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THE SOUND ENGINEERING MAGAZINE

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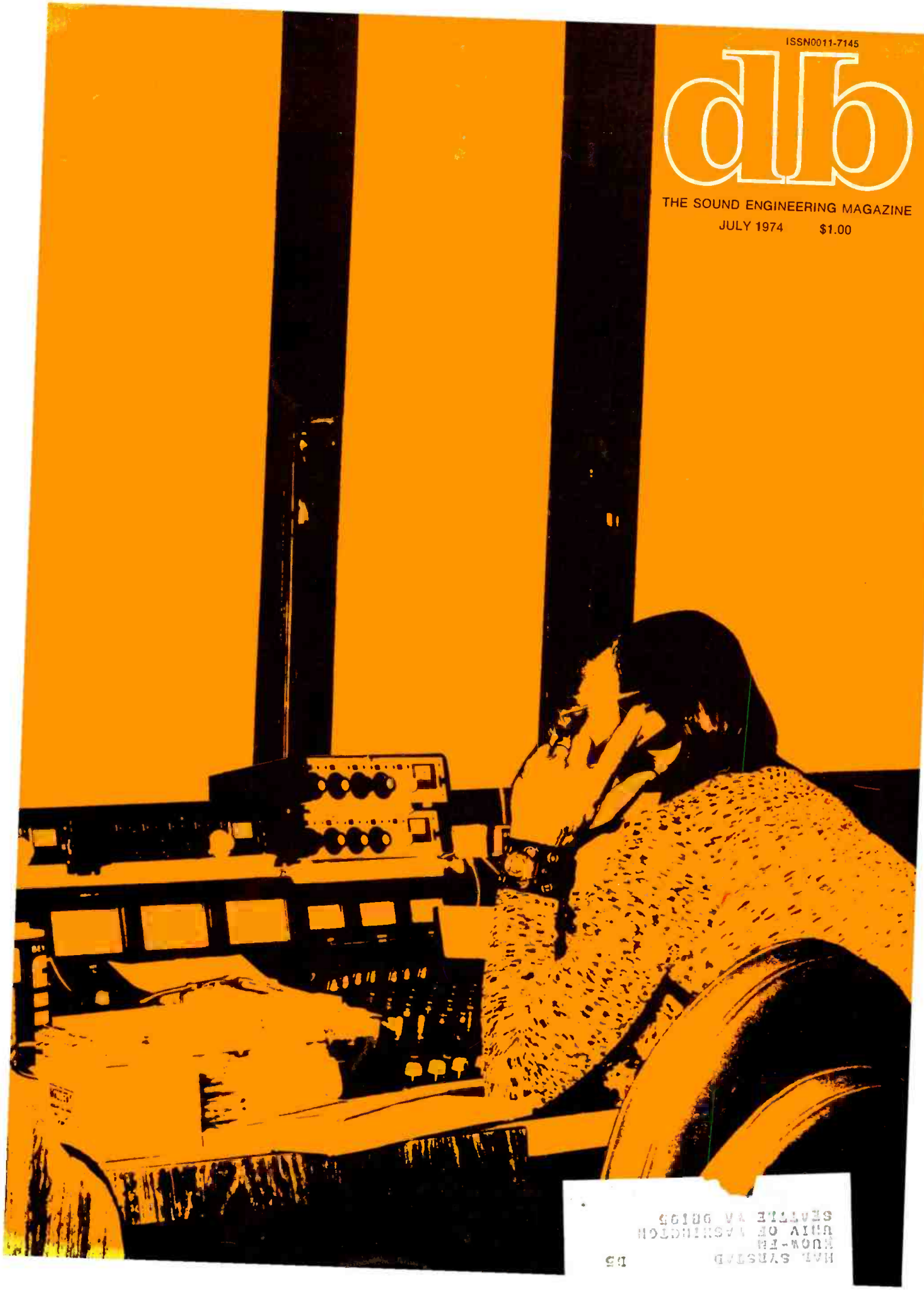

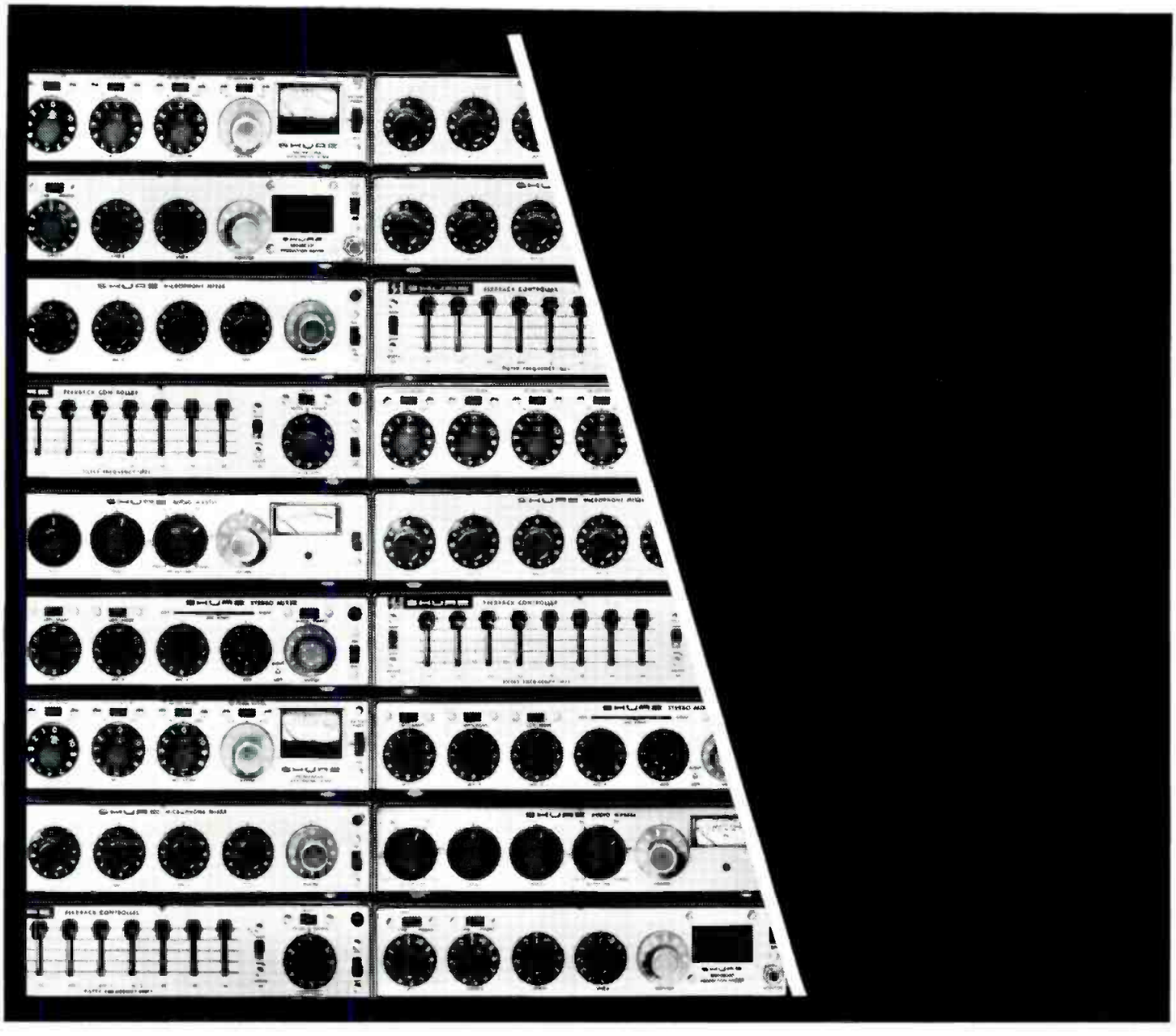

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COMING NEXT MONTH

● Sidney L. Silver returns to our pages with an in depth easy-to-read study of the use of controlled tone delays in speech reinforcement systems. This definitive article will find wide use.

Michael Rettinger also returns to our pages with a feature article that will be the first of what will be columns on studio acoustics, a field in which the author has considerable expertise.

And since this issue will be a pre-AES Convention (New York City's Waldorf-Astoria Hotel, September 9-12, there will be a map of the exhibitors and information on hours and events.

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

ABOUT THE COVER

● Marshall King's definitive story on video sound in conflict with house sound reinforcement is begun on page 22. All photos, including the cover, are by the author.

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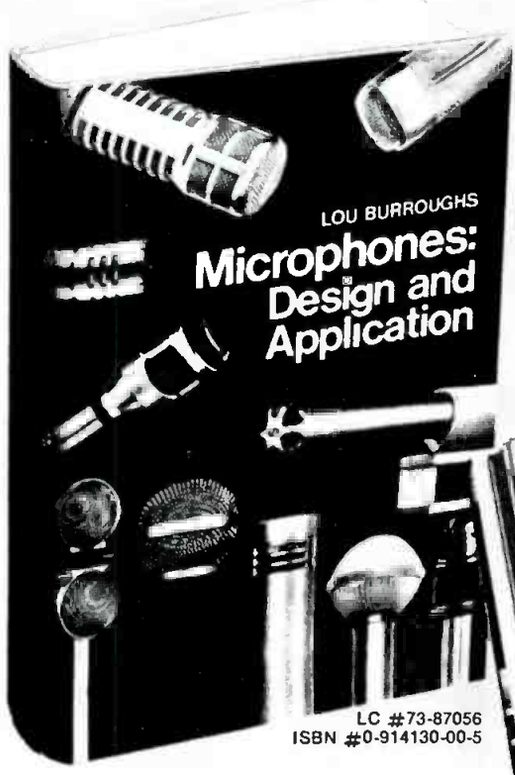
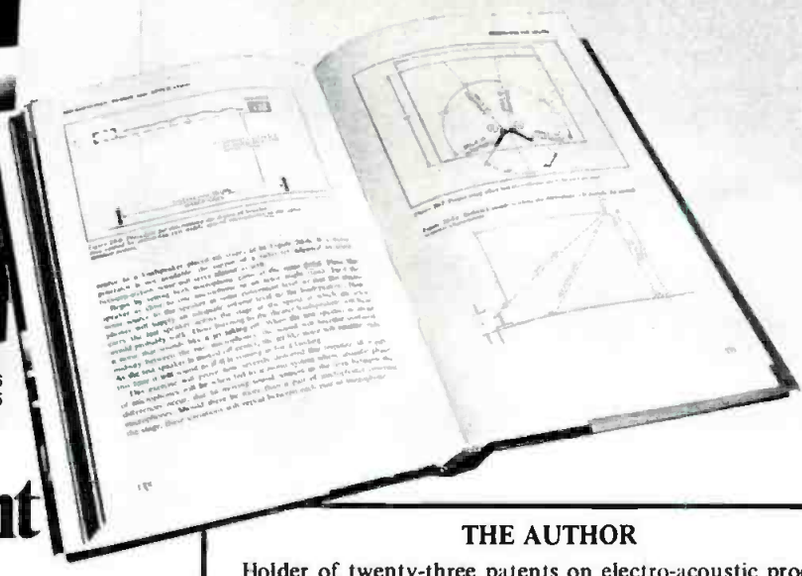


If you work with microphones, you need this book!



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* **How does dirt in the microphone rob you of response?**
* **How do you space your microphones to bring out the best in each performer?**

This text is highly recommended as a teaching tool and reference for all those in the audio industry. *Price: $20.00*

THE AUTHOR

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

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letters

The Editor:

Mr. Pritchett's letter in response to my November column intrigued me. While I cannot find that he really disagrees with any position on which I have thus far expounded, I find it interesting to see how he interprets what I said.

First, I did not intend to pass judgment on whether U.S. institutions of higher education are worth going to. They certainly have a useful function to fulfill, one they are currently not even engaging, for the most part.

That comment about my unfavorable comparison between American and English schools puzzled me. True, I compared preparation at one time provided by British schools, with what American schools provide now. But then Americans tell me theirs used to be much better, and I believe them. As far as I can tell, they have deteriorated on both sides of the Atlantic!

Our reason for leaving Britain over twenty years ago was that government controls were making progress impossible there. Don't laugh, please! The British bureaucrats, although a nuisance, had not grown so smart then as their American cousins are now in using education as a zombie-making machine! So, for what it's worth, that is one up for the Americans, not the British.

Mr. Pritchett comments on the value of the native capabilities of the individual, with which I have no argument. But I do argue about how education can affect development of those capabilities. From my observation, that kind of capability can be generated in at least 95 per cent of the students with whom I have had dealings on either side of the Atlantic.

On this, American educators say I exaggerate, that extensive capability can be expected of less than five per cent of the population. Two conclusions seem possible: either we are talking about totally different populations, because we have been living on a different planet; or else we approach the same population quite differently!

