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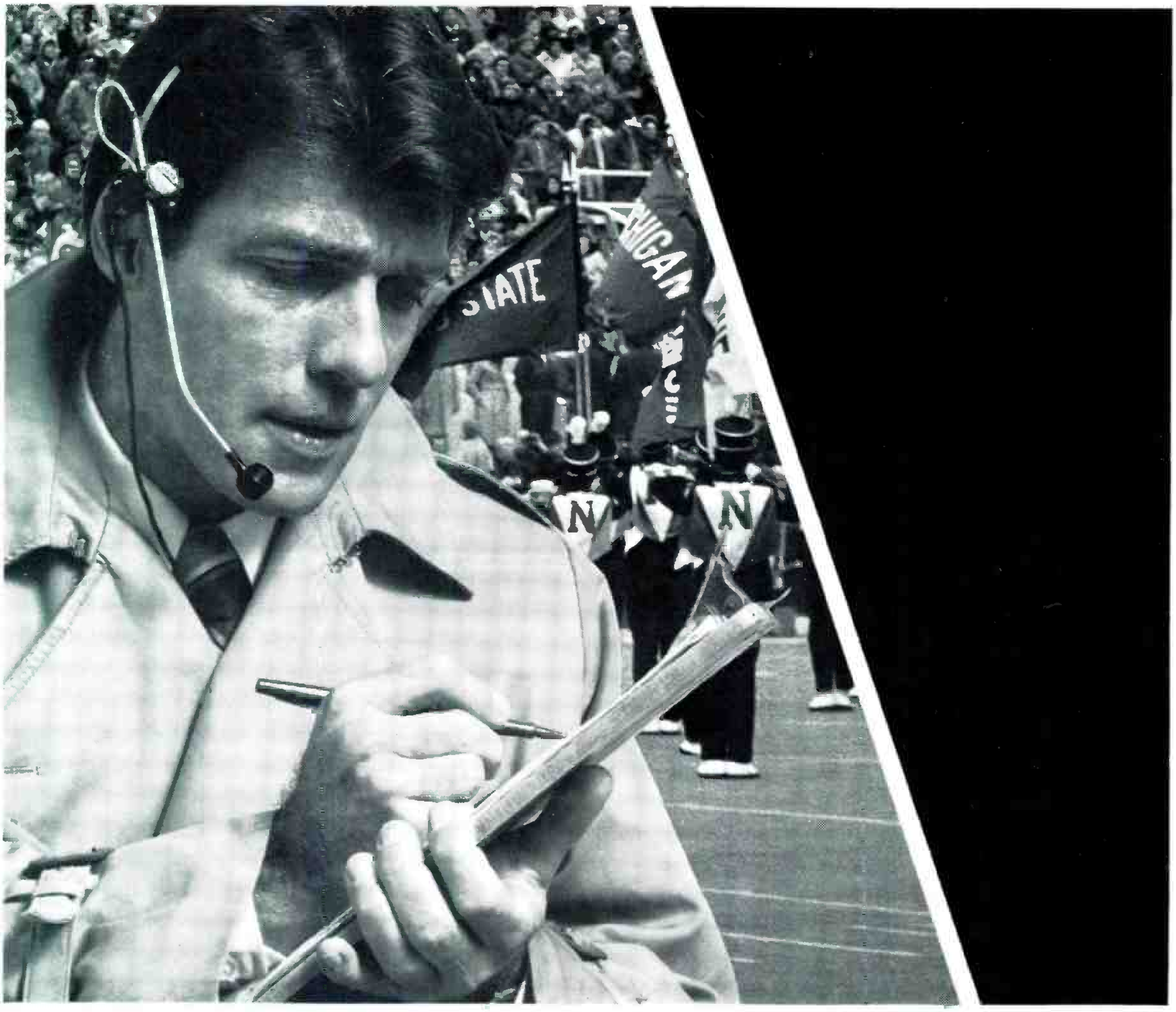
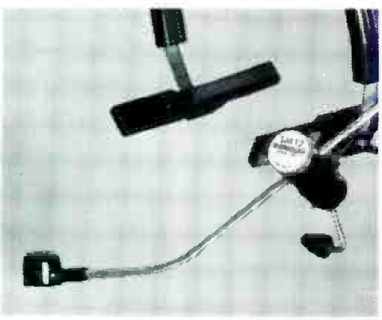
THE SOUND ENGINEERING MAGAZINE
FEBRUARY 1976 $1.00

IN THIS ISSUE:

- The Whites of their Eyes
- Dynamic Control Of Sibilant Sounds
- Psychoacoustics



Next best thing
to a sound proof booth.



