THE SOUND ENGINEERING MAGAZINE

db

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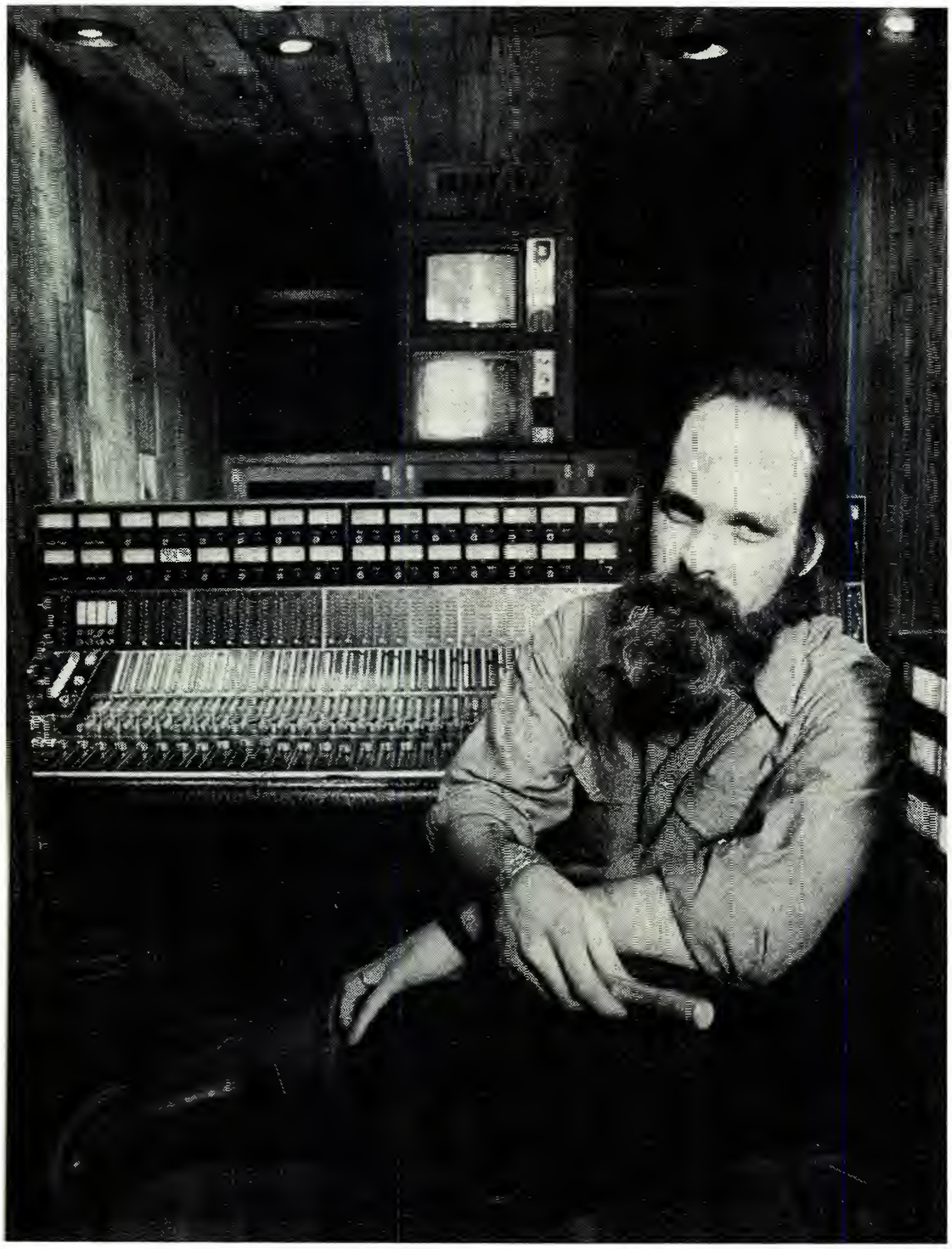
fact: "I never thought such a rugged microphone could sound this great"!



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Coming Next Month

• The April issue of **db** features our big look into the Nashville music industry. We packed-off Associate Editor, Sam Zambuto on a plane to Nashville to do some knocking on doors and find out what's going on in Music City, USA.

Also, Almon Clegg examines the principle of Thevenin's Theorem in audio. What is Thevenin's Theorem? Find out in next month's issue of **db—The Sound Engineering Magazine.**

db

THE SOUND ENGINEERING MAGAZINE

MARCH 1980 VOLUME 14, NUMBER 3

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

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About The Cover

• The Starship Enterprise as seen in "Star Trek"—The Motion Picture. Inset: Al Jolson in the leading role of the landmark original talking picture—The Jazz Singer. For a behind the scenes look at the creation of the synthesized sound effects for the Star Trek movie, see Dirk Dalton's feature article, beginning on page 44 in this month's issue of **db.**

db, the Sound Engineering Magazine (ISSN 0011-7145) is published monthly by Sagamore Publishing Company, Inc. Entire contents copyright © 1980 by Sagamore Publishing Co., 1120 Old Country Road, Plainview, L.I., N.Y. 11803. Telephone (516) 433 6530. db is published for those individuals and firms in professional audio-recording, broadcast, audio-visual, sound reinforcement, consultants, video recording, film sound, etc. Application should be made on the subscription form in the rear of each issue. Subscriptions are $9.00 per year ($18.00 per year outside U.S. Possessions and Mexico; $10.00 per year Canada) in U.S. funds. Single copies are $1.95 each. Editorial, Publishing and Sales Offices: 1120 Old Country Road, Plainview, New York 11803. Controlled circulation postage paid at Kansas City, Missouri.

db Letters

TO THE EDITOR:

(In reply to Stephen F. Temmer's letter in the February, 1980 issue of **db**.)

I am pleased to see comment from members of the industry regarding my article on heaters for condenser mikes (**db**—December, 1979). Recently I spoke with Mr. Stephen Temmer on the subject of cleaning mike diaphragms. I then conferred with other industry representatives, including Geoffrey M. Langdon, Technical Manager, AKG Acoustics; and Albert B. Grundy, an authorized Schoeps service representative. There is apparently no industry concensus of methods of cleaning diaphragms, or the type of solvent permissible. The Neumann company's position is on the conservative (safe) side and therefore they advocate the use of distilled water, and then only by a qualified technician. Another company's representative mentioned the experimental trial of a much stronger solvent and an immersion technique.

A microphone manufacturer is aware of the exact materials composition of the delicate parts of his microphone and therefore can best recommend techniques for cleaning his own microphones and/or diaphragms, and in fact, this requirement may vary from model to model within a manufacturer's product line. I am sorry that I did not stress this point adequately in my article.

What I intended to stress was the *emergency* nature of the cleaning procedure: A professional recording engineer relies on his microphones. In an emergency, due to humidity problems, he must look for instant solutions—especially when on location there may be no nearby "microphone store." The first solution is, of course, to use a back-up microphone; another solution includes the warmup procedure over a 500 watt bulb (this and other techniques are described in my article); a last resort solution may involve cleaning the diaphragm with some solvent: Cleaning with distilled water in a humid environment would obviously defeat the original purpose of the cleaning attempt. That is why I had suggested one of the least volatile of the organic solvents—pure grain alcohol. Thus the recording engineer must choose between the slight risk of losing a costly diaphragm during cleaning, or losing an even more costly recording session!

In response to two other points made in the letter. FIRST: Neumann claims its mikes to be extremely insensitive to humidity problems, as do *all* other reputable manufacturers of condenser microphones. However, in my recording

(Continued on page 6)

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db Calendar

APRIL

9-11 **National Business Radio Dealers' Conference.** Denver, Colorado. Denver Convention Center. For more information contact: *Communications Magazine,* 3900 South Wadsworth Blvd., Denver, CO 80235. (303) 988-4670.

13-16 **National Association of Broadcasters (NAB) 58th Annual Convention and International Exposition.** Las Vegas Convention Center, Las Vegas, Nevada. For more information contact: National Association of Broadcasters, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500

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28-5/1 **NOISEXPO '80.** The National Noise and Vibraton Control Conference and Exhibition. Hyatt Regency O'Hare, Chicago, IL. Registration information is available from: Noisexpo, 27101 East Oviatt Road, Bay Village, OH 44140, (216) 835-0101.

15-18 **Communications '80.** Communications Equipment and Systems Exhibition. National Exhibition Centre, Brighton, England. For more information contact: British Information Services, 845 Third Avenue, New York, NY 10022, (212) 752-8400.

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28-5/1 **Audio-Visual '80 Exhibition & Conference.** Wembley Conference Centre, London, England. For more information contact: British Information Services, 845 Third Avenue, New York, NY 10022, (212) 752-8400.

MAY

3 **1980 Midwest Acoustics Conference.** Chicago, Illinois. Topic: Microphone Techniques for Recording and Broadcasting. Place: Hermann Hall, Illinois Institute of Technology, Chicago, IL. For more information contact: Tony Tutins, Knowles Electronics Inc., 3100 North Mannheim Rd., Franklin Park, Illinois 60131. (312) 455-3600.

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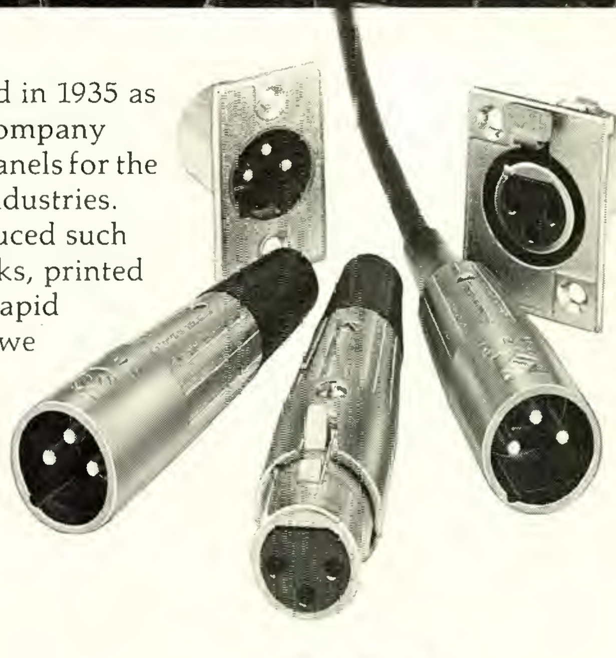

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6-7 **B&K Measurement Seminar—Audiometer Calibration.** B&K Instruments, Inc., 5111 W. 164th St., Cleveland, Ohio 44142. Telephone: (216) 267-4800.

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letters (cont.)

experience, condenser microphones made by the world's most respected manufacturers have occasionally developed humidity problems; and also have favorably responded to one of the solutions mentioned in my article. SECOND: The letter states that the new Neumann U89 has a "unique" construction, having both membranes at 0 volt potential, reducing possible dirt pickup. I feel compelled to mention that Schoeps microphones have always had this "unique" feature.

By the way, the Schoeps capsule must be sent back to Germany as special tools are needed for capsule maintenance. The preamp may be repaired in the U.S. I am pleased with this opportunity to participate in industry dialogue, and to clarify a few points in the readers' interest.

Bob Katz

Sound and Hearing

• Let's get back to this question of digital and analog. In previous columns we have often discussed how, at various stages in the advancement of audio, efforts were made to approach perfection in reproduction. At every stage, there have been aspects of reconciling theory and practice. And long before the words "digital" and "analog" came into common use, this involved the question of how to produce a replica that satisfactorily convinced the human hearing faculty that the sound was "real."

So this comes back to the question of how we hear. Our old friends Fletcher and Munsen did a lot of work, using frequency analysis as a base. They found what intensities of acoustic vibration at various frequencies gave sound impressions of equal loudness, and what levels were necessary for the presence of a stronger "signal" to mask the presence of a weaker one, according to the frequency relationship.

In other areas, people working toward greater realism in reproduction were experimenting with stereo. Back in the 19th century, the fact that binaural hearing produced a stereo illusion had been satisfactorily demonstrated. Now the advocates of stereo wanted to apply that to improve the realism of reproduced sound. And all of this was frequency related.

When the oscilloscope came along, that enabled researchers, experimenters and whoever, to look at waveforms, and some were concerned whether the shape of waveforms, or merely their frequency content, was important. And the answer seemed to be that shape could vary considerably—to limits where recognition by shape was impossible—so long as frequency content did not change, and our hearing could not tell the difference.

This led to the rather natural conclusion that what we really hear is a collection of frequencies, of varying intensity and other variables, that Harry Olson investigated very thoroughly, coming up with the prototype of all synthesizers, using the information he had developed. And that is where the question of digital and analog, with the parts they play in our hearing faculty, started to come into the picture.

Let us digress for a moment into an analogous development: the measurement of time. A clock or watch with old-fashioned hands, driven by a mechanism that included a pendulum or a balance wheel, indicates time in analog fashion. The hands move, to all intents and purposes continuously, to indicate the progress of time, and we read it off by interpolation of the position of the hands.

Then came digital, in which a high frequency master oscillator is used to measure off second intervals very precisely (my digital watch gains about 3 seconds in a month), and electronic counter mechanisms—is that the right word for something that has no moving parts?—produce a read-out of time in digital terms.

ANALOG/DIGITAL COMBINATION

We mention that, because the tendency is to think in terms of analog *or* digital. But now there are some watches appearing on the market that use a quartz oscillator as the master time element, with digital derivation of seconds from that, but then couple that to hands in the time-honored fashion, to give an analog display of the time. And when you think about it, you realize that even the old-fashioned analog timepiece, whether a grandfather clock or a wristwatch, had a digital element in it—the pendulum, or the balance wheel, counted off specific elements of time, a second, a fifth of a second, or whatever, as the escapement wheel rotated.

What this says is that we are never completely in either an analog or a digital world. What varies is where we

translate from one to the other. And this is important in the world of sound, too. Now let us consider the human hearing faculty.

Measurements showed that what we hear is quite critically-controlled by frequency. Human hearing can be extremely critical of musical pitch, the subjective quantity that corresponds with the objective known as frequency. The musical scale divides into semitones, whose intervals have the ratio 1.0594631. This means that if a note has the frequency of 1000 Hz, the next one will have a frequency of 1,059.4631 Hz.

We can clearly hear a step of frequency, represented by 59 Hertz in 1000. But we can hear more critically than that, because we also know if either note is sharp or flat, and a musical person can detect much finer variations than that. Musicologists use a unit called the cent, that divides the semitone interval into 100 cents. If the note is 1000 Hz, a cent is just over half a Hz. Few can hear this much shift in pitch, but a good ear can hear a few cents, which means even fewer Hz in 1000.

What this says is that human hearing can be extremely critical in its discrimination of frequencies. A rather natural assumption is that the human ear behaves somewhat like a microphone—and microphone designers would insist that it is essentially a pressure, not a velocity, microphone—that converts sound waves into electrical "signals" that are sent to the brain along the auditory nerve, for translation there, into the sound sensations we perceive.

NERVE RESPONSE TO STIMULI

But is that what happens? Neurologists have measured how nerves respond to stimuli. They transmit impulses along the nerve fibers at speeds that allow a repetition rate measured in milliseconds—thousandths of a second. In other words, any one nerve can convey only a few hundred impulses a second along it. If you read your driving manual, you will learn about reaction time. This is the time taken for you to see what is happening, for the message to go to your brain, and for your brain to send a message to your foot to apply the brake, or whatever is needed.

You are aware that you seem to react instantly, or close to it. But when reaction time is measured, you discover that what seems like an instant is, in reality, a few milliseconds. It is the time taken for the vision impulses to travel from the eye to the brain, for the brain to interpret them, and for the message the brain then generates to travel down the muscles that control your foot. All pretty quick, but it does take time.

And all human nerves in the same human body, take more or less the same transmission time. The optic nerve conveys visual messages. But the frequencies

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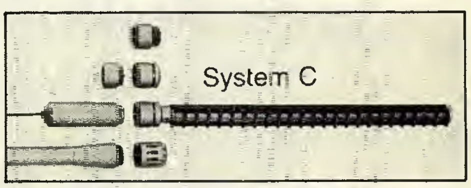

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associated with visible light are in the range between 10^8 and 10^9 megaHertz. Quite obviously the optic nerve does not "handle" frequencies in this range: it carries information about them.

THE AUDITORY NERVE

Similarly with the auditory nerve. It is feasible that the nerves could convey actual frequencies corresponding to the low end of the audible spectrum. But frequencies up into the tens of kilohertz affect what we hear, and must somehow get from our ears to our hearing faculty in the brain. And it is obvious that such frequencies cannot travel along nerve fibers as is.

There is another question that needs resolving: how are frequencies recognized so critically—or where is this recognition carried out? This has been established as the function of the hair cells and another minute organs, within the cochlea. So what the auditory nerve bundle conveys to the hearing faculty in the brain, is a set of impulses, with information *about* the frequencies received by the ear, not those frequencies themselves.

And the impulses conveyed by the nerve fibers is digital in character, not analog, although there may be analog aspects of the interpretation the hearing faculty builds from this digital information. When you realize this, you must also realize that a human ear works on a very different principle from any microphone you have ever used.

As you think this through, you realize that the human hearing faculty is the most complex sound analysis system you have ever encountered. And it does it all without conscious thought—or most of the time. The parent who accuses her child of "not listening" is speaking the truth. We hear what we want to hear and develop the faculty to ignore what we don't want to hear. If you don't believe this, try listening to a recording made of a discussion group in a sizable room, with a number of people.

When you were there in person, you had little difficulty—maybe no conscious difficulty at all—in hearing everything that was said, from every part of the room. But listen to the recording, and you become aware of sounds that make it almost—sometimes quite—impossible to hear what you are listening for. The recorder uses a microphone that does not possess the selective property your hearing faculty has. And now it's on the sound track, it's much more difficult for your hearing faculty to turn the unwanted sound "down."

Why discuss this in **db**? Audio is rapidly moving into digital systems and applications. What can be done digitally, and how can it be done best? That is the question. Mixtures of digital and analog can be made in a variety of ways. Perhaps it is not beyond conjecture that some day science may find a way of entering digital directly into the human hearing faculty, without benefit of ears as the conversion unit. But meanwhile, we are concerned with creating a satisfactory illusion of reproduction.

This, essentially, was the synthesizer concept on which Harry Olson worked. In those days, waveform generators were new, if they were available at all. An audio oscillator produced a sine waveform frequency (or something approximating it) by using frequency-selective circuitry to control the oscillation. Positive or negative feedback caused the sine wave to grow or decay in amplitude.

The advent of waveform generators gave us the means to produce a specific wave shape, as opposed to a wave of designated frequency. The basic waveshape of a waveform generator is triangular. The basic waveshape of a frequency generator is sinusoidal. Now, if you use a waveform generator, and make the shape more complicated, you can generate anything you want to. This is very useful for video, but not so directly useful for audio, where frequency content, rather than precise wave shape, is important.

But a waveshape does have advantages over the frequency generator for other reasons. Its growth and decay can be more precisely controlled. Even its frequency can be controlled better, in some ways. Its start and stop times can be more-precisely controlled. This is the main reason that today's synthesizers are a far cry from Harry Olson's.

Waveshapes can be added, or combined in any other way, very easily by digital techniques. If you take wave samples at some ultrasonic frequency, and add samples from different waveforms at each interval, you are mixing the two waves, and you have capabilities doing it that way, that are not so easily open to you with analog methods (using conventional mixers).

Perhaps the thing to remember is that, whatever you do, the audio frequencies, in the form of "tuned" sound waves, become the means by which your end product is transmitted from the loudspeaker that ultimately puts them into the air as acoustic waves, to human ears, where the individual human ear converts them back to digital impulses, to be transmitted along the auditory nerves to the individual brains.

What if you want to remove certain frequencies, the equivalent of a certain element in the "program," or something that may have been identified as "distortion"—how do you go about that? Now we are getting into a whole new ball game. And if, in this column, we can help you to think along a constructive track, instead of running down blind alleys, we will have served our purpose. ■

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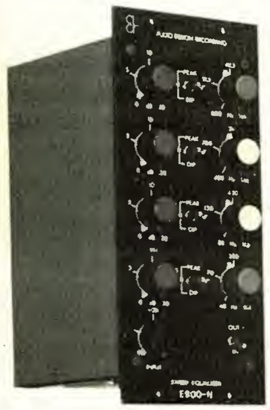

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MARTIN DICKSTEIN

db Sound With Images

Slide Business Is A Funny Business

• At the end of last year, I got involved in developing the technical end of a programmed slide show. The artistic director chose the slides, wrote the script, and designed the story board as a guide for the programming process.