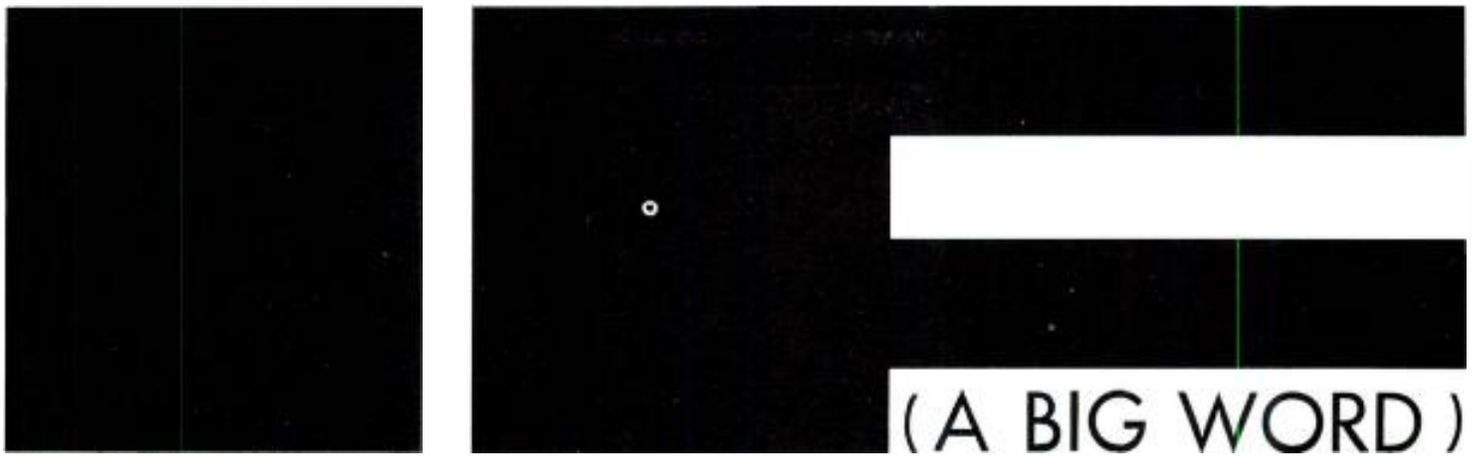
Why does he quarrel with my reference to teachers who do not understand my description of a good

teacher? In my November column, while acknowledging that I had encountered some good teachers, I attempted to emphasize that the training procedure, based on the kind of "education" courses offered, provides no guarantee of turning out good teachers.

About his suggestions for including practical experience with academic education, there is far more to say than a letter can cover adequately. One unfortunate effect of American education has been for those processed by it to conclude that they are in possession of all possible alternatives. This conclusion has occasioned some of my biggest battles with educators.

Well known in today's educational circles are *academic* and *vocational* education, as if that exhausts the possibilities. In my opinion, neither of these, as offered, is even a best approach for the purpose for which each is intended. I hope to elaborate on what can be done, once we escape the existing conclusion that we know it all, in later issues of my column.

Norman H. Crowhurst,
Educational Services International,
Dallas, Oregon



IF . . . .

Your **lathe** is still using a preview system for variable pitch and depth control.

Your **variable pitch and depth computer** is sampling only 4 times instead of 120 times per turntable revolution.

You have to **wait** over a second instead of returning instantly to fixed pitch after the last overide excursion.

You are **duplicating everything** in your program channel equally in the preview channel for your variable pitch/depth system.

You have to **make two** EQ, level, etc. changes for one, to maintain the lathe control accuracy.

Your lathe control circuits are **still analog** instead of digitally computerized.

You would like to have your lathe see every **miniscule change** made in the program signal for perfect groove geometry.

You are looking for **total automation** dependent solely on the recording level.

You would like to **cut directly** from mic, console, or any other source to disc master with complete variable pitch/depth control.

You would like to **do away** with the special preview tape reproducer, lengthy tape paths, and not have to worry about what speed the master tape was recorded at.

You would like to get as much **as 25% more time** on the disc, or trade the time gained for higher levels than ever previously possible.

You're tired of **losing your** starting diameter, or having to recalibrate your cutter every time you change a stylus.

You **can't touch** the lathe microscope once the master has been started.

You're **worried** about your turntable speed because your drive belts are slipping or the pulleys are worn.

You think your old Scully or Neumann can't **outperform** the present "state-of-the-art" machine.

You presently own a **Neumann or Scully** lathe, brand new or antique.

You don't believe there is a **300ms delay line** that has no measurable distortion (+18dbm), a dynamic noise figure of 90db or better, and is flat from 1Hz to 20kHz.

You can't cut a **60cm/s velocity** without a bottle of helium handy.

You have to use a high frequency limiter or "de-esser" to keep **those "S's" silky.**

Your cutting **system lacks headroom** for those difficult **high level 45's.**

Your **600 watts** still isn't quite enough to cut it.

You would like to cut **45's at 6db over** standard that will A/B identically with the input bus.

You can't cut a **1kHz square wave** at 6db over standard and have a 40 microsecond rise time after it has been processed through the entire cutting channel and played back with a commonly used professional cartridge.

Your **IM distortion** isn't under 2% from input to the cutting channel to the playback, at 6db over standard recording level with 7 kHz and 100Hz mixed 1:1. Or at normal level, your IM is over 0.5%. Try that on your present system?

You are **blaming your playback cartridge** because your cutting system can't hack the hot 45 levels.

You're **tired of updating** your cutter and driver system every year at an ever increasing expense to be able to compete.

Your supplier will not **unconditionally guarantee** the cutterhead he sells you for one year against all failures and factory improvements.

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Norman H. Crowhurst

THEORY AND PRACTICE

● My recent mail seems to center around "audio education." However, a closer look reveals that those words can mean two quite distinct things. When educators use those words, they usually mean ways in which audio is used to educate, whatever may be the subject to be learned. But when audio people use them, more often they apply to education in the subject of audio.

Having made that differentiation, next we find that the latter meaning can have its subject divisions, just as every aspect of education does. We can have courses on basic audio, audio systems, audio for studios, audio for public address and sound reinforcement, audio for sonar systems, audio for educational purposes (which gets close to the other usage of the words) and electronic music. There must be many more, but those are enough for starters.

All this division reflects compartmented thinking. There is nothing to say, for example, that audio circuits used in electronic music cannot have features in common with circuits used for a whole variety of other purposes. But where they do, it is a fairly safe bet that either they were discovered for the different purposes independently, or they transferred from one to the other by the accident of having some person transfer his interest from one field to the other.

In fact, we lose an awful lot of effort due to this compartmented thinking habit. Its bad effect extends even to our personal efforts to think things through rationally. Our minds become sort of blocked, at these "subject" boundaries. Let me quote a personal example. As most readers know, my real specialty is electronic circuitry. Of my efforts, a large portion has been devoted to audio, hut I have made side excursions into a fairly wide range of other applications.

Even so, I suffer from this compartmentation as much as the rest of you do. It would seem that education, meaning the study of what constitutes good teaching practice is quite a separate subject from that to which this magazine is devoted, which is definitely audio-related. For that reason, I was for a long while reluctant to write about education in this column.

The day I was invited to visit a private secondary school to observe and to introduce teachers to some new concepts of teaching, audio was the furthest thought from my mind. So I observed math classes, social studies classes, art classes, English classes, and so forth. Then the chemistry teacher almost insisted that I visit her class to help her with some ideas. At this point, my own compartmentation came into the picture very strongly.

You see, my own education never included chemistry, at any level. In school I took courses in physics, mechanics, elec. and mag., hut no chemistry. So the subject makes me uneasy—I felt that these kids probably knew far more than I did, that perhaps I would not even know what they were talking about! But this teacher was so insistent that I could hardly refuse.

She was using a good method, which was to assign to each student an element in the periodic table, for him to research and make a report on

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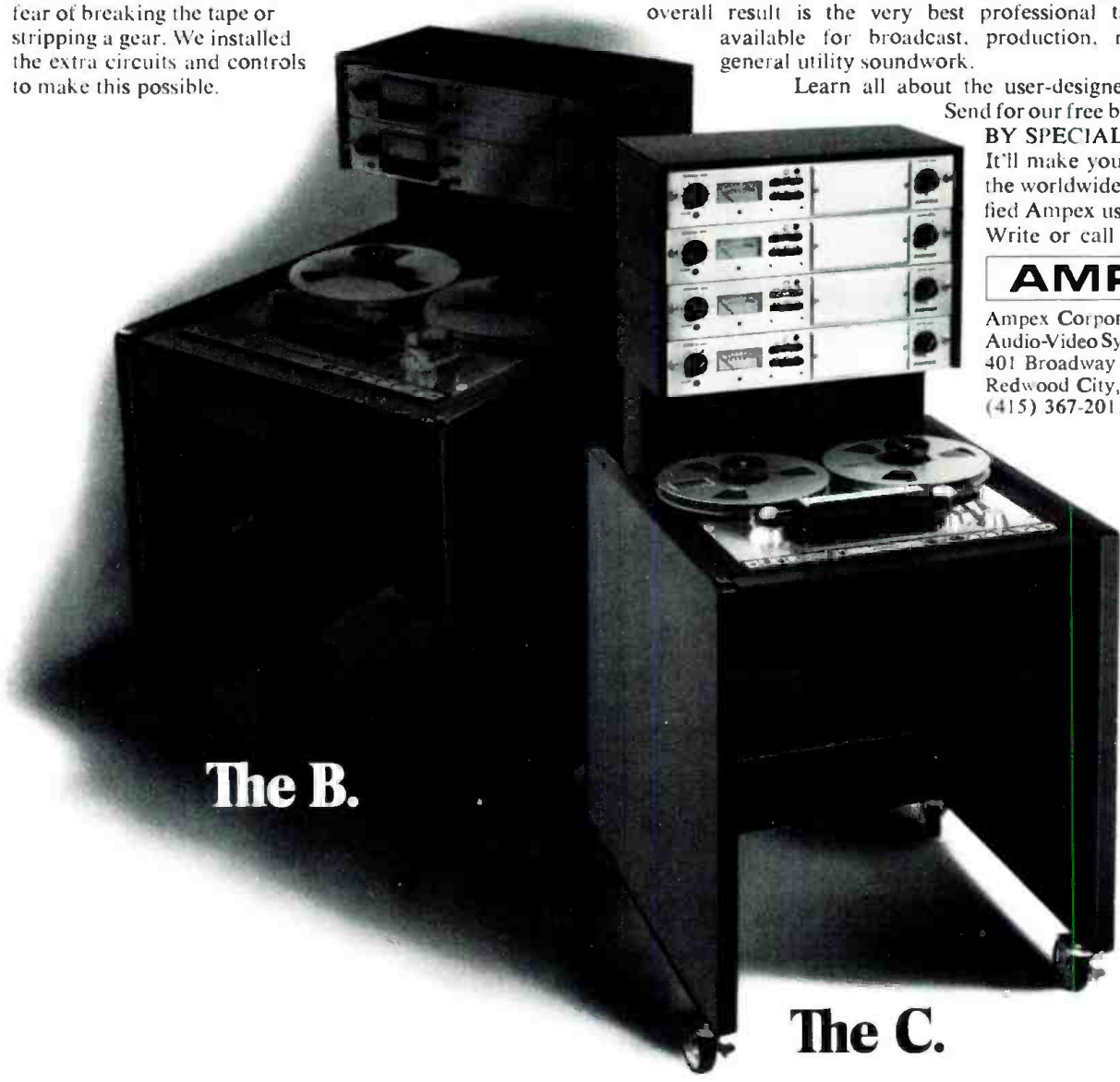

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to the class. The day I visited the class, the student making his report had been assigned silicon.

He covered the atomic number and weight of the element, then included sources of silicon, all of which I knew from somewhere, although I had not studied chemistry, and he finally listed some uses, last of which was "tunnel diodes."

Why he should have listed tunnel diodes, without mentioning any simpler kind of diode, or transistors, or any of the other devices we use in electronics and audio, in which silicon is used, puzzled me a little. Obviously that was the information he had retrieved in his research.

Continuing his report, he went on to comment that he had tried to research what tunnel diodes were, but had come upon such complicated language that he could not begin to understand what it was all about.

That was when I realized why I had been invited into that classroom precisely that day. I am sure that neither the teacher nor the student had planned this, just so I could help at this very point, yet it happened that way. As so often had happened before, I had the impression that there is a Force, ordering our lives, that is far too all-knowing for any of us to comprehend. The trouble is that we so often resist it, just as I had resisted (or wanted to do so) going into that chemistry class.

So I offered to provide an explanation. How could I explain what a tunnel diode is, to a class who had not the foggiest notion what even a simple diode is? At this point the lesson in that classroom departed from chemistry, or even electronics, as such. The subject matter, if it fitted anywhere within conventional school curricula, must have been in the area of communication, which is also sort of this magazine's business. From the school viewpoint, it would have been nearer to the English department, except that no course in English would include this piece of instruction!

First, in my own mind, I asked myself why anyone, probably compiling an entry for an encyclopedia, would list tunnel diodes as the lone electronic instance of uses for silicon? This had me reflecting on the way most compilers work. They search (often erroneously called *research*), all available literature for uses of a word, in this instance *silicon*. Obviously the guy putting this entry together had done so at a time when an electronics publication he happened to have handy had been discussing the development of tunnel diodes.

Of course, no such publication

would bother to mention that silicon was also used for other kinds of diode, not to mention transistors, etc., because all the regular readers of such a magazine would know that quite well. The magazine was not written—come to think of it, nor is this one—with encyclopedia researchers in mind! So all this researcher, who obviously had no electronics background, found out, was that silicon is used in tunnel diodes.

So I briefly explained all this to the class, who had been quite puzzled why things of this nature, that they could not understand, so often cropped up. Then I gave them a five minute introduction to what silicon devices can do in electronic circuits, at a level they could understand, realizing that they probably did not know the difference between voltage and current!

They were very interested in all this and asked some extremely intelligent questions. The teacher was very happy with the help I gave her class. Nobody there knew that I had been scared to go into that classroom! What her students learned that day was far broader than chemistry, a little electronics, or the uses of silicon! The issue was taking *care* in research, getting all the facts. and using them creatively.

How does all this relate to audio education? Let me ask this: how does any one thing, in this compartmented world, relate to any other? We never know, until we find an unexpected linkage like that. To me, the main lesson from that experience concerned the importance of making such a situation the basis for a useful learning experience.

Perhaps I can highlight what that means by thinking of the alternative. How was these children's education progressing, at that point? The teacher's method was indisputably good. Yet they were accumulating information, in subject categories, hoping to remember little pieces of hodgepodge that might someday be useful. As input, they probably encountered thousands, maybe millions of pieces of information like that "silicon is used to make tunnel diodes" bit.

If they happened to remember that particular piece, among the millions of irrelevant facts showered on them, the best possible connection they could later make might be that tunnel diodes are used in electronics for something or other. Thus they might eventually put it together, as random incomplete information. How does that strike you, as a way to learn?