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coming next month

- The coming of spring is traditionally celebrated in song. So, what is good enough for Mendelssohn is good enough for **db** . . . music is our March theme.

- Inventor Harald Bode provides a richly detailed explanation of FREQUENCY SHIFTERS FOR PROFESSIONAL APPLICATIONS, of special interest to those who are into electronic music.

- Marc Saul discusses methods of testing for harmonic distortion in musical reproduction in UNDERSTANDING HARMONIC DISTORTION.

- Another lesson in Feedback comes from Norman Crowhurst, the third in a series.

- March will also bring the first article in a valuable series by Patrick S. Finegan of Broadcast Audio. Mr. Finnegan has spent a long career in broadcast audio engineering and we're sure you'll find his expertise of interest. His first article will cover broadcast stereo separation.

about the cover

- Painstakingly researched figures bring history to life in the multi-media presentation of "The Battle of Bunker Hill" produced for the Bicentennial in Massachusetts.

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RAMKO RESEARCH

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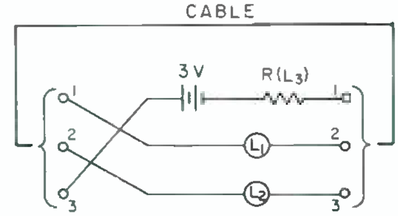
db letters

THE EDITOR:

Very good article on black boxes in the July issue—let's have more of them. I have a few comments which may be helpful to others. Amen to always checking for d.c. Even though I knew about it and had run into it before, I still managed (by persistence and stupidity) to blow a power transformer instead of just fuses when my "handy shirtpocket tester" was at the bottom of my bag and I was in a hurry. I have since modified all my multi-outlet strips by prying the jewel off the neon lamps so both electrodes are clearly visible and I always check first to see that both light before plugging anything in. (By the way, you say *filaments* in your article. Neon lamps have no filaments, but rather, electrodes.)

Thanks for clearing up what is inside of the cable tester boxes. I had seen one at a radio station and it seemed to be such a good idea, I built one when I got to the shop. Since I didn't know what should be in it and I had only had a quick look, I built my own (see figure) I used two AA



HOME BREW CABLE TESTER

penlight cells and for L_1 and L_2 I used two "grab bag" leds, which gave a good brightness, was somewhat comparable to current at line level, and resulted in an acceptable current when one led was shorted out by a bad cable. I found that R could be replaced by L_3, a low current 3V bulb (*not* a flashlight bulb). If a cable is good, both leds light (L_3 is too dim to see). If only one led lights or if none light and L_3 shines brightly, I know there is either a polarity reversal or short in the cable. (I could make up a table of what means what, but I made the box only for quick cable checks.) While I was at it, I also used another led rigged in a similar manner through L_3 and two-pin jacks to check out patch cords, speaker cables, etc.

Yes, always carry phase reversers, but don't buy them. They seem rather overpriced to me. Just make a short extension cable and reverse the wires between pins two and three. Even including labor, it's half the price.

DONALD WADE
Jackson Heights, N.Y.

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Telex/Magnecord series 1400 broadcast quality recorder/reproducer. An old name that spells reliability. A new design for today's state of the art.

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FREE LITERATURE

NEW PRODUCT DIRECTORY

A directory of manufacturers of a wide assortment of industrial equipment and musical instruments, some of which are applicable to audio interests, covers 20 pages. Mfr: Katy Industries.

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MINIATURE COMMUNICATIONS EQUIPMENT

Two-way communications equipment, with accessories, are described in a 4-page brochure. Mfr: Unex Laboratories.

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HOCKEY PUK RECTIFIERS

A new line of 650 amp fast recovery Hockey Puk silicon rectifiers is described in this data sheet. Mfr: International Rectifier.

Circle 84 on R.S. Card.

RECORD CARE

This is a six-page leaflet describing ways to protect records from deterioration through the use of record cleaners. Mfr: Uher of America, Inc.

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ELECTRIC POWER OUTLET STRIPS

Electric power outlet strips and wheeled carts are described in a four-page catalog. Mfr: SGL Waber Electric.