After the slides were positioned in drums, and the equipment assembled, the programming began. The desired effects were created according to the script and the music—slides dissolved or fast-cut, images popped or faded in and out, and a certain amount of horizontal movement was created where desired. It was a simple show, in that some take weeks to assemble and longer to program.

The show was well received. The cost was nowhere as horrendous as some of the more complicated shows, but for a rather simple 3-screen, 3-projectors-per-screen presentation, the cost was over budget. Costs for my time and that of the producer were figured separately and did not enter into the over-budget figure. Then came the big decision.

FILM TRANSFER

"Let's get this show on film," said the president of the company. "Then I don't have to get this complicated set-up if I want to show the program again."

"Sure," said the producer, "I'll get some numbers for you so you'll have an idea how much it will cost."

A week of waiting went by while the producer checked with several production houses. Finally, a company he had dealt with many times before came up with a figure. They would be doing the job at a lower amount than they would charge someone else because they had never done this type of project before, and wanted the challenge. They had the proper equipment because they specialized in animation, and they would make whatever adaptations were needed to fulfill the contract.

When the president was told the cost, there was a low whistle, a pause, and finally a go-ahead. The outside supplier was given all the slides, still in their drums, a ¼-inch tape with the audio on one track and the programmed cues on the other. They said it would take several weeks to do the job and they would need the help of the producer at different times to be sure they were doing the right thing in case of questions.

TECHNICAL CONSIDERATIONS

Several days later, I was invited to attend a briefing session before the work actually started. Both technical and production questions came up, and when the animators were satisfied, we left them to their work. During the meeting we were told that the cameraman would make a special rig for the job, but that was still part of the total quoted price. The rig would allow the cameraman to shoot 1/3 of the width of the 35mm film at a time, first the left screen, then the center, then the right. Doing it this way, perfect alignment across the total field was assured, and each slide would be

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5. Sound Recording Practice. *John Borwick.* Comprehensive handbook designed for the user of studio and electronic equipment. Articles by British experts on the studio and control room; on recording techniques for speech, drama, classical, etc.; special problems of broadcasting, television, disc and tape manufacture. 1976. 440 pages. **$45.00**

6. Sound System Engineering. *Don and Carolyn Davis.* The first of its kind, this book is the one source of sound information you can rely on to give you everything you must know to design, install, and service commercial sound systems. The book covers acoustics environments, design applications, equalizing, installations, and interfacing. Hundreds of drawings, photos, charts, and graphs are supplied. 1975. 296 pages. Hardbound. **$19.95**

28. Environmental Acoustics. *Leslie L. Doelle.* Applied acoustics for people in environmental noise control who lack specialized acoustical training, with basic, comprehensible, practical information for solving straightforward problems. Explains fundamental concepts with a minimum of theory. Practical applications are stressed, acoustical properties of materials and construction are listed, actual installations with photos and drawings are included. Appendixes illustrate details of 53 wall types and 32 floor plans, and other useful data. 246 pages. **$32.50**

32. Circuit Design for Audio AM/FM, and TV. *Texas Instruments.* Texas Instruments Electronics Series. Emphasizing time- and cost-saving procedures, this book discusses advances in design and application as researched and developed by TI communications applications engineers. 1967. 352 pages. **$26.50**

35. An Alphabetical Guide to Motion Picture, Television, and Videotape Productions. *Levitan.* This all-inclusive authoritative encyclopedia is a practical source of information about techniques of all kinds used for making and processing film and tv presentations. Profusely illustrated, with full technical information on materials and equipment processes and techniques, lighting, color balance, special effects, animation procedures, lenses and filters, high-speed photography, etc. 1970. 480 pages. **$37.50**

distinct and separated from the others on either side. Where it was necessary to use duplicate slides in the original show, in this process of shooting frame by frame, the original slide could be used each time it came up anywhere in the show to keep color quality uniform. Where densities were different, between the various slides, adjustments could be made to brighten or darken as necessary.

The original sound track was transferred to sprocketed magnetic tape, and the original cue track was used to indicate where slide changes took place. The story board was used as a guide for screen images and what happened at each cue spot. The project took about two weeks, and ended up as a 35mm film with a separate mag-track.

The producer took it to a screening room at his company and saw the show for the first time on film. He was disappointed in some aspects, pleased in others. All cues were perfect and the slides did what they were supposed to do. He was disappointed in one aspect of the show—the projectionist had left a tv cut-off plate in the aperture and the left and right sides were cut off. The lens in the projector did not allow for the full width of the screen, and the enormity of the original show was lost. The original presentation was on a 24-foot wide screen. The film playback was on a 4-foot wide image, for all three screens. Thus, each slide was only a bit over a foot wide.

THE KEY WORD IS "BIG"

Once the technician was convinced that the regular aperture plate should be substituted and a wider angle lens inserted, much of the original feeling returned to the showing, but it still was not as big as the producer wished. It seems that once the feet are wet in the ocean of audio-visual multi-screen, multi-image possibilities, bigger is better. Even if the images have no word copy at all—just pictures—BIG is the key word. This was the first time this company tried this new medium. They are now in the process of incorporating some of these possibilities into their presentation methods in place of the old standby, the single slide-after-slide-after-slide, etc. Perhaps there's hope for some of the old diehards.

"MOTION" SLIDES?

Speaking of slides being a funny business, does anyone know of a company still making the "motion" slides which have parts that seem to move when a polarized disc is rotated in front of the lens? This question had come up from time to time from readers, as well as clients and others in the field. If you have any information, please write to me and I will include the information in the next available column. It seems that Kodak was also unable to come up with any answers. They stopped making their motion-adapter devices some years ago and have not kept up this phase of slide-making. They did recommend one company, but that one was still in the process of looking at the whole business and was still not ready to start. They said the process for making the slides was not too complicated and they could do it, but they wondered if there was a big enough market. They could provide the needed polarizing film material to anyone who wanted to do it themselves, but they were not going into the business for some time. If there is enough interest among our readers, perhaps that would help them decide. Let us know.

While we're on the subject of asking you for information, perhaps **db** readers would also be able to suggest some frames, or mattes, that could be made and used for creating novel slides for multi-image use. There is one company (which we will be writing about in the near future) that creates the material for making different slide effects, and perhaps you might have some ideas that would help those just starting out in this funny business of multi-image. Thanks. We would also be happy to publish any interesting and exciting multi-image effects or shows that you saw or had a hand in, with name mention, of course. ■

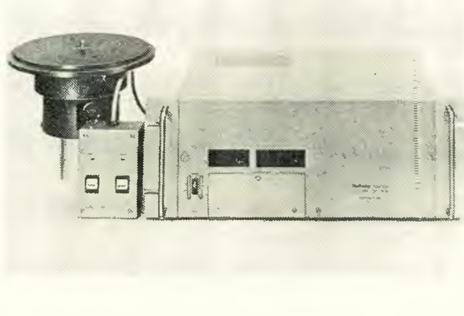
db New Products & Services

DIGITAL REVERB

• The Model 224 Digital Reverb has been updated with second generation software designated the "Version 2 Operating System." The new software features two new reverberation programs and a comprehensive set of hardware diagnostics for maintenance analysis. The first of the new programs, "Percussion Plate," provides expanded audio results with percussion and other fast-attack instruments. "Small Concert Hall-B," the second program, augments the original, supplementing natural and realistic sound. A new sub-program "Decay Optimization" can be applied to all reverb programs to improve the smoothness and naturalness of final decay. Other programs are available for the Model 224 which provide quality simulation of the reverberation of large and small concert halls, acoustic chambers, and plates.
Mfr: Lexicon, Inc.
Circle 50 on Reader Service Card

CUTTING MACHINE DRIVE SYSTEM

• Designed to fit the Neumann cutting lathe and upgrade performance to the level of quartz-locked, direct-drive turntables, the SP-02 direct-drive, quartz-locked, cutting machine drive system has greater rotational speed accuracy and more torque than any other drive unit presently available. The heterpole d.c. motor has 28 kg/cm torque which brings the cutting lathe turntables up to full rotational speed in three seconds. Included in the system is an electronic braking system that brings the turntable to a full stop within four seconds. Quartz synthesizer controlled pitch variation extends to ± 9.9 per cent of rated speeds. Additional SP-02 features include start/stop functions that are switched by a remote control unit and standard rack mounting.
Mfr: Technics Recording & Broadcast Series
Circle 51 on Reader Service Card



REAL-TIME ANALYZERS

• The VTU02 and the AIB232 are new real-time audio spectrum analyzers specifically designed for the TRS-80 and Apple computers respectively. They divide the audio spectrum from 20 Hz to 20 kHz into 31 third-octave bands, and displays these bands, with their relative amplitudes, on the computer CRT. The units can be used for measuring sound and noise levels, for optimizing the equalization of a hi-fi or public address system, for checking the frequency response of audio components, and for speech and sound pattern recognition (useful in voice control systems). Each analyzer is designed to interface with its host computer with a minimum of difficulty. The VTU02 plugs into the TRS-80 expansion port (and provides an equivalent port for further expansion), and the AIB232 has an interface board which fits one of the Apple interface slots. The AIB232 analyzer can make dynamic use of color, as the color of each bar of the display is under software control—one or several of the bars can change color in real time. Programs to access the analyzer are written in BASIC, and three are provided with each unit: Interactive Operation, Minimal Operation, and Self Test.
Mfr: Eventide Clockworks, Inc.
Circle 52 on Reader Service Card

SPEAKERS

• The Cabaret Series of musical instrument speakers: the 4621 Single Lead Guitar, 4623 Acoustic Guitar, 4625 Bass Guitar and 4627 Keyboard systems, were designed with an emphasis on portable sound reinforcement applications. These four new products augment the existing Cabaret line first introduced in June 1979. All Cabaret models are completely self-contained, with Baltic birch enclosures which offer flush-mounted covers and professional road handles for ease of set-up and tear-down. The 4621 Single Lead Guitar features the E130 15-inch extended range loudspeaker mounted in an enclosure designed specifically for electric guitar and is capable of handling up to 150 watts of continuous sine wave power. The 4623 is also equipped with the E130 in combination with a 2402 high frequency ring radiator and a specially-designed crossover network. The 4623 has a capacity of 150 watt continuous sine wave power. A 15-inch E140 low frequency loudspeaker is the basis of the Model 4625 with power handling capacity of 200 watts. Intended for reproduction of organ and piano or vocal reinforcement, the Model 4627 Keyboard System is equipped with an E145 15-inch loudspeaker, a 2901A High Frequency Power Pack and a specially designed crossover network for high accuracy and definition over a wide range of frequencies. The 4627 also handles 150 watts of continuous sine wave power. All models feature flush-fitting covers and durable black polyurethane paint.

Mfr: James B. Lansing Sound, Inc.
Circle 53 on Reader Service Card

VOCODER

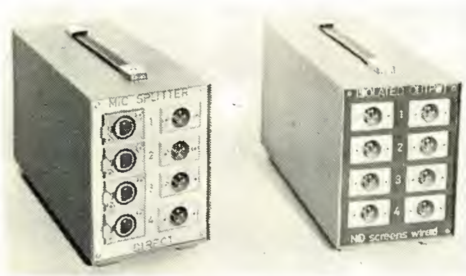
• The Syntovox 202 vocoder was designed primarily to make a match between a polyphonic keyboard, a boosted bass or a guitar and its player. Features include separate controls for speech, carrier, and HF Synthesizer.

Mfr: Synton
Price: $695
Circle 54 on Reader Service Card

MICROPHONE SPLITTER BOX

• A pair of microphone splitter boxes, models 4-157 and 7-880, feature transformers which enable them to take a direct 'short' and the loss of signal is less than ½ dB. The model 4-157 has four inputs which are linked directly for a straight in/out operation or can be split to give two additional outputs for each input. The model 7-880 is a more sophisticated version with seven inputs and an additional plug and socket complex using the Amphenol system for multi-pin operation.

Mfr: Keith Monks USA Inc.
Circle 55 on Reader Service Card



DISTORTION AND NOISE MEASURING SET

• The Model 3500 is a high performance distortion and noise measuring system incorporating an ultra-low distortion sine wave oscillator, a total harmonic distortion (noise) analyzer, a wide band and weighted true rms level meter and tuneable band pass filter. Leds conveniently guide the operator to the correct setting of controls and automatic electronic servos handle the delicate adjustments. Total harmonic distortion can be measured to below 0.001 per cent. Harmonics of the oscillator at mid-band frequencies are lower than 110 dB down and fundamental rejection in the analyzer exceeds 120 dB. At 100 kHz, the upper frequency limit of the system, measurements can be made to below 0.01 per cent. Oscillator settling time at the low frequency limit of the system, 10 Hz, is below three seconds. A unique high-efficiency switching power supply allows a single rechargeable internal battery or external 12 volt wall-plug transformer to provide two dual-polarity, isolated power rails to operate the oscillator and analyzer.

Mfr: Amber Electro Design Inc.
Price: $1600 (not including rechargeable battery or intermodulation distortion measuring feature)
Circle 56 on Reader Service Card

TABLE TOP CONSOLE

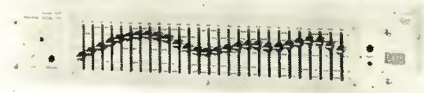
• Offering universal adaptation in a table-top transport console, the RL 300 will accept any 19-inch by 15¾-inch tape transport. Its standard instrumentation overbridge is 19 inches wide and will accommodate varying heights. The deck of the unit is canted at a 12-degree angle for operator convenience. Maintenance can be performed without removing the tape transport or going in through the back of the unit. The RL350 rack is equipped with casters for portability and can be purchased separately, or in tandem, with the RL 300.

Mfr: Ruslang Corporation
Circle 57 on Reader Service Card

COMPRESSOR/LIMITER

• A dual-input device, capable of automatic gain control over a range of 30 dB, the 7130 Compressor/Limiter offers three selectable functions (OUT, COMPRESS, LIMIT), as well as three selectable release and attack times. In the function OUT mode, the unit operates as a line amplifier. The COMPRESS and LIMIT modes offer 2:1 and 20:1 compression ratios, respectively. Operating as a line amplifier, the 7130 has a distortion rating of less than 0.2 per cent, 20 Hz to 20 kHz at +18 dBm. In the compression mode, distortion checks in at less than 0.25 per cent, 30 dB compression, 20 Hz to 20 kHz at +18 dBm. Each of the two microphone inputs accepts an unbalanced, high-impedance signal; and, an optional, plug-in transformer will convert an input to balanced, low-impedance.
Mfr: James B. Lansing Sound, Inc.
Circle 58 on Reader Service Card

EQUALIZER



• The Model 537 is the new extra-quiet successor to the model 527-A. Signal-to-noise is better than 110 dB at maximum output (greater than 20 dB improvement over the earlier 527-A), the result of active circuitry and components. The 537 provides 12 dB of boost or cut at each of 27 frequencies centered at ISO 1/3-octave increments from 40 Hz to 16 kHz. The 537's 27 filters are active, minimum phase L-C networks that combine for minimum ripple and phase shift when used in combination. Gain adjustment on front panel gives up to 20 dB gain. The 537 is completely self contained with a regulated power supply.
Mfr: United Recording Electronics Industry
Price: $796
Circle 59 on Reader Service Card

DISTORTION ANALYZER

• Offering measurements as low as 0.005 per cent and total harmonic distortion down to 0.003 per cent (with 0.001 per cent resolution), the Model 6801 Automatic Distortion Analyzer expedites measurements with a minimum of control modification. Total automatic level setting eliminates the need to adjust the meter for different input amplitudes between 100 mV and 13 volts rms. Frequency range selectors provide auto-nulling of fundamental frequency over a 10:1 range which further simplifies operation. A switchable high-pass filter is also provided to reduce the effects of hum and low frequency noise on the input signal. As an a.c. voltmeter, the 6801 covers the frequency range of 10 Hz to 110 kHz. A distortion output is provided for visual inspection or spectral analysis of the input signal after the fundamental has been filtered out.
Mfr: Krohn-Hite Corporation
Price: $1600
Circle 60 on Reader Service Card

AUDIO TEST SET

• The RTS2 is a new multi-purpose instrument that performs a full range of performance tests on tape recorders, audio amplifiers, preamplifiers, and turntables. Among the tests that can be made with the RTS2 are frequency response, signal-to-noise ratio, distortion, wow and flutter, drift, input sensitivity, and gain. An advantage of this single test instrument is speed and convenience of testing, as only a single input and output need be connected to the equipment under test. Set-up for tests is rapid using front panel pushbuttons. All results are read-out directly in per cent or dB without any translation or calculation. The test set can also be used to do analysis by attaching an oscilloscope, distortion analyzer, or other equipment to the output specifically provided for this purpose. The RTS2 weighs only 14 lbs. and can thus be easily taken to field locations. It contains its own checking circuitry and can be calibrated without reference to auxiliary equipment. RTS2 is supplied with test leads and a test tape containing both NAB and CCIR test sequences.

Mfr: Neal Ferrograph USA, Inc.
Circle 61 on Reader Service Card

POWER SUPPLY

• The PS-10 intercom power supply features enough power to drive up to 12 remote stations. The power unit also allows the user to adjust system volume for high or low noise conditions via a master volume control. Four output connectors provide flexibility in system set-up. The PS-10 is circuit-breaker protected from damage due to faulty cables. Short circuits are indicated by an illuminated led. Constructed in heavy gauge aluminum, the power supply is offered in portable or rack-mount versions.

Mfr: Clear-Com Intercom Systems
Price: $160
Circle 62 on Reader Service Card

EQUALIZER

• The Model EQ-2 graphic equalizer features stereo equalization on 12 bands/channel with a range of +10 dB nominal. The bands range from 28 Hz to 16 kHz. Frequency response is 10 Hz to 100 kHz at +3 dB, total harmonic distortion is rated at 0.02 per cent at 1 kHz. The unit is available in kit form as well as assembled.

Mfr: Symmetric Sound Systems
Price: $165 (assembled)
$100 (kit form)
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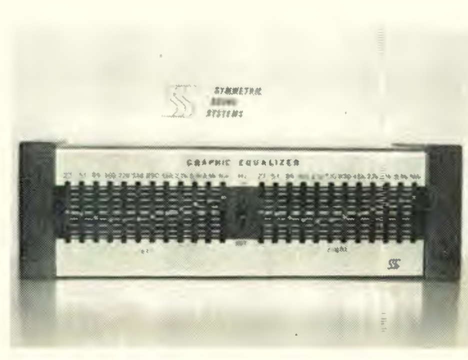
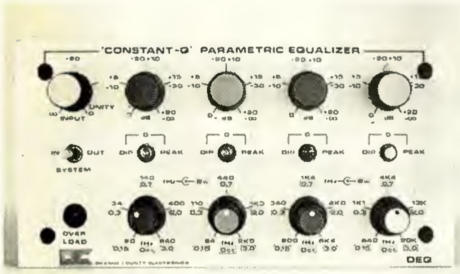


EQUALIZER

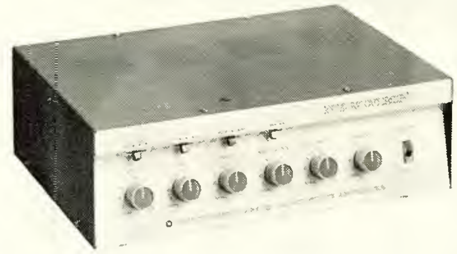


• The DEQ module is a four-band, parametric equalizer with center frequencies variable from 20 Hz to 20 kHz in overlapping five octave (32:1) ranges. The bandwidth is variable from 0.15 to 3 octaves, with each section tuning over an 80 dB control range (60 dB cut, 20 dB boost). The signal-to-noise ratio of the unit is 110 dB, with all sections in 20 dB boost; and distortion is rated at 0.05 per cent at +18 dBm output. The output capability of the DEQ is +30 dB into a 10k load; +24 dB into a 600 ohm load.
Mfr: Orange County Electronics Intl., Inc.
Circle 64 on Reader Service Card

COMPUTERS

• The HP-85 computer, designed for personal use in business and industry, features a powerful central processor, typewriter-like keyboard with 20-key numeric pad, high resolution CRT display, and a thermal printer. Other features include cartridge tape drive, enhanced BASIC language, and interactive graphics in a fully integrated system the size of a portable electric typewriter.
Mfr: Hewlett-Packard Company
Price: $3250 (Optional memory expansion module and software available.)
Circle 65 on Reader Service Card

P. A. AMPLIFIERS



• A new line of public address amplifiers, designated the "Pathfinder," contains six models, ranging in power from 25 to 100 watts. Most of the units in the line offer features such as: mic-precedence music muting; a separate and independent response control for each mic channel; bridging jacks for joining two amplifiers together; and an output-to-tape jack and an output-to-booster jack unaffected by the P. A. amplifier's volume control. The Pathfinder line also includes two column loudspeakers, and a four-speed phono top.
Mfr: Newcomb Audio Products Co.
Circle 66 on Reader Service Card

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EQUALIZER

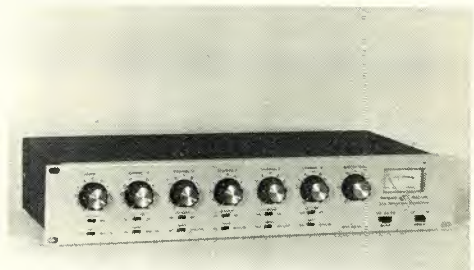
• The Model 1000B, a professional 10 band graphic equalizer features switchable equalization ranges (+8 dB, +16 dB), infrasonic filters, input level controls, total channel independence, and led overload indicators. The unit was designed for studio and stage applications where low noise and distortion are necessary. The Model 1000B comes complete with balanced and unbalanced inputs and outputs.