What this kind of process does not do is to generate the capability to think creatively for oneself. Data researching, to find things that go together, is not creative thinking. The learner within such a system is almost entirely dependent on external data. with very little guide as to how he can go about *ordering* such data into an intelligent concept of the universe.

Well-designed multi-media materials, particularly those that employ some form of audio accompanied by an appropriate form of visuals, can help bridge some of these many and enormous gaps. But would you ever dream of coupling chemistry, electronics and encyclopedia research in such a presentation? Probably not. Yet that was what that question about tunnel diodes led me to do, and was what that class needed—or certainly appreciated—at that point in time.

Perhaps, too, that would be a rather extreme kind of example to put into a mediated course. But that is the *kind* of thing we need to do: to break down the compartmenting barriers. so students can go about bridging the almost infinite number of gaps in learning, for which such compartmentalization has become responsible.

Try to put yourselves in the shoes of the students in that classroom, as an example typical of situations that happen by the million, every day, in American schools. Wihout that little bit of help, the piece of data, "silicon is used to make tunnel diodes," would have been just one more among millions of little pieces of useless (because unrelated) information to which they are continuously subjected.

Instead, it was converted into a piece of information about how all such situations can arise: a clue to help them toward unraveling both that and all similar situations. They didn't really *need* to know, at that stage, that silicon is used for making tunnel diodes, or probably many more of the millions of *facts* they accumulate, and mostly forget, because of the sheer enormity of the data bank they are expected to absorb.

In designing multi-media materials, such an experience can be converted into planned activities for students that will serve the purpose of leading students to learn how to deal with irrelevant information instead of being constantly puzzled by it and often completely misled as to what is important to them at this moment and what is not. They will be encouraged to start building their own personal knowledge and concepts, rather than collecting masses of apparently unrelated "facts." They will acquire the thinking-for-themselves capability that will develop them into creative, contributive citizens.

And this, really, is what it's all about! ■

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SOUND WITH IMAGES

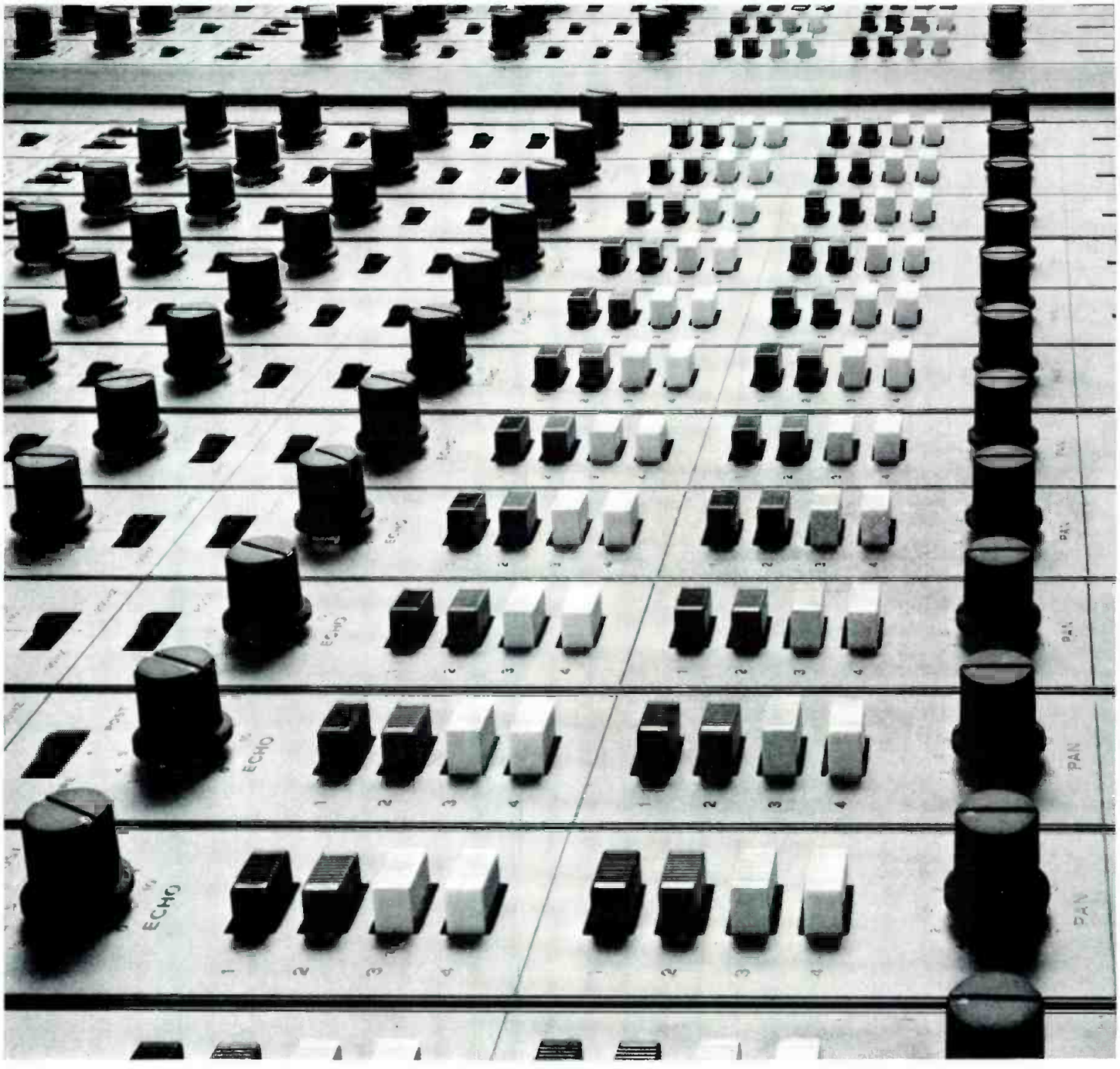
PIP

• Last time, we discussed a piece of equipment which might not be well known to all of our readers, with the idea that it might prove to be of some value in present or future a/v systems. This time we would like to brief through a complete a/v presentation system which also might be unfamiliar to some of you.

Almost everyone is familiar with at least one method of presenting a complete show, including the sound and the visuals, in an automatic setup. For example, a film-strip can be shown completely automatically by using a disc or tape which contains the audio portion and a series of triggering signals for advancing the film. This provides a series of individual images on the screen with a continuous running commentary on the speaker. With the disc, the show always remains the same, while with a tape, the cues and sound track can be changed if desired, but a frame-by-frame image is still presented on the screen. Similarly, a two-track tape can also be used to provide the sound and triggering cues for a slide presentation with the single images advanced by the signals on the tape. Here again, no motion is possible on the screen unless a means is found to add a film projector and a special method for including more equipment to trigger the film. Another limitation to the slide presentation is that drums, cubes, and trays can only hold a certain number of slides and must be changed at some point to continue the showing. A presentation system introduced several years ago compensates for these shortcomings.

This same presentation system also has advantages over a film showing which has motion, but no still-frame. If the projector has a still-frame capability, the sound will stop when the picture stops. If a single image is to be kept on the screen for any length of time, the film keeps running at the same speed, but the same frame is repeated as long as needed in order to keep the audio going. This relatively new system can incorporate stop-motion, slow motion, skipped frames, and can even be adjusted during the presentation, while the audio continues normally. It is called Personalized Individual Presentation (PIP), and has become widely accepted by industry, educational institutions, and government.

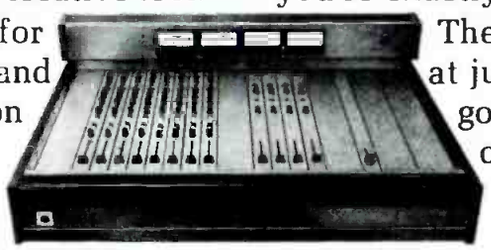
The idea was conceived toward the end of 1967, developed by Philips of Holland, and in 1968 the first unit was sent to this country for evaluation. The Norelco Training and Education Systems Group of North American Philips added some new features and set up production facilities for the



The Model 10 Mixing Console
When you've got more talent than money

Any mixing console is simply a creative tool. Getting the most out of it calls for imaginative insight into music and skill in the practical application of sound.

If you've got the talent but you don't have the money, you're exactly who we built this board for. The basic 8-in, 4-out board starts at just $1890. From there you can go to 24-in, with options and accessories enough to fill a studio. The TASCAM Model 10. It gets your inside outside.



TASCAM CORPORATION

5440 McConnell Avenue
Los Angeles, Calif. 90066

Circle 16 on Reader Service Card

manufacture of the necessary equipment to make up the complete audio/visual system. The individual units which go to make up the total system include an audio/visual playback unit, a frame pulse generator, a pulse sequence generator, a visual cassette for the film, a standard audio cassette for the sound, and accessories such as a storage album, headset, and carrying case.

The audio-visual unit is self contained and is ready for use as soon as it's plugged in and the visual and audio cassettes are inserted. The unit consists of a rear screen (4¾ inch x 6½ inch, a built-in speaker as well as two headphone jacks, and a volume control. Separate controls are available for the audio and the visual. The tape can be played, stopped, and run fast forward or rewind. The film can be advanced frame-by-frame or at fast speed in either direction. The total unit is 9 inches wide, and 16 inches in both depth and height. It weighs 16 pounds.

The frame pulse generator produces the control signals which regulate the movement of the film. It provides a frame-advance tone of 1000 Hz (±0.1 percent) with a duration of 32.5 ms (±5 percent), and an automatic stop signal of 150 Hz (±2 percent) for a period of 50ms (±5 percent). For setting up these pulses to record on the tape, there are individual push buttons for each signal, and four different modes to control the speed of the film movement: Manual, 1 to 24 pulses per second (for film motion at any desirable speed), fine adjustment for lip sync., and for external sync. from the pulse sequence generator. The frame pulse generator has a digital counter to read from 0000 to 9999, the capability to count down from any preset number to 0000 with automatic stop at the end during recording, and to count up from 0000 or preset number during playback. A built-in loudspeaker with volume control permits the operator to monitor the sound while setting up the control pulses. The unit is made for standard 19 inch rack mounting and takes 5¼ inches of rack space. It is 9 inches deep and weighs 19 pounds.

The pulse sequence generator, for which provision is made in the fourth mode of operation of the frame pulse generator, is used when it is desired to provide skip-frame operation. It is used in conjunction with the frame pulse generator, is 6¾ inches x 5¼ inches x 2⅜ inches deep, and weighs 2 pounds.

The visual cassette contains standard silent Super-8 film and has a capacity of up to 50 feet (3600 frames). The reel-to-reel hubs permit winding of the film manually, or with a simple jig. The cassette also was engineered with a special tight-wind mechanism to control the way the film lays in the cassette and to prevent unwinding when the cassette is taken out of the equipment. A special pressure and gate plate are built into each cassette to guide the film during forward and reverse motion.

The audio cassette is the standard tape type that comes with a running time of up to 60 minutes in one direction. The tape can only be used in this way because the recording of tone signals for control of the film prevents the cassette from being used in the normal flip-over fashion. The tape audio portion is recorded on the lower two tracks; there is a third track which is not used, to prevent interaction between the sound and the control signals, and the control pulses are recorded on the fourth (top) track. The tape width is 0.150 inches.

In actual operation of the system, there is a pulse on the tape for each

frame that is to be advanced. With the separation of sound from the visual film, the images can be advanced at any desired speed but the sound will continue at the normal rate. Thus, the film can be advanced slowly (at any speed from 1-24 fps) or stopped still at any frame, with precise lip-sync. and normal sounding speech. Normal film projectors run at a constant 24 fps only to keep the audio quality satisfactory, but with this system, the film can run at any speed or even stand still while the sound keeps going. In fact, the film speed can change during the same sequence while the background sound or narration remains normal. The sound will also remain continuous and normal even with frames being skipped at fast speed, and the frames will go by quickly enough to fool the eye into believing the visuals were practically normal.

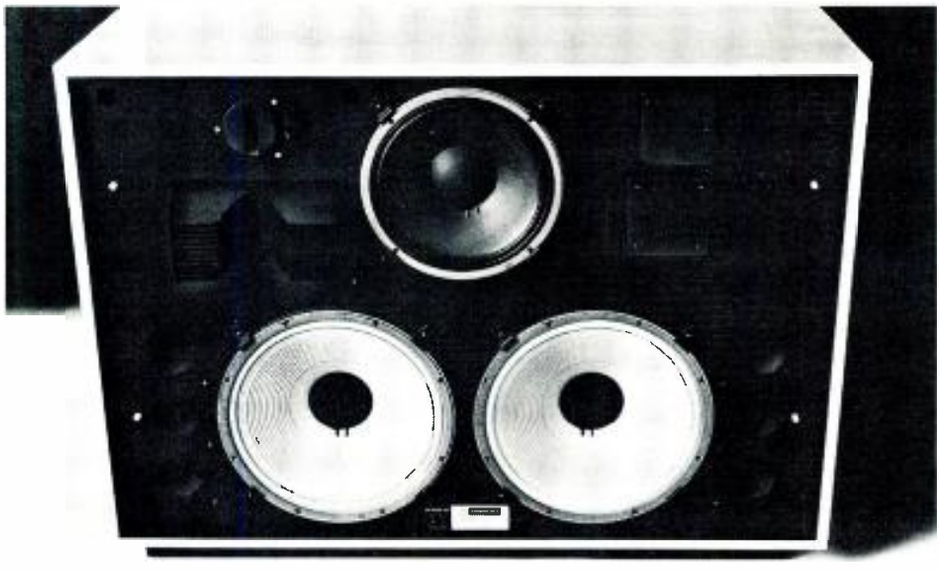
To accomplish this speed change capability, a unique high-speed pulldown mechanism had to be developed. This consists of a continuously rotating shutter which connects with a two-toothed claw by means of a disc and off-set pin. The claw is thus kept in sync. with the shutter at all times. When the film is to be advanced, a solenoid is activiated which engages the claw and the film pulldown is achieved. The shutter and claw move at approximately 55 revolutions per second with the pulldown coming when the shutter is blocking the aperture. The film is advanced at a rate less than 1/100th of a second and the excellent registration of the frames always provides a perfect screen image. It is this speed of operation which also permits quick-cuts and skipped frames almost undetectably. When the claw is not activated, it is held in place by a magnet. With the claw retracted, the frame being seen can be on the screen for any desired length of time at full brilliance (not like the operation of a film projector where a special heat-shield drops into place to protect the film but also cuts down on the light). Pulsing an advance activates the solenoid coil and nullifies the magnet.

