour-Change unit blends moving colors slowly for a dream-like effect. A series of slip-in discs is available to create such effects as squares, dots, triangles, lines and ovals, which can rotate and move horizontally.

One of the most widely used effects in the disco field comes from a laser light. By manipulating the movement and the patterns these brilliant color emitters can produce, the operator can create an immensely dramatic light-with-sound presentation. There is also equipment which can operate by itself, without manual control, to create programmed effects around the area. Laser Physics, for example, in establishing the system for the latest

FINALLY!!



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Please allow 4 to 6 weeks for delivery disco in New York, uses a remote control system for a setup of lasers hidden behind mirrors hanging over the bar and using an optical scanner driven by an optical cable source. Various other companies are also involved with supplying lasers and modulators for sound-to-light effects.

One requirement for any laser system to be acceptable is that it must conform to either state or federal regulations. Lasers are known to be powerful enough to burn holes in anything they concentrate on. For laser systems in discos, the power of the beam must be cut way down. There is still, however, a controversy as to whether the low level of the beam can cause any damage to the human body. The contention is that the beam, as weak as it may be, can still damage the eye by destroying the optically sensitive cells in the cornea in a direct hit. This also holds for reflection from sequin dresses, jewelry, etc. To avoid this, of course, the dancers must not wear reflective clothing or accessories, and must never look up at the source of the light beams. There would be no pain in the damaged area, and the lesion would be small, but future sensitivity would be seriously affected.

New York State, the only one to establish safety requirements, maintains that each laser light operator of a unit over 1 watt must hold a certificate of competency, diagrams must be provided by the performing group using lasers of the path of the beam of each layer, proper alignment of the optics and scanning beam pattern must be verified, no beam in the 400-600 nanometer frequency range shall strike the audience nor shall any reflective surface be in the path of the beam of this wavelength to deflect it toward any occupied area. The laser system must have two interlocks to turn off the beam if the scanning system fails, the laser and beam must be in continuous view of the operator, and must be turned off by the operator (and the key removed) when he leaves the operating area.

SNAKE LIGHTS

Strobes are old hat to most people, but other flashing devices have made the scene. Snake lights, for example, by LaTec International (a division of Musical Instrument Corp. of America) makes flexible plastic tubes 16 feet long containing 84 lamps wired to four separate channels. With any of the many multi-channel programmers and control units available, the lights appear to follow each other along the tube. Any shape and any length can be set up to include up to 25 individual snakes.

Various companies produce the software used with the effects projectors. The discs that rotate in the motorized front ends of the many projectors available come in many colors, patterns, and images. These same companies also produce various other devices for creating special effects. For example, catalogues contain specs on rotating lights, similar to police units, bubble machines, fog machines, and a myriad of others.

Other special light-including accessories can also be found. Whole dance floors can be made up of sections, each containing lights covered with a strong plastic transparent top that acts as the dance floor. Sections are connected together and can be programmed like any other light show. Another item containing lights is manufactured by Swivelier, who make a panel with fiber optic clusters. These can be used as table tops or hung on a wall. The source is a single bulb, but the effect can be of changing patterns and colors that vary every second. And let's not leave out the hologram. The Holex Corp. has a com-

plete catalogue of these images that can be purchased according to the type desired. There are transmission holograms and reflection holograms, the former illuminated by light from behind (transmitted light), and the latter by light from the front (reflected light). There are also different types of images. The virtual image, for instance, appears to be behind the hologram; the real image appears to be in front of the hologram. With an image plane, the image appears to be surrounding the surface of the hologram. Such descriptive titles as Shark, Racing Cars, Bat, Flying Saucer, Monsters give one an idea of the possibilities. There are also movies, brief to be sure, with titles like Train (train coming out of a tunnel), Tetra (a computer generated three dimensional hologram), and Goldfish Bowl (which has a fish swimming forward—and backward).

LOVELINE

An interesting sound-related system was also described at Disco III. Called Loveline, the system consists of a phone hookup, with a red instrument on each table. To call someone at another table, just dial the number of the lighted ball over the called table. The other phone will ring, and the phone conversation remains private. A variation is to replace the ringing bell with a flashing red light. The manufacturer is Intercommunications, Ltd.

An unusual sound transmitting device was also on display. Called Soundsphere, and made by Sonic Systems, Inc., the unit is actually a sphere with small speakers located around the ball at carefully selected positions and a spherical distribution pattern. Power handling can be 250 watts with an impedance of 4 ohms; frequency response is 35 Hz to 20 kHz, maximum sound level is 128 dB at 4 feet with 100 watts.

According to the list of exhibitors, there were 89 "non-sound" booths, and fifteen sound rooms. Among the lighting booths were such names as Blackstone Productions, creators of polarized animated slides and "atmospheres" with multi-image presentations; AVL, multi-image programmer devices; Span Engineering, holograms; Edmund Scientific Co., unique lighting and special effect devices; Digital Lighting; Soleil Laser Entertainment; Selectrocution, Ltd., audience participation games for singles; and Package Lighting Systems, lighting instruments and illuminated dance floors. Among the sound names were Sigma Sound Studios, Rosner Sound, Technics by Panasonic, Portman-Shore Electronics ("Sound Sweep" device), Altec, and Cerwin-Vega.

All in all, it was quite an eye and ear opening (or closing) show. One interesting sideline to the light and sound business is the application in the newest craze, the roller skating rink. Although the lighting can be similar to the disco effects, since there is music to which the skaters dance, and the lights can create a similar atmosphere, what is to be done about the required level of sound at the rinks? The sound of the roller skates during the dancing is extremely loud. The music has to top this general ambience by a difference comparable to the level of the disco music over the sound of simple shoe shuffling along the floor. It can be a formidable problem. There also has to be a slight modification in the lighting compared to the disco. On the skating dance floor, bad reflections can cause momentary blindness and possible accidents. It's a whole new ball park, or dance arena, rather.

P.S. I've received several letters requesting addresses of people and firms mentioned in the column. For general information, here they are: The Variable Speech Control Co., 2088 Union St., San Francisco, Ca. 94123, attention George Leslie. Also requested, Jim Sant'Andrea, 300 E. 44th St., New York, N.Y. (212) 557-0070. ■

New Literature

INDEPENDENT STUDY

An Associate in Specialized Technology degree in Electronics Technology can be earned in a program described in this home-study catalog. Contact: Center for Degree Studies, Electronics, AST, INTEXT, Catalog 969V, Scranton, Pa. 18515.

TOOL HEAVEN

More than 3,000 tools for electronic assembly and precision mechanics are described in the 1977 Fall Catalog. Mfr: Jensen Tools & Alloys, 1230 S. Priest Dr., Tempe, Az. 85281.

RELAYS

878 models of various relays, photocontrols and opto-isolators are featured in this catalog. Mfr: Sigma Instruments Inc., 170 Pearl St., Braintree, Mass. 02184.

FREQ. OUT

"Freq. Out" refers to an 8-digit counter described in a four-page brochure. Mfr: Continental Specialties Corp., 70 Fulton Terrace, New Haven, Ct. 06509.

MIC TALK

A free guide to microphones, "A Brief Guide to Microphones," is a 15-page booklet explaining the basic facts about microphones. Mfr: Audio-Technica, 33 Shiawassee Ave., Fairlawn, Ohio 44313.

CAPACITORS

A 12-page short form capacitor catalog, #52-03, details a line of ceramic capacitors. Mfr: Murata Corp. of America, 1148 Franklin Rd. S.E., Marietta, Ga. 30067.

PROFESSIONAL TAPE

Tape cassettes for professional use are described in a new brochure. Mfr: TDK Electronics Corp., 755 Eastgate Blvd., Garden City, N.Y. 11530.

WIRE AND CABLE

A new 32-page booklet lists this firm's latest line. Mfr: Consumers Wire & Cable Co., 6600 N. Lincoln Ave., Chicago, Ill. 60645.

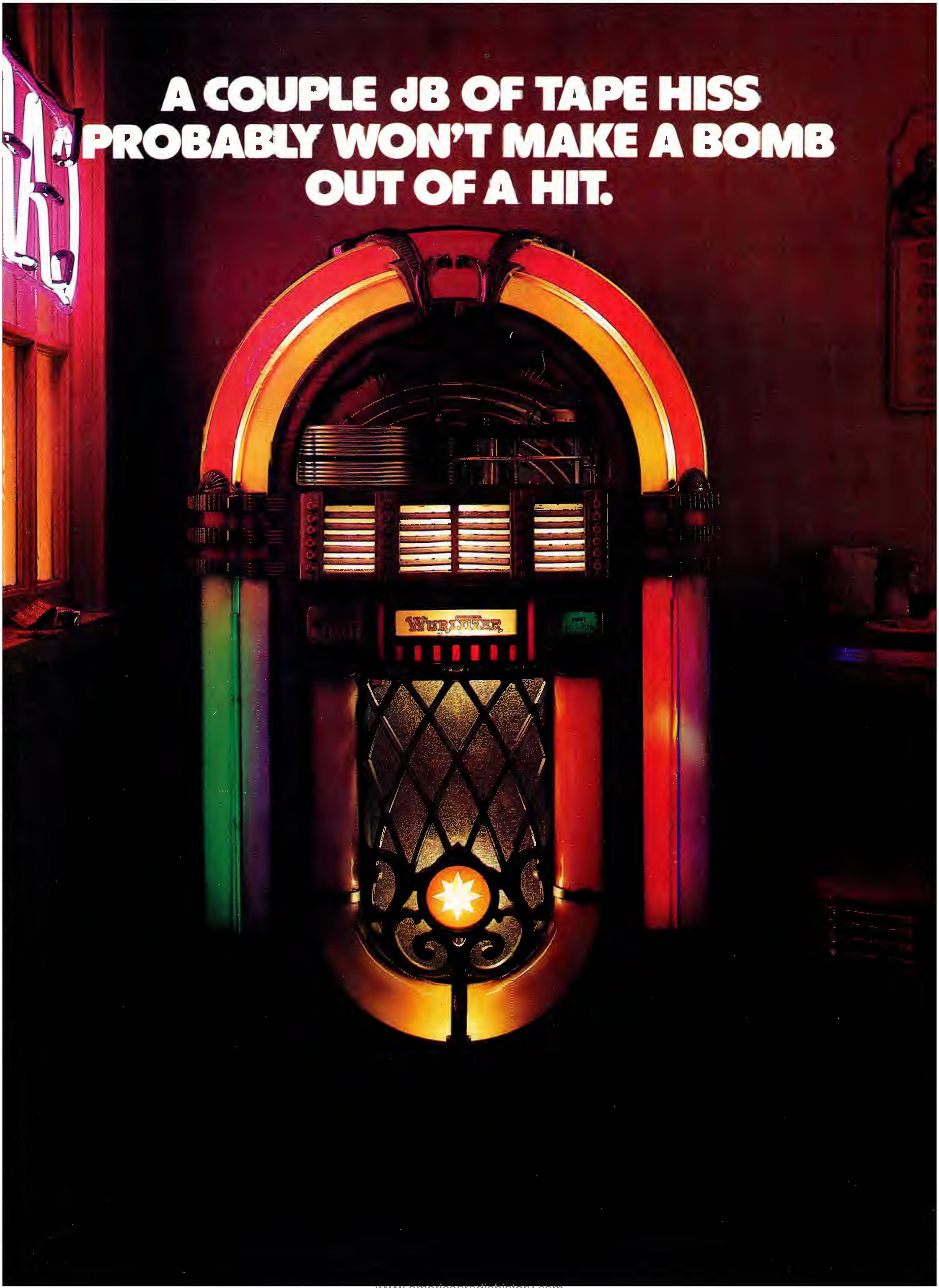
DIE CASTING

Three compact publications packaged in a folder answer the basic questions about die casting, including directory information of suppliers. Mfr: American Die Casting Institute, Inc., 2340 Des Plaines Ave., Des Plaines, Ill. 60018.