Mfr: Spectra Sound
Price: $595
Circle 69 on Reader Service Card

MIXER/PRE-AMPLIFIER

• Offering six channels that can be used either for microphone or line mixer purposes, the G-222 Mixer/Pre-Amplifier has input transformers that switch from microphone level to 600-ohm line level input. Any channel may be switched to an auxiliary input. Special circuitry supplies 12 volt phantom power for condenser microphones. Special out-in jacks for an equalizer or limiter are one of the features of the G-222. Other features include: IC circuitry throughout, balanced 600 ohm output, speech filters for each channel, and a frequency response that exceeds the audio range.

Mfr: Grommes-Precision
Circle 70 on Reader Service Card



POWER AMPLIFIER

• The Model 2401 Power Amplifier features the capability of driving 2 and 4 ohm resistive loads at 0.025 per cent thd. The unit is part of the high resolution "01" Series of power amplifiers. The use of two complimentary amplifiers allows the first to handle the positive slope of the waveform and its complement to handle the negative slope. Since the output of each amplifier is a mirror image of the other, any dynamic distortion is automatically cancelled out. Another feature of the Model 2401 is the "natural" damping factor which provides for strict speaker control, regardless of input. The amplifier is rated at 250 watts per channel minimum rms into 8 ohms at a range 20 Hz to 20 kHz.

Mfr: Scientific Audio Electronics, Inc.
Price: $950
Circle 71 on Reader Service Card

DIGITAL MULTI-METER

• A 4½-digit DMM, the model 8050A is a micro-processor-controlled bench unit with true rms, and a large lcd readout. Other special features in the 8050A include an offset mode and a dB measurement mode. The offset mode allows the user to zero-out lead resistance for high resolution measurements or establish a voltage to which all other voltages measured may be referenced. In the dB measurement mode, the 8050A reads the absolute level (dB) of signals directly, with a range of –56 dBm to +48 dBm and a choice of sixteen different reference impedances. The 8050A provides 7 functions: d.c. volts, d.c. current, a.c. volts, a.c. current, dBm, resistance, and conductance; and 38 ranges.
Mfr: John Fluke Mfg., Co., Inc.
Circle 72 on Reader Service Card

EXPANDER

• The Model C-8E expander is the latest addition to the Catalina line of mixers. The C-8E adds the capability of eight more inputs to the existing C-12 Master Console. Each input has a mic-line switch, overload led, three sends, three band EQ with sweepable midrange, four mix busses with panning, along with solo and 100 mm slide fader. The expander contains mixing amplifiers and a self-contained power supply for necessary operating voltages and 48V phantom power. Interconnection via the line level outputs enables the C-8E to be used as a bus expander, input expander or dedicated submixer by appropriate choice of patching.
Mfr: Tapco
Price: $1450
Circle 73 on Reader Service Card

INTERCOM SPEAKER STATION

• Offering ease of operation via hands-free use, the KB 124 intercom speaker station features a high-noise switch which allows for full duplex operation (simultaneous two way communication) in noisy locations, as well as low noise areas, from distances up to 20 feet. A high technology logic circuit operates a gain shifting network adjusting the relative levels between the built-in microphone and speaker. Room echo has been reduced by the incorporation of side tone circuitry. Additional stations can be added without affecting the side tone with reference to balance. An optional handset or headset may be introduced for private communication.
Mfr: Clear-Com Intercom Systems
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Introducing a present

Once you go through a recording session with the new ATR-124 24-channel recorder by Ampex, you'll want to go through another. Because with each new session you'll discover something new you can do. Things that you can only do with a recorder that's full of features of the future.

ATR-124 gives you the unheard of: Time on your hands.
Which means you can use that time to give clients more of what they're paying for—your creative skills. With the ATR-124 microprocessor-based control system, you can pre-program what you want to do ahead of time so you won't waste studio time setting things up. When their time starts, you're ready to record by touching a single recall button.

ATR-124 also lets you duplicate a technique you may have used earlier in the session without having to rethink what you did. Just touch the memory button and it'll all come back to you. ATR-124 lets you rehearse what you've got in mind, without recording it, to make sure what you've got in mind is right. Tape can be manipulated faster which means you'll get the sound you want sooner. And the chance to try something "a little different." All because of the speed and accuracy that ATR-124 puts at your fingertips.

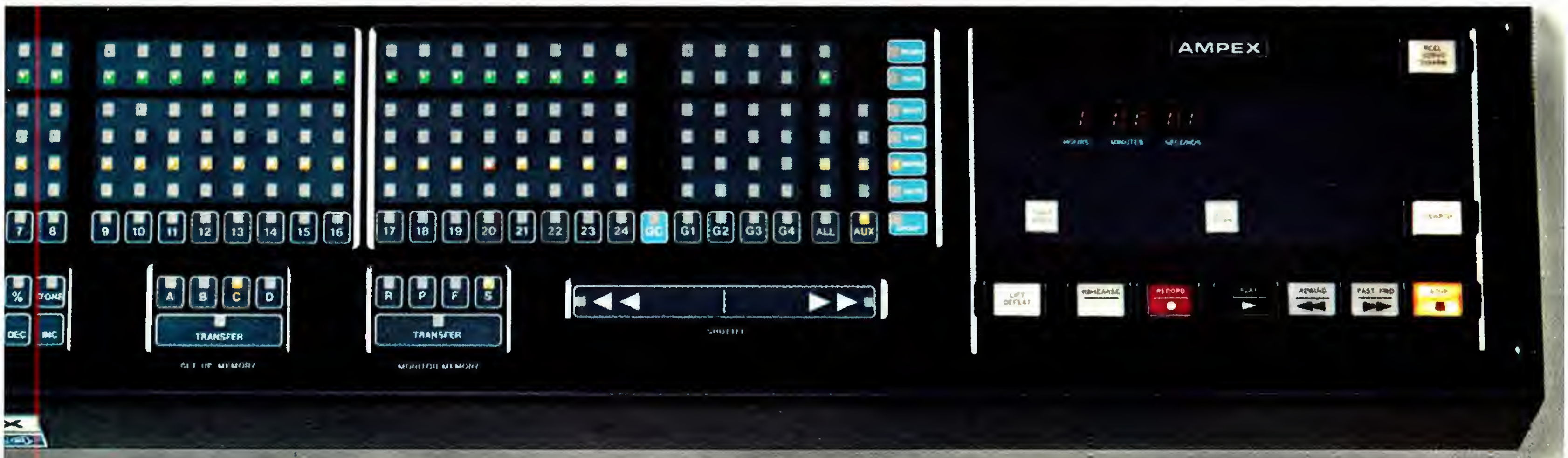
ATR-124 doesn't take away your creativity, it adds to it.
The less time spent setting up, correcting, and redoing, the more time spent creating. And when you add features that help you create to the ones that help you save time, you've got one very potent piece of audio machinery. Take the control panel for instance. It's like nothing you've ever seen. Pushpads linked to a microprocessor give you a new level of creative flexibility. Program a setup, then change it. Then change it back, all with a single fingertip.

A repeatable, variable speed oscillator for pitch correction and special effects is built in. In addition

from the future: ATR-124.

to the standard output, there is an optional auxiliary output with each channel that enhances flexibility. So don't think that ATR-124 is going to

Memory, and Record Mode diagnostics. The point is this: If you like the ATR-100, you're going to love working with the ATR-124.



ATR-124's Control Panel. Speed and accuracy at your fingertips.

replace anything that you do. On the contrary, it's going to improve the skills you have, if not help you develop some new ones.

ATR-124 picks up where ATR-100 leaves off.
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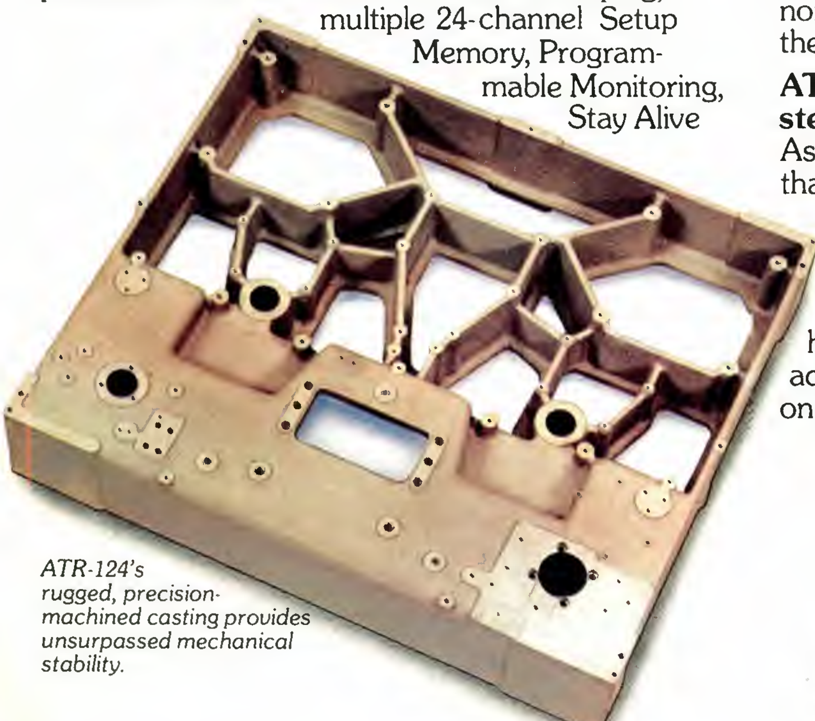
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db Editorial

As our multi-track recording technology continues to expand, we have long-since given up trying to speculate how many tracks are *really* needed for a state-of-the-art production facility. It used to be 16 (real old-timers may recall even less than that); now its 24, or maybe 32—or even 48. The really progressive studios think nothing of syncing two machines together when the need for even more tracks arises.

Just think of it—two machines running together in perfect synchronization! Very impressive, but what about 48 machines at once? Even the most easy-going recording engineer would probably not be amused by a producer who shows up with a 48-track master, with each track recorded on a separate piece of tape.

Just imagine Barbara Streisand recorded live on one tape, with Donna Summer in an isolation booth on another. To make things interesting, part of the live performance is drowned out by a passing airplane, and the strings can't be heard at all. However, a separate string track is available from an earlier string section rehearsal. By good fortune, it's almost in sync with the live performance, and the producer is sure you'll have no trouble attending to this little detail.

If you're ready to go into some other line of work, consider the lot of the film sound engineer, who routinely copes with chores such as this all day long (plus dialogue and sound effects, of course). In other words, there's a world of difference between record and film sound, and even 'rock and roll' doesn't mean the same thing anymore.

We get underway this month with Ralph Hodges' account of Sound for the Cinema, where there may be anywhere from one to five or more speaker systems in use. Speaking of the latter, we recently went around the corner to the local movie palace to see—and hear—the latest cinematic spectacle. The marquee proudly proclaimed, "Recorded in Dolby Stereo." What stereo? Inside, it sounded pretty much like so-so mono. In other words, viewer beware! Yes, the film was recorded using the Dolby system. However, the theater was not equipped for Dolby reproduction, or even for stereo. Of course, the marquee wasn't lying, but then it wasn't exactly telling the truth either. So, if you think your hearing is starting to fail, first ask the manager to show you the sound system. If you find a rack-full of high class gear, get your ears checked. But if you can't find more than one speaker behind the screen, suggest that all those "super-sound" signs be taken down.

Next, John Eargle surveys the kinds of speakers you're apt to find behind the screen, and John Mosely presents the COMTRAK System. Formerly known as Kintek, the system offers an Academy mono track, plus a four-channel discrete sound track (left, center, right, and surround), for theaters equipped for COMTRAK playback.

Of the main ingredients of any sound track (dialogue, music, and sound effects), the effects component may be least familiar to engineers who spend most of their time in the broadcast or recording studio. With special effects, things are seldom as they seem. As every good sound effects specialist knows, if you want the sound of a slamming door, the last thing that should be tried is a slamming door. The trouble with real doors is that they just don't sound like real doors.

Well then, what about the sound of a photon torpedo? For that matter, just how do you mike a photon torpedo? Come to think of it, what *is* a photon torpedo? If you don't know, you obviously haven't seen Star Trek yet. Go see it (hopefully, in Dolby Stereo), and then come back and read Dirk Dalton's account of how all those strange sounds were created.

For a change of pace, we conclude with an application note on designing audio pads. A recent column by Patrick Finnegan turned up lots of reader interest on the subject, and this application note is largely the work of several of our readers. As always, we're delighted by reader responses (pro and con), and welcome your comments and suggestions.

And that brings up an important point, which needs to be re-stated. Like most other publications, *all* letters received here are considered for publication in our **db** letters column. If you do NOT want your letter to appear in print, just write, print or scribble "Not for publication" on it. Or, if you don't mind having your letter used, but would rather not be identified, let us know that too. Otherwise, we use our discretion, which we'd like to think is impeccable, but probably isn't.

In any case, keep those cards and letters coming! ■

RALPH HODGES

Sound For the Cinema

Different from music-studio practice, film sound production utilizes methods, terminologies and technology which have evolved in response to the industry's specific needs.

"*When I came into this* [*cinema sound*] *after ten years in the recording industry, it was completely foreign to me. Everything they did was different. The recording was different, the syncing requirements were different, and for several months I was overwhelmed.*"—Tom Scott, one of the mixers of the sound track for *Apocalypse Now.*

"*A single helicopter may be built up with three or more different effects; one putting in the 'thwacks,' one putting in the 'ticks,' and one putting in the 'thwocks.' But all you actually see or experience is a man standing beneath a helicopter, with perhaps a bit of music.*"—Ioan Allen, Vice President of Marketing at Dolby Laboratories.

"Different" and "complex" are descriptions frequently applied to film sound, particularly by those whose background is primarily music recording. The production of film sound *is* different from music-studio practice, if only for the reason that it evolved separately and, for the most part, earlier. The film industry developed facilities for recording, synchronization, and complex mixes from several sound sources long before delivery was taken on the first multi-track console. In fact, many of these techniques antedated the advent of magnetic recording. And, when filmmakers couldn't find equipment to implement those techniques, they invented and built it themselves.

Today, with devices for elaborate audio processing comparatively plentiful, film people have in some cases adopted what has seemed useful and logical in the context of their own specialized activities. But in general they have not been notably eager to abandon the tried and proven, simply because another industry has come up with some alternate technology. Their methods, terminologies, and outlooks remain largely their own, and continue to evolve in accordance with their specific needs. This article will try to present some idea of what those needs are and what is done to meet them.

THE THEATRE

As a first step, it is necessary to establish where a film is going; that is, into a theatre that may have one, or—for multi-channel presentations—as many as five loudspeaker groups behind the screen. Possibly, there are more speakers to the sides or rear of the audience section, or in the ceiling, for so-called "surround" effects. The theatre's projection system may be limited to playing back optical sound tracks in mono only, or it may have stereo optical pickups or perhaps a magnetic reproducing system that can handle four- or six-track magnetically recorded prints.

Unless a theatre is equipped to alter its facilities to accommodate different sorts of film configurations, or "formats," the release print has to be chosen—if there is a choice—to fit the theatre. There are, however, some interformat compatibilities; For example, Dolby Stereo optical prints can normally be handled by mono optical equipment, and some 35mm prints have been released with multiple magnetic tracks for stereo presentations, plus a mono mix on a single optical track. More will be said about such cases a little later on.

Theatre facilities vary widely in quality as well as quantity. Loudspeakers and amplifiers may be up-to-date or antique. The sound system may be well-maintained or partially inoperative, because of blown or rubbing voice coils, general neglect and abuse, and the aging of parts. Perforations of the projection screen may be blocked with dirt, muffling the high-frequency output from the loudspeakers firing through them. Improper placement of the speakers relative to the screen will have the same effect; the speakers may also be of the wrong type for the theatre's physical layout and acoustical properties. And those

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acoustical properties themselves may be problematic: too reverberant for good voice intelligibility, plagued by strange-sounding reinforcement/cancellation effects from local reflections, or perhaps overly dead for the size of the space involved, so that the front rows get blasted because of the levels needed to give the rear rows anything at all.

Now that wide-range sound tracks for motion pictures are being produced regularly, and theatres around the world are taking a lively interest in being able to reproduce them to fullest effect, these matters are assuming even greater importance. Fortunately, the attitudes of most in the film industry toward improvement have tended to be cooperative and progressive, as the excellent sound that has been recently heard in theatres will testify. The theatres themselves have shown willingness to gear up for ambitious sound tracks, their suppliers have made the equipment available, and the filmmakers have been forthcoming with software of appropriate quality. At this point let's take a look at how that software comes into existence, beginning with a consideration of motion-picture sound formats.

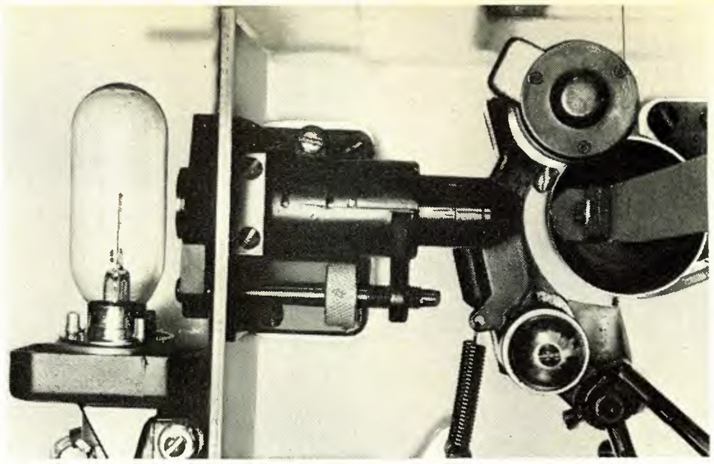


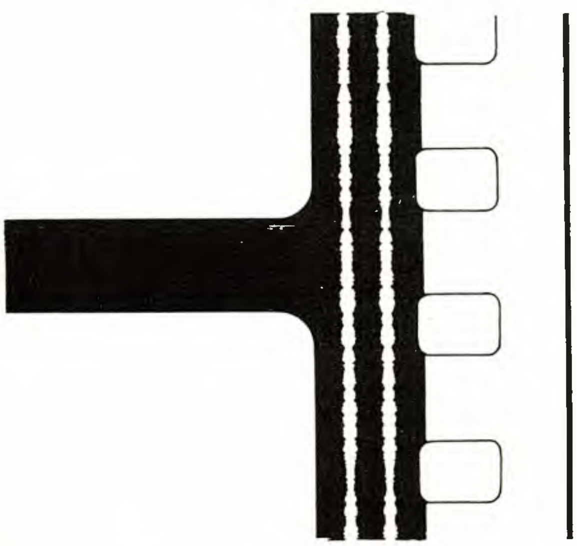
Figure 2. An optical sound head as found on a modern 35mm projector. See Figure 4 for a call-out of parts.