The preparation of the film and tape must be worked carefully if the final presentation is to achieve the success intended The visuals can come from any film at any speed. The final film on Super-8 is then made up from a precise story board which indicates the number of frames of action, the still-frames, and the speed of motion during film advance. The audio copy is then marked accordingly to show where the cues will come, and the speed of movement. For single frame advances, the pulse button can be activated manually, while for film movement the number of frames is present (including the speed) and the entire sequence set off with a single start. The film will then stop at the end of the sequence and the process can continue. Should it be necessary to go back, the film (or tape) can be rewound or fast-forwarded independently. With a good script and storyboard, the operator can then resync. the film with the tape at any point and continue the cue process.

Some seemingly important limitations can be visualized, such as the small size of the screen, or the inability to resync. automatically if one of the sync. pulses should get lost. However, the present small screen is meant for small groups or individual viewing and a projection-type system is in the works. As for the lost cues, the system is believed to be so reliable that it was not felt it was necessary to include such provisions.

The system also has great advantage in the economy of software, since less film is necessary and reproduction costs are low. Further information is available from Norelco Training and Education Systems, Morristown, New Jersey. Tell them we sent you. ■

Nobody ever made a monitor that could match this sound.



Type of System	4-way
Components	(2) 15" low frequency loudspeakers (1) 12" midrange loudspeaker (1) High frequency compression driver with horn lens (1) Ultra high frequency compression driver
Frequency Response	30 to 20,000 Hz ± 3dB
Sensitivity (SPL at 30' 1mW)	46.5 dB
Power Output (SPL at 10 ft. in a room volume of 2000 cu. ft. with 1/2 rated power input —150 watts)	110dB
Crossover Frequency	250, 1100 and 9000 Hz
Size	35"x48"x20"
Net Weight	243 lbs (110 kg)
Configuration	Bi-amplification only
Price	Utility finish shown $1314 Walnut finish $1464

The 4350. Three years ago JBL's technical staff was asked to produce the best studio monitor that technology and artistry could create. That was their total assignment. Considerations of cost and monitor size and studio application were secondary. The search was for a sound. The name was 4350. Its birthday was April 13, 1973. And, from the day it was born, it was the best sounding studio monitor money could buy:

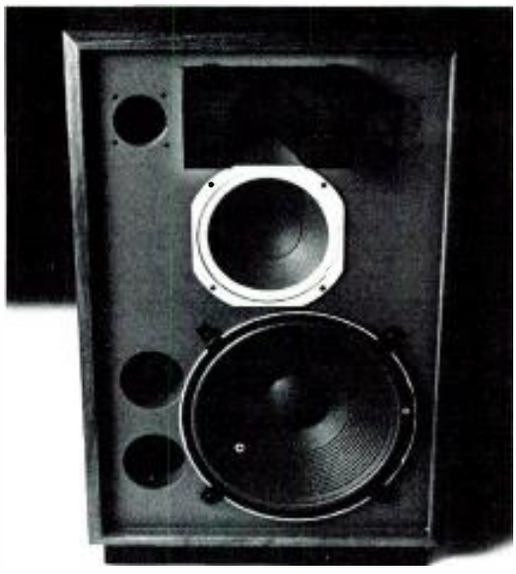
A virtually flat frequency response from 30 to 20,000 Hz. Minimum phase shift throughout the entire band pass. Extraordinary response to onset and transient signals. Carefully controlled, semi-diffuse dispersion pattern throughout the frequency range. Uniform sound characteristics from *ppp* to *fff* dynamic markings. Extremely low transducer distortion within the recommended dynamic range values of more than 90dB. High sensitivity for maximum conversion efficiency.

But, wait. A spec is not a sound. Come hear the 4350 and see how far sound can go.

Circle 31 on Reader Service Card

James B. Lansing Sound / Professional Division / 3249 Casitas Avenue, Los Angeles 90039

Until now.



	The 4340/41	The 4332/33	The 4330/31
Type of System	4-way	3-way	2-way
Components	(1) 15" low frequency loudspeaker (1) 10" midrange loudspeaker (1) High frequency compression driver with horn lens (1) ultra high frequency compression driver	(1) 15" low frequency loudspeaker (1) High frequency compression driver with horn lens (1) Ultra high frequency compression driver	(1) 15" low frequency loudspeaker (1) High frequency compression driver with horn lens
Frequency Response	35 to 20,000 Hz ± 3dB	35 to 20,000 Hz ± 3dB	35 to 15,000 Hz ± 3dB
Sensitivity (SPL at 30' lmW)	44dB	44dB	44dB
Power Output (SPL at 10 ft in a room volume of 2000 cu ft with 1/2 rated power input—37.5 watts)	101dB	101dB	100.5dB
Crossover Frequency	250, 1250 & 9500 Hz	800 and 8500 Hz	800 Hz
Size	38"x24"x20"	30"x24"x20"	30"x24"x20"
Net Weight	179 lbs (81 kg)	121 lbs (55 kg)	96 lbs (44 kg)
Configuration	for bi-amplification or with high level network	for bi-amplification or with high level network	for bi-amplification or with high level network
Price	to be announced	to be announced	to be announced
Availability	June 1974	June 1974	June 1974

Four monitors. Virtually one sound. A matched set: you could record on one, play back on another, mix on a third and master on a fourth.

Four monitors. Their only differences are acoustic output, cost and size.

Hearing is believing. Come hear what you can do.

JBL

NEW PRODUCTS AND SERVICES

RECORDING CONSOLE

● All switching on the Series B recording console is done with mos analog switches. Advanced equalization uses inductorless circuits for minimum phase shift and ringing. Simultaneous indication of average and peak levels is provided by led clipping level indicators. Module interconnections are accomplished by using computer flat cable and connectors. All coupling transformers have been eliminated. 100 percent operational amplifier circuitry includes short-circuit-proof bus driver stages, eliminating unstable push-pull transistor outputs. Protective shielding encloses all modules; the slide fader uses sealed rotary cermet potentiometers. Dual tracking power supply features regulation to .1 percent ripple below 2 mV rms and silicon controlled rectifier crowbar circuitry. All panels are anodized and etched.

Mfr: Multi-Track

Circle 60 on Reader Service Card

SIGNAL PROCESSOR

● The functions of compressor, limiter, and expander are incorporated in Spotmaster CLE-500, aiming to provide optimum level for maximum modulation power and coverage without danger of overmodulation. The manufacturer claims the presence of all characteristics of traditional gated automatic gain control amplifiers and fast acting peak limiters. The unit contains input level control that accepts normal program levels over a 50 dB range; output level control to match any 600 ohm transmitter or line; peak-to-average "tightness" control. Compression, timing, and expansion limits are all determined automatically, while a switch provides for test and proofs of performance. In the test mode, the unit acts as a fixed gain amplifier. It operates on peak program content and average program level separately; an average level section raises and lowers overall gain of the unit to maintain average output at the required level. The peak control section is a dual action limiter. Fast gain reduction with an attack time of approximately 0.1 millisecond will hold all peaks under about 8 kHz, with absolute minimum distortion to lower frequencies, followed by a clipper to cut off higher frequency components until gain reduction occurs.

Mfr: Broadcast Electronics, Inc.

Circle 61 on Reader Service Card

LABORATORY POWER AMPLIFIER

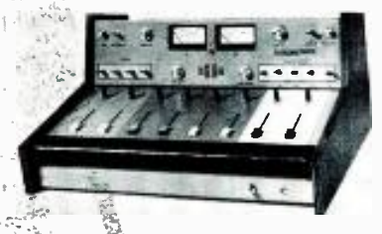
● Over 700 watts can be delivered into an 8 ohm load by model 750 amplifier. The unit can be operated in either mono (bridge connected) or stereo mode and features forced air cooling, silicon controlled rectifier crow bar protection, front panel mounted circuit breaker and as much as 900 watts total output power. There are 3,000 watts of output power transitors, for safety.

Mfr: BGW Systems

Price: $899

Circle 62 on Reader Service Card

BROADCAST CONSOLES



● Six "off-the-shelf" broadcast consoles, designated Series 30000, are being offered by this manufacturer, consisting of a 5-mixer mono unit, two five-mixer stereo and two 8-mixer mono units. Most of the units feature stepless slide faders, mic preamps with built-in limiters, padded armrests and wood grain end panels. All are built with plug-in i.c. op-amp circuitry, accessible for service while the units are in operation by means of hinged meter and control panels.

Mfr: Fairchild/Robins

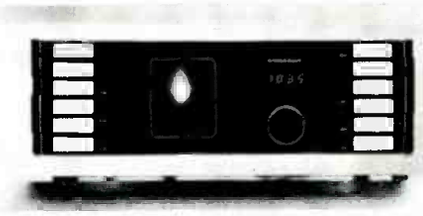
Price: $750.00-$2,990.00.

Circle 72 on Reader Service Card.

F.M. TUNER

● Model 1 f.m. tuner features a 4½ inch flat face oscilloscope displaying four pushbutton operated functions: a panoramic view of all broadcasting f.m. stations located 1 mHz above and 1 mHz below the tuned frequency (optional); a fine tuning display showing the instantaneous carrier deviation of the tuned f.m. station against the derived signal strength plus a.m. products of multipath; a stereo display exhibiting the left and right stereo channels along a perpendicular X-Y axis, used for checking separation and phase characteristics of stereo program material; a display showing external audio information of monophonic, stereo, or four channel sources. Other pushbutton functions include separation, used to separate or blend the highs, useful in eliminating unwanted stereo noise, a Dolby pushbutton, three muting pushbuttons, a stereo/mono mode pushbutton, a pushbutton to dim the panel lights and the on/off button. The tuned station frequency is displayed on a digital readout.

Mfr: The Sequerra Co. Inc.
Price: $2,000 ($500 additional for panoramic feature)
Circle 63 on Reader Service Card



SWEEP FUNCTION GENERATOR

● It is possible to set the upper swept frequency limit of model 411 2mHz function generator to 2 percent of full scale; the lower limit is controlled by a sweep width adjustment. Frequency is specified in six-decade ranges from 0.02 Hz to 2 mHz and the dial accuracy is ± 2 percent of full scale. The unit may be frequency modulated over 1,000 to 1 ratio, either internally or externally, up to a rate of 10 kHz. Waveform outputs are sine, square, triangle, ramp and a T²L compatible sync pulse square wave. Amplitude of the main output is 20 volts peak-to-peak open circuit and 10 volts into either 50 or 600 ohms load.

Mfr: Systron-Donner (Datapulse)
Price: $450
Circle 64 on Reader Service Card

MARSHALL KING

Sound in the House

What happens when a television mixer comes into a hall that has its own sound system and operator. This article explores how both the room and the television feed get the best possible sound.

IF A P.A. SYSTEM is working properly, the paying customer should be unaware of it. If the public becomes aware of the public address, it is usually because of some negative aspect such as

- Seeing a performer walk up to a microphone, seeing his lips move, and not hearing a word.
- Having a performance interrupted by a screeching howl which we've all come to call feedback.
- Suffering through a performer's insecurity as he walks up to the mike, taps on it with great vigor, leans into it and shouts, "Is this thing working?"
- Trying to enjoy a glass of wine in an otherwise elegant restaurant while trying to hear one's partner's words as four strangers ninety feet away are trying to start World War III, using only guitar amplifiers as weapons.

In spite of this nonsense which happens daily in Wellington as well as New York, in Novo Marinsk as well as London, there are many marvelous things occurring, both in equipment and manpower, which render modern-day public address a thing of delight. So much so, that without this excellence, a great deal of the entertainment business which supports us would not be possible.

Probably the ultimate in the good use of p.a. is to be found in the clubs of Las Vegas, where sound is everything. If there's any doubt about this, just turn off the p.a. and everything will come to a halt . . . rehearsals will stop during the day and customers will want their money back at night. This is not to imply that the network of elaborate p.a. systems along Vegas' glittering strip is the only thing holding that town together, but even with the attraction of gambling it's not hard to believe that without its p.a. systems, Las Vegas might join Rhyolite and Tonopah as interesting ghost towns of the past. So important has "sound in the house" become to the billion dollar night club industry there, that we've devoted the last half of this article to Vegas sound, as seen from the viewpoint of John Scheib, one of that city's p.a. men.

But all of us don't work night clubs, and our p.a. problems take different forms. Of particular interest is the public address required when a show is being filmed or taped for television. The one glaring difference between this type of p.a. and the Vegas kind is that here the target for our sound is not just the audience sitting in front of the performers; it is the sound track of our film or tape.

In fact, to some extent, the live audience is a nuisance to the t.v. mixer. Why? Because he is trying to get a tight sound, trying to get a recording-studio quality, trying to keep some control over the final product. The one thing that can destroy it for him the fastest is a p.a. that's too loud. And the matter of what constitutes "too loud" has caused many a squabble between the talent and the technician. The extreme viewpoints are that the performer wants a bunch of it, for it is his security—the t.v. mixer would like to hear none of it, for it destroys the sound he is trying to put on tape. In between is a continuing tug-of-war and a perpetual compromise, which usually means that no one is totally happy. When calmer heads prevail, performers know that too much p.a. makes the taped audio sound as if it's coming from the moon, while on the other side of the coin, the mixer has to admit that if the live audience can't hear the material, the performer won't get their reaction, which is critical to the performance.