OVERHEAD PROJECTOR

Centurian 2000, a new overhead projector, is described in an introductory brochure. Mfr: H. Wilson Corp., 555 W. Taft Dr., S. Holland, Ill. 60473.

Circle 34 on Reader Service Card


A COUPLE dB OF TAPE HISS PROBABLY WON'T MAKE A BOMB OUT OF A HIT.
WURLITZER

BUT SOONER OR LATER YOU'RE GONNA HAVE TO CLEAN UP YOUR ACT.

WHY LIMIT YOURSELF WITH MASTERING TAPE?

You won't catch a professional racedriver putting cheap gas into his Lotus. It's just dumb.

And the same holds true in the studio. With all that heavy machinery and expensive talent, it makes no sense to compromise on your mastering tape.

TODAY'S SCOTCH 250 IS THE STATE OF THE ART.

With 250 you get far less tape noise. Considerably more high end clarity. Our exclusive oxide formulation and application reduces Mod noise. And when you add all that to dbx or Dolby it's positively the cleanest sound around.

SINCE WORDS ARE CHEAP, WE PUT 250 TO A ROUGH TEST.

Whatever the numbers or the meters say, it's your ears you should listen to. So we went to a very fussy, very fine engineer and asked him to devise a test to demonstrate the difference between 250 and our nearest competitor.

The guy first thought we were nuts.

"You're serious?" he asked. "I use 250. What if my test proves the other tape is cleaner?"

We gulped a little, and told him to go ahead. This test was bound to be expensive. But it would also be worthless, if everything wasn't above-board. That's why we chose Tom Jung of Sound 80, Minneapolis, to put it together. You may have heard of him.

THE TEST PROGRAM WAS RECORDED—ON TWIN MACHINES.

Jung, as we expected, left nothing to chance. On April 18, 1977 he recorded an original music program simultaneously on two 24-track MCI's fed by one console. One recorder was carefully optimized for 250. The other, just as carefully, for the competitor's tape.

Jung used NAB equalization at 15 ips. He really packed both tapes at 6db (370 nWb/m) over standard operating level—without a shred of noise reduction.

THE TRUTH CAME OUT FIRST AT THE AES SHOW.

It was May 10, 1977 at the LA Hilton. For playback we set up identical machines (our own M79 24-tracks, this time) with Altec 19 speakers. Then we opened our doors.

For each group of engineers we played not only the full mix, but individual tracks, first on one machine, then the other.

THERE WERE SOME WHO COULD NOT BELIEVE THEIR EARS.

"Play that bass track again," they'd say. And we'd play it.

"Are you sure both tapes were recorded at the same level?" We assured them they were.

"Lemme hear the strings with the horns."

In three days close to 600 people heard our 20-minute demo.

AND THE TRUTH IS...

We didn't find one engineer who didn't hear the difference in L.A. Ditto in Nashville, where the demo was repeated July 13 and 14.

You can simply pack more sound on Scotch 250 and still stay clean.

So the bottom line is this. Scotch 250 is cleaner tape.

3M COMPANY

CLEAN UP YOUR ACT WITH "SCOTCH" 250.

Circle 14 on Reader Service Card

db New Products & Services

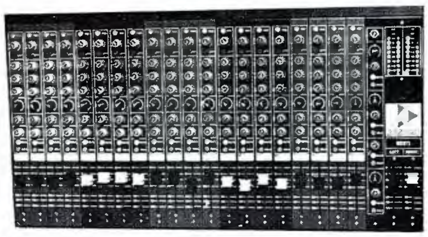
MINIATURE LOUDSPEAKER

• Tiny (6.85 in. x 4.25 in. x 4.65 in.) 200A speaker is rated at 30 watts, and provides 90 dB of sound pressure for a 1 watt input at one meter distance. The unit is equipped with a 4 in. woofer and 1 in. dome tweeter using a high density, high temperature metal voice coil system. It has recessed color coded quick disconnect terminals, and can be wall mounted, horizontally or vertically.
Mfr: Analog & Digital Systems, Inc.
Price: $105.
Circle 60 on Reader Service Card

STEREO CROSSOVER

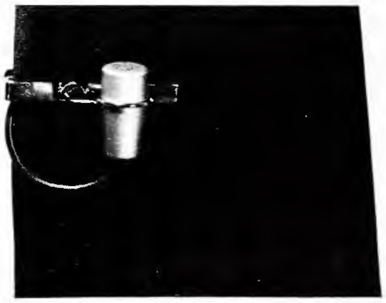
• Sound is separated into low and mid/high frequencies by Pyramid 1000 stereo crossover. Crossover frequency is 800 Hz. Claimed total harmonic and intermodulation distortion is less than 0.5 per cent. Complementing the Pyramid 1000 is the S-2501 electronic frequency dividing network, a two-way stereo unit. The S-2501 can be used in conjunction with any bi-amplification system.
Mfr: Showco, Inc.
Circle 61 on Reader Service Card

PORTABLE MODULAR CONSOLE



• Sophistication or simplicity, at the option of the purchaser, are available on modular 2022 portable mixer. The console is available with a 16, 24, or 20 input mainframe with a basis of 6 input modules and a wide variety of optional features. Output noise is 80 dB below, plus 4 dBm (OVU) and input noise is —128 dBm, 10 Hz-10 kHz. Frequency response is ±1 dB 20 Hz-20 kHz; claimed thd is less than 0.005 per cent: overall gain is 75 dB.
Mfr: 2005AD, Inc.
Price: Mainframe—
16, 20 inputs . . . $1,760
24 inputs . . . $1,900
Circle 62 on Reader Service Card

MINIATURE LAVALIER MIC



• Almost invisible (3/8 in. diameter, 7/8 in. length) condenser tie clasp microphone CO90 is supplied with a tie bar mount, windscreen, storage pouch and six feet of cable which connects the microphone to its belt clip battery/transformer housing. Optionally, Model CO90E is available powered directly from wireless transmitters. Frequency response is 40 to 15,000 Hz with an output level of −57 dB into a low-impedance input.
Mfr: Electro-Voice
Circle 63 on Reader Service Card

AMPLIFIER

• A system of analog logic circuitry called "Vari-Portional" anticipates power demands and supplies only a proportional amount of power as required by varying input signal voltages on the New Class amplifier. The unit delivers 250 watts rms per channel at 20-20 kHz, both channels driven into 8 ohms with a claimed t.h.d. of less than 0.1 per cent. In addition to the energy-saving circuitry, the unit has a solid-state fail-safe overload protection circuitry with automatic reset. L.e.d. indicators include a red clipping signal and monitors for the degree of usage of the vari-portional system. There are dual power cords for remote a.c. on/off, removable side panels for rack mounting, v.u. meters with range selection for increasing sensitivity 10 and 100 times, switching for two speaker systems, power switch, and separate gain controls.
Mfr: Soundcraftsmen
Price: $549.00.
Circle 64 on Reader Service Card

Editorial

Is Four Channel Dead?

In this issue, three articles discuss the present status of four channel sound. Two of the articles view this from the vantage of what broadcast will do for it, or how broadcast can, and possibly should, handle it.

John Woram discusses the alternatives and opts for a discrete system of broadcast. He opts for the concept of discrete broadcasting but does not endorse any of the systems. Those systems are described in detail, indicating the benefits and tradeoffs of each, by Len Feldman.

It is left to Peter Scheiber to take up the cudgels for matrixed quad. He points out in passing that matrix quad needs no special FCC permission.

Ah—the FCC. What will it do? And when? Our crystal ball is beclouded at best when we look into it for that answer.

Will it be discrete (which one)? Will it be matrix (which one)? Or, is it even possible that the FCC in its wisdom will simply fail to act—thus giving the nod to matrix without any endorsement?

Perhaps the biggest *if* of all is the one facing the recording industry. Should it continue to record four channels? Isn't four channel dead?

No question. The consumer market for four channel sound is (nearly) dead. But will a broadcast standard revive it? Ask an industry expert from any of the camps and you will get some answers to that last question. The specific answer will depend on the camp, of course and we fall behind our cloudy crystal again when we try to divine an answer.

One thing is clear to us. Four channel sound is not dead. Studios should continue to master for quad release, and release in stereo, of course.

What about the FCC and quad? We think the air will clear in 1978. *L.Z.*

PETER SCHEIBER

360° Space in Two Channels

Perhaps too much attention has been given to four channel sound. The author views quadriphonics in a different way.

WHO NEEDS four channels? That is a question I asked myself back in the late '60s. What audio needs is *space*; total, 360 degree space can be communicated through control of phase in two channels.

Even the most conservative audiophile won't quibble with the statement that two channels are here to stay; it's not going to be "back to mono." What are these two channels for? Is it better to replace the old mono "hole in the wall" with two holes in the wall? Is it better to have the audio program reach the listener through two channels rather than through one?

Obviously, talking about channels simply misses the point. Stereo is not sound coming from two point sources instead of one—two "holes in the wall"—stereo is *space*. Stereo is an improvement over mono because it takes the "no space" point source of mono, and stretches it into the now-familiar "stereo stage"—really, a left-right wall of space.

But, walls are flat, and the world (including the world of sound) is round. The step from mono to stereo was a step in the right direction, but only a first step.

At this point, let's move one step back ourselves, and take the long view of what the art of sound reproduction is all about. All those microphones, recording consoles, 2, 4, 8, 16, 24-track tape machines, all the disc cutting lathes, the phonograph pickups putting out signals measured in billionths of a watt, as well as the amplifiers to bring these tiny signals up to hundreds of watts to drive speakers, all the f.m. transmitters and, at the other end, tuners, are simply some of the links in a chain whose single purpose is to carry information—audible information, that is, but coded into more "shippable" electrical form—from point of origin to each of millions of "output terminals"—the listeners' loudspeakers. The whole progress of the audio art is the story of progress in bringing the human ear more and more audible information.

AUDIBLE INFORMATION: FREQUENCY AND INTENSITY

The first sound recording and reproducing equipment was "flat" from a few hundred Hertz to a couple of thou-

Peter Scheiber can rightly be called the "father" of four channel matrix. He is presently president of Peter Scheiber Sonics of Indianapolis, Indiana, manufacturer of the decoder discussed in this article.

sand—well, not flat, really, with tremendous peaks and dips even in this narrow range. The audio art still had a long way to go in conveying complete frequency information: we are capable of hearing about from 20 to 20,000 Hertz.

Today, state-of-the-art recording and reproduction can bring us this whole audible frequency range. And, even everyday home reproduction equipment is able to bring at least 60 dB of dynamic range—covering a range of audible intensities ranging from quite soft to quite loud. Distortions, adding *unwanted* information in the form of error signals generated by the equipment itself, are now routinely kept below one per cent.

Frequency and intensity information—doesn't this include all the audible information that we have set out to communicate? Think about it: if we can reproduce every overtone of any sound properly, with minimal distortion, and with a full range of intensities, then aren't we giving the ear all the information it needs for a perfect electronic re-creation of any conceivable sound that can be heard? Isn't this all that is needed to reproduce an audibly perfect singing voice, gunshot, acoustic guitar, synthesizer—any sound we can hear?