OPTICAL FORMATS

Most present-day sound tracks for commercial motion pictures are optical. They are located near the edge of the film just inside the sprocket holes, and like the picture they are projected—not on a screen, but on a photocell within the projector. The continuous stream of record-groove-like undulations along the track, clearly visible in FIGURE 1, are actually sound modulations recorded there by a photographic process. They modulate the light from a small "exciter" lamp as it passes through the film to fall on the photocell, the electrical output of which varies with the amount of light reaching it. The result is a signal that will drive a preamplifier specifically designed for the application. The photocell pickup, the exciter lamp, and the slit lens that focusses its light into a scanning beam are shown in FIGURE 2, along with the purely mechanical parts of the optical sound head.

FIGURE 1 is typical of modern optical sound tracks for 35mm films. Two separate tracks are apparent, but examination will reveal that they are identical. This is therefore a mono sound track, called Academy duo-bilateral variable area, or simply Academy mono optical. "Academy" is a reference to the Academy of Motion Picture Arts and Sciences. "Duo-bilateral" means there are two tracks, each with both sides modulated, and "variable area" means that the modulation takes the form of changing track area. Academy sound tracks date from the late 1930s, and they are not a wide-frequency-range medium, typically being down 25 dB or so at 9 kHz in the auditorium when reproduced in the normal way.

Figure 1. A mono duo-bilateral variable area sound track. Redundant mono tracks are pretty much a standard these days.



Stereo optical sound tracks for commercial 35mm films (FIGURE 3), while first proposed some time ago, took considerably longer to become an established format; the first commercial film in the current stereo format was released in 1975. To recover the two tracks of information, the photocell in the projector sound head is replaced by a dual photosensitive pickup (stereo solar cell), to respond to the two dissimilar tracks in FIGURE 3 and produce two separate electrical outputs. From these, plus an additional channel of electronics and a second loudspeaker, a minimal sort of stereo presentation would be possible, although, as we will see, it would far-from-realize the full potential of the format. FIGURE 4 shows how the two tracks are scanned by the slit lens and picked up separately by the solar-cell assembly.

Stereo optical sound tracks for 35mm are of wide frequency range (usable response typically extends to 12 kHz and beyond), and they are invariably encoded with Dolby A-type noise reduction. Hence, this format is called Dolby Stereo bilateral variable area, or sometimes just Dolby SVA. Ideally, it is reproduced in a theatre with two channels of Dolby A-type noise reduction for decoding the two tracks, plus special circuitry to derive a center-channel signal (for a central behind-screen loudspeaker) from them, and more circuitry to extract a fourth "surround" channel for loudspeakers located in the audience area, should the producer of the film have chosen to provide such a channel. This surround channel exists within the two tracks in the form of a phase matrix, which has been encoded with the Dolby B-type noise reduction system prior to being matrixed. Therefore, when played back in a theatre, it requires Dolby B-type noise reduction decoding. It is also sent through a delay line that minimizes the perception of unintended crosstalk from around or behind, and ensures temporal coherence in a large auditorium.

Some information on preparing theatres to handle this format is given in the box at the end of this article. In recent years it has been the fastest growing of the multi-channel formats, principally because it avoids many of the expenses associated with magnetic prints, as discussed in the next section. It also has the great advantage of being compatible with theatres equipped to play only Academy mono optical prints. The mono sound head sums the two tracks, much as a mono cassette player sums a stereo recording, and the equalization used in theatres for Academy films renders the Dolby A-type encoding largely unobtrusive.

MAGNETIC FORMATS

In commercial cinema today there are three main magnetic sound formats: 35mm four-track, "conventional" 70mm six-track, and Dolby Stereo 70mm six-track. FIGURE 5(A) shows

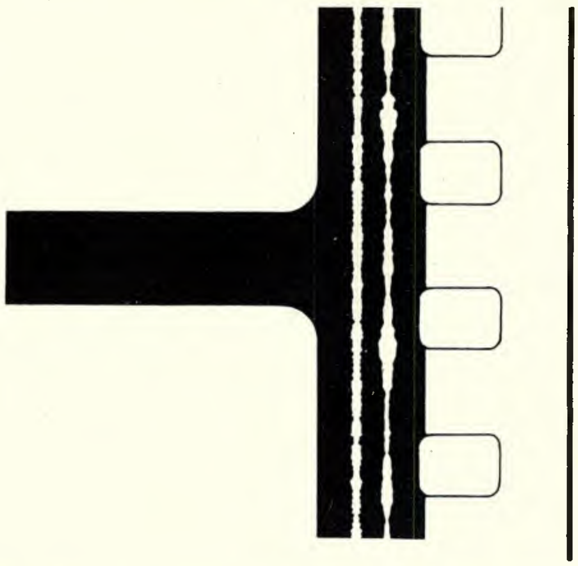
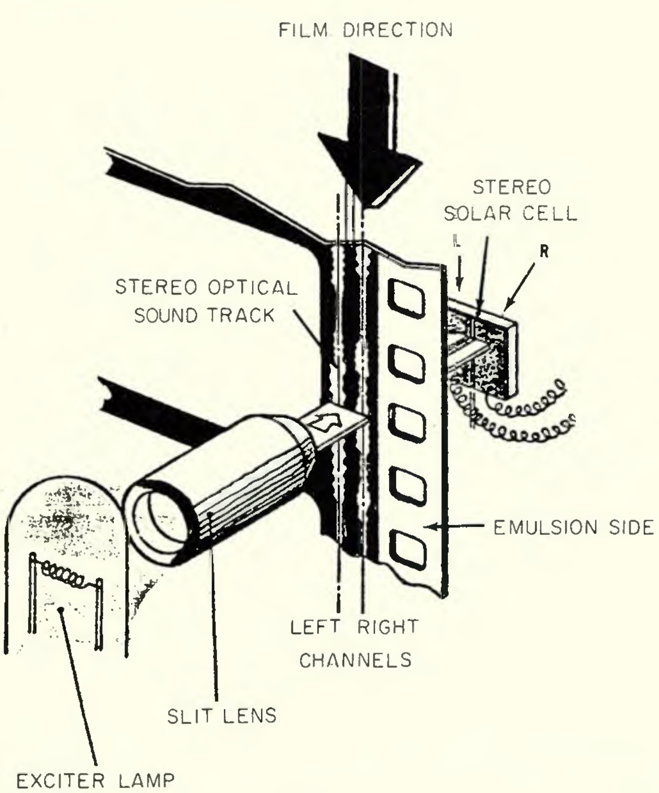


Figure 3. A stereo optical sound track. Note the difference in modulation between the two parts of the track.

the oxide-striping plan for the four-track format; the actual recorded tracks themselves are 1.5mm wide for the three wider stripes (left, center, and right behind-screen speakers), and 0.89mm for the narrower stripe (surround speakers).

The magnetic striping for 70mm prints is illustrated in FIGURE 5(B). Two recorded tracks share each of the wide outer stripes, with one on each narrow inner stripe, for a total of six. All tracks are 1.6mm wide. The six tracks provide signals for five behind-screen loudspeakers, plus a surround channel (FIGURE 6). In the case of conventional 70mm, the two additional behind-screen speakers are driven full-range and are intended to provide a seamless, stable multi-channel spread across a screen perhaps 80 feet or more in width. For Dolby Stereo 70mm it was decided that the latest film-sound recording techniques and the physical layouts of modern 70mm theatres rendered the additional full-range speaker channels unnecessary and sometimes even undesirable. Therefore, in the Dolby format, only the extreme left, center, and extreme right speakers carry full-range information (Dolby A-type encoded) recorded on tracks 1, 3, and 5. Tracks 2 and 4 carry low frequencies (below 200 Hz) only, and they drive the "half-left" and "half-right" behind-screen speakers. This increases the low-frequency power-handling capability of the overall theatre system, so that when extra bass punch is needed (as it is increasingly often in big moments of new releases) it is available. Low-pass filters used during playback reinforce the steepness of the 200-Hz rolloff (to 24 dB per octave), and eliminate any need for noise reduction on these tracks. Normally, both the conventional and the Dolby Stereo versions of this format reserve track 6 exclusively for surround information, the only difference being that in the latter case the surround information is also encoded with Dolby A-type noise reduction.

Figure 4. Picking up the two tracks of a stereo optical film separately requires merely the installation of a stereo solar cell in the sound head.



Unfortunately, magnetic sound tracks are expensive and time-consuming in both manufacture and use. While optical sound tracks are created along with the picture on the release print in a single-pass two-stage photographic process that proceeds at high speed, magnetic stripes intended to carry a sound track are not even applied to the film until the picture frames are fully developed and ready for projection. After the oxide stripes are painted or rolled on (very carefully!), some three days are allowed for drying and curing, after which the sound can be recorded on them, in real time or sometimes even

SURROUNDS AND WHERE THEY COME FROM

Involvement of the audience is what motion pictures strive to achieve. The means to that end can be dramatic or technical as long as they are effective and affordable. Getting sound sources out into audiences, where they can erupt behind and around them, is a feasible and often striking way of bringing viewers into the picture. Surrounds aim at doing just this, as four-channel-stereo consumer recordings and equipment attempted some years ago. But the history of surrounds for film sound goes back even further.

Magnetic stripes on film originally made multi-track and surround presentations convenient and manageable in theatres that had installed the necessary equipment. The 35mm four-track format that began the wide dissemination of surround effects had a narrow and hence somewhat noisy surround track, but it was adequate for loud sounds, and when it was not in use a pilot signal on the track shut it off. Films in 70mm conferred full-width equality on the surround track, opening up the possibility of using it for subtler sounds and effects, even if the opportunities were not always seized upon.

Ultimately, the application of noise reduction to release prints was one of the keys to surrounds that were "on" throughout virtually the whole film, participating in the creation of an acoustical environment that fully enfolds the audience. You could, for example, view a field of wheat in front of you while hearing—almost to the point of feeling—the wind gently agitate it all around you. The audience was perhaps not directly conscious of the effect all the time, but it struck on a subliminal level.

Apocalypse Now in the Dolby Stereo 70mm format has the most complex surrounds produced in recent years. Directional information comes from five sources: three behind the screen (left, center, and right) and two in the audience section (left rear and right rear). No predictions can be made as to whether this scheme will be used for other productions, but its effectiveness has been noted by most people who have seen the film. ■

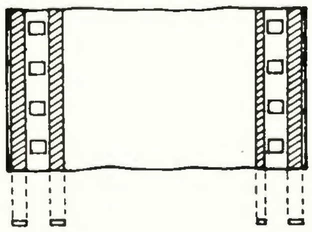


Figure 5(A). The oxide striping for a 35mm magnetic release print.

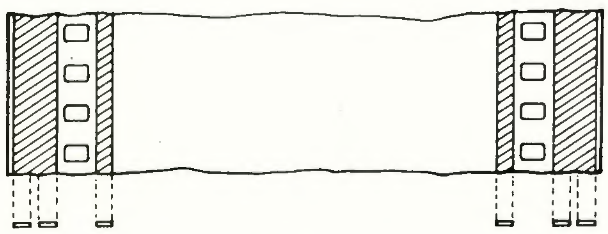


Figure 5(B). The oxide striping for a 70mm magnetic release print.

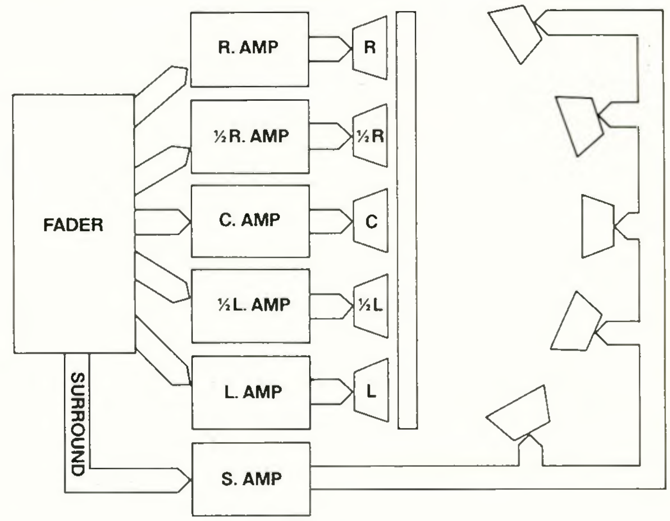


Figure 6. The loudspeaker arrangement in the theatre for conventional and Dolby Stereo 70mm release prints. For the Dolby Stereo format, the half-left and half-right speakers will reproduce only frequencies below 200 Hz.

more slowly. The result of all this, other things being equal, is that a typical 70mm release print with magnetic sound tracks may cost $11,000, while a comparable 35mm optical-track print comes in for $1,000 or less.

In the theatre, more complications arise. The magnetic playback heads have raised pole pieces that support the film only at the edge regions where the stripes are located, since contact with the picture frames themselves must be avoided. Normal film stock employs an acetate base material some 0.127mm (5 mils) in thickness—much stiffer and thicker than recording tape. Thus, high film-to-head forces are required for good contact, and pressures at the small pole-piece areas are impressive. In time—and not much time at that—the magnetic striping will begin to wear and flake, and wear of the head gaps will bring on drastic high-frequency losses. In a theatre that shows matinees as well as evening performances, six weeks is said to be a good estimate for the practical lifetime of a magnetic head, before treble losses doom it. A replacement, if it is one of the combination four- and six-track types that can handle all magnetic formats, can cost $1,200 or so, plus the time and labor to install it. As for a replacement print, the trick there may be to find one. Because of their manufacturing costs such prints are frequently in short supply.

PRODUCTION

The recording of film sound by a production crew can be relatively straightforward or extremely complex, but the job is always approached as being made up of three basic components or *elements:* dialogue, music, and effects (D, M, and E). The three elements are handled separately through most of the production process, being brought together for mixing only at the very end, when virtually all the sound for the film has been recorded and the picture portion of the film is in final edited form—or close to it.

The most important of the elements is dialogue, it being literally the voice of the motion picture. Dialogue recordings are always made during the photographing of the action, if only for use as "guide tracks" for reference and coordination later on. Poor audio quality, inappropriate background noises, the familiar case of laryngitis, or various other problems may mean that much of the dialogue must be re-recorded afterward ("replacement dialogue") in what is usually called a looping studio.

Miking of the original dialogue on a set or on location is difficult at best, with the situation complicated by the need to keep mikes and booms (and their shadows) out of the camera's view, and by noises from the camera, the director and production crew, and possibly from electric generators. For best sound quality boom-mounted microphones would be the logical approach, but photographic requirements often mean that concealed lavalier microphones are resorted to. These tend to be muffled by the costumes and to pick up noises from them, to the point where concealed mikes have been called the greatest single detriment to dialogue quality in cinema.

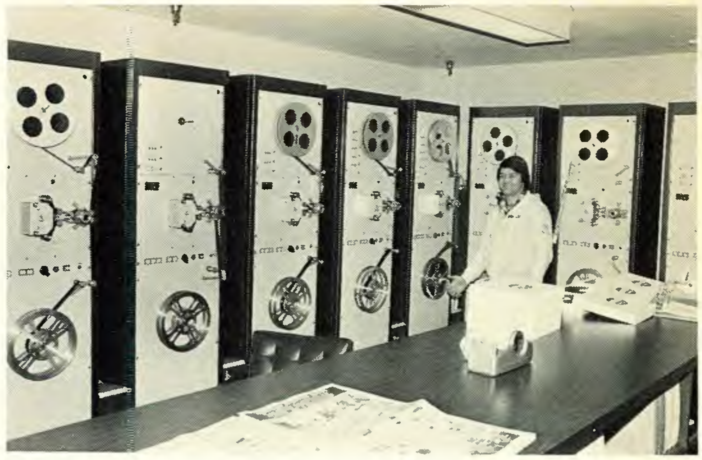
The dialogue recording is mono, on quarter-inch tape at 7½ in/sec; should a stereo release be planned, panning in a later production stage will take care of any movement or localization effects that are desired. The recorder itself is almost always a Nagra machine with a special head for laying down sync tones on the tape. The tones lock the tape—and later the film recorder that will be used to make a copy of the tape—to the camera in precise synchronization. Indeed, keeping the sound in step with the picture is a primary concern throughout the entire production process, because the two will not be wedded on a single piece of film until the very end.

After each shooting session, the dialogue tape is copied—overnight if possible—onto 35mm magnetic film, which is then edited to ensure that sound and picture will start and stop together all the way through when the day's shooting is reviewed the following morning. During the review of these "dailies" or "units," scenes are approved, dropped, cut, rearranged, and otherwise manipulated, and the sound editor's job of making sure there is always a dialogue track that fits the latest version of the picture really begins.

As scenes start to solidify into a final form, the recording of replacement dialogue for material that is unsuitable or requires changes can commence. In a looping studio, an actor can listen to (and view) his original performance of a scene repeatedly and then, cued by timing indicators on the picture, make a re-recording of it when he feels prepared. "Looping" refers to the continuous loops into which the original dialogue film, the picture film, and the new strip of magnetic film to be recorded are formed, all closely synchronized. As the actor hears and sees the continuous loops going round and round, he can build up a rhythm, get set, and have himself punched in when the moment seems right. As the resulting recorded material is generated, it is spliced into the evolving dialogue track that is following the film around, and safety copies are stored in case of catastrophe.

For other re-recording jobs an ADR (Automatic Dialogue Replacement) machine may be available. Among other conveniences, it has fast-rewind capabilities and therefore saves the time required to form film loops. However, it is not as conducive to the build-up of a sympathetic rhythm on the actor's part.

The sound track for Apocalypse Now *was mixed on an automated MCI 24-track console. The great majority of cinema-sound consoles now in use were created for and often by the film industry, however. Photo courtesy American Zoetrope.*



Batteries of magnetic-film recorders and reproducers occupy the machine room at Goldwyn Studios, all locked in sync with the projector and with each other. Photography by R. A. Peterson; Dolbylabs photos.

MUSIC PRODUCTION

Music is one of the later steps in sound track production. Ideally it would be among the very last, but pressures of scheduling may force it to be created before the picture portion of the film is complete and final, in which case the music is composed and performed according to the expected timing and emotional development of the scenes in question. If this is not necessary, the completed scenes can be projected in the sight of conductor and musicians as they perform. (Video tape copies of the film are coming into increasing use in this application.) The film will have cue marks on it to alert the conductor of coming developments; he may also listen on headphones to a "click track"—marks that have been made on the film's soundtrack area as rhythmic guides.

Music may have to be composed fairly intricately to fit certain scenes. It is not enough, for example, simply to back off on levels when some intimate action takes place on screen. Orchestra forces will have to be reduced and rebalanced, and in general the music planned for the scene almost as if it were a dance. And, naturally, if the scene changes through editing, the music must change too, through recomposition.

Music scoring sessions, as they are called, take place on sound stages with facilities for projection of the film. Equipment and miking techniques are today often those of the music studio, and twenty-four track recorders locked to the film chain through a time-code sync signal are not at all uncommon. Many have noted that movie sound-track recordings tend to be somewhat drier (less reverberant) than comparable productions by the music industry. This is because of the acoustical character of the sound stages, and because it is assumed that the movie theatre itself—a concert-hall-like space—will supply reverberation of its own.

EFFECTS PRODUCTION

Effects is an area in which things can get really interesting. Tom Scott again:

"Various gunshots and explosions for Apocalypse Now *were recorded in special outdoor sessions where Russian, Chinese, and American weapons were fired and picked up by as many as six different recorders—mono Nagras, multi-track recorders, even a PCM machine—and microphones varying from ordinary dynamic types to quad condensers. All aspects of the sound effects are needed as raw materials for the editors (soundcutters): trigger and mechanism clicks and clunks; the crack of discharge; the whiz of bullet "byes" overhead; the boom of reverb in a natural outdoor environment; the whistle of ricochet; even the 'plap!' and clangs as bullets hit various materials."*

Sound effects created for films tend to be composites assembled from numerous elements or "sub sounds" that are recorded separately on 35mm magnetic film, combined in a careful timing arrangement, and then synced with the screen action. You have probably heard stories of legendary effects men who have fashioned, for example, the everlastingly ultimate automobile crash out of bits and pieces that had nothing to do with an automobile crash. This sort of thing is not unusual; even when the sound of the real thing can be recorded convincingly, it is common practice to enhance it with little sonic details gathered here and there, the idea being to reinforce the reality the picture is striving for with an almost unreal wealth of sensation. If the effect is successful it is accepted by the audience and thought about no further. But subliminally there is a certain satisfaction in having experienced the sound of something so intimately.