The p.a. systems used in auditoriums where people watch televised shows are, as a group, embarrassingly absurd. They constitute one of the saddest commentaries on audio planning to be found anywhere, with my apologies to the exceptions. They aren't planned at all, they just happen, like warts or three-car collisions. Thanks to Vegas (And I guess this means thanks to Las Vegas money) better techniques and thoughts for *planning ahead* are being embraced, ever so slowly, by the television industry. But even today, at this writing, you can walk into the studios where the top forty shows are produced in front of a live audience and find at least half (this is my guess) of the p.a. systems are nothing more than a guy sitting in the audience with one pot in his lap which controls whatever composite feed the mixer sends him from the booth. And even more unbelievable, this feed *follows* the mix in the booth. You can imagine the great "out-guessing game" that must ensue between the p.a. man and the mixer. This undesirable situation, shown in FIGURE 1, is not uncommon.

When I am assigned to a show where this is the going practice, I merely let the *normal* jacks prevail (at Point B in the diagram of FIGURE 1) so I can control the p.a. myself. Then I tell the p.a. man to sit back and enjoy the show, since his pot is not connected to anything anyway. The result is invariably better, not because I am more capable than he, but because he cannot possibly know when I am reaching or ducking a particular fader in a particular circumstance.

A far better solution would be to make the man a virtual necessity by giving him a proper p.a. console with enough feeds to conrtol the sound in the house, each feed being independent of the mixer's settings in the booth. This happy situation does indeed exist in a growing number of places, and is shown in FIGURE 2.

What happens when a t.v. mixer and a Vegas house p.a. man are to work together on the same show? On the surface it looks like it would be a cinch, for the happy situation of FIGURE 2 would surely prevail, where an auxiliary take-off from every pre-amp of the t.v. console would be fed un-mixed to the p.a. console in the house.

Marshall King is a television audio mixer with many big specials to his credit.

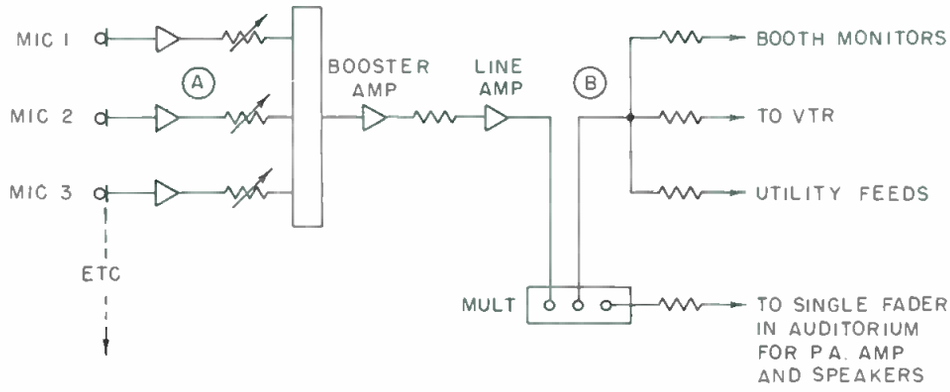


Figure 1. A single composite feed to public address.

A joyous occasion, to be sure, but it almost never works that way for the following reasons.

Let's say that a Vegas show is drawing big crowds and along comes a t.v. producer who decides that it would make a great television special. His decision has come at the last moment after he has raised the money and when there is no time (nor is it included in the budget) to arrange for an expanded p.a. to accommodate the situation. Often, here's what happens.

The p.a. mixing console in the house is set to handle at least three groups of sound sources: the solo mics, the orchestra sections, and special effects. This board might be sketched as shown in FIGURE 3. True, he has a spare input or two, but they are kept open mainly for emergencies. Now the emergency happens to be the *televising* of this house show.

Let's say that you have been hired as the t.v. mixer and a video truck has been provided with a modern audio console. After a moment's discussion with the house p.a. man you can see that the following serious problems exist:

1. The mikes you need to do the t.v. show are different both in number and placement than the ones he uses night after night. All of your t.v. sound comes from the output of the microphones and they must be placed accordingly. His house sound, on the other hand, comes not only from his mikes but from the performers *directly* (especially from the orchestra), so his mikes are placed to accommodate this reinforcement. For example, the customers can hear the brass section without any help from p.a. mikes, but the video tape will not get an acceptable pickup unless the brass is miked appropriately.

2. Even if they could use common mics, neither man wants to double-terminate the output of each mic into two consoles. Ignoring the obvious mis-match, the lack of isolation would be unacceptable, for any hum, buzzes, or shorts on any one input will be reflected into the other.

3. Taking un-mixed feeds from each of the t.v. preamps and sending them to the p.a. console 1,500 feet away is an ideal situation that probably cannot be realized simply because you can't get your hands on 22,500 feet of cable.

4. Even if you could find the cable, the house p.a. console cannot accommodate your 15 un-mixed feeds, for he has only two or three spare inputs on his board, the ones he was saving for emergencies. He cannot tear down his normal stage patching to his p.a. console just to accommodate your t.v. show, for the minute your work for television is through, he must go straight ahead with another p.a. performance for the house—and he scarcely has time to re-patch his board and check out all circuits before show-time. He wouldn't do it even if he could, for he is not about to put the house show in jeopardy; that's where his bread-and-butter comes from, not from a one-time t.v. show in which he has only a passing interest.

Now there you stand, knowing full well there are two possible situations that would work, and neither is available to you. One would be that the p.a. man had fifteen un-used inputs to accommodate your fifteen un-mixed feeds, and the other that he had a p.a. console with auxiliary take-offs on each of *his* pre-amps so that he could feed *you* unmixed feeds on every circuit. Incidentally, even if the above solutions were available, there would be a very subjective human element at work which might make both mixers feel uncomfortable unless there existed a mutual feeling of complete trust and understanding. That is, whichever man is *taking* the feed is at the total mercy of the other's equipment, and most mixers are reluctant to rely solely on someone else's feeds when they're involved in a production that earns both their livelihoods and their reputations, and one that is costing someone a hundred thousand dollars.

This impasse almost suggests that there will be two complete sets of mics on stage, one for the house performances and one for the television show. But as you might have guessed, this is an unallowable situation, for no one would be able to see the performance because of the hardware. What we know is this: When Sammy Davis walks to stage center, in no way does he want to see two stands and two mics. We know that he wants to grab one mic off one stand. . . . whose is it going to be? As far as the t.v. producer is concerned, Davis had better be heard on television coast-to-coast three months from now when the tape is released. As far as the club manager is concerned, he'd better be heard by the cash customers as soon as he grabs that mic. As far as Davis is concerned, he'd better be heard by everyone, both now and later. Any questions?

We who work in electronics have been trained to believe that anything can be done—smartly, neatly, professionally—given enough time and information. But, as stated, when the almighty dollar takes over at the last minute, and when one set of parameters (the t.v. requirements) moves in on another set (the house requirements), we have to forget our textbooks and search for a solution that will produce a show, however expedient. Science notwithstanding, we do it again and again, and such expediency is called television. We have learned to live with it much as we do arthritis. To the freelance mixer it's a way of life, and he comes to regard it with the same affection he holds for the 72-mile hike between the airplane and the taxi stand at the Las Vegas airport.

It is the good fortune of all of us that the house sound men in Las Vegas are the nice guys they are. Invariably they will go out of their way to help our problems disappear. In the case we're discussing here, the solution most certainly arrived at is to have his mics feed his p.a. system during the evening's shows that are not televised, while your mics go directly to the t.v. truck.

This means that during his 8:15 house performance, your mics have been hooked up and tested and are wait-

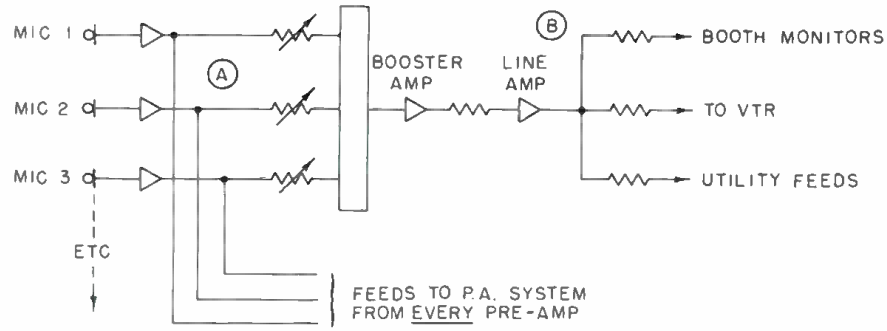


Figure 2. Unmixed feeds to public address.

ing unused in the wings. Just prior to your 11:45 televised show, his mics are taken off the stage and placed in the wings while yours are set in place. The audience hears your t.v. show on the p.a. by virtue of your feeding the output of one or more sub-buses to the house p.a. booth, the number of feeds depending on how many spare inputs he has. While the limiting factors of time and facilities have made this the only compromise in sight, it is a poor one that we must live with, for he is now taking a feed that follows your mix, the ugly situation described in FIGURE 1. In a night club this can be disastrous, for the volume of sound in the auditorium is expected to be, if nothing else, consistent. Yet, in t.v. mixing, when a singer belts a note, you may have to duck the fader to preclude an overload, and of course if the p.a. feed follows your fader, it takes an accompanying nosedive. This forces the house man to work 180 degrees out of phase with you; when you go down he goes up. It's an effort, and he'll usually do it with both skill and spirit, for he knows, just as you do, that all other avenues are impractical under the circumstances.

Television hook-ups nothwithstanding, Las Vegas sound has to be the leader in the p.a. craft as it applies to four walls, and we'll get a closer look at it in the second part of this article. First, let's look at some of the p.a. problems likely to be found by the tv-mixer on a show that is done at outdoor locations on the road. Such a show was called *Operation: Entertainment!* and it toured U. S., military bases in 1967 and 1968.

This show was designed to be performed in fields which could accommodate several thousand troops, and the only equipment provided for us at each location was the bare field and a source of a.c. power. We brought our own stage, our own t.v. truck, our own tents, our own p.a. system, and all the rest. More than once our taping had to be stopped by a twister or a line squall moving through the area. The only time we moved inside because of bad weather was at the Norton Air Force Base in San Bernardino. We moved our stage from the aircraft runway to a spot inside the giant hangar, and I realized at once I was in the world's greatest echo chamber. It was with heavy heart that I listened to a workman, high up on a catwalk near the ceiling, hammering away on a steel girder. Each stroke of his mallet bounced around the huge cavern long after he had done the actual pounding. When director Bill Carruthers came over and asked if I thought the acoustics would be acceptable, I couldn't resist telling him:

"Bill, do you hear someone hammering?"

"Of course I do."

"Well, I don't want to discourage you, but there's no one up there now. That hammering was done yesterday."

But we got through the show in fine shape, if you can discount the fact that the massive reverb made all the performers look as though they were out of sync. More important to us here is the p.a. setup on the remaining 38 shows which were done out-of-doors.

An independent public-address firm supplied us with a man named Bob Bradley who brought along many pounds of amplifiers, speakers, and scaffolding—all of which were driven in a leased Red Ball van, along with the rest of our gear, to arrive ahead of our airline flights. Bradley was nearly autonomous in his methods for feeding sound to the great outdoors, and on the one occasion where I felt obliged to challenge him, I turned out to be wrong.

There's no denying that his equipment was old-looking. The woofers were trying to hang on to their skins of simulated black leather, beaten and scarred from years and miles of transport. And while the array of high-powered tweeters had once been sprayed gray, they now had the look of long-abandoned beehive parts as they might appear to a gnat investigating an explosion. There was nothing solid-state about his amplifiers (which pleased me at the outset, for I've always preferred he Fleming-valve sound to the harsh, crystal-breaking sound of transistors) and the heat from a formidable array of his 6/16's in push-pull/

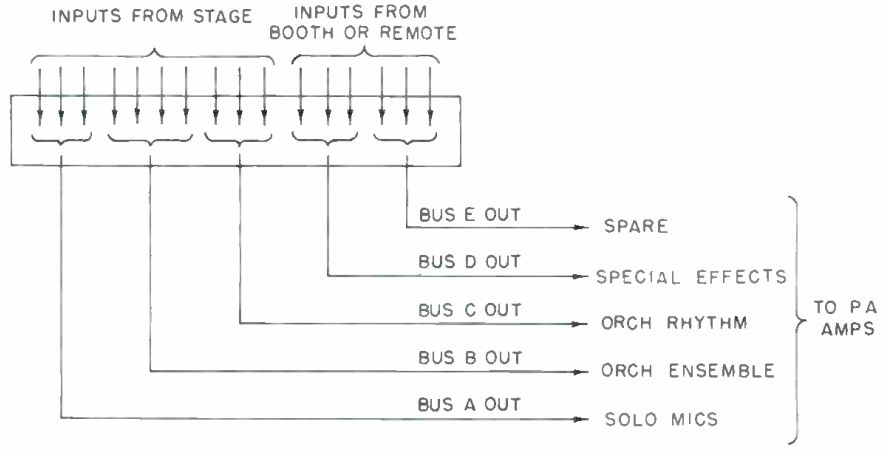


Figure 3. A typical house public-address console.

parallel was enough to thaw a brick of ice at thirty paces. At Ft. Leonard Wood in Missouri we had been given an estimate that 34,000 troops would view our show, and this meant a p.a. throw of a quarter mile or more. My idea was to plant small, low-power speakers all along the meadow that sloped up towards the woods which surrounded the vast area where the troops would be sitting. Bradley wanted to put all his eggs in one basket by mounting all his speakers up front by the stage: the low-power units eight feet off the ground to service the immediate area, and the heavy-duty horns high on a twenty-foot scaffolding aimed at a spot just below the horizon.