The answer is yes but—

Now we are able to re-create all sounds taking place in the "sound world" in which we all live—but not the sound world itself. We live in 360 degrees of sonic space, and stereo gives us, at best, a 60-to-90-degree segment of this space. We can reproduce nearly perfectly *what* any sound is, but not *where* it is. Today, in the "age of stereo," the audio art is bringing us nearly all the frequency and intensity information, but losing most of the spatial information.

FINDING THE SPACE FOR THE SPACE

We are looking for a way to convey a 360 degree sound world; conventional stereo gives us only a flat, left-right wall of sound. What is missing, clearly, is the front-back dimension, which, in combination with the existing left-right dimension, can make possible the re-creation of the full 360 degrees of space.

But before figuring out how to get where we are going, it often helps to review how we got where we now are. In doing this, we are essentially following the same path of reasoning that I took in the late '60s on the way to my well-publicized demonstrations of the encoded quadriphonic disc.

Stereo "codes" the left-right position of sound sources by controlling *amplitude* ratio in the stereo pair of channels. For example, in the recording studio mixdown process, we want to place a rhythm guitar at left center in the stereo mix. To do this, we turn the pan pot carrying this guitar until we are feeding, say, 2x volts of the guitar's signal into the left channel, and x volts into the right channel. In playback through the stereo pair of speakers, the rhythm guitar will be heard from a position left of stereo center. Now, the guitar can play louder or softer, changing the *absolute* signal voltage (x) fed by the pan pot into the stereo channels; or we can even replace the guitar with an entirely different instrument—say, a synthesizer—but the 2:1 *ratio* of amplitudes set by the pan pot, feeding the two stereo channels, will not change, and the sound—rhythm guitar, synthesizer, etc.—will not budge from left center position. The important thing here is that position on the "stereo stage" is determined by controlling the proportions (*ratio*) of signal applied to the left and right channels. Stereo mixdown is a *coding* of left-right position in terms of *amplitude ratio*.

This is where stereo is now. We are looking to keep this left-right dimension, and add the front-back one, because

The Scheiber 360° Spatial Decoder

if we can do this, we will be in a position to carry in our "stereo" pair of channels not just the usual flat, left-right "wall of sound," but a full 360 degrees of space.

It turns out to be mathematically demonstrable that there is a close analogy between the parameter of *amplitude ratio* in two channels, which is generally controlled in order to place sounds along the left-right dimension of the stereo "wall of sound," and the parameter of *phase difference*, which, in conventional stereo, is not used in a controlled way at all. If we control the amplitude parameter to get left-right placement, and the phase parameter to get front-back placement, then, between the two, we can place sounds anywhere in 360 degrees of space. The mathematical theory behind this phase-amplitude analogy was published in the *Journal of the Audio Engineering Society* in 1971 under the title, "Analyzing Phase-Amplitude Matrices." Essentially, this paper showed that by controlling amplitude in two channels, we get a single left-right spatial dimension, while by controlling amplitude *and* phase, we get a spatial "phase-amplitude sphere."

The upshot is that with stereo, we've become accustomed to using only half the spatial-information-carrying capacity of our "stereo" channel pair. The audio-bandwith pair of channels present on disc and on f.m. broadcast, and probably soon to be on a.m. as well, is capable of carrying 360 degrees of spatial (or directional) information. [Through phase difference/amplitude ratio coding, each of the various signals in a program (not necessarily four) may be assigned a specific position on the phase-amplitude sphere, remaining electrically separated from all other signals in the channel pair to the extent that its spherical co-ordinates (latitude and longitude) differs from the others.] The major challenge—which we're just beginning to meet with success—has been related to making this theoretical surround-space capability of the "stereo" channel pair into the most effective acoustical reality.

The 360° Spatial Decoder was designed on the basis of some quite new positional recovery techniques with the aim of demonstrating a high order of 360 degree localization from two-channel surround-coded program sources, including, notably, disc and f.m. broadcast.

Success of the 360° Spatial Decoder in generating an effective acoustical reality is gauged by the reactions of major audio reviewers, substantially all saying that the unit's audible performance in reproducing SQ-coded program equalled or surpassed what they had previously heard from discrete four-channel sources. However, this represents a misinterpretation of the design goals of the 360° Spatial Decoder. The device was *not* designed to make obsolete the use of four discrete channels for surround sound reproduction. Remember, we are interested in auditory *space,* not in channels. The design aim of the 360° Spatial Decoder is to show how successfully *two* channels (the commonly available stereo pair) may be used to carry the total, 360 degree audible environment.

ADVANTAGES OF CODING 360° SPACE IN TWO CHANNELS

Encoding 360 degree sound space in two channels has many practical advantages from the viewpoint of a spatial medium for the stereo music market. It can be broadcast now, without changes in FCC regulations. And, it doesn't reduce radio audience coverage, as any discrete four-channel system must as a result of the shunting off of a portion of the station's power into additional subcarriers not demodulated by the mono and stereo audiences. When a.m. stereo broadcast is approved by the FCC, which seems more and more inevitable, the coding method will be the only way possible to put surround (left-right/front-back) program on a.m. radio. The encoded quad record is somewhat more rugged than the one existing discrete quad disc, since it contains no extremely fine, ultrasonic modulations, and the dynamic range of the encoded disc is appreciably wider, frequency range slightly wider, and distortion much lower.

A single decoder circuit suffices for both records and surround broadcasts, while the discrete quad system must use a separate circuit for each. In fact, whenever we have a "stereo" pair of channels, we can use it not just for left-right stereo, as we usually do, but for left-right *plus* front-back stereo—that is, 360 degree spatial stereo—through control of phase. This is phase-amplitude coding.

THE CLINCHER

Study of encoding-decoding problems revealed that more spatial information was going on to encoded surround records than we were, so far, able to get off again. Decoding equipment simply did not exist that was capable of retrieving all the positional information being put on the coded records. Audible separation obtainable in playing *existing* surround-coded records would be a function of ongoing improvements in *decoding* technology.

This rather exciting conclusion was soon corroborated by demonstrations of three "super-decoders:" CBS Technology Center's "Paramatrix," the Tate, and the author's 360° Spatial Decoder, the only one of the three so far available. All three demonstrated audible separation in reproducing existing SQ-coded records of a level previously believed by many to be impossible. Technically, all three are based on "parametric" or "cancellation" principles new to the art, and their order-of-magnitude audible performance improvement is in part attributable to the fact that they can achieve full separation without the use of "gain-riding," or turning off of channels.

Priorities in the design of the 360° Spatial Decoder included lower distortion and wider dynamic range than achieved in any other device for the reproduction of surround program from disc; 360-degree positional accuracy and stability, and "smoothness," a term used by my colleagues at the CBS Technology Center to mean that the space and separation appear to be "just there," without any sense of the electronics used to get them. Some circuit features of the device are:

1) Precision components are used as a matter of course—not because a 1 per cent resistor or capacitor sounds different from a 5 per cent resistor or capacitor, but because the 360° Spatial Decoder's design specifications required that the performance of the actual unit exactly conform to mathematical calculations.

For example, the phase shifter networks which form the foundation of the entire device employ 1 per cent capacitors custom-built to values calculated by the author. Only with precise phase control over the entire audio band, can the Spatial Decoder do precisely what the equations call for—with especial reference to accuracy and stability of sound source placement.

2) Positional sensing is by the precise axis-crossing (phase comparator) method.

3) Phase detection is based on a modified Fletcher-Munson curve instead of the simple high pass that is quite satisfactory in consumer-grade devices.

(4) The basic SQ matrix used in the 360° Spatial Decoder has been re-calculated for sharper side image localization. An additional benefit of this is that there is a more in-phase relationship among the sounds radiated by the four loudspeakers, resulting in a subtle, but perceptible quality of "smoothness" or "fullness" of bass characteristic of the instrument.

5) The 0.05 per cent distortion specified for the Spatial Decoder refers to intermodulation, and is a conservative rating (most units test around 0.02 per cent). Unlike any other decoding equipment, this figure is contributed almost entirely by class A, f.e.t. circuitry which determines the basic sound quality of the unit; conventional (bipolar) transistors account for less than 0.1 per cent.

6) The Spatial Decoder achieves a 90+ dB dynamic range. This is the widest range of any genuinely functioning quadriphonic disc or broadcast reproducing equipment. In my own record listening, I use an audiophile phono preamplifier known for exceptionally low noise. With no record playing, listening through the Spatial Decoder, it is possible to hear a faint hiss in a quiet room. But if the volume control on the preamp is turned down, the hiss level reduces considerably, even though the Decoder is still wide open. Most of the audible noise is generated by this preamplifier known for its quietness, and not by the Decoder!

7) Perhaps the most important difference in the audible output of the 360° Spatial Decoder is the most difficult to explain because it deals with a technological challenge new in the audio art: every decoder must recognize genuine positional information among the welter of random-phase relationships of musical program material. In comparison with other "super-decoder," the Spatial Decoder has a fuller array of mechanisms for discriminating against phase error information. The audible result has been described as a "smoothness"—a sense that spaciousness and 360 degree sound source localization are "just there," without any awareness of the electronic means used in achieving them.

WHAT NEXT?

One of the most rewarding aspects of studying the ability of two audio-bandwidth channels to carry 360 degrees of spatial information with audible success is that each performance advance has started out from a level generally believed to be incapable of being exceeded. And, that *existing* 360 degree spatial programs phase-amplitude coded in two channels can be reproduced with ever-improving spatial precision as decoding techniques continue to be refined. Programmable digital filtering and multiplexing techniques suggest the possibility of independent decoding of substantially every Fourier (frequency) component of every directional signal in a coded surround program. The 360° Spatial Decoder exemplifies what we can do today.

Who needs four channels? I've heard some great spatial sound reproduced via four discrete channels; my own preference has been to investigate the potential inherent in phase-amplitude coding 360 degrees of auditory space in the two channels that we already have. Through control of phase information, the "stereo" pair of channels can carry not only a flat, left-right wall of space, but a full 360 degrees of surround space. We've been wasting half the spatial information capacity of our pair of channels. Let's put it all to use. ■

LEONARD FELDMAN

Whatever Happened to 4-Channel Broadcasting?

Despite extensive standardization studies, quad development still remains in limbo.

On March 23, 1972 the Consumer Electronics Group of the Electronic Industries Association (EIA) sent a letter to the FCC, advising that regulatory agency that the EIA had just voted to sponsor the organization of a National Quadraphonic Radio Committee. The objectives of the NQRC, as later stated in their charter dated May 9, 1972 were:

1. To determine the basic channel requirements (of quadriphonic sound) from the sound reproduction standpoint.
2. To clarify the technical issues between possible systems that meet these requirements through appropriate field tests.
3. To determine f.m. signal specifications based on these field test data and the best scientific information available.

From mid-May, 1972 until the massive final report of the NQRC was forwarded to the FCC in November of 1975, more than one hundred skilled engineers, scientists and technicians gave of their time and of their company's resources, serving on six separate sub-committees or panels, working out the mathematics of the five systems which were lab and field tested, and preparing the summary report which was submitted to the FCC at the conclusion of this monumental effort.

It is now more than two years since that report was submitted to the FCC and, as of this writing, we seem no closer to having a recognized and standardized 4-channel discrete broadcasting system than we were when the work of the NQRC began, more than five years ago.