Of course, effects needn't be loud or particularly dramatic to be complex. Visualize, for example, a man walking through a woods in late autumn. There are: the dry crunches of leaves underfoot (a man in a studio pacing around on some suitable material in sync with the picture); wind noises (a wind machine, possibly with enhancements, and frequently recorded and then formed into a loop so that it repeats); a distant church bell (the real thing? a studio pickup with reverb added?). As a rule these bits are all separate recordings. And there can be many more individual sonic details: the snapping of twigs, the delicate clatter of bare branches in the wind, the chatter of a squirrel, and so on. Sometimes these are the real sounds; other times they are contrived. It makes economic sense to capture authentic sounds on location as much as possible, but when it is not possible because of noise, or when the result is not convincing, the sound crew must find substitutes, either from an effects library of prerecorded sounds or by making new recordings. For effects such as people walking through dry leaves, sand, etc.; studios have facilities called "Foley stages." These are sound stages with various floor surfaces and props, where footfalls, clothing rustles, and other sounds of moving characters can be recorded in sync with the projected picture.

For the film's final mixing or *dubbing* session, it would be splendid if the sound crew would gather all the effects for each scene and put them together on a single piece of magnetic film, all ready to sync in. But before that can be done, several questions must be asked. Are they certain that they're working with the *final* edited version of the film picture at this point? Are they sure everyone, including the producer and director, will be satisfied with the balances and equalizations they adopt? Are they certain they won't be asked to alter effects (add a little extra "oomph" to an explosion sound with a synthesizer, for example)? If the production is stereo, are they sure, for two simultaneous effects, it won't be necessary to pan one while the other holds stationary? Since the answers to these questions are generally "no," the sound crew is limited as to how far it can go in assembling this part of the sound track beforehand. Separate effects can perhaps be worked up from their component bits and pieces in a series of premixes. But in general, much of the material has to remain in unmixed form to give the dubbing mixer maximum flexibility.

THE DUBBING SESSION

The dubbing session is the final step in assembling the sound track prior to its being married to the picture on a single length of film. It takes place in a studio very similar to a motion-picture theatre. A mixing console, often organized so that three mixers can work at it at once, occupies an advantageous position in front of the screen and monitor speakers. In acoustically isolated separate rooms are projectors and a number—sometimes an impressive number—of magnetic-film recorders and reproducers. All of these are locked in sync, and are controlled from the console in such a way that the push of a single button will cause them to start, stop, or reverse in perfect unison.

Prior to arriving at the dubbing studio, the three sound-track elements (D, M, and E) will have been carefully prepared. All will be on magnetic films precisely the length of the picture film; syncing indicators will have been provided so they can be threaded up properly; and exactly cut lengths of blank film will have been spliced in as spacing to get the timings between picture and sound correct. Much of the dialogue may be on a single length of film recorded with separate tracks for each actor, to permit balancing, separate equalization, and (if required in a stereo production) panning. In some productions, effects may occupy many tracks on many separate films, and in some cases will have been recorded in stereo. The component parts of all three elements are loaded onto film reproducers, and film recorders are prepared to receive their contributions.

The film industry's name for the usual mixing procedure in a dubbing studio is "rock and roll." It sounds like a dance, and in a sense it is, performed to a complex and discontinuous rhythm. The dancers are the dubbing mixer, who usually handles dialogue, and two additional engineers for music and effects. Thus assisted, the dubbing engineer works his way through the film in irregular advances and retreats, always seeking the mix that will give a scene—often created in fragments—a sense of continuity.

If, for example, two cardinals appear on the screen conferring furtively in an arcade of the Vatican, it could conceivably be that the voice of one was recorded right there on location, the voice of the other thousands of miles away in a small dialogue-replacement studio. Through equalization and reverb the mixer will strive for the best match of perceived acoustical environments for the two voices, and then he'll bring up the effects channels (crowd noises and the like) and music (if any) to see how well they cover the seams. When he is satisfied, all films are backed up a final time, and the record mode is thrown in.

The design of the dubbing equipment permits punch-in recording at any time and place; the rise of the bias in the record circuits is controlled to prevent punch-in thumps on the recording, so that transitions from one take to another are undetectable. Also, deliberate offset of sync between machines can be readily accomplished when necessary. If, for example, the composition of an effects track (perhaps a continuous loop) puts a distracting off-screen sound on top of an important piece of dialogue, the effects track in question can be "slipped"—that is, retarded a foot, a frame, or even one sprocket hole (1/96th of a second)—to locate the distraction elsewhere in the scene. Once the scene is recorded, the slipped track is returned to its original relationship to the other films and the mix continues normally.

Comprehensive as the facilities may be in a well-equipped dubbing theatre, mixes have a way of outgrowing them in complexity. There have been occasions when 150 or more separately recorded sounds and effects were brought together to accompany a mere few minutes of screen action. And the increasing use of noise reduction with its ability to reveal complex interweavings of sound is likely to invite the addition of still more numerous subtle touches to a sound track. But in any case, when dubbing is successfully completed, the result is a single- or multi-track length of film that synchronizes with the picture, has fades, transitions, and panning appropriately carried out, and equalization judiciously applied to ensure the intelligibility and impact of the dramatic action. It will have been mixed and otherwise prepared for direct transfer to its ultimate format, be it Academy mono optical, Dolby Stereo optical, three- or four-track 35 mm magnetic, one of the 70mm formats. It is, in other words, a completed sound track, at last ready for marriage to the picture it will accompany and explain.

The foregoing is too cursory to give more than a hint of the flavor of sound recording for motion pictures. And, unfortunately, those who know this work best are usually too busy doing it to educate others on how it is done. For those in search of more information, the texts listed below are generally recent and explicit enough to be of some assistance. ■

BIBLIOGRAPHY

Frater, C. B. *Sound Recording for Motion Pictures*. New York: A. S. Barnes and Co., Inc., 1979.

Happé, L. B. *Basic Motion Picture Technology*, second revised edition. New York: Hastings House, 1975.

In addition, current and back issues of the *Journal of the Society of Motion Picture and Television Engineers* (862 Scarsdale Ave., Scarsdale, NY 10583) will prove invaluable for research on specific subjects. The best source for them is probably an established technical library. The Society publishes five-year indexes organized into subject category, subject, and other listings.

REJUVENATING THE THEATRE

For some years now Dolby Laboratories has offered, together with its theatre equipment, training courses that prepare local technicians to assess the suitability of a theatre's existing facilities for wide-range sound-track reproduction, and to undertake the installation and adjustment of whatever additional equipment is required. Although the primary objective is to permit the showing of one or more of the Dolby Stereo film formats, the treatment the theatre receives improves the handling of all formats.

As a first step, the theatre's loudspeakers, their installation, the power-amplifier resources available, and the general electrical and acoustical situations are reviewed and, if necessary, recommendations are made for their alteration. When minimum performance requirements are met, and new loudspeaker/amplifier channels are put in or repaired as necessary to handle the proposed formats, installation begins.

In place of the projectors' existing sound-head photocells, stereo solar cells are fitted and wired to a cinema sound processor that fills all the theatre's audio electronics needs up to the inputs of the power amplifiers. The cells and the rest of the optics are then physically adjusted for proper cell-to-film spacing, focus, stereo separation, azimuth, and optimum high-frequency performance using test films, a dual-trace oscilloscope, and a real-time analyzer. The procedure includes ensuring the cleanliness, correct orientation, and uniformity of the optical slit (which forms the image that falls upon the sound track) and the other components of the system. Then, adjustable peaking circuits in the processor's optical preamplifiers are "tweaked," to provide the greatest smooth extension of the system's high-frequency response possible, using a pink-noise test film and a real-time analyzer. Finally, Dolby calibration is established.

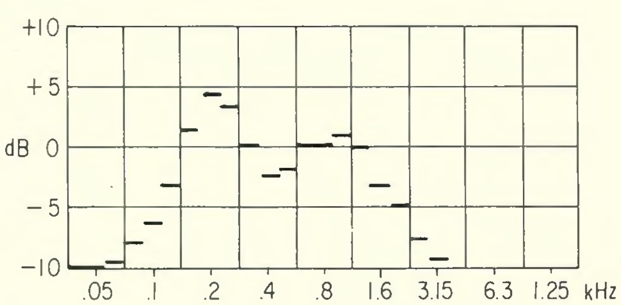


Figure (A). Response of a loudspeaker in a theatre before house equalization.

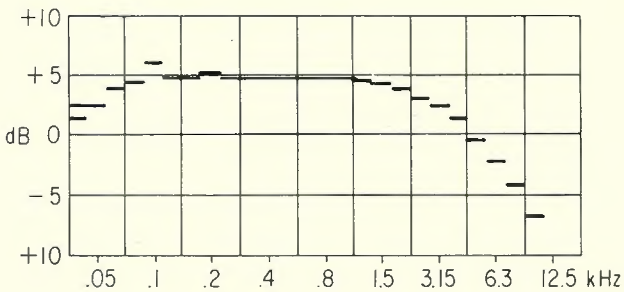


Figure (B). The same speaker after equalization. Steady-state pink noise is the test signal in both cases.

Next comes house equalization. A microphone connected to a real-time analyzer is set up in an appropriate place in the auditorium and the loudspeakers driven one at a time by a pink-noise generator. Initially, the response of a theatre loudspeaker *in situ* is likely to resemble FIGURE A, which certainly affords plenty of room for improvement. In particular, the prominent dip in the response in the crossover region (characteristic of the highly-efficient speaker systems used for such PA applications) needs attention, occurring as it does in an important band of mid-range frequencies. Multi-band equalizer modules built into the cinema processor have proven quite effective in smoothing and extending the speaker-plus-auditorium characteristic that constitutes the overall house response. The modules—one for each loudspeaker array, or at least one for each behind-screen speaker group—have broad-band high- and low-frequency controls to shape the overall spectrum, plus twenty-seven one-third-octave-band controls at ISO centers for dealing with narrow-band irregularities in response, such as the crossover dip. After adjustment of the equalizers, the final response curve (which should closely resemble FIGURE B) conforms to an ISO standard that has been found to be most appropriate for movie-theatre-size spaces. The high-frequency roll-off suggested by the figure does not actually occur on speech and music information. What FIGURE B actually shows is not a treble roll-off but a gain (room gain) at lower frequencies that takes place when a test signal such as steady-state pink noise is used.

Narrow-band equalization has been warmly received in music-studio control rooms and other comparatively small spaces. But in a large space such as a movie theatre it can be even more satisfying and effective, providing a smooth, balanced spectrum to a broad area of audience with excellent uniformity ■

JOHN EARGLE

Motion Picture Sound Systems

The introduction of special low-frequency effects, Dolby noise reduction, and a shift away from large movie houses has led to the development of new requirements for theater sound systems.

MOTION PICTURE SOUND SYSTEMS have not changed markedly since the Bell Laboratories auditory perspective experiments of the early thirties. Wente and Thuras were responsible for these early two-way horn-loaded systems, and the past half century has added little in the way of basic technology. Lansing, Shearer and Hilliard [4] refined the art, and motion picture sound quickly settled down to a body of practice which has remained relatively constant over the years. Even the advent of multichannel reproduction during the fifties did not change the basic approach to sound system design.

It remained for the introduction of special low-frequency sound effects and Dolby noise reduction during the seventies to change the sound requirements in any substantial way. The low-frequency enhancement systems required considerable acoustical output in the 25-40 Hz range, while the requirements of noise reduction called for greater high-frequency power-handling capability and overall peak power-handling requirements.

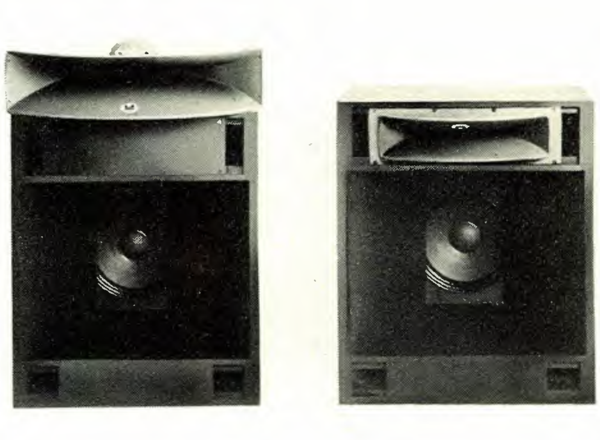
While the large movie palace has pretty-much faded from the scene, the multiple-theater installation, with its four to six units, has filled the gap. Large loudspeaker systems have given way to smaller systems which can be installed in relatively-shallow spaces behind the screens of the newer theaters. In this paper we will not discuss low-frequency enhancement systems inasmuch as the requirements have not been standardized. Our discussion will address only the full-range requirements normally encountered in theaters.

THE NEW REQUIREMENTS

Typical of the loudspeaker systems required by many small houses are the JBL models 4672 and 4674, shown in FIGURE 1. Systems such as these are available from many manufacturers and have found general utility in small-scale sound reinforcement applications. Sensitivity is generally in the range of 101 dB/1W/1m, and the more robust of these systems are capable of handling a steady-state power input of 200 watts.

For the larger houses, the models 4676-1 and 4676-2 are more typical. These systems, shown in FIGURE 2, have sensitivities in

Figure 1. JBL models 4674 (left) and 4672 (right) are representative of loudspeaker systems required by many small motion picture houses.



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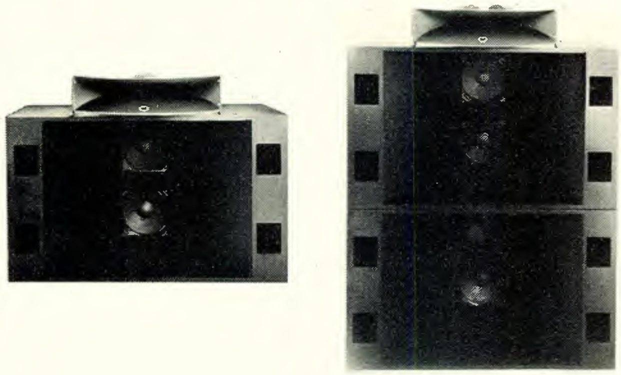


Figure 2. JBL models 4676-1 (left) and 4676-2 (right) are typical of loudspeaker systems used in the larger motion picture houses.

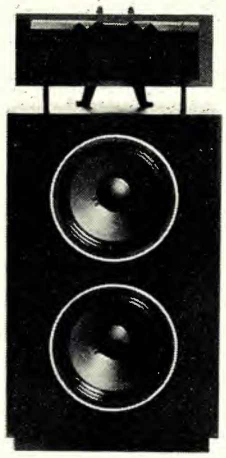


Figure 3. The JBL model 4670 is a small system capable of high output. It can be equalized for an effective frequency response ranging from 40 Hz to beyond 12 kHz.

the range of 104-107 dB/1W/1m, and they are capable of handling power inputs on the order of 200-400 watts.

Over the years, the bandwidth of theater systems has been limited to 40-50 Hz at the low end, and 9-10 kHz at the high end. While the systems shown in FIGURE 2 have the capability of being equalized at high frequencies for today's requirements, there has been a need for a smaller system—for the 200-500 seat houses—capable of high output throughout the frequency range. The model 4670 system shown in FIGURE 3 was designed with these requirements in mind, and it can be equalized for effective response from 40 Hz to beyond 12 kHz. The system makes use of two low-frequency transducers which were developed for the musical instrument market and which have greater power handling capacity than the normal theater woofer. The enclosure is a 226 liter (8 cubic feet) vented box, tuned to 40 Hz. The high-frequency portion of the system consists of a folded-plate acoustic lens, with a nominal horizontal coverage angle of 100 degrees coupled to a compression driver with a 100 mm (4-inch) diaphragm. The depth occupied by the system is only 559 mm (22 inches), allowing it to fit easily behind the screen in the smaller multiple-theater complex.

The acoustical characteristics of typical theaters with seating capacities ranging from 200 to 1500 are shown in FIGURE 4. The electrical requirements for attaining an SPL of 100 dB in the far field are given for the class of product which would normally be chosen for the job. Additional far-field SPLs are given for steady-state and peak-power ratings of the systems. The calculations are made for the 250-500 Hz range, and a directivity index of 7 dB (Q = 5) was assumed for the loudspeaker system.

REQUIREMENTS FOR EQUALIZATION

The classes of systems we have been discussing are limited in overall sensitivity by their low-frequency sections; in all cases, the high-frequency drivers have been padded down to match the

Figure 4. The acoustical characteristics of typical theaters with seating capacities ranging from 200 to 1500.

For Systems of Sensitivity of 101 dB/1W/1m								
Seating Capacity	Volume	Area	Room Constant	Reverberation Time (seconds)	Critical Distance	Power for 100dB-SPL (Watts)	Max. Level, 200 Watts (dB-SPL)	Max. Level, 400 Watts (dB-SPL)
200	1,700m³ (60,000 ft³)	1,040m² (11,200 ft²)	694m² (7,466 ft²)	0.5	8.2m (27 ft)	53	106	109
350	2,832m³ (100,000 ft³)	1,396m² (15,000 ft²)	929m² (10,000 ft²)	0.6	9.6m (31.6 ft)	72	104	107
500	4,531m³ (160,000 ft³)	1,858m² (20,000 ft²)	1,236m² (13,300 ft²)	0.75	11m (36 ft)	100	103	106

For Systems of Sensitivity of 104 dB/1W/1m								
1000	8,496m³ (300,000 ft³)	2,787m² (30,000 ft²)	1,858m² (20,000 ft²)	0.95	13.5m (45 ft)	73	104	107
1500	14,160m³ (500,000 ft³)	3,716m² (40,000 ft²)	2,462m² (26,500 ft²)	1.2	15.4m (51 ft)	95	103	106

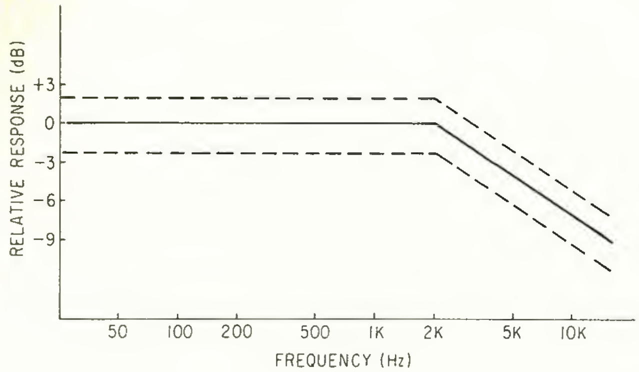


Figure 5. Recommended equalization contour for motion picture sound systems.

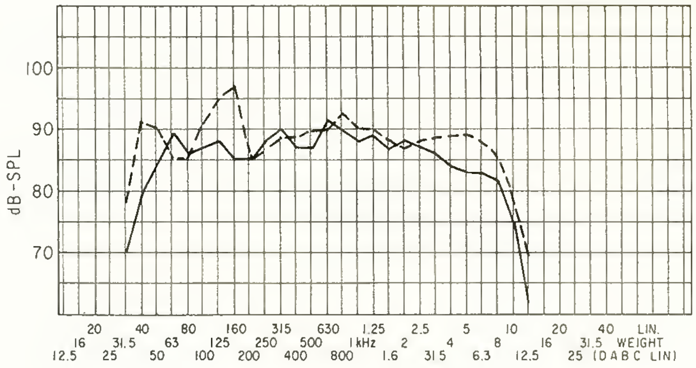


Figure 6. Typical response of the JBL 4676-1 Theater System. Dashed line, before equalization; solid line, after equalization.

low-frequency sections. With the amount of padding indicated here, the systems would be nominally flat:

Model	LF Sensitivity (dB/1M/1m)	HF Sensitivity (dB/1W/1m)	HF Padding
4670	101	107	− 6 dB
4672	101	111	−10 dB
4674	101	111	−10 dB
4676-1	104	111	− 7 dB
4676-2	107	111	− 4 dB

Motion picture sound systems are not equalized for flat response; rather, the preferred curve, based on extensive work done by Dolby Laboratories, is flat out to 2 kHz with a 3 dB/octave roll-off above that frequency, as shown in FIGURE 5.