True, his plan was the more conventional, but I felt that because of the vastness of the area to be covered, conventional methods would not do. My arguments against Bradley's plan was two-fold: first, I didn't think a speaker existed (in 1968) that could give distortion-free sound in a quarter-mile throw, and second, I was sure that the "lag" felt by the troops sitting in back would be intolerable.

His arguments were exactly opposite. He said that the high-power units would be distortion-free *only* at great distances, and that as far as lag is concerned, it would be far worse to plant low-level speakers interspersed throughout the area where the audience would hear sounds from two sources at different times: the nearby speakers at once, and the neighboring speakers a second or two later. Better for those troops in the distance, Bradley said, to hear the sound only once, and never mind the lip sync, for they couldn't see the faces on stage anyway. (I don't know what he would have said if we had had video monitors throughout the area so they *could* see the faces on stage).

I felt my position weakening, but as a last salvo I challenged him with, "If your higher speakers are that powerful, how will the guys up close be able to stand it? They'll be stripped of their virility the first time the brass section plays a flatted ninth!"

"Simple," he said. "It'll go right over their heads like a swiftly-thrown frisbee. All they'll hear will be the lower speakers."

Bradley was right. For the first fifty yards or so from the stage the big horns may as well have been disconnected, for all the listener could tell. But further out, where the meadow sloped up toward the wooded area, those horns supplied a bounce-free signal that was clean as a reformed junkie. As far as the cross-over area was concerned, Bradley must have done his homework there, too, for in my walk from the distant area down to the stage there was no discernable point where the scaffold horns gave way to the lower speakers. There may have been other ways to do it, but this certainly was one solution to an intimidating p.a. problem.

A final example of p.a. on the road in an obstinate circumstance will suffice before we turn our attention to Las Vegas house sound. Since he has the final responsibility, the mixer must have the final word in audio matters, unless he is released by an over-ride from the producer or director. While he may bow to veteran opinion, as in the example just mentioned with Bradley, there are times when a showdown is inevitable.

Once, on this same *Operation: Entertainment!* we were all set up in the field at what I recall was the Marine Base at Parris Island. Our gear had been tested and found to be in good order, and we were merely standing by waiting for the talent to show up so we could begin rehearsals. To my amazement, a 40-foot covered van pulled up and the young driver started to unload elaborate audio equipment, including powerful p.a. gear with scaffolding. He was the driver, and sound man, for a famous group who were basking in their current hit of *Indian Lake.* They were one of twelve acts who would appear on this particular show. I could appreciate the fact that, since in their travels they probably had to appear in places where the sound system was either atrocious or non-existent, they were obliged to carry their own. Yet, I had to explain to this ambitious youngster that our audio facilities were tried and true and that he'd be proud of the sound we were going to deliver both to the p.a. and to the video tape. I further suggested that since his massive equipment was not only redundant but outright detrimental, why didn't he just relax after his long drive and mosey over to our *Red Ball* van to enjoy an icy six pack?

Operation: Entertainment! Fort Gordon, Augusta, Ga., May 16, 1968. The program was brought to a complete twenty-minute halt by a tornado!

He continued working as though I hadn't spoken. Up went his ironwork, on went his amplifiers, and to feed them he even had his own mics on stage . . . not to feed the video program, but just to feed the audience his own p.a. The result would have been that, during his act, we'd have two sets of mics and stands for the camera to look at—not a very pretty picture. I went to our director and told him that a minor problem was in the making which I could easily handle except that I didn't want to antagonize any of the talent. He merely said, "Do it your way and keep me informed."

By the time I got back to the stage, the visiting sound man was testing out his system, and I was apoplectic. I don't know how many watts he had, but when his group hit their downbeat note it had an immediate effect on the environment: one of our technicians lost control of his bladder and a tornado forming in the distance was blown into Carolina. Obviously I could not tolerate this. For one thing it would have meant that eleven of our twelve acts would be serviced by our own husky p.a. while his act would throw the audio balance of the show into deep trouble. With some discretion, I removed his mics from the stage and gave him a single composite feed from the audio console in the t.v. truck. I had control over this, but every time I took his level down he'd turn it up . . . until he had none left. He took the matter to his boss, the lead singer, and I conferred with the director. The problem was solved in seconds when the director ordered the whole array taken down because it made an ugly picture for the cameras. Fortunately, such encounters are as rare as they are pathetic.

Public address at its finest exists, I feel, in the beautifully equipped clubs in Las Vegas. While this may get a howl of laughter from those sound men who work there and wish they had more facilities (do we *ever* have enough facilities?) there's no denying that these men are responsible for a whole new enlightened approach to sound dispersion on stage and in the adjoining auditorium. True,

Bob Goulet (standing) depends on John Scheib shown here at his equipment (and being helped by wife Robbie Scheib).

they have only a live audience to cater to—no sound for film or tape—and as a result, they can fill the house with volumes of sound that give spasms of ecstasy to performers and screaming nightmares to t.v. mixers. Nevertheless, they have developed techniques that are giving the rest of us clues to better p.a. even while recording for television.

To name one, we have learned not to be afraid of heavy *slap back* (or *stage monitors*, as Vegas calls them) to feed a performer who is working close to a mic. Early in bygone days of television we learned to become very jumpy about feeding a performer's audio back to him with speakers on stage, for until very recently it was a sin to see a microphone in a television picture, so we had to work the mic at some distance away. Judy Garland changed all that for television when she not only insisted on holding the mic against her mouth but she used the mic cable as a prop to fling around her torso to emphasize a dramatic lyric. At last! We could do what Las Vegas had been doing for years—feed the performer a heavy dose of his own audio without any harm being done to the recorded sound on tape. Although Miss Garland gave us this breakthrough in 1965, it is now commonplace to see such performers as Sonny & Cher cover their faces with a Shure SM 61 painted in their favorite cuckoo-bird eggshell. I couldn't be happier, for I've always felt that not allowing a mic in the picture was like not telling the viewers where babies come from.

To name another, Las Vegas is showing t.v. executives (and others who control the purse strings) that there is indeed some great value in establishing a p.a. mixer in the house who has autonomous control over the audio as heard by the studio audience. It is being learned slowly, as only t.v. can do, that there might be some profit in it. Better sound, better program, better rating, more money for stockholders, etc. etc.

Third, many audio mixers who were raised in the profession as true loners who handled everything themselves (early radio, for example), are learning from the p.a. techniques of Las Vegas that in cooperating with sound men working on the same job, a tremendous amount of "impossibles" can be extracted from any production. This means a blending of minds among people having different types of training, belonging to different unions, and wielding different kinds of authority over the end-product. It's great to sit down over hot coffee, even at four in the morning while waiting for a sunrise flight home, with a handful of "strangers" who have helped you help them get through an audio "operation bootstrap." It's happening all the time.

I met John Scheib in just such a circumstance. I had flown in to Las Vegas to do a telethon at the *Circus Circus*. John was working across town as the regular sound man traveling with Bob Goulet who was currently appearing at the *Sands*. Working around his schedule with Goulet, Scheib was able to double as my p.a. man and all-around *confidante* in matters audio at the telethon.

It was after our work was over that I learned what his job was like as a sound man who is paid by a specific performer (Goulet in this case) and who travels with him from theater to theater, as contrasted to a house man who is part of a club's regular crew, no matter what particular talent is appearing at the moment.

Actually, the two work closely together and have the same goals, except that the traveling technician is usually obliged either to take out a working permit from the local union or to hire from their roster a stand-by technician to be on hand all the time he is working on the premises, or both. The way Scheib arranged his set-up at the *Sands* was that he set up his own gear backstage to feed the four monitors to Goulet and the dancers (two speakers on each side in the wings and two out front on each apron), while the house man up in the booth took care of the audience p.a. A third man, also a house technician from IATSE Local 720, was a most affable and busy worker named Marty Roma who did a smooth job not only in handing off the mics to Goulet and cast as they made their whirlwind entrances and exits, but also performing some wizardry in keeping straight and untangled the many mic cables that had to be fed out and coiled back to accommodate the comings and goings of such performers as singers, dancers, comics, and Goulet himself. All traffic seemed to railroad through the narrow passage at stage left where Scheib had his amplifiers and where Marty had the mics and cables coiled for instant use.

Even though Scheib had the able assistance of these two house technicians, he was the one who was responsible for the layout and set-up of the show's audio, and he alone had to answer to Goulet in all matters pertaining to sound. Here's what John had to say:

"Road work is half sound/half politics. Unless you bring the complete sound system and the men to set it up, you need the good-will and cooperation of local personnel. In my present situation, I carry only that equipment needed for on-stage monitoring by the talent. What gets to the audience is in the hands of the local house man. This has advantages and disadvantages. For example, I know what the artist wants his audience to hear, so I could probably mix it myself more easily than explain it to someone else. However, the local man knows his "house" better than I and he knows the little tricks needed to get the right sound out there. Even if I had a complete system with me, I'd need his cooperation because of this. No man knows all there is to know about sound and acoustics (although I've met some who think they do). Cooperation is especially important when using a split system—that is, road sound to the stage and house sound to the house. If I'm riding the gain up while he's riding it down, we both go crazy. Good communication is very important.

"Another important aspect is *understanding* between the artist and the sound man. It's especially so when you're working together constantly. I've seen more than one

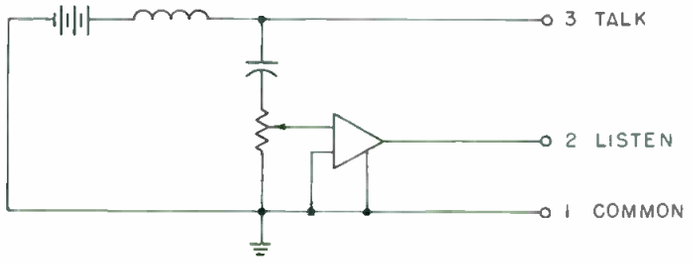


Figure 4. This is the author's suggested cue-calling circuit.

man fired over personality differences (myself included). If you don't like the type of material the artist is doing, chances are you won't do the sound well, consistently. And in the case of a singer, consistency is more important than quality.

"It's also important to remember that what worked at the last nine theaters won't necessarily work in the tenth. Each theater (or club or arena) has a different set of acoustics to deal with. As an example, there are two theaters in Edmondton and Calgary (Alberta, Canada) built from the same blueprints. But the accoustics are vastly different! After travelling a bit you'll learn to look over the theater and find the right *starting point*. I've been in places where everything sounded great at rehearsal and lousy when the audience was in. Also, I've found that in some theaters the sound is better with the air conditioning *on* rather than *off*, and some the other way around. But here's a tip: always make sure that the fans are *on* during rehearsal, for that's the way it's going to be during the actual show.

"It's also important to bring everything you might need and some things you might not. Even in the larger cities, it's difficult to find even the simplest item if you don't know where to look for it. Always ask your local man (house technician) where's the best place to find things. If he doesn't know try asking a technician or the chief engineer of a local t.v. station. Bring plenty of alligator clips, spare connectors, and one-to-one transformers, for at least once a month you'll find a ground loop that doesn't want to quit.

"Whenever you can, place yourself in the audience. The house man can get by in his glassed-in booth because he knows the difference between what he hears and what the audience hears. You don't. Stay with your crowd as much as possible.

"A.c. cords (if you havn't used them all!) are great speaker cables, but mark them as such in large letters. Mic cables are second best for this. Use pin 1 for one side and pins 2 and 3 tied together for the other. The shield usually has a greater cross-sectional area, hence greater conduction than the other two wires combined.* Also, if the mic cable, unlike the borrowed a.c. cable, is later used in a circuit for which it was intended without restoring its conductors properly, there will be no damage to the circuit (mic or pre-amp). WARNING: never use a substitute when an a.c. cable is needed; *always* use an a.c. cable.

"Ground your system at one point only (bring all microphone grounds, power supply cords, etc. back to the mixing console whenever possible). Ground all instrument amplifiers, especially when a *direct* pickup is to be used. This cuts down on buzz, hum, and prevents shock from a strong voltage between the a.c. and the instrument.

"If you're travelling with a packaged show, bring your own headset system. It's surprising how many theatres lack good facilities for cue-calling. Build one up using standard mic or speaker cables. Here's a suggested sketch in FIGURE 4. Connect the carbon transmitter to pins 1 and 3, the receivers between 1 and 2. Improvements can be added, such as using a limiting amplifier, or adding a pot in series with each receiver and running the amplifier gain at maximum. If you're responsible for dressing-room monitors, more than one sound man has used a phono-oscillator with some cheap pocket radios, one in each dressing room. It will save hours in set-up and strike time. Be sure to remove the tuning knobs on the radios so they can't be tuned to the ball game instead of your cue-ing circuit.

"Use multi-cables (6-pair, 12-pair, sleeping-beauty boxes, etc.) when practical, but don't lock yourself into it. Have enough adaptors to be able to run individual cables when necessary.

"Have a patch bay with a portable system? You can bet your life, and probably two or three shows a year as well. You should be able to patch into and out of *every* active component in the system. Replaceable modules will help in case of failures, but they aren't much help when you suddenly discover you must do something you hadn't planned on. (I once made a bass amp by using a hi-Z transformer into a pre-amp and eq, then to a power amp and speaker. It wasn't what the bassist was used to, but it got the show on the road until the bass amp was repaired).

"Another life-saver is a pair of phones and an amp wired to *bridge* the output of every active component. A large rotary switch can do the trick if you're adding to an existing system. On a new system, use a momentary button for each. It's great for hunting the source of that strange noise or distortion. It should not affect the mix to the house or stage in any way. (Solo buttons in recording boards are nearly right, but most of them remove the mic from the mixer).