We will examine the reasons for this seeming procrastination on the part of the FCC shortly. For the moment, it is interesting to note that all has not been totally "quiet on the quadriphonic front." For one thing, the Federal Communications Commission issued a "Notice of Inquiry" on July 6, 1977 whose stated objective is "to determine if there is sufficient interest to warrant the Commission's adoption of standards for quadriphonic broadcasting, and if so to develop a record which will assist the Commission in formulating the needed standards for this service." In plain English, all of that means that the FCC may be ready to begin considering the adoption of 4-channel broadcast standards.

In the notice of inquiry, the FCC discusses no fewer than twenty-eight separate matters (many of them divided into sub-questions) which it is asking the public and interested parties to comment upon. These include everything from the basic question of whether the broadcasting industry and/or the listening public are interested in and willing to spend the money necessary to transmit or receive quadriphonic f.m. sound, all the way to questions regarding the trade-offs implicit in the various discrete, semi-discrete (so called 4-3-4) and matrix (4-2-4) systems currently under consideration.

LISTENING TESTS

In a separate but related undertaking, the FCC itself recently completed a Laboratory Report, entitled "A Subjective Evaluation of FM Quadraphonic Reproduction Systems—Listening Tests." A report detailing the results of these listening tests was issued on September 14, 1977. Thirty-eight auditors were used in the quadriphonic tests, fifteen listeners were used in the stereo compatibility tests, while ten listeners were used in the monophonic compatibility tests. Listeners were seated in fixed positions in a listening room measuring some 15 by 22 ft. and were subjected to musical fare as well as localization "chirps." They listened to discrete 4-4-4 systems, the RCA type 4-3-4 encode-decode system (one of the discrete proposals for 4-

Leonard Feldman is a well-known audio consultant and writer.

channel f.m.), QS (Sansui) encode/decode systems, SQ (CBS) encode/decode systems and Matrix H (BBC) encode decode systems and were tested on their ability to localize sounds for all of these systems as compared with localization possible using discrete 4-4-4 systems. While most of the listeners basically favored the discrete 4-4-4 approach, the SQ system, in its most sophisticated logic-enhanced mode, proved to be almost as satisfactory with most musical material used in the tests.

This raises the question of whether or not a 4-4-4 discrete broadcast system is really called for at this time. It should be recalled that when the work of the committee (NQRC) began back in 1972, enhanced-logic matrix decoders were still in their infancy and the industry then leaned toward a discrete system. The development of highly sophisticated logic systems now raises the question of whether or not the present stereophonic f.m. broadcast system currently in use needs to be changed at all, since "matrix" 4-channel broadcasting not only requires no change of rules but has actually been in use for some years now.

ECONOMIC FACTOR

A third factor enters the quadriphonic-f.m. equation—if only indirectly. It will be recalled that in the late 1950's, when stereophonic sound was first gaining wide attention, f.m. broadcasters were in deep economic trouble. Despite the demonstrable advantages of f.m., a.m. was the dominant broadcasting medium and f.m. stations were filing bankruptcies as rapidly as others were being given licenses to broadcast. So, when the NSRC (National Stereophonic Radio Committee) began its work in the late 1950's, the FCC and the industry saw stereo f.m. broadcasting standards as a means whereby the fortunes of struggling f.m. stations might be bolstered. If f.m. broadcasters could transmit stereo, sponsors might be induced to spend money for f.m. commercials and the f.m. broadcast picture could be improved. Thus it was that the FCC acted relatively quickly (the new rules were promulgated on April 19, 1961) and by mid-Summer of 1961 several enterprising f.m. stations around the country were already broadcasting stereophonic programming. Bear in mind, too, that by 1961 there was an ample supply of software (records and tapes) and stereo sound in homes had been well accepted.

In the intervening years, f.m. broadcasting has actually become the dominant radio medium. How much of this success of f.m. is owed to its stereophonic broadcast capability is academic. The point is that now a.m. stations find themselves in the position of underdogs and feel that it is time that they, too, were permitted to broadcast stereophonically. Accordingly, on the same date as the Notice of Inquiry relating to 4-channel f.m. broadcasting, the FCC issued a similar notice of inquiry dealing with a.m. stereophonic broadcasting. Meanwhile, another committee, the National A.M. Stereophonic Radio Committee, sponsored by the EIA, has been preparing its own report based upon work of its various sub-panels conducted over the last two years (including field tests of three proposed a.m. stereo systems conducted in the Washington, D.C. area).

What has all this to do with 4-channel f.m.? Simply this: it is the opinion of many industry experts that the FCC is likely to turn its attention to stereo a.m. standards before it even considers 4-channel f.m. standards simply because public and broadcaster pressure is much greater in that area.

Don't overlook the fact that a.m. radio is still the dominant program source in automobiles. Recent interest in automobile high fidelity equipment has prompted many car owners to install stereo cassette and/or 8-track music systems in their vehicles and if those vehicles are not equipped with f.m. radio (but have a.m.), the introduction of stereo to the a.m. band would provide a relatively inexpensive additional stereo program source for such users (assuming that stereo a.m. adaptors would be relatively simple to manufacture and install).

THE NQRC REPORT TO THE FCC

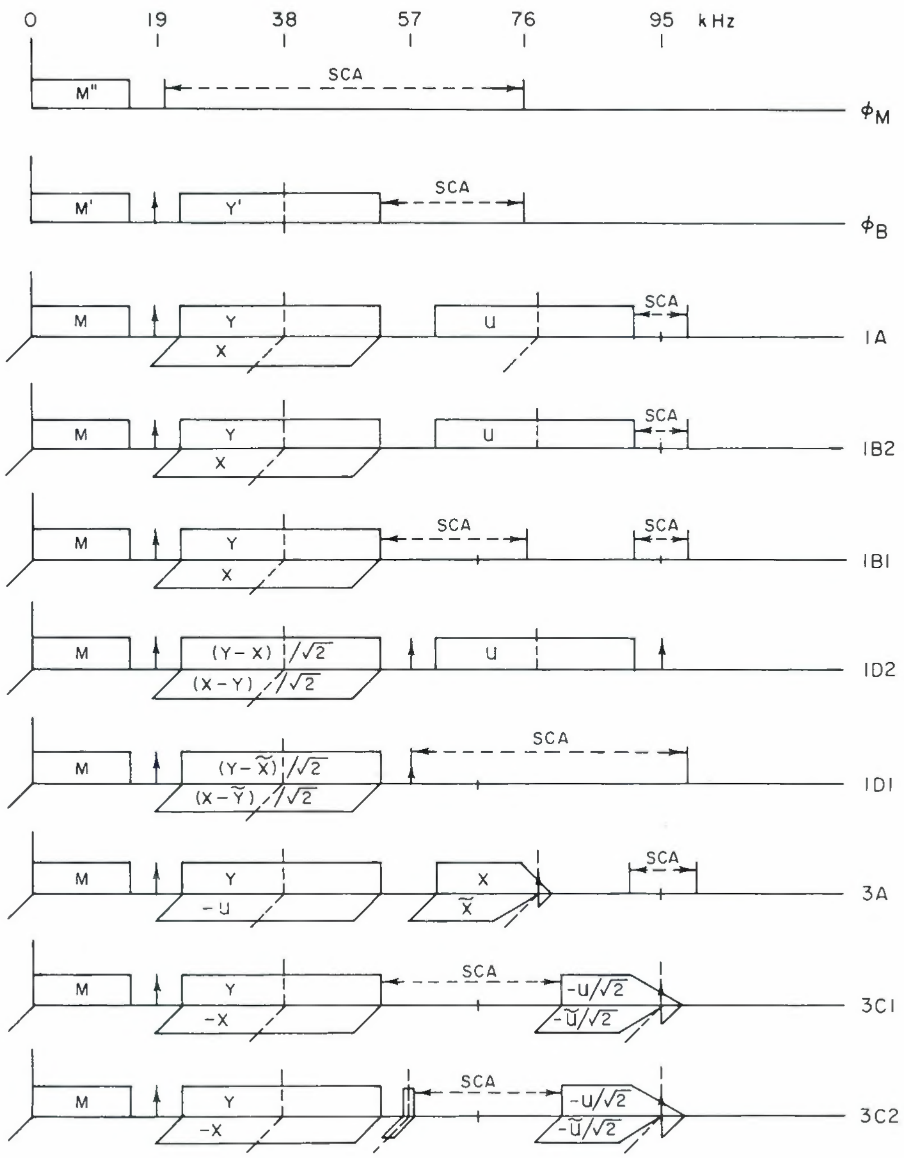
As has been the practice of EIA committees in the past. the NQRC did not make an actual recommendation to the FCC regarding which of the five quadriphonic systems tested should be favored. Instead, they presented two thick volumes of data to the FCC, who must now sift through the data in conjunction with comments received from other interested parties based upon the notice of inquiry previously mentioned. A brief summary of how each of the five tested systems works will serve to illustrate the similarities and the differences between the various proposed systems.

Systems are identified as 1A (proposed by Quadracast Systems, Inc.), 1B (by RCA Corporation), 1D (by Cooper-UMX), 3A (General Electric Company) and 3C (Zenith Radio Corporation). The diagram of FIGURE 1 illustrates the quadriphonic baseband spectrum occupancy of all the proposed systems. Existing monophonic broadcasting spectrum utilization is shown in the top line (θ_M), while spectrum utilization in the currently practiced stereo f.m. system is shown in the second line of the diagram (θ_B). Note that in monophonic service, the SCA (Subsidiary Communications Authorization) transmissions (such as background music or other private subscriber programs) many occupy spectrum space from 20 kHz to 75 kHz. When stereo f.m. is broadcast, SCA service is confined to a subcarrier having its center frequency at 67 kHz. In the case of proposed systems 1A, 1B2 (system 1B offers various options), 1B1 and 3A, SCA service would have to be "pushed" out beyond the present 75 kHz channel limits of f.m. as practiced in the U.S. The pilot signal (designated by an arrow) at 19 kHz is the present pilot used for stereophonic f.m. broadcasting and, in all the systems, it remains unaltered. Some of the newly proposed quadriphonic systems require additional pilot signals at other frequencies while others make do with just the existing 19 kHz pilot.

SYSTEM 1A

The Quadracast Systems Inc. proposal was originally developed by Louis Dorren. In this system, main channel information consists of the sum of all four channels of program material (LF + LB + RB + RF). Instead of the two-channel stereophonic sub-channel at 38 kHz, there is now a quadriture sub-channel. This sub-channel contains two distinct quadriphonic subcarriers in what is called quadriture modulation. The first of these crosses the time axis together with the positive crossing of the 19 kHz pilot and is modulated with a "left minus right" signal ((LF + LB) — (RB + RF)). The second quadriphonic subcarrier leads the first by 90 degrees and may contain either a "front minus back" difference signal or a criss-cross signal. Assuming the former, this subcarrier would therefore be modulated by ((LF + RF) — (RB + LB)).

The final component of the composite signal is a third sub-carrier which would have its center frequency located at 76 kHz (four times 19 kHz) and would be modulated by ((LF + RB) — (LB + RF)), the so-called "criss-cross" difference information. If SCA service is desired, the center frequency of such an SCA carrier would have to be located at 95 kHz (five times the 19 kHz pilot frequency). The approximate signal-to-noise degradation of this system, as compared with the s/n loss in stereo f.m., is estimated by this proponent as being around 7 dB. (Remember, that in going from mono to stereo, the signal-to-noise degradation was in excess of 20 dB, so that this further deterioration is small by comparison).