In typical equalization practice, the tailoring of the HF response lessens the HF drive at the upper end of the spectrum; however, substantial losses may be encountered in large houses.

FIGURE 6 shows typical response, before and after equalization, for a 4676-1 system located in a small theater of 1416 m ($50,000\ ft^3$) volume, and measured at a distance of 12 meters (40 feet).

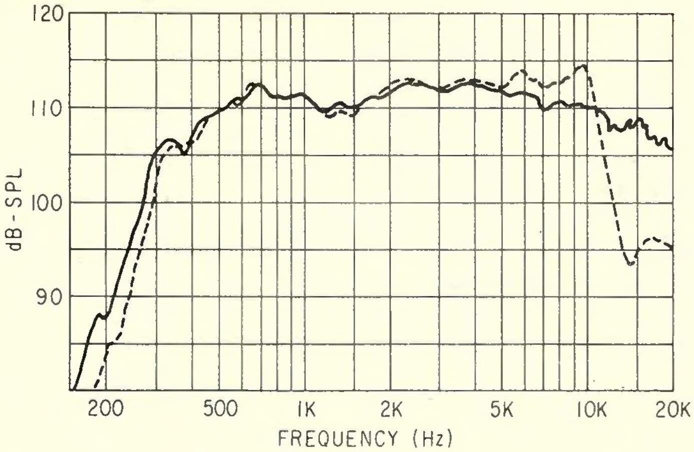


Figure 7. On-axis response of two drivers on a JBL model 2350 radial horn; one watt at one meter. 2441 driver, solid line; 2440 driver, dashed line.

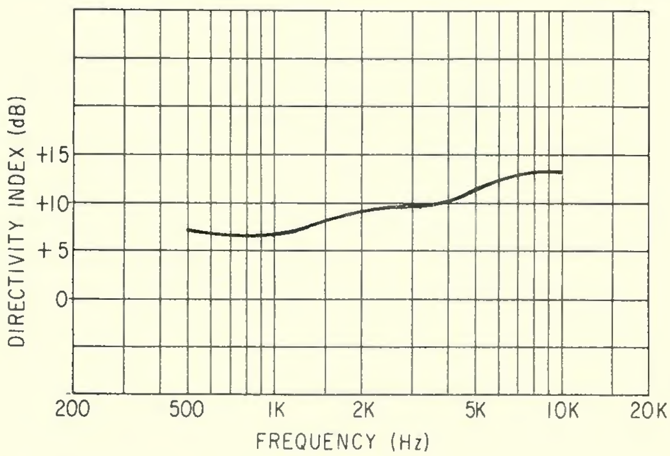
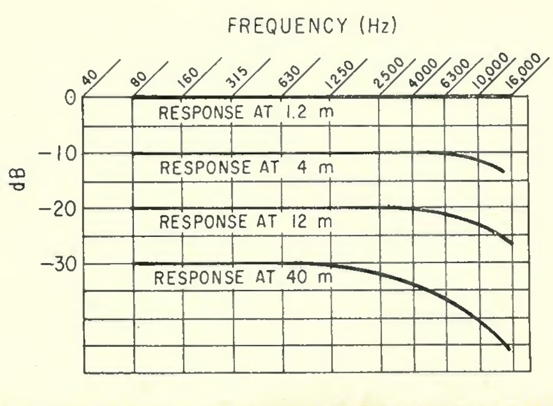


Figure 8. The directivity index for the JBL model 2350 radial horn.

Figure 9. Losses due both to inverse-square fall-off and atmospheric attenuation at high frequencies at distances of 1.2, 4, 12 and 40 meters. (At 20 per cent Relative Humidity and 20 degrees Celsius)



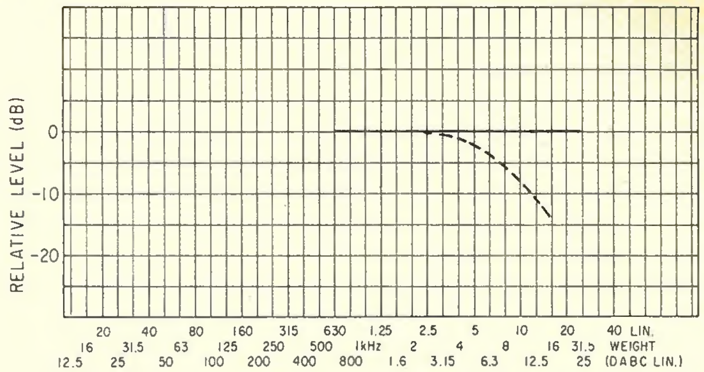


Figure 10. Measurement of through-the-screen losses. Dashed line represents attenuation through perforated vinyl screen (15 mil, 8 per cent opening). Samples provided by Stewart Film Screens.

The model 2440 driver was used in this installation, and it exhibits a characteristic sharp roll-off above about 9.5 kHz. A more-recent improvement in the driver, the 2441, extends response by about another octave. FIGURE 7 shows the on-axis response of both drivers on a JBL model 2350 radial horn. The new driver obviously offers a considerably greater range for system equalization well out to the 12-15 kHz region. The rising directivity index of the 2350 horn, shown in FIGURE 8, helps to maintain the on-axis response of the new driver without the need for additional electrical equalization. There is, in fact, good reason to prefer the older horn designs as opposed to newer, constant-coverage designs, especially in narrower houses, because of the greater "throw" of these horns at high frequencies.

HIGH-FREQUENCY LOSSES

In large installations, high-frequency losses may become significant. FIGURE 9 shows losses, over and above the normal inverse-square-law losses, due to air absorption. The effect is most significant at low levels of relative humidity. Beyond distances of about 12 meters (40 feet), the losses become extreme. These losses cannot be directly compensated for by equalization without upsetting the high-frequency balance as perceived at closer-in listening positions. Some trade-off is required in balancing the listening requirements throughout the house.

Through-the-screen losses are not significant out to 8 kHz, if perforated-screen material is used. Beyond 8 kHz, the toll on electrical drive requirements will become significant. Typical losses are shown in FIGURE 10.

All things considered, quality theatre systems can be expected to perform well out to the 12.5 kHz range before the effects of screen losses and atmospheric losses in large houses become a limiting factor.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the work done on the JBL theater product line by Jim Brawley of Technical Systems Reps, Chamblee, GA, while he was applications engineer in the JBL Professional Division. ■

BIBLIOGRAPHY

1. L. Cowan *et al., Recording Sound for Motion Pictures* (McGraw Hill, New York 1931).
2. J. Eargle, *Sound Recording* (Van Nostrand Reinhold, New York 1976).
3. J. Frayne & H. Wolfe, *Elements of Sound Recording* (John Wiley, New York 1949).
4. —, *Motion Picture Sound Engineering*, Compiled by the Research Council, Academy of Motion Picture Arts and Sciences (Van Nostrand, New York 1938).

JOHN MOSELY

COMTRAK

The COMTRAK System offers an Academy mono track (fully-compatible with existing systems), plus a four-channel discrete sound track for theaters equipped for COMTRAK playback.

COMTRAK IS THE shortened name for the "Combined Academy Monophonic and Compatible 4 Track Stereophonic Photographic Sound Track." Why, you may well ask does one need such a system? A good question for one schooled in the art and craft of producing phonograph records. Before attempting to answer this central question, it is necessary to understand the great differences that exist in the two areas that are as dissimilar as chalk and cheese.

Since **db** is normally read by record makers, I shall not go into the techniques of record recording, but simply describe the various steps that go to produce a reel of film that is run in the cinema. Seldom, if ever, is any one person responsible for the overall sound. Instead, typically 25 technically-oriented people will handle the product before it reaches the cinema. FIGURE 1 shows a chart of organization. (Quite a difference from the times I used to go out with an Ampex 300 and one helper to record a full symphony orchestra. I then edited the tape, cut the master, OK'ed the test pressing and, was completely responsible for equipment maintenance, too!)

The production crew do their best to pick up the dialogue and live effects at the time, and in synchronism with the photography. This activity is often fraught with difficulties. It is often impossible to place the microphones properly, since they interfere with the camera or lighting. Under these circumstances there are two alternatives. The first is to wire each actor with a wireless microphone, which brings its own problems. The second is to "loop" the sound later. This means calling back the actors to an ADR stage (Automatic Dialogue Replacement) where they redo their lines in synchronism with the cut picture. The original recording will be made on ¼" tape with a synchronization signal. This tape is then transferred to 35mm striped film, which is used by the editors to cut in sync with the picture.

Sound effects are obtained by four means:

1. live recording.
2. taken from a library.
3. recorded on a "Foley" stage. This is a stage fitted with noise-making contraptions where an expert will make the appropriate sounds in sync with the picture.
4. extra stock effects may be incorporated at the time of dubbing if the lead mixer is not satisfied with what the editors have given him.

The music is often recorded on multi-track tape, similar to the record recording process. But normally it is recorded to picture. That means that the cut picture is projected on to the recording stage. Devices are employed by marking the picture and using audible cues to help the conductor work in sync. At the mixer's option, he will either mix down the multi-track tape later, or record on to 35mm magnetic film concurrently. At least three elements will be given to the dubbing mixer (strings, wind and percussion), to give him something to work with, in order to tailor the balance to suit the action on the screen, and of course to balance properly with the dialogue and effects. Invariably the music will take third place to the dialogue and effects, so it is necessary to resort to tricks of balance in order to make it acceptable.

The dubbing or re-recording stage is where the buck stops. Typically, some twenty elements will be used to produce the final composite balanced master. It is at this point that any problems encountered along the line have to be smoothed over. Since this paper is intended as an overview of the whole process, it is not germaine to go into the difficulties. Suffice it to say that this is the most exacting area in the whole process.

When the final master is approved, it has to be turned into a photographic negative so that it can be printed with the picture as a "married print." It is this type of print that will find its way to the cinema. Due to the behavior and nature of the photographic exposure and chemical processing, it is necessary to use a technique of predistortion in order to obtain an optimum print. Since COMTRAK is a photographic process, no reference will be made to other printing methods.

As will be gathered from the foregoing, it will be understood

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John Mosely is vice-president of KINTEK, Inc., Hollywood, CA, and is responsible for the development of the COMTRAK Process.

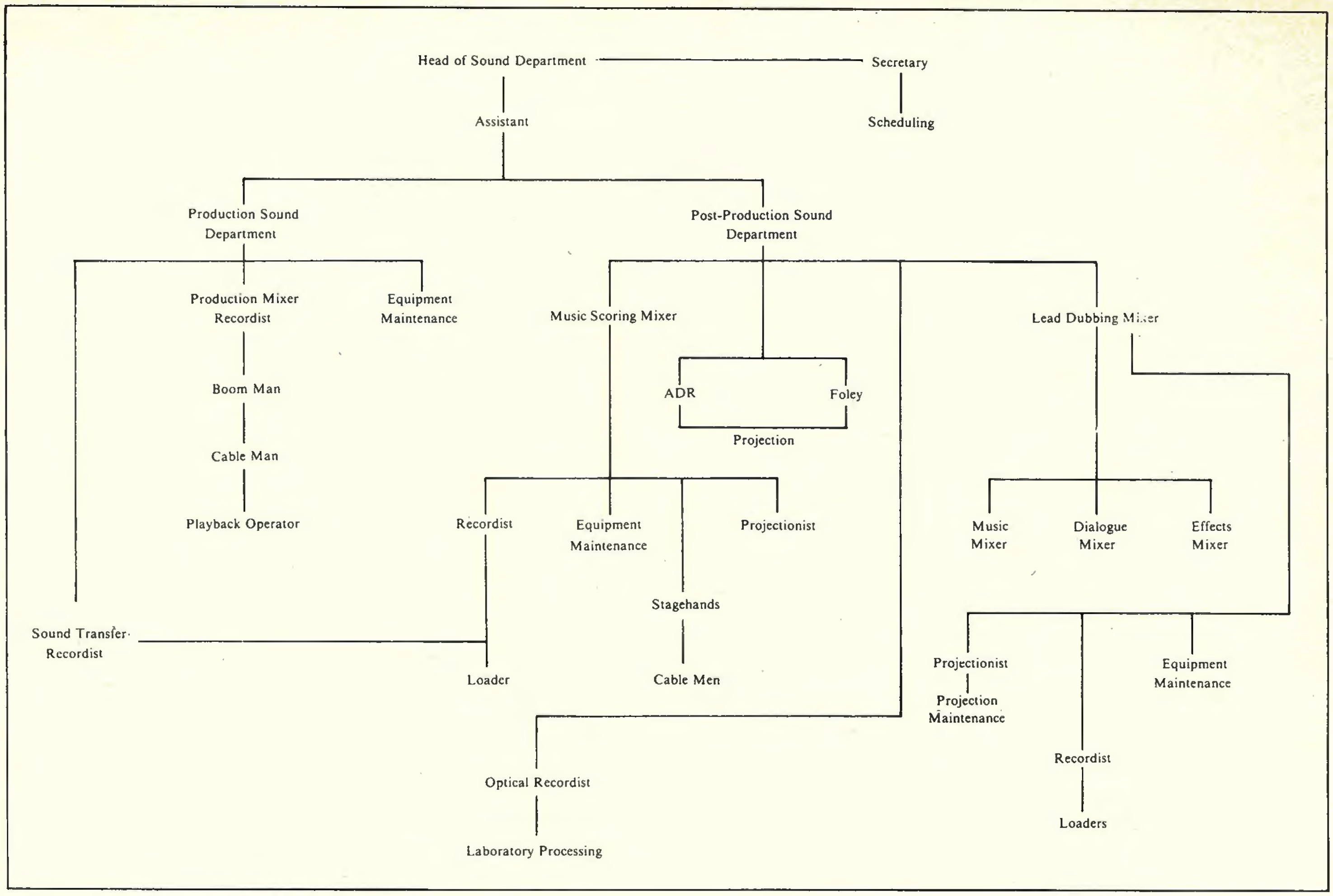


Figure 1. A chart of organization, indicating the various steps in the production of sound on a film.

that at best, it is an extremely difficult task to end up with what, in record terms, will be known as "Hi-Fi." In reality, there has been little incentive to improve film sound because the majority of cinemas around the world are unable to play anything other than the standard mono print, which will conform to the "Academy Curve" shown in FIGURE 2. Reference to this curve will make the reader aware that it is necessary to use considerable midrange boost in order to achieve acceptable presence and some high end. It is usual to include an Academy filter in the re-recording console so that the dubbing crew will equalize the master accordingly. It follows that it is nigh-on-impossible on a routine basis to make tracks intended for Academy reproduction compatible with wide-range stereophonic sound. One can argue that the two are diametrically opposed. In practice, when a picture is to be released stereophonically, the 4-track master will be made initially and will contain the left, center, right and surround tracks. Then the left, center and right will be remixed and re-equalized through the Academy filter in order to produce the mono track.

It must be appreciated that a standard optical reader projects a narrow, focused slit of light on to the sound track. The light then falls on to a photosensor, which gives out an electrical signal proportional to the change in light level. This is of course sensitive to both level and frequency. Unfortunately, the standard of care and maintenance of most theater equipment is abysmally low. Various attempts to improve film sound by more advanced technology, such as magnetic striping, have failed due to their cost and complexity.

I became fascinated with the problem of how to get better film sound reliably some five years ago. My goal has been to come up with a system that would satisfy all of the requirements of the three phases of the film industry: production, distribution and exhibition. Furthermore, it has to be operationally simple and easy to maintain. I believe the solution to these problems lie in the Kintek COMTRAK. It distinguishes itself from any other existing or proposed system in several ways.

1. One print will do for all purposes, mono and stereo.
2. There are four discrete high-quality stereo tracks.
3. The projectionist does not have to align any equipment, nor does he have to know that he is running a COMTRAK print. The control tracks automatically trigger the reproducing equipment to stereo when it reads the control tracks.
4. Easy maintenance is assured by the equipment design and layout.

The track layout is shown in FIGURE 3. As already noted, a standard optical reproducer works by the change of light falling in the photo-sensor. It will be noted that the only variable-width track out of the seven incorporated in the COMTRAK system is the one designated Academy Mono. All the others are modulated lines of constant width. Therefore, when a COMTRAK film is placed on a standard projector, only The Academy Mono track will be reproduced. The other tracks will add slightly to the background noise. However, in practice this is negligible.

The stereophonic reproducer contains a Charge Coupled Device (CCD) which looks at the entire signal as a video waveform. This is processed so that the individual track edges are read with a synchronized clock. Windows are formed which correspond to the points where the tracks will lie. The command and locator tracks ensure that the whole scale between them is correct so that the data will be in the correct window. They also form a servo to follow the mechanical jump-and-weave that is always a problem in the field. Although the tracks are only separated by two thousandths of an inch at full modulation, the electrical crosstalk is around 80 dB.

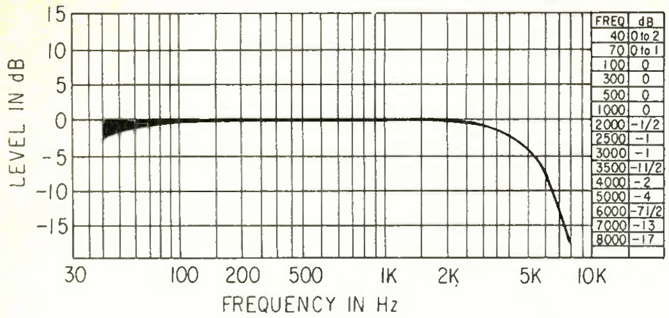


Figure 2. Motion Picture Research Council's standard electrical characteristics for Altec Lansing's Voice of the Theatre Systems. Electrical run, measured at the output of the power amplifier with a resistance equivalent to the speaker network load using the Research Council Standard Multi-frequency Test Film, Altec or RCA Test Film.

The tolerances of ± 1 dB up to 3,000 Hz, increasing progressively with frequency to a maximum of ± 2 dB at 7,000 Hz, should be rigidly maintained in adjusting equipment to these specifications. A greater tolerance is allowed at the low frequencies to compensate for the variation in the acoustical response of the auditorium at low frequencies because of a difference in reverberation time characteristics from one auditorium to the other.

The following maximum speaker system power indicates the maximum amount of power in electrical watts at the output of the power amplifier with which each speaker system should be used.

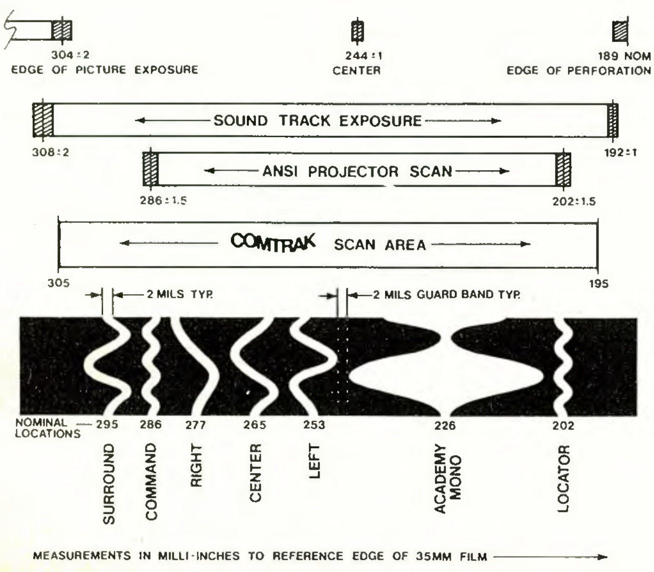
Loudspeaker Unit Attenuation: It is recommended that the high-frequency units be attenuated from 0 to 3 dB, depending upon the size of the high-frequency horn selected to properly cover the auditorium.