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HEAT SINK WALL CHART

A 25 x 38 in. chart contains a heat sink selection guide, featuring over 50 extrusions. Information includes surface area, weight, and thermal resistance. Mfr: Thermalloy, Inc.

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SPECTRUM ANALYZERS

Measurement of distortion, frequency response, wow and flutter, signal-to-noise ratio, and cross talk with low-frequency wave and spectrum analyzers is discussed in this 16-page booklet. Detailed graphs and copy cover audio equipment of all kinds as well as the various harmonics. Mfr: Hewlett-Packard Co.

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CHANNEL CIRCUITS

The intricacies of using channel circuits in wiring breadboard components are explored in a brochure and specification sheet. Step-by-step wiring of the boards, as well as descriptions of the various configurations are included. Mfr: Chanex, Inc.

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EQUALIZER MICROPHONE

E Qualidyne,™ a microphone that includes equalization and feedback control, is described in a four page booklet. Mfr: Shure Bros.

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AMPLIFIER OVERLOAD

A two-page application note discusses amplifier overload and recovery time. In addition to general information, the application note illustrates typical problems with a block diagram and waveform sketches.

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TABLE TALK NO. 8

What Happens to Your Film at the Lab, part 3—The Optical Sound Track, is the title of a brochure which explains in narrative form and with extensive detail exactly what happens to a movie film when it is processed. The article contains valuable tips for getting the most out of film. Mfr: Motion Picture Laboratories, Inc.

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DISCOTHEQUE SYSTEMS

A series of brochures details a complete line of equipment needed for discotheque audio production. Mfr: DISCOtheque Time Service.

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If there's one thing you need in commercial sound components, it's reliability.

Consider this.

We believe the Crown DC-300A amplifier to be so carefully crafted, so well-designed, and so thoroughly inspected, that for three years after purchase, if it doesn't work as specified, we will replace any defective part at no cost to you. We will also pay U.S. round-trip shipping costs (the DC-300A weighs 55 pounds) on units requiring service.

It should be obvious that we can offer such a warranty only because we have convinced ourselves that you probably won't need it. Crown builds the DC-300A to work — and to keep on working. It is reliable.

Consider further the output protection built into the DC-300A. Shorts, mismatches, open loads, all have no effect on the DC-300A. The amplifier will even drive totally reactive loads without damaging itself. Massive black-anodized heat sinks are thermally joined with the chassis to utilize the entire amplifier for efficient heat dissipation.

The Crown DC-300A could easily be the most reliable, service-free major component in any sound system.

But there are other good reasons for specifying the DC-300A.

One is the large amount of power available. The DC-300A is rated at 155 watts per channel (both channels operating) into 8 ohms. Or 310 watts per channel into 4 ohms.* or 500 watts per channel into 2.5 ohms.*

In the mono mode, which involves only one simple wiring change, the DC-300A will produce up to 600 watts into 8 ohms.* You can drive a 70-volt balanced line directly without installing a matching transformer.

Another good reason to specify the DC-300A is the almost absolute purity of its sound. When Crown introduced the DC-300A some years ago, the audio world recognized it as a significant improvement in low distortion and noise levels in a commercially practicable amplifier. At its rated output, IM and harmonic distortion are less than .05%, 1 Hz to 20 kHz, and hum and noise are 110 dB below rated output. Frequency response is ±.01 dB, 1 Hz-20 kHz @ 1 watt into 8Ω.

Reliability, power and high-fidelity are three good reasons the DC-300A should be in your next sound system.

There is one other reason.

The Crown name.

Crown people believe, as an article of their faith, that manufacturers have a responsibility to tell the exact truth about their product so far as it can be determined. As a result, any well-equipped laboratory should be able to test any Crown amplifier, and report test figures that are as good—*or better*—than the figures reported by Crown in its advertising and specifications.

That's reliability. Crown reliability.

For detailed specs on the DC-300A, write us or call 219/294-5571.

**Single channel operating; sine wave test signal into resistive load; extended operation or restricted air flow may require forced air cooling to maintain levels described.*

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db theory&practice

NORMAN H. CROWHURST

• Recently I have been receiving more than the usual number of letters from readers, asking how, or where, they can get courses in audio that will prepare them for a creative career in audio work. Some, realizing the shortage, ask how the "college of their choice" could be induced to start something that would provide such a program.