LF = LEFT FRONT SIGNAL
LB = LEFT BACK SIGNAL
RB = RIGHT BACK SIGNAL
RF = RIGHT FRONT SIGNAL

M = LF + LB + RB + RF
Y = LF + LB − RB − RF
X = LF − LB − RB + RF
U = LF − LB + RB − RF

↑ ↑ = PILOT

|← − →| = SCA SPECTRUM SPACE

Ã = HILBERT TRANSFORM OF A

M" = MONOPHONIC MAIN CHANNEL SIGNAL
M' = BIPHONIC MAIN CHANNEL SIGNAL = L + R
Y' = BIPHONIC SUBCHANNEL SIGNAL = L − R

Figure 1. Baseband spectra of various proposed 4-channel f.m. broadcasting systems analyzed by the NQRC.

SYSTEM 1B

The system proposed by the RCA Corporation is really one which offers two options. Concerned with the problems which might arise if SCA service were pushed way out to 95 kHz, one version of this system is actually a 4-3-4 system, in that only the quadriture related pair of extra subcarriers at 38 kHz are employed, as illustrated in Line 1B1 of FIGURE 1. In this system, SCA service can continue to exist at a sub-carrier frequency of 67 kHz, as it now does, and in addition, even a lower amplitude second SCA service of limited bandwidth might be located up at 95 kHz.

In this system, totally discrete programs are not actually recovered for the four channels. Channel separation is, however, considerably better in all directions than might be achieved with a 4-2-4 system *in the absence of logic separation enhancement*. Typically, a recovered LF signal, which we shall designate as LF^1 (since it is not a "true" LF) would consist of the following components: $LF^1 = 0.75LF + 0.25LB - 0.25RB + 0.25RF$. These coefficients show that the *desired* LF contribution to the LF channel would be three times as great as the contributions of the unwanted signals, which works out to be a separation of 9.54 dB. Interestingly, a phantom source (such as a "center front" vocalist, where LF = RF and where LB=RB=0) is reproduced exactly even using a 4-3-4 system such as RCA's 1B1 proposal.

For their alternate proposal, RCA introduces the same sort of third subcarrier (up at 76 kHz) that Doreen proposes for the 1A system already discussed. One major difference, however, is the addition of a small-amplitude pilot signal at 76 kHz (5 per cent of total modulation) which could serve as a triggering signal for receivers, directing them to "switch" from the normal 4-3-4 mode to a full 4-4-4 system. This system is identified in FIGURE 1 as the 1B2 system and resembles the 1A system in terms of sub-carriers used, although the modulations used for the quadriture-related 38 kHz subcarriers are reversed, compared with system 1A.

SYSTEMS 1D

The Cooper-UMX approach proposes two different but compatible systems for quadriphonic f.m. broadcasting. They are called TFMX (a 4-3-4 system which is compatible with existing SCA services at 67 kHz) and QFMX (a 4-4-4 system which is incompatible with SCA). The TFMX system uses three encoded channels during transmission. These are made up as follows: (Main Channel) = (LF + RB) + (RF + LB) = T_Σ ; $-T_\Delta = (LF-RB)_\Delta\ +45° - (RF-LB)_\Delta\ -45°$; and $-jT_T = (LF-RB)_\Delta\ +45° + (RF-LB)_\Delta\ -45°$. For the QFMX system, a fourth encoded channel is added, identified as $-jT_Q$ and equal to (LF+RB) —(RF+LB).

Examination of FIGURE 1 shows which of these signals is used to modulate which carrrier or sub-carrier in the Cooper-UMX 1D1 or 1D2 systems. In case you are wondering why all the complex algebra and phase shifts are needed, they are the features that make the Cooper-UMX system so interesting. It works out to be true that in all of these modes of quadriphonic operation (either 4-3-4 or 4-4-4), the two-channel signals that would be received by a conventional stereophonic tuner or receiver can be treated as matrix-encoded signals. Thus, with a proper form of matrix *decoder* a listener could obtain a matrix form of quadriphonic reception (one which presumably would be further enhanced by logic separation enhancement circuitry) while the listener who buys a new, properly designed tuner or receiver could have semi-discrete (4-3-4) or even fully discrete 4-channel reception (4-4-4) depending upon which of the two Cooper-UMX alternative transmission systems was finally approved.

SYSTEM 3A

General Electric, in their system 3A, gets around the problem of extended bandwidth (required by the third sub-carrier) by creating a vestigial-sideband type of upper sub-carrier at 76 kHz. In other words, essentially only the lower sideband of this 76 kHz-centered suppressed-carrier sideband modulation is used for the "fourth equation" in this 4-4-4 system. As with the other non-phase-shifting 4-4-4 systems described thus far, the main channel is modulated by a sum (all four channels) signal, the two quadriture-related 38 kHz subcarriers are modulated by left-minus-right and diagonal-difference signals, while the vestigially filtered upper sub-carrier is again modulated by the front-minus-back information. General Electric maintains that by limiting the upper sideband frequencies to, say 78,000 Hz, the IF bandwidth requirements of the receiver are reduced, allowing greater freedom to tuner and receiver manufacturers which, they say, will result in lower costs to the consumer. They do suggest a second pilot at 76 kHz and, in their case, if any SCA service is to continue, it would have to be way out at 95 kHz, as was true of systems 1A, 1B2 and 1B1 (where two SCA transmissions are desired).

SYSTEM 3C

Zenith Corporation, the final proponent in the discrete 4-channel sweepstakes, developed two quite similar systems which make a point of preserving the present SCA services at 67 kHz, the frequency they presently occupy. In order to accomplish this, Zenith's upper sub-carrier frequency is set at 95 kHz (instead of 76 kHz) and is accompanied by its own pilot signal. This time, vestigial filtering is used for the upper sidebands of this upper sub-carrier to prevent upper frequencies from radiating beyond 100 kHz. Since the lower sideband's lowest frequency will be 80 kHz (95 kHz less the highest audio frequency—15 kHz—to be broadcast), that leaves a nice open space from 80 kHz down to 53 kHz (the highest sideband of the two 38 kHz quadriture-related sub-carriers) into which the existing 67 kHz SCA sub-carrier can be nestled.

In a modification of their system, known as 3C2, a couple of quadriture related pilot carriers are added at a frequency of 57 kHz (three times the basic 19 kHz pilot carrier). These two separate and separable pilot signals, each having an amplitude of 5 percent of total modulation, can be used to control a compress-expand scheme (compression of up to 10 dB at the transmitter and corresponding expansion at the receiver) and to control a variable pre-emphasis/de-emphasis scheme at the transmitter and receiver, both of which additions would improve signal-to-noise ratio as well as available dynamic range of transmitted and received program material.

Even these brief descriptions of the five systems analyzed by the NQRC give a pretty good idea of how many thousands of man-hours went into the project, not to mention the countless dollars that were expended in the course of all this work. It is, in a way, unfortunate that because of a great number of other reasons not related to this outstanding engineering effort, the listening public has become disenchanted with quadriphonic sound. 4-channel home listening equipment is no longer being offered in great profusion. Very few records are now offered annually, either in matrix or in discrete CD-4 format.

If the public responds negatively (or not at all) to the FCC's notice of inquiry, it is quite possible that the FCC will abandon its considerations until such time as interest is renewed in quadriphonic sound generally. On the other hand, if the FCC, in the course of its deliberations on stereo a.m. and quadriphonic f.m. *should* issue rules standardizing both forms of broadcast service, we might witness renewed interest in quadriphonics simply *because* some f.m. stations would begin offering that service.

Many experts maintain that the *real* success of stereophonic sound only came *after* stereo f.m. broadcasting began and people became curious enough to want to hear what things "sounded like in stereo" as they heard radio announcers alluding to the fact that their programs were being broadcast stereophonically. Conceivably, the same thing could happen in the case of 4-channel. The availability of 4-channel broadcasting might also prompt discouraged record producers to resume issuing quadriphonic discs and a new ground-swell might ensue. ■

JOHN M. WORAM

What About Quad Broadcasting?

Awaiting the big FCC decision—matrix or discrete quad broadcasting, the long view counts.

As MOST **db** readers know, today's recording industry is inextricably linked to the broadcast industry. For we find that the success of many records is a direct function of "air-play," and, the success of many radio stations is a direct function of the (recorded) music that their program director selects.

As we enter 1978, the interdependence of radio and record is made even more apparent by the controversy over a standard for f.m. quad broadcasting. It seems that, finally, this may be the year in which the Federal Communications Commission comes to some sort of a decision on the subject. And, for better or worse, the record industry seems inclined to look to the Commission to solve its problem of what to do about quad. Some time ago, the Commission announced a "notice of inquiry" period. (See the August 1977 Sync Track). During this period, the record and broadcast industry—as well as the general public—was invited to submit comments about quad to the FCC. The deadline was 16 December, 1977, with an additional month prescribed for reply comments.

Since these letters to the Commission become a matter of public record, anyone may examine them, and if desired, issue a reply. As this issue of **db** sees the light of day, the reply period should be just about over, and the next move will be up to the FCC. (These words are being typed in mid-November, and do not take into account any last-minute deadline changes.)

For the confirmed quadnik, the letters on file at the FCC are indeed refreshing. Over 99 percent are in favor of quad, and these letters seem to come from a cross section of the listening public. So, what will the Commission do now?

There are several alternatives. It may decide to do nothing, reserving final judgment for some future date (otherwise known as stalling). On the other hand, it may decree that a matrix system is sufficient for f.m. quad broadcasting. Or, the Commission may authorize the transmission of one of four discrete channels of programming.

TYPES OF SYSTEMS

Before presenting an argument for the latter alternative, a little background information may be in order. By now, even the reader with no particular involvement in quad may realize that within the recording industry there are several competing quadriphonic recording systems. Adhering to time-honored tradition, the systems are naturally incompatible. Broadly speaking, there are the so-called "matrix" systems (SQ, QS) and the perhaps-mislabelled "discrete" system (CD-4). I say mislabelled because discrete means separate, and obviously a two-channel record groove does not contain four totally separate tracks, whatever the circumstances. If we were dealing only with tape, there wouldn't be anything to argue about. But even the most rabid proponents of one or another quad record system seem to be content with the "discrete/matrix" nomenclature, and at least it helps to divide the various warring parties into two fairly recognizable camps.

As for phonograph records, the marvels of SQ, QS and CD-4 have been described to death elsewhere, and I won't go into the gory details here. However, I would like to clear up the point that a discrete broadcasting system has no direct relationship to the so-called discrete (i.e., CD-4) record.

I'm acutely aware of the potential for confusion here, since as a consultant to JVC and Panasonic, I'm up to my ears in both CD-4 records and discrete broadcasting.

AHA! The truth is out, right here in the pages of **db**!! Obviously, my mind has been poisoned, and I'm supporting discrete broadcasting because of CD-4. Well, guess again folks. My mind may indeed be poisoned, or gone completely perhaps, but it's got nothing to do with any relationship between CD-4 records and discrete broadcasting. There are matrix broadcasting systems, and discrete broadcasting systems, but there is no such thing as a CD-4 broadcasting system, as we shall presently see. (I hope).