"For stage monitors, use a separate mix. Ideally, you could use an *echo send* bus. Otherwise, if your board has sub-channels, use one or more to re-mix separately for the stage. What the performer needs on stage is seldom anything like what should be heard by the audience. (Notice I said *needs* not *wants*. The performer needs to hear himself for pitch, reference, and security; he does not need, but may want, to hear the glockenspiel).

"As for any new ideas in house p.a. I guess the *Superstar Room* of the *Tropicana* represents the state-of-the-art

* Providing the shield is connected to pin 1 at both ends. M.K.

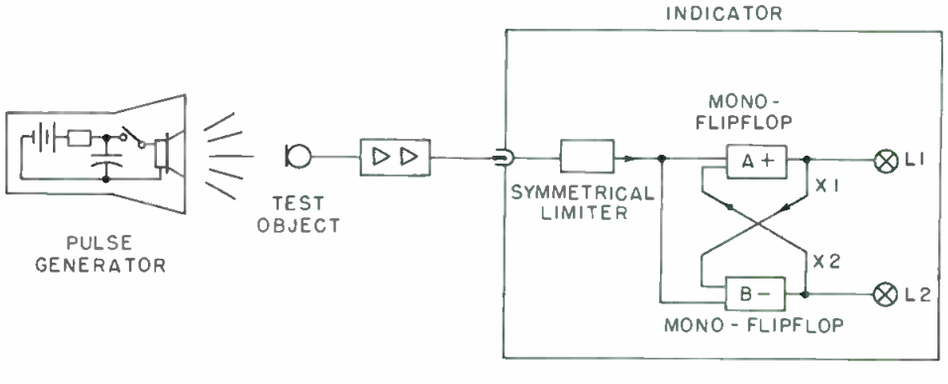


Figure 5. The block diagram of the EMT 160 polarity tester.

right now. The mixer works in the middle of the house rather than up in the booth, on a 32-input board with eight sub-channels and five stage buses! The board was made by PAL of Los Angeles.

"Wireless mics are the heart of good house sound, but the mic worn as a lavalier simply cannot compare to the mic held to the mouth. Therefore, although I've been using the Astro wireless mic, I'm now experimenting with a system designed by ex-Astro engineer Bill Swintek, a system consisting of a Shure 545 mic head working into an eight-inch transmitter operating at approximately 175 Hz —a package that will sell, transmitter and receiver, in the neighborhood of a thousand dollars.

"Always carry a voltmeter, a buzzer, a high-impedance phone with alligator clips, and an acoustic level-meter. Also, a good phase-checker is essential, a good one being the EMT for checking the phase of mics (FIGURE 5). For checking the phase of cables, I've been using an ohmmeter, but I want to build up a box having six lights; when three of them light, the cable is in phase, when the other three light it's not.

"Power amplifiers should be quickly interchangeable. Perhaps each should be equipped with accessible Cannon inputs (will we ever standardize?) and phased twistlock outputs to match the speakers.

"From personal experience I prefer not to use 70V lines, especially with solid-state gear. Reason: too many instances of mismatching, of exceeding the capabilities of the 70V system. Also, you can get distortion from overloading.

"Be careful where you get your a.c. Avoid so-called "hot circuits" from lighting boards. These can get turned off in the shuffle of changing cues, and almost always go off with the board's main switch. Too, they carry spikes from the electronic dimmers. Try to use an a.c. source separate from the lighting board, and *know where the circuit breaker is.* Figure how much of each type of cable you'll need for your estimated set-up, then bring three times that much if you can. You're bound to find yourself in an arena where you don't have enough, or where an uncalled for circumstance demands the excess.

"Find the best way to pack your gear, then memorize where each item goes and put it there every time you pack up. After awhile you'll get so you can look at your packing cases and know exactly what's going along or what's missing. When striking your gear after a show, have all packing cases in one place so they can be visually checked and counted before being loaded for cartage. Even then, before putting them on a truck or van, take one more walk around the premises to see if you've left something behind.

"With regard to glare from mic stands, don't paint them yourself. Take them to a good electro-plating firm and have the chrome-and-nickel stripped, then anodized and dyed black. The result is a permanent and professional-looking flat black . . . and glare free.

"Since security requires putting the mics away every night, use break-away mic clips wherever possible.

"If you order European mics (Sennheiser, AKG, Neumann, etc.), order them with Cannon connectors to match your other equipment. Where this is impossible, make *short* adaptors, including spares, so that you are using only one kind of mic cable.

"If condenser mics are used, build their power supplies into the console, or else all their supplies into one carrying case for convenience. If you generally use the same complement of mics, have one foam-lined case fitted for all, rather than waste time packing each mic into a box when striking.

"Carry multi-boxes of several kinds, according to what kind of connectors you use (Cannon, Yaxley, Hubbell, etc.). These are useful for a variety of feeds, including the headset system mentioned earlier.†

What do I consider the two most useful tools to have within arm's reach? A test headset and a roll of gaffer's tape!

"You've asked me how I bridge the gap between being devoted to the technicalities of electronics and living with the vagaries of talented performers. It's not that difficult, really. I try to keep abreast of what's happening in the technical field, but I never bother the talent with this information. All they want to know is: does it work and how soon can I have it! Performers are mostly human, rumors to the contrary. I don't argue too much, unless what they want is seriously detrimental to the equipment. If they want to try something—O.K., let's try it. Because I've often been surprised and learned something in the process. Keep in mind that he knows you're human, too, and admit it when you've made a mistake or missed a cue. If you always blame the gear or the circumstance, he'll know you're lying at least part of the time so he'll blame you all of the time.

"Never, repeat *never*, ride the gain from his mic to the stage monitor(s). Arrange the circuits so that the level remains as constant as possible, both on his stage monitors as well as in the house. It is intolerable for the performer to hear changes in the sound level when he is working—and believe me, he knows.

"Be consistent in your technique. Once you find something that works, don't change it unless asked to.

"Of course the sound man has to be production-oriented and have a natural feel for the show, but he must still be a technician. He'd better know how to maintain his own gear, for it's hard to find tehcnical help in Podunk, Iowa.

"What do I consider a challenging circumstance? That's when I do a "benefit" rather than my regular (Goulet) show. Benefits are a challenge, for suddenly you're doing sound for five or six acts you have never seen before, and with little or no rehearsal.

"As for personal gripes, here's one I don't mind telling you. Every equipment designer should alternate his years at the drawing board wtih years in the field, operating the very equipment he has designed, and have his livelihood depend on the results he gets. Also, he should be made to maintain it without an ounce of help."

Well, there they are, some of the thoughts of at least one busy house sound man who makes a good living dealing with audio in clubs and theatres where no two situations are the same. In talking to me, John Scheib was quick to point out that he makes no claim to being an authority on public address. "I only know what has worked well for me," John concluded, "and I have equal respect for those who do it another way. If it works for them—then that's it!"

There's no doubt about it, p.a. operation has taken on a new face. There are all kinds of enterprising people trying to change it for the better, including the imaginative technician at the *Forum* in Inglewood who, being bored by the worn-out expression "One two three, testing," wrung out his speakers for 22,000 fans prior to a basketball game by saying over the p.a. system, "Now hear this! A dry martini is actually quite wet." ■

† Although it represents an expense for which there is no tangible return, and it's an item that's too heavy to tote around on every assignment, it is good insurance to make up a Program Distribution Box having, say, ten isolated outputs of approximately 0 dBm. This is for those instances where your mics are the only ones on stage and the event is of widespread importance so that everyone (press services, Armed Forces, etc.) wants to take a feed from you. With isolated outputs, you don't have to worry about their equipment going down in flames and destroying your program. M.K.

JOHN WORAM

The 48th AES Convention and Exhibition

I THOUGHT I JUST DID a story about an A.E.S. Convention, and here I am doing another one! It turns out there's very little time between the European show and the one in Los Angeles, so these convention reports seem almost back-to-back. Yet, despite the timing, there was much to see in California. Fr'instance:

At the LaSalle Audio booth, Aengus Engineering showed their entry into the console field. Their desk is of modular design—in fact even the jack bay has been modularized. Each module contains mic and line insertions, and one track's worth of patch points. An interesting idea, and one that seemed to appeal to many visitors at their booth. In fact, if convention interest is any measure, Aengus should do quite well with this console. It was quite a feat to pry the knob twiddlers away long anough to get a picture or two. There's no overall shot here for a very good reason. Every time I stepped back, the mob closed in, blocking my view. But, next year for sure.

It was a bit easier to photograph Pandora Systems' console, since this little mother is only 22 inches long. I presume it's o.k. to call it that, since the Pandora literature refers to their larger board as the Model 2402 Big Mother. Anyway, little mother contains 12 inputs and 2 outputs, plus equalization and echo send/return facilities.

Pandora's digital delay line has provision for up to five outputs, with delays to 449 milliseconds. Delay times are set via a patch panel on the front plate of the unit. The Pandora people say they will soon have a peripheral gadget that will provide pitch change with no change in tempo, and *vice-versa*. So far, most such devices accomplish their goal at the cost of considerable distortion, making them unfit for music. It will be interesting to see (and hear!) what Pandora has in mind.

The Mic-Mix people were also on hand with a miniature 10 in—4 out console crammed full of goodies—such as compressors and phase meter. It is possible to pan any input across any two outputs via a rather confusing series of switches.

Mic-Mix also demonstrated their Master Room series of artificial reverberation devices. The series sounded most impressive via headphones at their exhibit. The Master Rooms are made in three versions, with decay times of 2, 5, and 7 seconds. Mic-Mix states that the units are designed to simulate the echo patterns in well designed rooms of 4, 200, and 750 thousand cubic feet. Although a brilliance control is included, the user is not able to make adjustments to the decay time. Prices vary from $985 to $1175.

Another new entry in to the console business is the Maze Corporation, from Birmingham, Alabama. Well known as a major supplier of other peoples' equipment—new and used—this is the first time, for me anyway, that I've seen equipment of their own manufacture. The console has 16 inputs, with 16 direct outputs, plus 4 mixing basses. There's a patch bay built in, plus talk back facilities, 20(!) meters, cue mixing etc. It's yours for $9,500, which should make it a strong contender for the budget studio. Or, if you're planning a remote studio, the latest Maze catalog lists a 25 foot Chevrolet Remote Van, wired (but less equipment) and ready to go for $10,000.

And still, *more* consoles!

A.P.I. now has a stock 16 in—4 out modular console, pre-wired to accommodate a variety of options—compressor/limiters, parametric equalizers, and such. Fully loaded, it goes for $17,700, although you can cut this down some by leaving out a few options till later.

The new MCI JH-110 series ¼ and ½ inch tape recorders were another crowd gatherer. Although it's too early to judge their on-the-job performance, they certainly seem to have an abundance of features aimed at pleasing

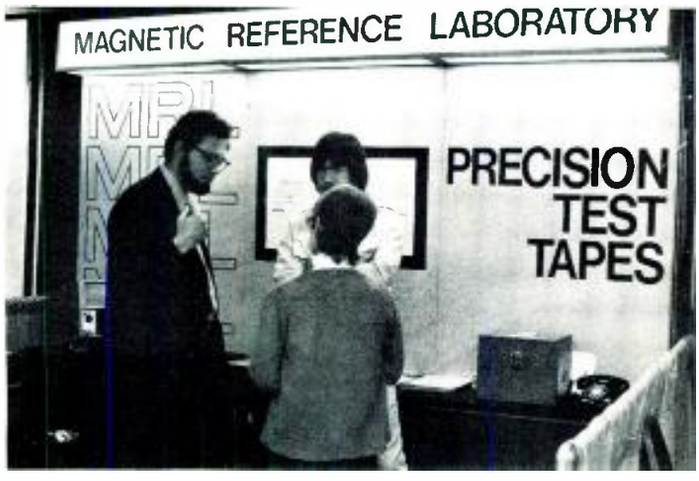
Associate editor John Woram (the big guy with the Nikon) is caught off guard at the Studer booth by the other active Nikon.

Photos are by John Woram and Larry Zide.

Discussions began even on the way. **db Magazine** *editor Larry Zide on left listens to a point being made by Audiotechniques' Ham Brosious.*

C. Hofman of Sennheiser holds a dummy head that accepts miniature condenser mics in its "ears" for binaural recording.

Jay McKnight makes a point about alignment tapes at his booth.



the studio crowd. Electronics are up front, just below the transport, on slide-out trays to facilitate alignment and mainenance. An l.e.d. readout card in the transport section is designed to give the operator a visual cue to system malfunctions, if and when. Tape speed is continuously variable from 5 to 45 in/sec.

I suppose it is unscientific to judge a machine by its cover—that is, by all the various eye-catchers and producer pleasers which may not do a thing to improve wow and flutter or frequency response. But it is refreshing to find MCI designing a machine which hopes to please the modern recording studio rather than the university research lab. Mind you, I have nothing against universities, research, or labs, but I would rather have a machine that is "studio proof" than one that is the delight of the academic community.

I tried to think of some elegant transitional paragraph that would take me away from what I just said before moving on to the Studer booth. However, . . .

Lately the Studer organization seems to be expanding their American operation. Yet, I can't help but wonder how much better they might do by studying—as MCI appears to have done—the American market. Their product shows to advantage the European tradition of craftsmanship. At their booth, they had a transport mounted on a rotating mechanism so that the under side could be seen with ease. I really wouldn't be surprised at all if some other machines would fall apart completely when turned end-over-end, but the Studer deck was certainly equal to the task and the display gave everyone a chance to admire the meticulous construction, and no-compromise quality.

But the machine is designed to European needs and tastes. We here in the colonies have other tastes. At the premium prices being asked, I would love to see a few modifications introduced to make the machine more appealing to the American studio operator.

Back in the dark ages (March, 1971) John Eargle and I did a New York A.E.S. section meeting on new signal processing devices. This was in the early days of electronic phasing, Kepexes, and such. As it happened, it was my job to talk about the just-introduced digital delay line. In describing applications, I speculated that digital delay might eventually replace the preview head in a disc cutting system. At the time, everyone agreed that was a pretty dumb idea.