WHAT ARE THE BASIC REQUIREMENTS?

The very asking of this question, at least in a college campus context, is apt to entrap us into the wrong kind of answer. For in a university setting, the words "basic requirements" carry a connotation of "what courses should I take?" So one starts looking down the catalog in question, to see what courses look appropriate.

As I am writing this, I happen to have a fairly severe cold, an event that happens to me rather rarely. This condition occasions the need for fairly frequent blowing of my nose. As I do not have to do this very often, at least with the severity occasioned by a heavy cold, I get to wondering whether I ever learned how to blow my nose properly?

I was almost afraid to write that, for fear the next thing that appears on college catalogs, all over the country, will be courses on correct nose-blowing technique! I still have vague recollections of kindergarten, or early grade teachers, showing small fry how to blow their noses properly, and happen to think that is the proper age to teach that kind of thing.

Let me take an item I see listed as an ingredient in a proposed "audio package"—solid state theory. Now, my bookshelf has about three feet of books on that topic. So I look through them, to see which, if any, would give the best preparation for an audio man. Most of them start out with the theory of atomic particles and energy levels, and plenty of equations that I am sure no audio man will ever get to use.

And yet I can see, and would myself insist, that a good audio man needs to know how various solid state devices can be used, in both analog (perhaps you know that best as *linear*) and digital circuitry, unless he planned to have nothing to do with synthesizers and electronic organs.

Remember how I have criticized current math programs, at both school and college level, for showing students how to *do* something, like solving equations, without bothering whether they understand it, or perhaps not even letting them understand it? The same goes for this approach into solid state theory.

So, after taking the course, the student can write down the relevant formulas for every solid state device in a given schematic. For some of these i.c. chips, that would be an encyclopedia full of formulas! But having written all that down, does he know how the chip works, or even know how to go about finding out how it works?

I could give you some more examples of the same kind of thing, but I think that example is enough to make my point. What the audio man really needs is the kind of know-how that will enable him to go after precisely the information about solid state devices he will need for the *audio* job he may have in hand. Knowing all that other stuff will be no help to him, unless he can apply it to something practical.

Of course, you also need background on acoustics, transducers, magnetic materials, electronics, and so forth. But, taking the first of these, must you always start with the D'Alembertian wave equation? If all you ever learned about calculus was how to do it, you don't really know what all those little incremental signs mean, and can only copy down what the course-work showed you about applying the equation through various "boundary conditions" to specific situations that, at best, only approximate the devices you are working with.

All that may be very impressive, to someone who doesn't "know all that stuff." But does it really help you to do a better job? What you need, far more, is a *feel* or a way of visualizing, what happens to sound waves in the kind of practical situation with which you will be working.

Or perhaps you followed all through that stuff for the purpose of memorizing the conclusions derived at the end, relating wavelengths to various acoustic effects, so you could apply the information to your practical situations. The problem there is that relying on memorized conclusions can often (and usually does) overlook any limitations beyond which those conclusions no longer apply.

Presumably another reason for going through all that theory was so that you would note the various places where certain parameters were assumed to be small enough to be negligible and thus realize that when they are not, the conclusion derived from that assumption is no longer true. But if you are going the memory route, that is an awful lot to remember. It is so much better if you can really understand the basics.

The trouble is, it is extremely difficult even to get at the basics, much less to understand them, when you have to plod through all that supposedly basic theory. So, maybe you accept all that material, merely because it is required, but you find it of no real use to you because it is impossible for you to apply it. So you concentrate your real learning effort on the practical side—working at consoles, making recordings, finding out through trial and error what you do wrong, and so forth.