I'd like to go on record (sorry about that) as saying that I've probably heard as many rotten quad records as the next person. And I've also heard some beautiful music too. Some of my favorite records are matrix-encoded, and some of my other favorites are CD-4. And for whatever it's worth (nothing, perhaps) the last two records that I engineered have been released by labels that support two of the leading matrix systems. As a listener, I've discovered that all systems have made impressive advances over the years. As a recording engineer, I know that we can expect even greater improvements tomorrow. And as a soothsayer, I haven't got the foggiest notion about which system will eventually drive the others off the market.

And as a reader, you may be wondering what all this has to do with a quad broadcasting standard. The answer is, plenty! Various matrix proponents are urging the FCC to adopt a matrix standard based around their favorite system, which I shall call matrix "X". This may be understandable, since an official FCC endorsement of matrix "X" would do wonders for the health of that system, and probably wreck the competition in the process. However, it seems to me that it would be a lot healthier for all of us if the competition got wrecked in the marketplace, as the record buying public made a free choice, based upon what it heard.

And, there's only one broadcasting system that will allow the record buyer to hear any quad format that's now on the market, as well as any other (oh, no!) that may come along in the foreseeable future. Before describing this discrete system, let's quickly review the basics of current stereo f.m. broadcasting. Prior to transmission, the left and right channels of the stereo program are mixed together to form what I shall label an **A** and a **B** channel. The **A** channel is a simple summation of left and right (**A**=**L**+**R**). In order words, it's a mono program—and it is this **A** channel that is picked up by a mono receiver. The **B** channel is formed by **L-R** and is received along with the **A** channel by stereo receivers. If you'll forgive a little math, it can be shown that there are two possible ways of combining **A** (=**L**+**R**) and **B** (=**L**−**R**). These are;

$$(\mathbf{L} + \mathbf{R}) + (\mathbf{L} - \mathbf{R}), \text{ and } (\mathbf{L} + \mathbf{R}) - (\mathbf{L} - \mathbf{R})$$

As the mathematicians love to say, "With two equations and two unknowns (**L** and **R**, that is) the problem may be solved." In English, that means that the stereo receiver may deliver a two-channel program.

DISCRETE SYSTEM

Well, for better or worse, a four-channel broadcasting system must coexist with this firmly entrenched system, so as not to render obsolete all the mono and stereo receivers now on the market. A discrete system does this by letting the **A** channel contain the sums of all four signals. The **B** channel contains the difference between the two lefts and the two rights. In other words $(\mathbf{L}_f + \mathbf{L}_b) - (\mathbf{R}_f + \mathbf{R}_b)$. The two additional channels, **C** and **D**, provide other combinations of the four signals. These are; $\mathbf{C} = (\mathbf{L}_f + \mathbf{R}_f) - (\mathbf{L}_b + \mathbf{R}_b)$ and $\mathbf{D} = (\mathbf{L}_f + \mathbf{R}_b) - (\mathbf{R}_f + \mathbf{L}_b)$.

Now, with four equations and four unknowns, we have full compatibility with existing receivers plus the ability to provide full four channel reproduction over a discrete receiver.

But, the four equations have no more of a direct relationship to the four channels of a quad program than our existing two-channel transmission system has to the conventional stereo record. In both cases, the program is "remixed" to suit the requirements of the transmission system, and later restored to its original format at the receiver, provided this receiver is equipped to do so. If not, the listener still hears the complete program, but minus the stereo (or quad) enhancement.

MATRIX DECODERS

Although a discrete broadcasting system plays no favorites among the competing quad systems, it does not mean that all systems suffer, as some people suppose. In fact, it is perhaps ironic that the discrete broadcast system has the potential to deliver better matrix "X" programs than the conventional matrix stereo system itself. This apparent contradiction is due to the fact that the very best matrix decoders cost about $2,000—well beyond the means of most record buyers, but not out of reach of the state-of-the-art radio station. In fact, the leading matrix proponents might find it advantageous to lend such super-decoders to some radio stations, so that listeners may hear matrix quad records under the most ideal circumstances. Furthermore, the matrix proponents have stated that we may expect to hear even better decoders in the future.

This means that if a quad broadcasting system is standardized around any matrix system, the listener will be obliged to buy a new decoder periodically in order to enjoy future advances in matrix technology. By way of contrast, if a super-decoder were in use at the station, this could be updated periodically, and *all* listeners would benefit, both now and in the future. Of course, this requires a discrete broadcasting system.

MONO

The mono listener receives an added bonus from discrete broadcasting, and this point should interest those stations that have abandoned their matrix encoded programming due to listener complaints. The complex phase relationships that are a function of every matrix system are removed prior to broadcasting. Therefore, the mono listener will hear a satisfactory program (still only mono, of course), with no strange cancellations due to subtractive phase relationships.

As another plus, the discrete system does not obsolete existing stereo receivers with built-in (or add-on) decoders. Since the **A** and **B** channels contain the entire stereo version of the transmitted program, this may be decoded at home by the listener who does not yet own a discrete receiver. This matrix-decoded program will be no worse (and no better) than the present f.m. system, but it will suffice until the listener is ready to step up to a fully discrete receiver.

In short, a discrete broadcasting system leaves the door open for future improvements. If the FCC adopts such a standard, it obligates no one to run out and rebuild his radio station. As in the early days of stereo, no doubt a few stations will change over almost immediately (some are now ready to do so), and these will attract the serious audiophile listener. Gradually, more and more stations will go discrete as the market expands. Improvements in a.m. stereo will surely persuade other f.m.ers to go discrete. And, the advantages of discrete broadcasting will give them somewhere to go to maintain their competitive edge.

In the meantime, the battle over the ultimate software system will be fought in the marketplace. And if matrix X is really the greatest thing since sliced bread, it will win easily, without being rammed down the broadcaster's throat by federal regulation. Of course, maybe someone will invent an even better system tomorrow. With discrete broadcasting, we shall all be able to hear it. ■

Sierra Audi

Sometime before the sun comes up, you'll learn to love your MM-1200.

Ampex gives you a lot of reasons to buy an MM-1200 multichannel audio recorder: capacity, fidelity, flexibility and reliability. The performance specifications alone have made this the best seller among professional multitrack recorders.

But you'll find your own reasons for loving the MM-1200 you buy.

Some morning, after a long session that dragged through the wee hours, you're going to realize just how many MM-1200 features you used to keep things moving. How you used the electronic tape timer, plus search-to-cue, to save precious minutes of time. How you used the quick-change head feature to switch back and forth between 8, 16 and 24 track work. The ease with which you employed the optional accessories such as the pure video layback head, synchronizer and variable speed oscillator to finish the audio portion of a video production.

The same professional drive for perfection that kept *you* going, kept *our* engineers working to refine an already-respected design.

That's why you see so many MM-1200s in professional recording studios. Sooner or later, before the sun comes up, everybody learns to love an MM-1200.

AMPEX

Ampex Corporation, Audio-Video Systems Division, 401 Broadway, Redwood City, California 94063, 415/367-2011.

Circle 33 on Reader Service Card

HAROLD LINDSAY

Magnetic Recording: Part II

From Todd-AO to digital recording; one thing led to another.

PART ONE, published last month detailed the beginnings of the fledgling Ampex Company and how its ailing finances during the development of the first American tape recorder were solved by a check bearing the signature of Bing Crosby. . . .

The first two Model 200 machines assembled went to Jack Mullin to help relieve the much overworked Magnetophons. The twenty machines for the A.B.C. installations were operated in their key locations for time-delayed broadcasting of network shows across the country. Their performance in this first application is best related in the following letter which was sent to Mr. Poniatoff at the close of the season:

. . . commencing April 25, 1948, and continuing through September 25, 1948 (a total of twenty-two weeks), the American Broadcasting Company in Chicago recorded on the Ampex, approximately seventeen hours per day. For thse 2618 hours of playback time the air time lost was less than three minutes, a truly remarkable record. We believe that a large share of this successful operation was due to the use of the Ampex tape recorder manufactured by your company.

We wish to thank you for your splendid cooperation in supplying us with this fine piece of equipment capable of withstanding the severe conditions imposed during our delayed daylight saving time program.

Very truly yours,
Frank Marx. V.P. in charge of engineering
American Broadcasting Company

In all, 112 Model 200's were manufactured. At about the halfway point in their production (the fall of 1948), we had acquired enough experience and knowledge, as well as input from our customers, to realize that we should consider the design of a new model. The Model 200 had served to demonstrate conclusively that magnetic recording had a lasting place, not only in radio broadcasting, but as a more convenient and flexible means of mastering recordings for phonograph record manufacturers.

In creating this first product in a field new to us, the key premise in our design philosophy was "uncompromising quality and unsurpassed reliability." In our intense desire to assure that these elements were not jeopardized we found ourselves with a product that was somewhat over-designed.

With our newly developed knowledge and skills, especially in the matter of magnetic head design, we were in a

Harold W. Lindsay, a distinguished audio pioneer and internationally recognized authority on magnetic recording, helped lead Ampex Corporation to success and growth and is currently special consultant to that company's magnetic tape division.

position to produce a recorder to follow the 200 at half the price; it could also be substantially smaller in size and operate at half the tape speed (15 in./sec.). It was thought that the lower operating cost of 15 in./sec. and the reduced physical size would appeal also to users with smaller monitoring and control rooms.

MODEL 300

In November, 1948, we set to work on a new project, the result of which was to be our Model 300. Tape speed would be halved and the dimensions reduced, but performance and reliability kept as close to the 200 standards as possible. By halving the tape speed, we could reduce the reel size and tape length and still maintain the playing time of the Model 200. This new 10½-inch reel, with later modifications, eventually became the NAB standard. This challenging assignment was pursued on an all-out basis and the first production run was conducted in July of 1949 when fifty units were manufactured. The first machine off the line went to our good friend Jack Mullin.

The response in the market place was beyond our most hopeful expectations. As a result, we were now faced with a new set of problems—how to supply an unending rush of orders. The "300" was an immediate success, and within the first few years of the design's long lifetime in the market place it was to be found in all of the major radio networks as well as widely used in the smaller nets and individual stations. The big name phonograph label record manufacturers were all using the "300" for mastering and editing.

The basic design of the "300" remained virtually unchanged throughout its lifetime until the late '60s; its solid state version was introduced in 1966. In all, somewhere around 20,000 Model 300s were manufactured during this time.

The Model 300 received recognition in October 1950 when the publication *Electrical Manufacturing* presented to Ampex a Certificate of Award for "outstanding achievement in product development, design and engineering."

As noted earlier it had been decided in embarking on the "300" development project to lessen the over-design of the "200." Our goal was reduced size, weight and cost.

The Ampex 300 appeared in early 1949, running at 15 in./sec. speed (also 7.5) and at both reduced size and price from the 200. This was the first ad. Note the specs.

while retaining reliability and outstanding performance. Fortunately, the Model 300 retained a certain amount of over-design, which some two years later, in 1950, proved to our great advantage.

MODIFICATIONS

By 1950, after the first year of "300" production, Ampex started to receive requests to supply special modifications of the basic "300" to be used, not for normal audio purposes, but for data recording in industrial, military and scientific research. These highly specialized applications were so tempting to us that we succumbed and entered headlong into a development program which spurred us into the new field of instrumentation data recording.

This is where the "excess" capability of the original "300" design paid off. We were able to modify the transport to handle tape speeds from 1⅞ in./sec. to well over 120 in./sec. By this time our skills in magnetic head design and fabrication had advanced sufficiently to enable us to produce narrower gap reproduce heads and multi-channel heads with acceptable crosstalk.