Well, ha-ha! HAECO have just showed us their AHVP-VDLSC, or, Advance Headless Variable Pitch, Variable Depth Lathe Control System. Using digital delay, a single playback head with appropriate signal processing devices routes the signal to the pitch and depth control mechanisms and, after a suitable delay, to the cutting head. Thus, duplication of limiters, equalizers, and such is no longer necessary. I told you so!

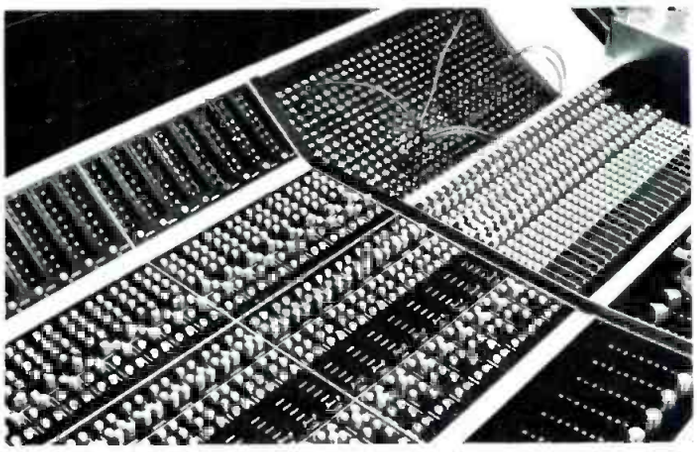
Dukane showed an interesting Audio Spectrum Analyzer, with built-in white and pink noise generators. Scope and trigger outputs are provided for visual display of response in ⅓ octave increments.

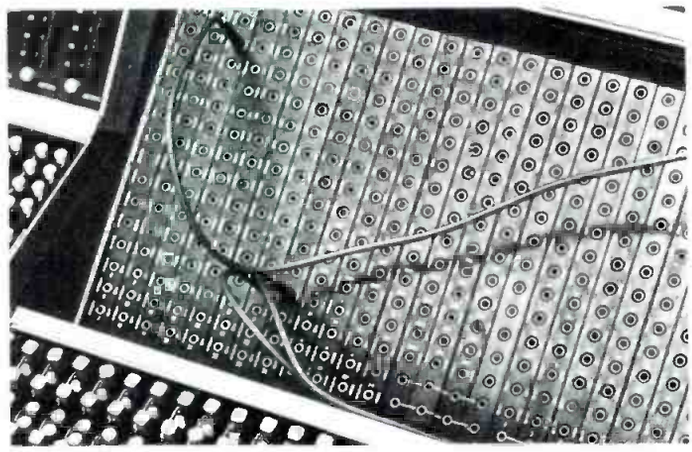
THE NEXT A.E.S. CONVENTION

The 49th convention is by now not too far away. It's September 9 through 12, at the Waldorf-Astoria Hotel in New York. In addition to the regular technical sessions and equipment exhibitions, this year the A.E.S. is sponsoring a seminar series—tutorial lectures intended for the working studio man looking for a better grasp on some of the technology with which he comes in contact.

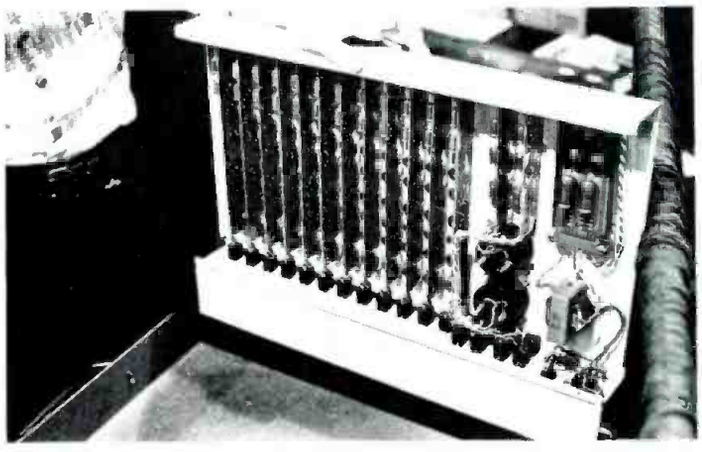
On Monday, Sept. 9th, there will be a program on applications of desk-top calculators to audio problem solving. In the afternoon, there will be an introduction to computer programming, with attendees taught the basics of a simpli-

At left the new Aengus console with their own graphic equalizer; at right a clear shot of the modular patch bay.





Inside (left) and outside the Pandora Mother board.



fied machine language to program typical audio engineering problems.

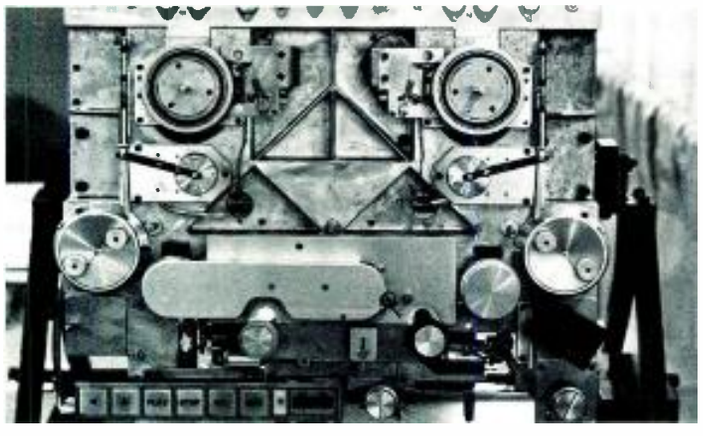
In the evening, several experts in the field will demonstrate audio problem solving techniques on desk top calculators, and discuss the role of the computer in audio engineering.

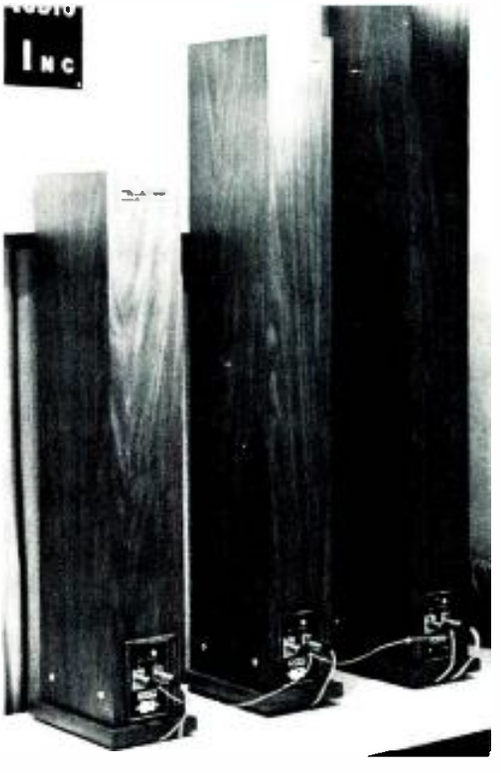
On Tuesday, Sept. 10th, Jay McKnight will discuss the basics of tape-recorder equalization and alignment. And in the afternoon, consultant Robert Hansen will discuss practical studio acoustics.

This seminar series comes about as an effort to offer the applications-oriented man a brief educational service. A more complete description will appear shortly in our coming events section. ■

Gotham Audio showed the smaller EMT 240 stereo reverb unit.

The insides of the Studer A-80, proudly shown by the company.





The Mic-Mix series of Master Rooms.

ABOUT OUR DIRECTORY

● By now, subscribers have received their bonus—a copy of the first Directory of Professional Audio Products. Yes, I *know* that there are some omissions, and *how* could we possibly have overlooked the such-and-such company, and what about etc. etc.?

This little opus took a long time to prepare. For one thing, we are new to the directory business—for another, many companies are reluctant to part with information about what products they manufacture. In more cases than I'd care to remember, it took several notices, plus countless phone calls to prod the necessary information loose. Some folks just ignored us completely. Until they got their copy of the directory.

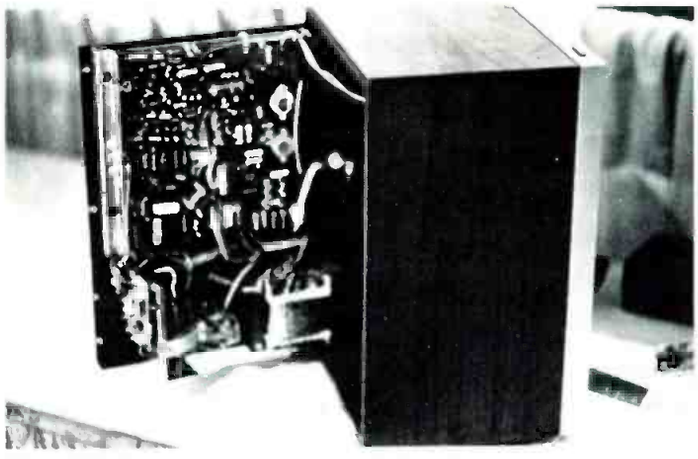
Now, you should see the mail! "How *could* you?" they say. Well, to those companies we overlooked, we're truly sorry. To those who ignored our calls, letters, prayers, and threats, we're sorry too, but we just couldn't wait for you any longer. There'll be a new (bigger and better) directory next year, and we hope that everyone will be included in it. If you are a manufacturer that we overlooked (or perhaps you overlooked us?) make sure we have your name and address soon, so that we may send you our next questionnaire. And when you get it, fill it out and mail it back to us. We'll both be glad you did.

John Woram

MCI's series JH-110 tape recorder. At right the transport is raised to show its undersides.

The Maze 16-track console.

The Tascam Model 10 can now have an advanced monitor control panel, shown here two from the right.



The AKG booth was the scene of the showing of Philips' new bi-amped speaker system.

Electro-Voice's tie-tack condenser microphone.

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PEOPLE, PLACES, HAPPENINGS

• The FTC has issued a trade regulation rule, effective November 4, 1974, intended to standardize claims made by manufacturers regarding power capability in amplifiers used for consumer products. The following disclosures must be made when any representation is made concerning the power output (in watts or otherwise), power band or power frequency response, or distortion capability or characteristic of sound:

The manufacturer's rated minimum sine wave continuous average power output in watts, per channel.

The load impedance, in ohms, for which the manufacturer designs the equipment to be used.

The rated power band or power frequency response.

The rated percentage of maximum total harmonic distortion at any power level from 250mW to the rated power output.

Following are certain minimum standard test conditions to be employed when measuring the disclosed performance data:

The power line voltage shall be 120 volts a.c. (230 volts when the equipment is made for foreign sale or use, unless a different nameplate rating is permanently affixed to the product), rms, using a sinusoidal wave containing less than 2 percent harmonic content. In the case of equipment designed for battery operation only, tests shall be made with the battery power supply for which the particular equipment is designed and such test voltage must be disclosed. If capable of both a.c. and d.c. battery operation, testing shall be with a.c. line operation.

The a.c. power line frequency for domestic equipment shall be 60 Hz and 50 Hz for equipment made for foreign sale or use.

The amplifier shall be preconditioned by simultaneously operating all channels, at one-third of rated power output for one hour using a sinusoidal wave at a frequency of 1,000 Hz.

The preconditioning and testing shall be in still air and an ambient temperature of at least 77 degrees F.

Rated power shall be obtainable at all frequencies within the rated power band without exceeding the rated maximum percentage of total harmonic distortion after input signals at said frequencies have been continuously applied for not less than five minutes at the amplifier's auxiliary input, or if not provided, at the phono input.

At all times during warmup and testing, tone, loudness contour and other controls shall be preset for the flattest response.

Murray G. Crosby

• Murray G. Crosby, perhaps best known in audio engineering circles for his contribution to f.m. radio technology and stereo f.m. multiplexing techniques, died at his home in Syosset, New York on June 8, 1974, at the age of 71.

Crosby earned his B.S. degree from the University of Wisconsin in 1927 and a Professional Electrical Engineering Degree in 1943. A Fellow in the IEEE and, more recently, in the AES, Mr. Crosby was awarded the Modern Pioneer Award by the National Association of Manufacturers in 1940. He was associated with RCA Laboratories in Riverhead, New York, for nearly 20 years and during World War II was commended for his work as technical consultant to the Secretary of War. In 1966 he received the Marvin J. Kelly award (named for the former head of Bell Labs) from the IEEE. More recently, his contributions to Audio and FM Radio were recognized by the presentation of a special award during the 1973 New York AES Convention.

Mr. Crosby held over 200 U.S. Patents, the last of which was granted to him just one day before his death. His Patent for Stereo f.m. Multiplexing was the subject of court battles in 1963-4 after the FCC approved the currently used stereo f.m. standards which Crosby felt infringed upon his patent granted in 1958. Though victorious in a Federal court suit, the decision was reversed by an appeals court and Crosby reaped none of the financial rewards which might otherwise have been his—through licensing of manufacturers of all stereo f.m. tuners and receivers which now number in the millions.

Regarded by many as "another Major Armstrong" (the inventor of f.m. radio), Mr. Crosby continued his research, even after his bitter disappointment and subsequent dissolution of his publicly owned Crosby-Teletronics Corporation. During his last years, Mr. Crosby was involved in a digital sub-audio t.v. transmission system which is to be used for statistical monitoring of t.v. commercials throughout the country, if the FCC approves the technique for broadcast purposes. The company involved in this new effort, Audicom, Inc., plans to continue the promotion of Crosby's newest invention.

Those of us who knew and worked with Murray Crosby will miss his wise counseling, his spirit of innovation and inventiveness and his dedication to his field of endeavor and to the science of communication at large. He is survived by his widow, Marie, and three brothers, Harry, James 2nd and Stuart.

db Magazine thanks noted writer/engineer Leonard Feldman for this recollection.

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