HOW TO GET THE REAL BASICS

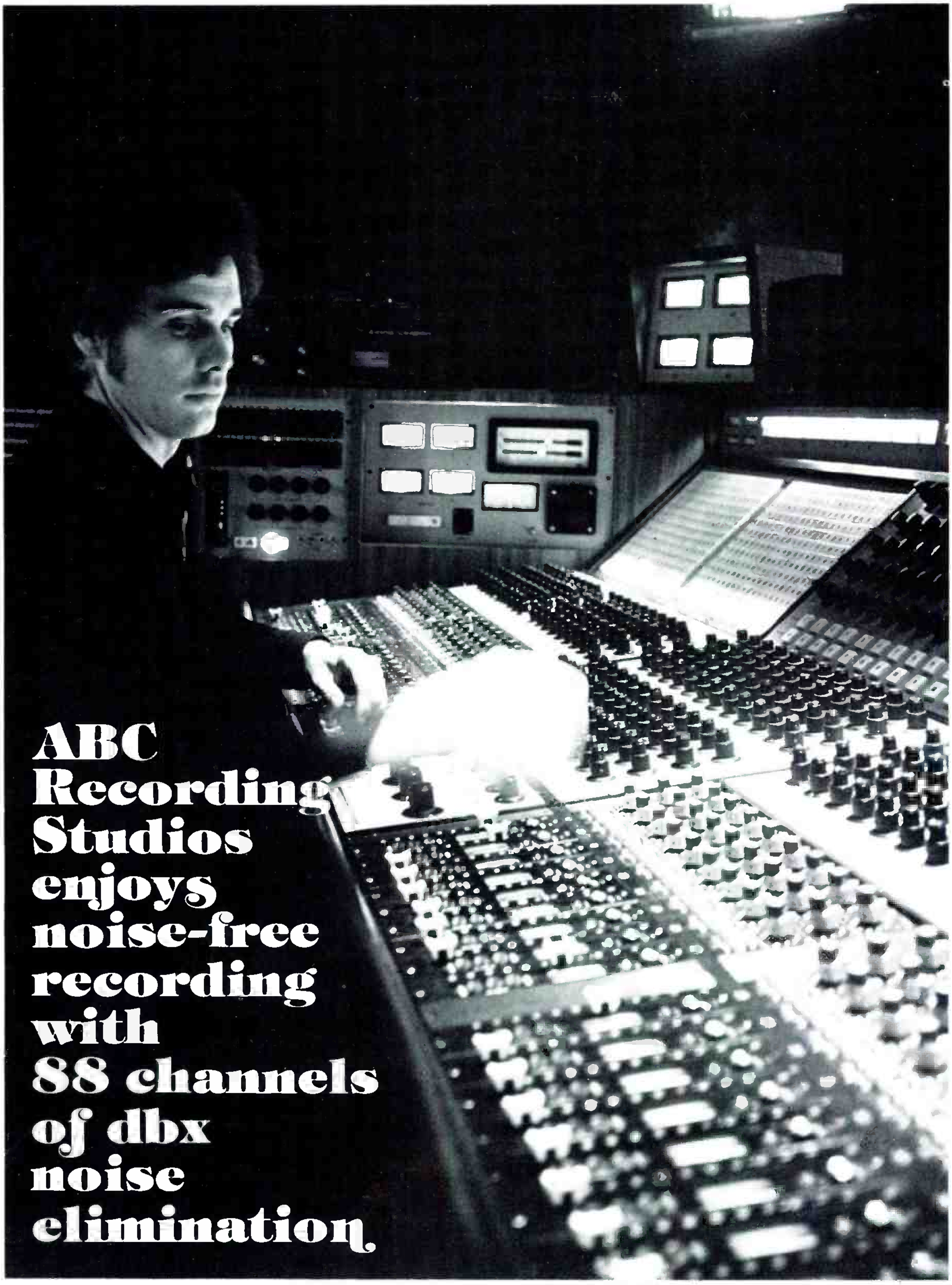
I don't want to knock hands-on experience of this type. It can be valuable. But what for? Are you learning "how it is done?" Or are you merely getting the feel of how one particular console does its job, or how certain specific effects are achieved?

There is considerable appeal to a student who wants to become a recording man and has never had his hands on a console in the offer of "hands-on" experience, as part of the course offering. And, of course, if that is the basis for the students' choice, they feel the more hands-on the better.

What they tend to become, going this route, is good "audio mechanics," rather after the style of the mechanics at many neighborhood service stations. If they know precisely what they have to do, they can do it, with varying degrees of proficiency, according to how good their hands-on experience was. But give them something they have not been shown, and they are lost.

This weakness can apply either to a new type of console or to the production of a different type of program. Unfortunately, while it may be much more fun, in other respects, the hands-on approach, without the needed background to go with it, is very much like rote learning. You learn only what you are shown how to do.

Perhaps it is relevant here, to compare this field with the one in which I have spent much more of my life, engineering. I have always been designing, or developing, something new, that nobody has made before. Often I get the question, "Where did you



Howard Gale at the Studio B console during session for the Three Dog Night album Comin' Down Your Way, ABCD–888.