MODEL 3200 DUPLICATOR

These developments enabled us to introduce the Model 3200 tape duplicator system (based on Model 300 modifications), consisting of a high speed tape master playback machine feeding banks of slave recorders. Thus it became possible as well as practical to duplicate master tapes at reasonable cost for retail sales of prerecorded high fidelity tapes.

For instrumentation applications we also introduced frequency modulation recording, as well as pulse code modulation systems. We were then in a position to supply

An Ampex alignment tape circa 1948. This is probably the first professional alignment tape made in this country. Ampex made these tapes available to purchasers of Model 200 machines. Photo from Jack Mullin's product museum, as shown at a recent AES Convention.

The author (left) with Alexander M. Poniatoff at the introduction of the Ampex ATR-100.

record/reproduce equipment covering a wide range of data requirements from direct current levels and digital coded information, to high frequency signals well above the audio range. This capability resulted in Models 301, 302, 303/311, and others. Instrumentation magnetic tape recording was here to stay and Ampex was to remain as an important influence on the growth of this new technology.

Entrance into the instrumentation field did not de-emphasize our efforts in the audio field. New audio models were forthcoming. The 400 series, which had been first manufactured late in 1949, was upgraded to become the 401 but turned out to be the least successful of the early introductions, having a relatively short life in the audio market place. In 1952, Model 350/351 was first introduced and became a very popular professional recorder, evolving through the years and a number of revisions.

THE MYSTERIOUS VISITOR

It was at this time (1952) that an interesting incident occurred at Ampex. Mr. Poniatoff received a phone call from a New York banker who stated that an important visitor would soon be coming to our facilities. Though he could not disclose the identity of the mysterious guest or the purpose of his visit, he did indicate that it could result in important new business for Ampex.

On arriving, the visitor introduced himself as "Mr. Edwards," without bothering to disclose why his large gold cuff links and tie pin carried the initials "M.T."

Early in the conversation that followed, "Mr. Edwards" inquired whether the people at Ampex had seen Cinerama (the initial public screenings had occurred just before the visit) and if we could record sound on photographic film prints with magnetic striping.

His next inquiry, whether Ampex had done any work in stereophonic sound recording, was effectively answered by a very impressive demonstration. Our demo of three-channel stereophonic playback, using theater-type loudspeaker systems, satisfied our visitor, who finally confessed that his name was not Edwards at all, but Mike Todd!

Mr. Todd was so impressed with what he had seen (and heard) that he made an on-the-spot decision to select Ampex to produce the sound system for the Todd-AO motion picture system (a further improvement on the Cinerama development).

While working on the Todd-AO project, Ampex developed a four-track multi-directional sound system which was introduced in 1953 and was featured in the first Cinemascope film, *The Robe*. Two years later, *Oklahoma!* was premiered with Ampex six-track sound; it was literally an Oscar-winning performance. Other design advances emerged, and by 1967 Ampex had installed sound systems in theaters around the world.

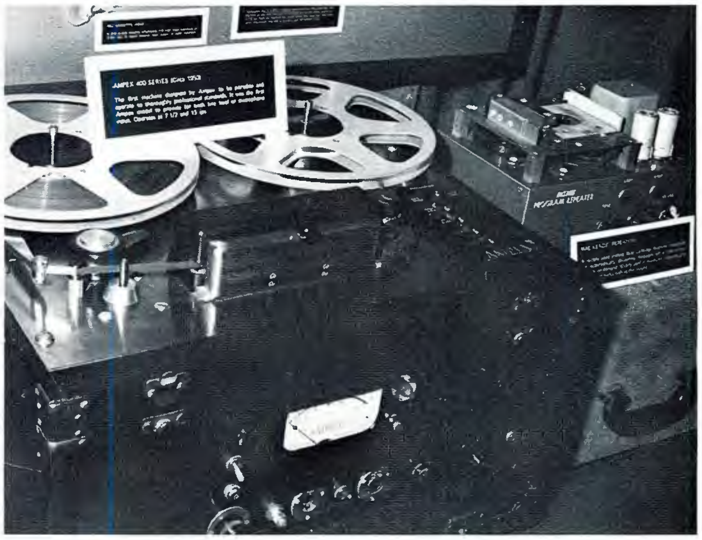
In 1967 we introduced a solid state, improved version of our wide screen multichannel systems. But these systems, though widely acclaimed, remained on the market for only about two years. The interest in super-wide screen presentations was diminishing and sales were dropping off. Ampex had to face facts and retire from the motion picture sound business.

CONSUMER AUDIO

Let us look back now on an earlier year—1954. It was in this year that Ampex introduced the Model 600, intended initially for the professional market as rack-mounted modules or as a single case portable assembly. This recorder became the second Ampex product to achieve distinction by receiving an award for design excellence and has become the Ampex audio product wtih the greatest total sales volume.

The adaptation of this design to produce the Model 612 brought about the company's entry into the consumer audio field. The 612 was shown at the Ampex booth at the National Association of Music Merchants Show in the summer of 1955 and created broad interest as the world's first stereophonic music system for home use. Subsequently Ampex established a consumer division, separate from professional audio and continued with a long series of

A new model appeared in 1950. This is an Ampex 400, the first portable machine designed to professional standards. It was also the first machine to provide for both the level and microphone input. It operates at 7.5 or 15 in./sec. speed. Photo from Jack Mullin's product museum as shown at a recent AES Convention.



product introductions for a period of sixteen years before phasing out of what had become a highly competitive market place.

To cover all of the consumer products developed through that period is beyond the scope of this article. However the following account has such historic significance that it is included.

FOUR-TRACK STEREO TAPE

In attempting to develop interest in home music applications for prerecorded tape, Ampex, in introducing the stereophonic Model 612, had by 1957 come to the realization that tape could not compete price-wise with phonograph records unless higher tape packing density could be achieved. The resulting engineering effort brought forth in 1958 the four-track stereophonic head. With the introduction of this new head Ampex hoped to coax tape duplicators into immediately bringing out four-track prerecorded tapes, and thereby stimulate sales of stereo tape recorders. The idea didn't take hold, so Ampex decided to take the initiative and enter the duplicating field. The importance of such a facility to the developing home music industry is suggested by the fact that within eighteen months following Ampex's introduction of four-track stereo heads, 750,000 tape recorders had been sold by major manufacturers!

In June 1959, Ampex formed United Stereo Tapes (later Ampex Stereo Tapes) and acquired duplication rights for some of the leading phonograph record labels. These included Verve, MGM, Warner Bros., Mercury, and later London. Elk Grove Village, a suburb of Chicago, became the company's custom duplication center. Equipment consisted of Ampex 3200, and later ADM-500 and AD-150 duplicators. Through the years this facility has developed into one of the largest and most complete establishments of its kind.

During the decade 1955-1964, Ampex audio engineering personnel found themselves under heavy pressure to carry on the development programs in which they had become involved. These were the consumer product lines, tape duplication equipment and motion picture sound systems. For the most part new product introductions in professional audio had slowed down.

Only two new professional recorders were introduced in this period; the PR-10 in 1959 and the MR-70 in 1964. The PR-10 enjoyed good acceptance and was continued until its successor, the AG-500, was marketed in 1967. The MR-70, an outstanding design concept for its time, was to have been a state-of-the-art recorder at its introduction, incorporating many mechanical refinements and the best that advanced tubes and nuvistors had to offer. Unfortunately, the development project was timed badly, starting too late to put the recorder in the market place before the onset of the solid-state audio era.

The last of the 350 series, the AG-350 (with transistor electronics), became the basis for the design of a new line of very successful recorders, the AG-440, released in 1967. The years 1967 and 1968 brought many new product introductions. During this time the AG-500, AG-440, AG-440-8, AG-600, the 3400, and the large (12, 16 & 24-track) multichannel AG-1000 and MM-1000 machines were released.

MULTICHANNEL RECORDERS

The decade which followed 1967 to the present brought great emphasis on engineering large multichannel recorders and high speed duplication equipment. Duplicators appeared in 1969 with the BLM-200, in 1971 the CD-200 and in 1972 the AD-15. Introduced in 1973 was the multichannel MM-1100.

The years 1974 and 1975 were without new audio product introductions and some concern was shown in the industry; was Ampex about to give up its position of leadership in professional audio? What was not known by outsiders at the time was that this two-year stretch was devoted to perfecting products to be announced in 1976. a new and improved multitrack, the MM-1200, a highly perfected portable, the ATR-700, and a state-of-the-art analog audio recorder, the ATR-100.

The public display and demonstration date for the latter unit was the May 4, 1976 opening of the 54th Convention of the Audio Engineering Society in Los Angeles.

ORRADIO INDUSTRIES

It is pertinent at this point to recall an event in 1949, although at the time it was not related in any way to Ampex. It was destined in years ahead, however to play a prominent part in the affairs of the company.

We have already referred to the two German Magnetophons that had been sent home after World War II by John T. Mullin and how they influenced Ampex's entrance into the field of magnetic recording. Somewhat paralleling this development was the establishment of ORRadio Industries in Opelika, Alabama, in 1949 by Major Herbert Orr. Orr had also sent home a war souvenir Magnetophon and had, in addition, acquired a formula for making tape. Ten years later the firm, then known as Orr Industries, producing *Irish* brand tape, was acquired by Ampex and eventually became the magnetic tape division.

From this point forward the Ampex tape division placed increasing emphasis on tape development and improvement of manufacturing processes along with the development of a responsive marketing organization. All of this over the years added up to wide acceptance and the winning of an important share of the tape market.

ATR-100

The acquired skills of tape design, formulation ,and processing which allowed the tailoring of a new product to specific performance parameters paid off in a big way during the development of the ATR-100. For now Ampex had the advantage of being a company with design skills in both recorder and tape technologies. The result was the introduction of the ATR-100 and Ampex 456 Grand Master tape as "go together" products. One was designed to be used with the other to bring out the maximum performance of each in true synergistic relationship.

History had repeated itself, for just forty years before, the German A.E.G. & I.G. Farben companies had teamed up with their respective skills to create the Magnetophon and its tape.

As we pause at the close of this commemorative year. it may be useful to survey the state of our knowledge and accomplishment, and address the question: Just how far have we come in these past thirty years? Perhaps some insight can be derived from a simple comparison of the performance specifications of two products representative of then and now, i.e. the Model 200 and the ATR-100.

DIGITAL VS. ANALOG

As I look over my shoulder at some thirty-plus years of trying to meld art and science in this expanding industry, a thought keeps recurring: in a rapidly evolving technology, today's state-of-the-art can be ancient history by tomorrow.

Model 200 vs. ATR-100: Comparative Performances

Measurement	Ampex Model 200	ATR-100 Ampex
Overall Frequency Response at @ 30 in/sec	Within ± 1 dB 30 to 15 kHz	Within ± 0.75 dB 200 Hz-20 kHz Within ± 2.00 dB 35 Hz-28kHz
Signal-to-noise-ratio taken at 30 in/sec AES full-track.	30 Hz to 15 kHz Unweighted over 60 dB	30 Hz-18 kHz Unweighted 77 dB
System Distortion	Using 3M Co. Type 55 Tape 4% intermodulation distortion at peak meter reading with "harmonic" distortion not exceeding 5% 10 dB above peak meter reading.	Using Ampex 456 (Grand Master) tape SMPTE intermodulation distortion < 1.0% at recorded flux level of 370 nWb/m(OVU)
Flutter & Wow	"Undetectable wow and flutter content even in the most susceptible program material"	NAB rms unweighted at 30 in/sec 0.03%
Speed Accuracy	± 0.03%	± 0.03%
Rewind Time	5.400 ft. (0.002" thick tape) (36 min. P.T.) 1.75 minutes	2400 ft. (0.0015" thick tape) 2.7 minutes

Already the industry is looking to digital audio recording. Digital-to-analogue conversions of 15 bit/50 kHz scan and greater need no longer be regarded as "humpty-dumpty" propositions. It is now possible to make the analogue-digital conversion and put all the pieces together properly. High performance systems are at hand and these most certainly will find their first use in super-critical mastering applications.