Model	High-Frequency Units		Low-Frequency Units		Maximum Speaker System Power
	Number	Type	Number	Type	
A-1-X	4	288	6	515	160
A-1	2	288	6	515	80
A-2-X	4	288	4	515	120
A-2	2	288	4	515	80
A-4-X	2	288	2	515	60
A-4	1	288	2	515	40
A-5	1	288	1	515	30

The CCD reader also improves the quality when reading standard variable-area Academy tracks due to the fact that it only reads the transitions. It will be appreciated that all the audio data are to be found at those transitions where light changes to dark and vice-versa. Since the area occupied by the transitions in a conventional print is only 10 per cent of the area which is read, it follows that 90 per cent of the area contributes only to noise. Hence, when playing a worn print, one gets a tenfold improvement in signal-to-noise ratio, or 20 dB.

Signal processing gives a very acceptable signal-to-noise ratio in the order of 70 dB. As already noted, there are four discrete tracks to accommodate the left, center, right and surround signals. Since films are normally played in large rooms, it is essential to have a solid and discrete center signal, so that the central dialogue will not stop around the screen for non-centrally seated observers. Unfortunately, processors such as SVA (Stereo Variable Area), using two tracks and a matrix, leave a lot to be desired in this area. Bell Labs undertook interesting listening tests in the 1930s that laid down the physical ground rules for listening to sound in large and small rooms. These rules of course still hold true today!

Figure 3. COMTRAK compatible track layout.



The production of the COMTRAK system required the development of an entirely new recording system. This has been accomplished by means of a cathode ray tube modulator. Being a massless device, it is free from resonances and the high frequency limitation normally associated with standard mechanical modulators. It turns out that one can record from d.c. to about 22.5 kHz on modern sound recording film, completely flat, but for practical purposes it is generally considered satisfactory to limit the response to 20 Hz—14kHz.

In recent years, there has been an increased interest in reproducing the low end of the frequency spectrum. Apart from MGM's 1936 picture, SAN FRANCISCO, which had a special sound system to reproduce the earthquake effect, it has been generally considered undesirable to reproduce anything below 40 Hz. Indeed, the "Voice of the Theatre" loudspeakers, which are to be found in most theatres in the United States, cut off at 40 Hz due to the design of the cabinet. In order to satisfy this requirement, low frequencies are placed on the command track in f.m. They are demodulated and fed into a properly-designed sub-woofer containing its own high-power amplifier. Tone detectors in the reproducer switch the system into the stereophonic mode when the 8 kHz tracks are present. These tracks are also encoded with "Touch Tone" signals so that theatre equipment, such as lights and curtains, can be operated from the film. Special effects, too, can be triggered from this track.

This paper has set forth the constraints under which film sound is made. It is hoped that COMTRAK will open the way for movie theatres to enjoy better sound. Once the exhibitors find that they can enjoy this medium without costly maintenance and breakdowns, it is believed that stereophony will become the norm in the cinema as it is in the home. Since COMTRAK is fully compatible, there is no reason why the producers should not use the system as soon as it is introduced, remembering that one print will suffice for all purposes. With the rapid improvement in the quality and size of television, it seems important that film makers grasp all the available tools to offer some good reason for the public to leave the comfort of their homes for the cinema. ■

DIRK DALTON

Creating Synthesized Sounds for Star Trek

Using Synthesizers, a complex network of signal processors, and a fire extinguisher, the various sound effects for the Star Trek movie were created.

BEING READERS OF science-fiction, as well as long-term fans of the original Star Trek tv show, we at Media Masters Inc. were extremely pleased when we were called in to assist the post-production effort on "Star Trek—The Motion Picture." As outlined by director Robert Wise and editor Todd Ramsay, our responsibilities were to include creation of the major sound effects, such as the voice of "V'ger," the warp drive, the "wormhole" effect, the transporter, the "sonic shower," and many others.

We have been working with synthesizers and complex signal processing networks for many years, so we were well-suited to the task, in terms of both hardware and experience. Working primarily on film and television audio, Media Masters Inc. (Santa Monica, CA—formerly Dalton Recorders) has a good track record as a music facility also, having hosted such luminaries as Barry Manilow, Fleetwood Mac, Van Morrison, The Beach Boys, Shaun Cassidy, Jose Feliciano, The Osmonds and others. Staff member Joel Goldsmith, who actively collaborated with me throughout the Star Trek project, is also responsible for the excellent synthesizer programming heard in the score of the science-fiction film, "Logan's Run." Myself, Joel, and staff members Melody Shepherd and Elizabeth Black made up the basic effects team.

Dirk Dalton is chairman of Media Masters, Inc., Santa Monica, CA. Mr. Dalton was responsible for the synthesis and recording of the major sound effects for the motion picture "Star Trek."

Sound editors Richard Anderson and Steve Flick had emphasized their preference for "new" sounds that had not been over-used in earlier sci-fi films, and we agreed to actively pursue this goal. We resigned ourselves to dealing creatively with the cinematic assumption that sound waves *can* travel in a vacuum, and plunged noisily onward.

SYNTHESIZERS

In order to handle the tremendous variety of sound effects required, we needed practically the entire in-place facilities of our 24-track studio, as well as a few rental items. The synthesizers in our standard day-to-day set-up included (of course) a Mini-Moog, an ARP 2600, a Yamaha CS-60 and CS-80, and the Korg vocoder, not to mention various synthesizer-related electronics, such as sequencers, frequency followers, and special interfaces.

SIGNAL PROCESSORS

All of the above was set up in our main audio control room. This room utilizes a Sphere Series A console connected to an Ampex MM-1200 24-track recorder with Dolby noise reduction. Mixdowns were to an Ampex ATR-100 two-track quarter-inch machine, also with Dolby. For monitors, we used the UREI 813 (Time-Aligned), as well as the JBL 4311 and the Auratone cube. This control room also contains the majority of our outboard signal processors, all of which were in use in some phase of Star Trek. These include the Lexicon 224 digital reverb, the Lexicon Prime Time ddl, a Systems Technology stereo phasor, a Systems Technology Flanger, an AMS ddl (a honey), a pair of Eventide H910 Harmonizers, the ever-present Orban parametric EQ, and the Ursa Major Space Station digital reverberation, as well as other echo chambers and echo devices, noise gates, limiters, de-essers, and all the other customary stuff. (The above-mentioned phasor is not the same sort of device wielded by James Kirk and friends).

As work began to advance, we decided that if we could perform the synthesizer adjustments while looking at the visual material they were supposed to complement, the subjective realism of the product would be greatly improved. So, in order to speed up the recording process, we installed an Audio Kinetics *Q-Lock* synchronizer and a three-quarter-inch video editing and playback room. Shortly thereafter we discovered that in terms of speed, ease of use, and accuracy, this system is excellent for not only effects-to-picture audio work, but also for every other phase of audio production in the film and television areas, including scoring, Foley, dialogue replacement, and most of all, final dubbing.

RECORDING TECHNIQUE

For Star Trek, our 24-track masters were recorded at 30 in/sec. with Dolby. Our reference fluxivity was 250 nW/meter ("+3"), as was the Dolby reference level. Our 30 in/sec. record EQ was to the AES curve. All of the same specifications apply to the two-track stereo mixdowns on the Ampex ATR-100. Our choice of tape was Ampex 456, for a number of reasons, most notably dynamic range, availability, and suitability for the Ampex machines. In using 456, we find that 250 nW/meter (midway between old NAB "O" and "+6") is the best level for our purposes. If we did not have an Audio Designs "Vu-Scan" or other device with which to monitor peaks, we might prefer a more-conservative record level, but since our engineers can clearly see both the peak indication on the Vu-Scan and the VU indication on the Ampex MM-1200 (left in the set-up position so as to enable off-tape verification of level during recording), we have no fear of accidental tape saturation. We do know of a few studios in Los Angeles which utilize reference fluxivities as high as 380 nW/meter even though they have no means to measure instantaneous peaks (it certainly is a way of getting around the need for a noise reduction system). However, when tapes from these studios pass through our hands, we find the gently-clipped peaks clearly audible and undesirable. We feel that the combination of moderately increased level (250 nW/meter as compared with the old NAB 185 nW/meter standard), high energy tape, Dolby noise reduction, and peak metering provides the most desirable characteristics for effects and music recording.

Normally, in addition to supplying 25-to-50 slightly-different stereo mixes of each of the major effects, we would also make mixes of various smaller sonic components within the overall effect (to facilitate flexibility in final dubbing). These additional component mixdowns could be as simple as transferring one track directly from the 24-track to the quarter-inch with no effects added, or as complex as you could possibly imagine. Our 30 in/sec. Dolby mixes were transferred to 35mm three-track Dolby magnetic film for final editing and dubbing. Two of the three tracks on the mag film were left and right signals directly copied from the quarter-inch, but the third was a mono mix of the two tracks, for two reasons. First, and most important, that third track lined up with the mono heads on the Moviolas most of the sound editors were using, allowing them to hear both channels of information. However, through the terrible speakers and headphones that are standard on the solid and traditional Moviolas, the effect is not at all one of honest reproduction. In some cases, editors keep headphones on for extended periods of time to avoid the excessive mechanical noise that emanates from a Moviola. The second use of the third track on the 35mm mag turned up during final dubbing, when the number of available faders was exceeded by the number of channels of information coming into the console. The first thing to go was the pre-calculated stereo spread on individual sound effects elements. It was extremely handy to have the mono track available right at the 35mm playback machine.

BUILDING EFFECTS

We have been asked a number of times how the deeply-layered sounds of the Enterprise engines were made. The essence of the final procedure was as follows: Over various carefully-calculated periods of time, approximately 36 tracks (utilizing pre-dubbing to expand the 24-track format) of synthesized sounds were recorded, beginning with the subtle low-end vibrations and moving toward the more intense, high-pitched, and obvious sounds. As we rolled, both the high-frequency filtration characteristics on the synthesizer *and* the tape speed of the recorder were varied in a prescribed fashion, which resulted, on playback, in sounds which, as time passed, became richer in high-frequency harmonics as well as growing higher in fundamental pitch. Once these tracks were recorded, and the pre-dubbing had gotten us a few open tracks, we began fine-tuning the effect. The re-recording (or "ping-ponging") of individual tracks through various combinations of sound modifiers (with carefully planned level and effects changes—which, of course, we could punch in) proved to be an extremely useful technique. It not only allowed us to creatively tailor tone quality and application of other special modifications, but also permitted immediate improvements in the subjective quality of both the synchronization and the stereo perspective localization. Again, the use of the synchronized video was a tremendous advantage. This last "ping-ponging" phase of production brought with it the key to this effect. As we went from track to track, we ran through an Eventide H910 Harmonizer which was set up to do two things. First, to raise pitch by two per cent, and secondly, to recycle this transposition of pitch (simple feedback), creating a seemingly infinite series of upward glissandos that disappear only where the digital circuitry has its upper bandwidth limit. This effect, superimposed in a number of different guises on the previously recorded tracks, formed the basis of our engine acceleration sounds.

FIRE EXTINGUISHERS PRESSED INTO SERVICE

Some very odd equipment was pressed into service to create another very different effect. The photon torpedoes used in Star Trek seem to rush past the audience's vantage point at extremely high speeds. We had relatively little difficulty finding appropriate sounds for the initial firing of the light projectile, but the pass-bys seemed to require a very violent sound, full of complex Doppler shifts and other problematic manipulations. We could not seem to coax sufficient impact out of the synthesizers. It finally occurred to us that it might be feasible to naturally simulate an approaching, passing, and receding sound source. What we did, at two in the morning in some quite dense fog, was to split into pairs—two of us in the company truck and two of us on the sidewalk with an AKG 414 (on a very long cable). We in the truck backed-off a couple of blocks, waited, and contemplated the possible negative aspects of shooting-off large fire extinguishers from the open windows of moving vehicles. Then we gave the agreed-on signal to roll tape: a couple of toots on the horn. And away we went. Coaxing the truck up to a healthy 55 mph or so, we zoomed past the front of the defenseless studio, simultaneously firing-off the fire extinguisher, which not only covered our compatriots on the sidewalk rather thoroughly with a white film, but succeeded also in covering most of the rest of the block—including the microphone, which after all, was by intention less than a foot from the truck as we passed. This unusual procedure worked beautifully—with a bit of EQ, a little bit of digital delay, several overdubs, a thorough mixing job, and so on.

MUSICAL EFFECTS

Synthesizers and fire extinguishers were not the only sound sources employed. One morning we received a call from composer Jerry Goldsmith, whose superb score (beautifully edited by music editor Ken Hall) makes an outstanding contribution to the overall effect of the picture. He suggested that we record some acoustically-produced musical sounds, reassuring us that we would be impressed with how other-worldly (and therefore appropriate) some of the naturally generated effects could be. Specifically, the composer suggested that Emil Richards, a noted percussionist, bring in his collection of some of the world's most unusual percussion instruments—including some of the creations of the late Harry Partch, famed avante-garde composer and instrument designer/builder. At the subsequent recording sessions, we opened our ears to some very strange and beautiful sounds, many of which found their way into the film. The high, eerie sounds that seem to keep moving, deep in the sonic background, are produced by Emil Richards playing Partch's "rub-rods."

Though our liason with visual effects experts Doug Trumball and John Dykstra was good, we would have preferred to work even more closely with them, as we feel that more feedback between our two areas of endeavor would make for some really fine science-fiction effects, with sound and picture in harmony from the point of initial creation onward. It certainly would save the final dubbing mixers a lot of headaches. One cooperative effort that worked out extremely well was John Dykstra's contribution of a modified Tesla-coil sound (an electrical arcing effect) to our efforts at finding a suitable sound for the "digitalization" effect (in which V'ger turns matter into pure data, and stores entire spacecraft, even planets, as data). All we really needed to do was work at "padding" that basic sound with other similar, yet less harsh sounds of our own, add several digital delays, and then multiply *that* texture by twenty or so by recording it on as many tracks as possible, each slightly out of sync with the rest. Subsequent remixing took advantage of the almost unlimited processing capabilities, eventually resulting in the finished sound.

Some of the most important effects in the film occur during the final confrontation at V'ger's heart, near the original Voyager VI spacecraft. The director, Robert Wise, asked that the "voice" of the half-living, half machine creature known as "V'ger" sound like a living machine trying to speak, and yet not sound like a voice. He asked us to strive for some delineation of emotion in V'ger's audible responses to the frustrating situation facing V'ger in the film's concluding minutes. We did our very best with this difficult problem. We tried everything. The director knew exactly what he wanted and did not mind waiting for us to come up with it. The strange sounds heard in this sequence are certain evidence that it was worth the effort. One of those strange sounds lurking in the atmosphere of the scene is the voice of Joel Goldsmith, slowed down to approximately 10 per cent of its normal speed, with plenty of various digital delays applied. Another more prominent sound was created by physically slapping a piece of carefully over-modulated 2-inch tape against the 24 track heads, and running the resultant outburst through a series of echo and reverb devices. This was the only effect in which Dolby noise reduction was *not* employed.

WARP-SPEED IN THE FINAL STAGE

The final dubbing took place in Goldwyn's dubbing room D, to the Dolby stereo optical format with matrixed-in center-front and "surround" channels. As may well be imagined, the quantity of material submitted for final dubbing was prodigious, in some cases elaborately pre-dubbed from upwards of 80 original tracks. Luckily, the competent mixers at Goldwyn, under the capable direction of Bill Varney, were able to handle all the material, plus stick to the incredible schedule that was set for the last few weeks of dubbing. Also remarkable was the organized teamwork displayed throughout post-production by Richard Anderson's sound editing line-up. They accomplished incredible amounts of work in a limited period of time. Their efforts were matched only by the last-minute magic of editor Todd Ramsay, who, in cooperation with the director, Robert Wise, managed to create a highly artistic and complex film while working under tremendous pressure. Robert Wise modestly, and narrowly, escaped the toast he richly deserved, following the final dubbing of the last few feet of film (mere days prior to release). We drank a few rounds anyway. ■

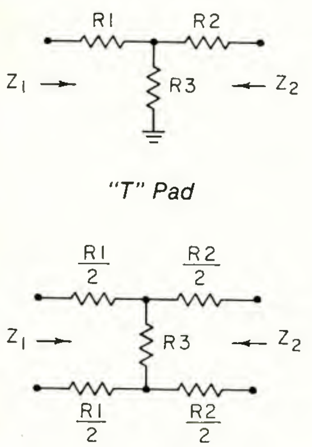
More on Audio Pads

Patrick Finnegan's recent column on "Home-built Audio Pads" (November, 1979) generated a lot of reader comment. Several letters pointed out a formula mixup, while others contributed additional information on attenuator pad design.

Jerry Carmean notes that the column "*...was quite interesting and informative. I like to see this kind of article in magazines such as* **db**, *because it gives individuals working in audio knowledge and ideas they will be able to use throughout their professional lives.*"

Mr. Carmean draws our attention to the fact that, in the formulas given, "*...the character, N, should represent the desired power loss, not the loss in dB as indicated.*"

Finnegan's pads and formulas are reproduced in FIGURE 1. As Mr. Carmean correctly notes, N represents the desired power loss—actually, the power *ratio*—and *not* the loss in dB, as stated in the original column.



Formulas:

$$R_3 = \frac{2\sqrt{N Z_1 Z_2}}{N-1}$$

$$R_1 = Z_1 \frac{(N+1)}{(N-1)} - R_3$$

$$R_2 = Z_2 \frac{(N+1)}{(N-1)} - R_3$$

Z_1 = Source Impedance
Z_2 = Load Impedance
N = Power Ratio

Figure 1. The "T" and the "H" pads. The "H" is the same as the "T", but arranged for balanced circuits.

For the standard formulas for computing resistor values based on a desired *dB loss*, reader Steven L. "X" (sorry Steve—can't read your last name) refers us to Howard Tremaine's *Audio Cyclopedia* for formulas involving a "K" factor. Readers who don't have the Cyclopedia on hand may simply substitute K^2 in the formulas given in FIGURE 1.

Which brings up the question, What is a "K" factor? Tremaine says, "*It is the ratio of current, voltage or power corresponding to a given value of attenuation, expressed in decibels.*" This is somewhat mis-leading, for if we wish to identify a current or voltage ratio as "K", then the corresponding power ratio should be labelled, "K^2", or, as Finnegan and many others prefer, "N." This will satisfy both of the following familiar equations:

$$\text{dB loss} = 20 \log (E_1/E_2) = 20 \log (K)$$

and

$$\text{dB loss} = 10 \log (P_1/P_2) = 10 \log (K^2) \text{ or, } = 10 \log (N)$$

In the real world, we have been long-accustomed to dealing with the decibel, and usually don't think much about the power (or voltage) ratio that it represents. Therefore, the proper value for the K factor may not be immediately apparent to those whose math is a little rusty.

To find K^2, simply take one-tenth of the dB attenuation that you want. The anti-log of this value is equal to K^2, or N. In other words, dB loss/10 = log K^2, or, K^2 = the common antilog of dB loss/10.

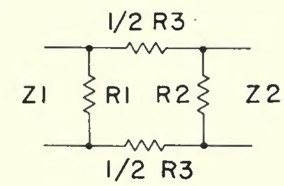
Example: What is the K^2 factor for an attenuator that will supply a 20 dB loss?

K^2 = anti-log (20/10)
= anti-log 2
= 100

Summing up, if you know the power-loss ratio (N), use the formulas, as given in FIGURE 1. If you know the desired dB attenuation, find K^2 (that is, N) as stated above.

Some attenuator formulas require a value of K instead of K^2, so keep in mind that K – 1 is *not* N – 1!