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learn how to do that?" Of course, I had an engineering education, but the way the questioner asks it, makes it similar to asking Thomas Edison where he learned to invent the light bulb (or any other of his numerous inventions).

People who invent things are always making "firsts"—something that nobody has done before—and thus there is nobody around to show them how. Can you imagine Edison going to the local bookstall, to find a book, *How to Invent the Electric Light?* Had there been such a book, obviously someone else must have already invented it, and Edison would have been too late!

Although the successful audio man may not be an inventor, in quite the same sense, there is one respect in which what he does, or should be able to do, is quite similar: he must be creative. He needs to be able to dream up, and thus execute, "firsts." This means he is *not* copying what someone else has shown him.

HOW TO ACQUIRE CREATIVITY

Because a creative person is doing what has not been done before, and because he never copies what someone else has done, you might imagine he works best alone, in isolation. While he must be capable of *thinking* alone, beyond the lines of thought he has already been shown, he also needs to be vitally aware of what others are *doing.*

In the fiield of engineering, had someone working in isolation developed a Moog synthesizer, say a year or two after Bob Moog did, would that do him any good? Bob has all the patents on his way of doing it. The fact that this second comer had done it independently, without actually copying Moog, would not make it original, would it? Not in the patent sense, anyway.

Now that synthesizers have made it into the world, via the brains of inventors like Bob Moog, how is the best way for someone else to get into the synthesizer business? Take a good look at various synthesizers on the market, and I think you'll get the idea.

That relates to creativity in developing hardware. Some of you are more concerned with software—making various kinds of records. But the same principle applies. If you work in isolation, you are apt to find yourself "re-inventing the wheel."

Just because your primary concern may be with software—you want to produce some gold records—do not rule out any interest in hardware, as a means of getting there. Some of the better ideas that have been incorporated into audio systems have originated in the heads of men whose real interest was in producing a different kind of sound. Maybe they put something together themselves that the hardware people later copied. More often, they had a good idea of what they wanted, and went to the hardware people and said, "Can you make me up a unit that will . . ." and after some back and forth, a new idea became fact.

Are you getting a picture of what creativity is, and more importantly, how it happens? So how do you go about acquiring creativity?

It is a big help to try to simulate the creative activity of the past. Instead of merely examining what somebody creative has already done—by then, it seems so obvious, so how come nobody has left you anything obvious to do like that?—try to put yourself in the creator's shoes. Supposing you had not seen it done, how do you think he would have come across the idea? For me to attempt to answer that would destroy your effort. But in a classroom session, tossing ideas like this around can be helpful.

One thing is on our side; human beings are naturally creative, although sometimes that is difficult to believe because creativity has been so successfully stifled by our educational system. But because this is so, a session in which creativity is sparked is always an exciting experience—it turns people on.

As I am beginning to look at how much space is left this month, I want to pass on to you some of the advice that Bill Putnam gave to last year's BYU Workshop participants. He told them how necessary the kind of basics that we were giving them were, that as far as "hands-on" experience is concerned, any good studio would rather have a man with little or no hands-on experience but long on creativity and do what training might be necessary in the "mechanics" department, themselves.

Somewhere about the time you read this, advance notices about this year's workshop should be appearing. There will be prerequisite material available, so you can come on campus, armed with what you should know, to make the very best of your time there. We are still working on how to get an effective program that will give more than is possible in a summer workshop. But meanwhile, lots of past summer workshop participants have stretched what they got there a very long way, to become highly successful in the field. And they are not slow to give credit where it's due. ■

db the sync track

JOHN M. WORAM

• Every time I hear about a new audio book, I get a little sweaty, since my own opus is just about ready to be launched. To all those who have inquired, "When, where, how much, why?," I'm delighted by your interest. But, as they say in the publishing biz, the book is "in production." At the moment, it depends on an assorted bunch of shady characters, such as typesetters, proof readers, commercial artists, editors, and book binders. When—and only when—these folks are done with their foul work, the book will be ready. My astrologer tells me this will be about the time of the spring thaw. I suppose that means sometime in May, 1976, but who knows—it could be earlier or later. As for the price, it will have to be sufficiently outrageous to take care of all these hangers-on, and their insatiable appetites.

In the meantime, I suggested to our esteemed editor that *he* review those *other* books and write scathing reviews. You'd think that would be the least he could do. Well, he liked the basic concept, but seemed to have some sort of reservations about lawsuits and other types of unpleasantness. So, I shall have to do it myself. How typical.