Will analogue audio recording survive the challenge of the digital assault? As a practical and relatively simple approach, analogue recording should continue unretarded in its amazing growth. Its position in the industry should be strengthened through supportive interaction with the newer technology rather than being reduced to obolescence. We can all recall that the advent of magnetic tape did not spell doom for the disc, but instead helped greatly in its revitalization.

In the foregoing we have glanced back some thirty years. At this point do we dare guess what may lie ahead over a similar period?

Other audio recording possibilities have already suggested themselves. Vastly improved optical and electron beam recording systems are just around the corner. But where will the next giant step take us? We should not overlook the progress which has already taken place in the development and miniaturization of magnetic core memories. With their almost limitless potential as memory storage devices, there are exciting possibilities for magnetic recording/playback static systems, sans-tape, where motion stability will no longer be a concern, when the only moving system elements will be magnetic lines of force and electrons. ■

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EXCEPTIONAL OFFERING, like new: EMT 930 turntable with extras; Revox A-77 2-track deck; (13) Dynaco Mark III power amps, 35 watts per channel; (4) Dynaco Model 70A stereo amps 70 watts; (2) Dynaco Mark IV amps, 40 watts; Cinema Eng. type 9205-A degausser ten inch reel size; Sony 1-inch color video recorder, Model EV-320; JBL 5306 pro-mixer; Sony Model CLP-1B video color pack; original Norden Bombsight, good condition, minus power supply; Philips sound delay machine EL 6911/02 multi-head tape loop delay system; (4) Scully 280 electronics 280 series; (5) Technics turntables SL 110A. **Cinema/Sound Ltd. (212) 799-6940.**

PATCHBAYS . . . New from Nexus. All Switchcraft; 96 holes, 2 double rows of 24. Front panel is normalled and fully wired to back panel which terminates in standard RCA jacks. This unit is complete and ready to interface with TEAC-Tascam, dbx, phase shifters, echo units, etc. wtih no soldering! Just plug this patchbay into your studio and start recording with more flexibility. Just $289. **Nexus Inc. 50 Chuckanutt Dr., Oakland, N.J. 07436. (201) 337-0707.**

FOR SALE: MCI JH-528 recording console wtih producer's area, $46,000; replacing with new automated JH-528-B Plasma Display. **Sound 80, Inc. (612) 721-6341.**

WANTED

WANTED: Universal Audio Model 1008 tube preamps, up to 30 each. **Artists' Engineering, 14444 Skyline Blvd., Woodside, Ca. 94062. (415) 851-0388.**

WANTED: RECORDING CONSOLE 16-in/16-out; 16-track recorder; misc. equipment. **(201) 359-5520.**

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MAINTENANCE ENGINEER. Multiple studio, 24-track recording studio of excellent reputation seeks an experienced maintenance engineer to work with, primarily, MCI equipment. Must have a minimum of three year's experience with multi-track recorders and consoles, and with contemporary peripheral equipment. Appropriate education may be substituted for one year's experience. Individual must have the ability to work wtih extremely high standards, and to work closely with people. Excellent location. Salary commensurate with qualifications. Repy with resume and letter of introduction to **db, Dept. 12, 1120 Old Country Rd., Plainview, N.Y. 11803.**

REX HUMBARD ministry has immediate opening for audio maintenance engineer. At least five years experience in recording studio-type equipment. Some national and international travel required. Send resume to **David Ginaven, 2690 State Rd., Cuyahoga Falls, Ohio 44223.**

ELECTRONIC TECHNICIAN/WIREMAN; recording studio in midtown Manhattan; experienced schematic reading, wiring, testing; assistance in studio maintenance. **Call (212) 687-9030.**

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Major N.Y.C. studio. New automated 24-track. Send resume to **Dept. 83, db Magazine, 1120 Old Country Rd., Plainview, N.Y. 11803.**

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db People/Places/Happenings

• Coming from the **Cetec Corporation, John F. Schneider** has been appointed by the **McMartin Company,** of Omaha, Neb., as sales manager for the Northwest area. Mr. Schneider's address is 13516 89th Pl., N.E., Kirkland, Wa. 98033.

• The Georgia World Congress Center in Atlanta, Georgia will be the site of the **International High Fidelity Show,** running May 19-21, 1978. Manufacturers and importers may secure floor plans and show data from the International High Fidelity Show, 331 Madison Ave., New York, N.Y. 10017. (212) 682-4802.

• While maintaining his post as national sales manager, **Mike Govorko** has assumed the position of vice president of marketing for **VOR Industries,** of Anaheim, Ca. Mr. Govorko has been with VOR since January, 1977; prior to that he was with **Wallichs Music Cty.**

• The position of general sales manager for all consumer electronics products at **Sanyo Electric Inc.** of Compton, Ca. has been filled by **Art Westburg.** Mr. Westburg has been with Sanyo since 1975 in the capacity of a national sales manager for radios and tape recorders. He is replacing **Bill Kirsch,** who has resigned to form his own rep company.

• **Gary T. Draffen** has been promoted to the post of vice president of the OEM components division at **U.S. Pioneer Electronics Corp.,** of Moonachie, N.J. This is an enlargement of Mr. Draffen's previous position as general manager for OEM of the components division.

• A new division for the purpose of acquiring and operating radio and television stations and related properties has been formed by **A-T-O Inc.** of Willoughby, Ohio. Under the designation, A-T-O Communications Division, the venture will operate out of Los Angeles, headed by **Saul L. Rosenzweig.** Mr. Rosenzweig has owned and managed television stations in various parts of the country during the past twenty years.

Dr. Peter Goldmark, former head of engineering research and retired president of CBS Laboratories, died in an automobile accident at the age of 71 early in December. Dr. Goldmark worked continuously on innovations in audio and communications, but was known chiefly for his connection with the long-playing record, developed in the CBS Lab under his direction. Dr. Goldmark was also active in the development of color television and, most recently, work on electronic video recording, which made the video cassette possible. During his term as head of the CBS Lab, engineers at the lab also developed the sapphire stylus which replaced the steel needle, vinyl plastic to take the place of shellac, a lightweight tone arm, and a smoother-running turntable, developments spurred by the needs of the long-playing record. After his retirement in 1971, Dr. Goldmark became interested in establishing television and data communications between widely scattered groups of people. To achieve these ends, he established his own company, Goldmark Communications Corp., a subsidiary of Warner Communications, Inc.

Dr. Goldmark was born in Hungary in 1906, obtained his technical education in Germany and Vienna, and came to the U.S. in 1933. His association with the Columbia Broadcasting System commenced in 1936. Recipient of many honors, Dr. Goldmark received his last award in November, 1977, when he received the National Medal of Science from President Carter at a White House ceremony.

• Moving up from the post of sales manager, **Robert P. Farrell** has been appointed vice president for sales at **B & K Instruments, Inc.** of Cleveland, Ohio. Prior to joining B & K in 1974, Mr. Farrell headed **Farrell Associates.**

• **John A. Young** has been elected president and chief operating officer of the **Hewlett-Packard Company** in Palo Alto, Ca., replacing founder **William R. Hewlett** in the presidency. Mr. Hewlett will continue as the company's chief executive officer with the designation of Chairman of the Executive Committee. Mr. Young comes from the position of executive vice president. His post has been filled by **Dean O. Morton.**

• A new engineering group devoted to supporting contractors, consultants, architects, and engineers has been formed at the **Altec Lansing Sound Products Division,** Anaheim, Ca. Focalizing the new service is **Bob Davis** as Director of Systems/Applications Engineering. Joining Mr. Davis are **Dr. Rex Sinclair,** acoustical expert, engineer **Chris Foreman,** and technical writer **George Westbrook.**

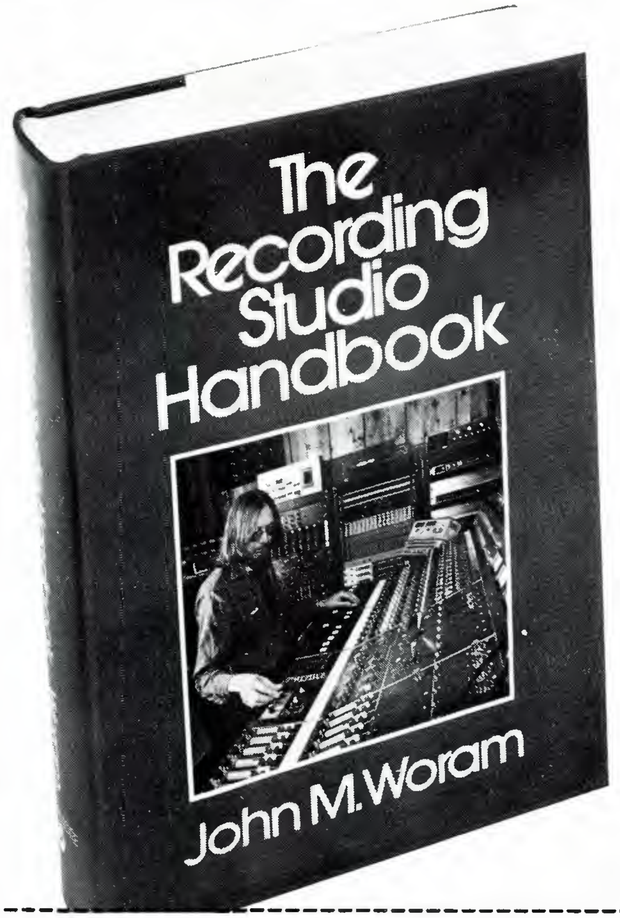
• An in-depth directory of more than 100 recording studios in northern California has been published by **BAM Publications** under the name **THE MIX.** The directory is distributed free to recording personnel and musicians, available from BAM, P.O. Box 6395, Berkeley, Ca. 94706.

• **Harold J. Newman** has been appointed vice president for marketing at **Lectrosonics, Inc.** of Albuquerque, New Mexico. Mr. Newman had previously been with printer **Good Impressions,** of Mill Valley, Ca., which he had co-founded.

• **Soundmixers,** a million-dollar "super studio" opened on September 15 at 1619 Broadway, New York City. The plush facility, under the direction of **Harry Hirsh,** has three 24-track recording studios, outsized control rooms, an experimental 16-track studio, a state-of-the-art electronic music center and a complete range of editing, film and videotape equipment.

John Woram's The Recording Studio Handbook

FOR RECORDING ENGINEERS, TECHNICIANS AND AUDIOPHILES



The technique of creative sound recording has never been more complex than it is today. The proliferation of new devices and techniques require the recording engineer to operate on a level of creativity somewhere between a technical superman and a virtuoso knob-twirler. This is a difficult and challenging road. But John Woram's new book will chart the way.

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- **The Modern Recording Studio Console**
- **The Recording Session**
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John Woram is the former Eastern vice president of the Audio Engineering Society, and was a recording engineer at RCA and Chief Engineer at Vanguard Recording Society. He is now president of Woram Audio Associates.

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