Don MacLeod, from Ridgewood Sound in Oakland, California adds that it is often more practical to use Pi and square, or "O" pads. He points out that *"The square pad even requires two-fewer resistors than the H pad, and is almost as easy to compute.*

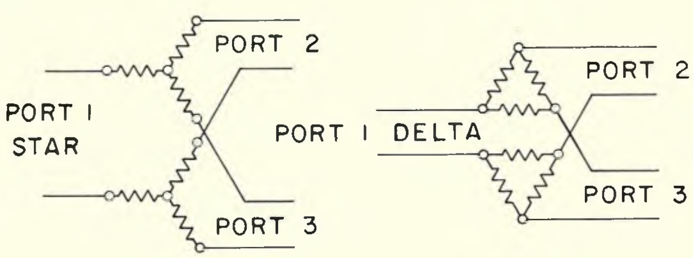


$$R3 = \frac{N-1}{2}\sqrt{\frac{Z1,Z2}{N}}$$

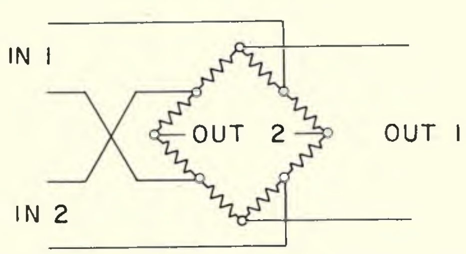
$$\frac{1}{R1} = \frac{1}{Z1}\left(\frac{N+1}{N-1}\right) - \frac{1}{R3}$$

$$\frac{1}{R2} = \frac{1}{Z2}\left(\frac{N+1}{N-1}\right) - \frac{1}{R3}$$

Anyone using the tricky divider network should realize it creates instant unbalance to ground in the two outputs. Two better schemes are the dual star and dual delta which cause no unbalance. They require standard resistance values for 600 ohm circuits, each resistor is 100 ohm for the star and 300 ohm for the delta. Both insert a 6 dB loss, and the delta configuration requires no tie points.



The use of these simple dividing networks for combining two signals, such as left and right stereo into mono, can create problems as they provide a 6 dB loss path between sources. A good solution is the classic resistance hybrid circuit. It is a ring of eight equal resistors of $\frac{1}{2}Z\sqrt{2}$ *ohms and has an insertion loss of 10.7 dB. It requires identical loads on its two outputs for perfect balance which results in no transmission between inputs. An unused output should be terminated in at least a resistor equal to the circuit impedance. For a 600 ohm circuit, the computed value of the resistors is within 2 per cent of the standard 430 ohm value."*



WDOE chief engineer Ed Silverman suggests a way to get better accuracy with stock-value resistors. *"While working part-time at a large local electronics distributor (who stocks resistors by the thousands in bins), I found that, apparently, due to variables in production control, many resistors fall outside their five or ten per cent tolerances and don't get "weeded out" before they are shipped. For example, in a batch of two-hundred-fifty 560 ohm resistors, maybe fifty will measure 600 ohms, ±5 ohms. So we developed a store policy to let engineers, technicians, and hobbyists who do business with us regularly to rummage through our bins with their ohmmeters, to find their exact values. This benefits both seller and buyer. With this procedure, it is possible to build pads that will be equal in performance to commercially manufactured pads (if stray inductance and capacitance are not critical) at the price of ordinary resistors. So ask the manager of your local distributor (if you have one) if you can go through his resistor bins to select your values, explaining your reasons, and impressing on him that you are depleting his "defective" inventory by doing so. If you're a regular customer, there should be no problem. Then grab your "260" or DVM and start measuring... you'll be pleased with the results. Unless, of course, the impedance of your broadcast equipment is not quite 600 ohms (or other* exact *value); this happens. But in any case, your homemade pad will be superior to one made with "close" stock resistors."*

Ronald Ajemian—a frequent contributor to **db**—sent in a BASIC program to compute the resistor values for T and H pads. It's one more application of the personal computer for audio problem-solving. For the H pad, Mr. Ajemian uses R4 and R5, in place of the R1/2 and R2/2 seen in FIGURE 1.

Here's the program:

```
100  PRINT "T AND H PAD DESIGN"
110  PRINT
120  PRINT "(IF IMPEDANCES ARE UNEQUAL, ENTER
     THE LARGEST FIRST.)"
130  PRINT
140  PRINT "ENTER Z1  ";
150  INPUT Z1
160  PRINT "ENTER Z2  ";
170  INPUT Z2
180  PRINT "ENTER THE DESIRED ATTENUATION,
     IN DB  ";
190  INPUT A
200  K = 10^(A/20)
210  S = SQR (Z1/Z2)  [or, S = (Z1/Z2)^.5]
220  R1 = Z1*(K^2 + 1 - (2*K*S))/K^2 - 1)
230  R2 = Z2*(K^2 + 1 - (2*K*S))/K^2 - 1)
240  R3 = Z2*(2*K*S/K 2 - 1)
250  R4 = R1/2
260  R5 = R2/2
300  PRINT "T PAD VALUES"
310  PRINT "R1 = ";R1
320  PRINT "R2 = ";R2
330  PRINT "R3 = ";R3
340  PRINT:PRINT
350  PRINT "H PAD VALUES"
360  PRINT "R3 = ";R3
370  PRINT "R4 = ";R4
380  PRINT "R5 = ";R5
400  END
```

In the program, lines 100 through 190 prompt the operator to enter the appropriate values for Z1, Z2 and A. To save time, these lines could be replaced by the single instruction; 100 INPUT Z1, Z2, A

Lines 200 through 260 do the necessary math, and 300 through 380 print out the answers. The program ends at 400, although this could be replaced by instructions to return to 100 (or perhaps 140) to do another calculation. ■

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BEST PRICE ON TEAC, Tascam, Ampex Sennheiser, Allison, Eventide, Sound Workshop, UREI, BGW, Electro-Voice, Lexicon, ADR, Marshal, Orban, JBL and more. **Paul Kadair's Home and Commercial Audio, Baton Rouge, Louisiana (504) 924-1006.**

TEST RECORD for equalizing stereo systems; Helps you sell equalizers and installation services; Pink noise in 1/3-octave bands, type QR-2011-1 @ $22.00. Used with various B & K Sound Level Meters. **B & K Instruments, Inc., 5111 W. 164th St., Cleveland, Ohio 44142.**

FOR SALE—ALL IN excellent condition, 3M-M64 2 track recorders in console, UREI model 813 speaker systems, Ampex 351-2 with Inovonics Electronics, Ampex 300-2 in console, Ampex 300-4SS in console, set of 8 track heads for 3M-M79, OP-AMP Labs model SM 100 50W/Channel, Eventide 1745A DDL, and Eventide 1745M DDL. Contact: **Frank Tarsia (215) 561-3660.**

TASCAM, TEAC, Sound Workshop, Technics Pro, Otari, dbx, MXR, Eventide, E-V, Shure, Maxell, Ampex, UREI, Stax, Sennheiser, Orban, Spectro Acoustics, DeltaLab, NAD, Ivie, BGW, Studiomaster and more! Send for price quotes.

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¼-INCH TAPE duplicating system. Six Crown 800 transports. New 4-channel heads. Solid state. Mint. $4,200.00. **(215) 338-1682.**

IVIE SOUND ANALYZERS, all models in stock—demo models and discounts available—sales and rentals. **Theatre Technology, 37 W. 20th St., New York, NY 10011. (212) 929-5380.**

BX20 AND BX10 AKG reverberation systems. FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

ONE YEAR OLD MOBILE disco/playback sound system and lighting system, state of the art, 1200 watts audio, BGW, Gauss, Bose, Technics, etc. all Anvil cases. **(901) 885-4504.**

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FOR SALE—1 Crown RTAII, Brand new w/warranty, including 7" Anvil Rack Case w/lids front & back, and Anvil Suitcase type case, foamed-lined w/wheels for air transport—$1700 firm. Also, 1 UREI 100-A Soni Pulse complete w/case and warranty (Demo Unit) $800 firm. **(215) 589-2546.**

ORBAN. All products in stock. FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

SOUND LEVEL METERS: General Radio #1933 and 1551 B; Tape Recorder: Roberts #770X. **Acoustical Consultants, Inc., (415) 421-1164.**

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Dealer Inquiries Invited
*Price subject to change w/o notice.

LEXICON 224 Digital Reverberation. FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

AMPEX, OTARI & SCULLY recorders in stock for immediate delivery; new and rebuilt, **RCI, 8550 2nd Ave., Silver Spring, MD 20910.** Write for complete product list.

IVIE ELECTRONICS REAL-TIME ANALYZERS, etc. Very slightly used demonstrators at discount. Full factory warranty. Money-back guarantee. **JML Company, 39,000 Highway 128; Cloverdale, CA 95425.**

Lexicon Prime Time: FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

25%-PLUS DISCOUNTS on all Electro-Voice Sentry and Interface speaker systems, raw speakers, and pro music products. Best prices BGW amplifiers, HME wireless microphones, Shure Pro Master, etc. Prompt delivery to all USA and foreign destinations. For quotes call 24 hours, 7 days—**(305) 462-1976.**

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dbx 155: FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

BGW: FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

NEUMANN SM-69 FET Stereo mic system, NS-69 Power Supply, EA-30 Suspension, M-35a 18-foot Stand, G-35 Boom. Like new. Best offer. **Mike (301) 665-4978.**

SCULLY, NEW and used: FOR IMMEDIATE DELIVERY. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

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For Sale: MCI JH-538 Automated Console, MCI 2, 4, 8, 16, and 24 Track Tape Machines with JH-45 Synchronizers. All less than 150 hours use.

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New York, NY 10036
(212) 921-5920

REELS AND BOXES 5" and 7" large and small hubs; heavy duty white boxes. **W-M Sales, 1118 Dula Circle, Duncanville, Texas 75116 (214) 296-2773.**

UREI: FOR IMMEDIATE DELIVERY most items. **UAR Professional Systems, 8535 Fairhaven, San Antonio, TX 78229. 512-690-8888.**

SALE: LOADS OF MC30, MC40 tube amps. Ampex AG300-2 @ $1000; AG300-1 @ $800; 3M-79-2 servo $3000; Neumann U48 ea. $1000; Sennheiser MD421U-DIN (6 pcs) @ $110 ea.; Dolby 360 ea. $600; MXR-DDL $700; Mac-2100 @ $500; Crown D-75 @ $225; SAE, Revox other used equipment available from stock. Also, new and used Trident consoles and parts. Complete parts for 3M79 series machines. Custom consoles and components: Melcor EQ, Electrodyne 709L, 710L, Gotham HW 600, line amps, pre-amps, etc. Quantities available. Call for other brokerage listings. **Empirical Audio, 3A Todd Place, Ossining, NY 10562. (914) 762-3089.**

NEUMANN CUTTING SYSTEM w/SX68 head, complete with console; tape recorder w/preview heads, speakers—$60,000. Call **Paul (312) 225-2110** or **(312) 467-9250.**

AMPEX, OTARI, SCULLY—In stock, all major professional lines, top dollar trade-ins; 15 minutes George Washington Bridge. **Professional Audio Video Corporation, 384 Grand Street, Paterson, New Jersey 07505. (201) 523-3333.**

THE LIBRARY...Sound effects recorded in STEREO using Dolby throughout. Over 350 effects on ten discs. $100.00. Write **The Library, P.O. Box 18145, Denver, Colo. 80218.**

USED RECORDING equipment for sale. **Dan (415) 232-7933.**

FOR SALE

Ampex 300 mono w/351 electronics, in console—$1,000. Ampex 300 mono, old style electronics, unmounted—$600. Curtain Infonics reel-to-reel 2-track high-speed duplicator Model 74-M2, makes 3 high-speed (30 ips) at a time—asking $995. Starbird Mike Boom, new $595—asking $250. Large quantity of plastic 10½" empty reels—75¢ each; in plain white box—$1.50. Call **Dan** at **(617) 426-3131.**

STOCK CLEARANCE

REVOX, OTARI, TECHNICS & other quality recorders, mixers, headphones, mics, pre and power amps, speakers, etc. Lists from—**Entertainment Sound Services, Inc., P.O. Box 66, Madison, Ala. 35758. (205) 772-0251.**

NEVE CONSOLE 24 tr., 3M M79 24 tr. tape recorder, 24 tr. Dolbys—$100,000. 3M M79 2 tr. w/Dolby, Crown pwr amps, UREI speakers, Steinway 7-foot Grand, Hammond B3, UREI 1/3 octave eqs., Kepexes, AKG BX-20 reverb, everything needed for 24 tr. studio—$120,000 takes all. Call **Paul (312) 225-2110** or **(312) 467-9250.**

ROAD CASES, factory direct prices on premium quality cases, also custom cases for any need. Call **(517) 372-5342** or write **Aarmor Case, 410 E. Grand River, Lansing, MI 48906.**

SERVICES

MAGNETIC HEAD relapping—24 hour service. Replacement heads for professional recorders. **IEM, 350 N. Eric Drive, Palatine, IL 60067. (312) 358-4622.**

AMPEX SERVICE COMPANY: Complete factory service and parts for Ampex equipment; professional audio; one-inch helical scan video systems; video closed circuit cameras; instrumentation consumer audio; professional audio motor and head assembly rebuilding. **2201 Lunt Ave., Elk Grove Village, IL 60007; 500 Rodier Dr., Glendale, CA 91201; 75 Commerce Way, Hackensack, NJ 07601.**

CUTTERHEAD REPAIR SERVICE for all models Westrex, HAECO, Grampian. Modifications done on Westrex. Quick turnaround. New and used cutterheads for sale. Send for free brochure: **International Cutterhead Repair, 194 Kings Ct., Teaneck, N.J. 07666. (201) 837-1289.**

JBL AND GAUSS SPEAKER WARRANTY CENTER. Full lines stocked. Instant recone service, compression driver diaphrams for immediate shipment. **Newcome Sound, 4684 Indianola Ave., Columbus, Ohio 43214 (614) 268-5605.**

ACOUSTIC CONSULTATION—Specalizing in studios, control rooms, discos. Qualified personnel, reasonable rates. Acoustilog, Bruel & Kjaer, HP, Tektronix, Ivie; equipment calibrated on premises. Reverberation timer and RTA rentals. **Acoustilog, 19 Mercer Street, New York, NY 10013 (212) 925-1365.**

MULTI-TRACK RECORDING specialists —1-2-4-8-16-24 tracks, authorized dealer for Tascam, Otari, Ampex, Teac, Technics, AKG, AB Systems, Crest, SAE Pro, dbx, Orban, Tapco C12, Audioarts, Loft, Lexicon, Ashly Audio, Altec, PAS, PSL, Shure, and many more. Single items or complete studio packages. Studio design and construction. Phone or write for a prompt written quotation. **Professional Sound Labs, Inc., 42 North Franklin St., Hempstead, NY 11550. (516) 486-5813.**

WANTED

WANTED: RECORDING EQUIPMENT—mikes, recorders, consoles, outboard gear. **Greg Field, Box 243, San Mateo, CA 94401. (415) 343-1353.**

BUSINESS OPPORTUNITIES

COMPLETE AUDIO STUDIO package available in Tulsa, including MOOG 55 and 3 module Arp synthesizers, 8-track and 2-track Ampex recorders with dbx units, mixing board and much more. Call **(602) 488-3454,** or **P.O. Box 1316, Carefree, Arizona 85377.**

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People/Places/Happenings

• **Don Richter** has been named sales manager of **Modular Audio Products (MAP)**, a division of **Modular Devices, Inc.**, Bohemia, NY. Prior to joining MAP, Mr. Richter was with **Automated Processes, Inc.**, Huntington, NY.

• Equipped with a new MCI Series 600 audio console, **Sound Recorders, Inc.** announces the construction of Kansas City's first automated 24-track studio. **Jim Wheeler**, formerly with **Dick Marx and Associates** in Chicago, is the general manager. The new facilities are located at 3947 State Line, Kansas City, Missouri 64111, (816) 931-8642.

• **Ampro/Scully,** Newton, PA, has announced that they will continue to manufacture the Scully 270 Series tape reproduction system. Designed for use in long-play background music and automated broadcast music and automated broadcast systems, the Scully 270 utilizes 14-inch reels, and features bi-directional capabilities.

• Reponsible for the management of **Ampex Corporation's** full line of professional audio recording systems and accessories, **Edwin W. Engberg** has been appointed product manager of the audio products group in the company's Audio-Video Systems Division. Mr. Engberg most recently served as manager of the audio engineering department at Ampex, directing the development of the ATR Series of multi-track audio recorders.

• Appointed applications engineer for the Professional Division at **James B. Lansing Sound, Inc., Mark Gander** will assist JBL professional sound contractors in product applications, and will provide technical information on JBL professional products. Elsewhere at JBL, **Bill Hamilton** has been named Eastern regional sales manager for professional products, supervising all sales activities in the Northeast, Mid-Atlantic states and Southeast.

• **DeltaLab Research, Inc.,** Chelmsford, MA, has appointed **James L. Camacho** vice president of sales and marketing. Mr. Camacho joins DeltaLab from **dbx, Inc.,** where he was director of corporate marketing. **Phil Markham,** of DeltaLab, will continue as national sales manager—directing the domestic sales effort and administering the DeltaLab rep organization.

• Specializing in sales, installation, and 24-hour service of most major lines of sound reinforcement equipment, **Spectrum Sound, Inc.,** sound reinforcement consultants, has moved their offices to Suite 101, 50 Music Square West, Nashville, TN 37203. Telephone: (615) 329-1982.

• In a corporate realignment, **Milton T. Putnam** was elected chief executive officer and chairman of the board of the **URC Companies.** In addition, **D. F. Morris** was elected president; **Lillian Sewell** chief financial officer, secretary and treasurer; **Brad Plunkett** senior vice president; **Ray Combs** vice president of manufacturing; and **Dean Austin** vice president of recording. The URC Companies comprise the following: **United Recording Corp.** in Hollywood; **United/Western Studios** in Hollywood; **Coast Recorders, Inc.** in San Francisco; **U.R.E.I. (United Recording Electronics Industries)** in Sun Valley; and **Teletronix Information Systems Division** in Redlands.

• **McMartin Industries,** Omaha, NE, has announced the appointment of **John R. Barton** to the post of executive vice president. Mr. Barton's duties will include management of international projects in which the company is engaged. In addition, **Robert A. Switzer** has been named vice president of sales. Joining McMartin in 1976, Mr. Switzer most recently held the post of director of domestic sales.

• In an expansion of its national sales staff, **Leader Instruments Corporation** has added **Michael Gomez** as Eastern Regional Manager and **Marc Gottlieb** as Western Regional Manager. Mr. Gomez makes his headquarters in the company's new corporate facility in Hauppauge, NY; while Mr. Gottlieb operates from Leader's Chatsworth, CA office and service center.

• **Otari Corporation,** San Carlos, CA, has announced the appointment of **Tom Sharples** as a special project engineer. Initially, Mr. Sharples will be in charge of the MTR-90 multi-track support program. Before joining Otari, Mr. Sharples managed **Proper Sound,** a studio maintenance, consultation, and recording equipment rebuilding service. Mr. Sharples is currently an owner of a sixteen track music and commercial recording studio in San Francisco.

• **Audio Designs and Manufacturing, Inc.,** Roseville, MI, has changed its corporate name to **ADM Technology, Inc.**

• **John H. Ochtera** has been promoted to president of the **Bogen Division of Lear Siegler, Inc.,** Paramus, NJ, succeeding **John T. Morgan,** president of the division the past eleven years, who retired for health reasons. Mr. Ochtera has been executive vice president of Bogen the past year. In addition, three new appointments were announced: **Ronald Kashkin,** vice president, operations; **Donald Oakes,** director of materials; and **Mark Koller,** director of engineering.

• Formed as a vehicle for leasing high-quality audio equipment, **Harrison Systems, Inc.,** Nashville, TN, has announced the establishment of a leasing subsidiary, **Harrison Leasing Corporation.** Although Harrison Leasing Corporation is a wholly-owned subsidiary of Harrison Systems, Inc., the leasing program will not be limited to Harrison equipment. In fact, the company is encouraging package leases of studio gear, including high-quality studio equipment manufactured by other companies.

• **Polyline Corporation,** Des Plaines, IL, announced that it has merged with its divisions, **Recording Supply Co.,** and **Pro Audio Specialties Co.** The official name will now be that of the parent firm, Polyline Corporation.

• Three executive-level promotions were announced at **Audio-Technica U.S.,** Fairlawn, OH. **Fred W. Nichols,** formerly vice president, marketing was promoted to senior vice president; **Paul A. McGuire,** formerly national sales manager, was named vice president, sales; and **Dean R. Slagle,** formerly operations manager, was appointed vice president, operations.

• **Don V. Larson** has been appointed vice president and chief executive officer of **Orange County Electronics International Inc.,** Winnipeg, Canada. Mr. Larson is a member of the Board of Directors of the **Northland Bank,** and is chairman of the **Audit Committee.** Although Orange County's manufacturing facilities are located in Winnipeg, worldwide marketing is handled by **Parasound Inc.** of San Francisco, CA.