INTERNATIONAL DICTIONARIES OF SCIENCE AND TECHNOLOGY: SOUND—R. W. B. Stephens, editor. Halsted Press, div. of John Wiley & Sons. 853 pages ($37.50).

"Coverage includes . . . an exhaustive treatment of topics like architectural acoustics, audio circuits, disc, magnetic, and optical recording, sound editing. . . ." (from the flyleaf).

Thirty seven bucks.!!? for a *BOOK?* As Ed McMahon would say, "Isn't it amazing that for a mere $37.50, they've given you *everything* you need to know about all those subjects?"

Well, it would be impressive indeed if it had lived up to its promise. Just think of a book that would define the gauss and the oersted, and clarify the meaning of the dBm, dBV, and the VU. Or is it vu? V.U.? Maybe v.u.

Bad news, folks. Gauss is listed, oersted isn't, although the latter term *is* found within the definition of the former! Decibel is briefly defined, but there is no mention of dBm, dBv, etc. Sel-Sync and overdub are not to be found. Neither are inertance, fluxivity, gobo, bus, retentivity, quad, foldback and such.

You *are* in luck though if you were wondering about:

quack—*short, loud, harsh, throaty sound such as that made by a duck, or any similar sound.* (Duck is not defined.)

Sneeze, yap, bray, bleat are similarly covered, along with the rest of the barnyard. After all, it *is* a dictionary of sound.

In all, 3,556 terms are defined in English (and numbered). Each definition is followed by the translation of the term (but not of the definition itself) in Dutch, French, German, Italian, Portugese, Russian, and Spanish. The definitions take up about two thirds of the book. The final third contains alphabetical listings of each term in the seven languages just listed. Here, each term is keyed to the appropriate definition number. For example, the Russian speaking engineer may look up OCHOBRA and find that it is definition #0355. Turning quickly to 0355, he finds the English definition of **base.** Now he's got to understand English to get anything out of it. But, if he understands English, why look in the foreign language section in the first place? Of course, it would be unreasonable to expect a complete definition in each of the seven languages, and I realize the cross reference will be valuable for the bi- or multi-lingual engineer who may not be familiar with the English equivalent of a particular term in his native language. Or, he may wish a cross reference of terms from one language to another.

But, this is a lot of space to devote to the needs of such a small percentage (I think) of readers. Perhaps this should have been a two volume set: Volume One a more thorough dictionary—Volume Two a multi-lingual cross reference available for those who require such a tool.

FREE-WHEELING DEFINITIONS

As to the terms that are defined, many leave something to be desired. For example, there are definitions of free-field conditions, free-field correction, f-f current response, and so on, but no definition of free-field itself. If you think to look up free-field room, it says, *See anechoic room.* There, it says, *Room lined with sound absorber, having sufficient absorption to enable a sound field free from objectionable reflections to be produced, enabling free-field measurements to be made.* Reading between the lines, one gets the idea that a free-field is an area in which there are no interference-producing reflections around.

Directional characteristic. *Characteristic of a microphone, expressing the degree by which the sensitivity is greater in a particular direction.* Huh? What does degree mean, angle or amount? And what about the directional characteristic of a loudspeaker? That can be found under *Directivity Pattern.*

On the other hand, anatomical terms are clearly defined. (Incus, malleus, stapes, et al). There are also good definitions of some musical instruments. (Drum and base drum are in, though snare drum and tom-tom aren't.)

In short, this book is not for everyone. Some of the definitions will sail right over the heads of many readers. Others take a bit of detective work to figure out. The book itself is elegantly produced, well bound, clearly printed, and with excellent illustrations. I hope there will eventually be a second edition, with the necessary revisions. We could certainly use it. In the meantime, I'd suggest looking the book over carefully before buying it.

SOUND SYSTEMS ENGINEERING by Don and Carolyn Davis. Howard Sams & Co. 295 pages ($19.95).

Now here's a book of a different color (yellow, as a matter of fact). Author Don Davis is well known for his work in sound systems engineering, and I believe this book is used as a text in his *Syn-Aud-Con* lecture series.

The book addresses itself to the theory, design and installation of sound systems, specifically reinforcement systems, large and small. Although it should be required reading for anyone who meddles in p.a. work, there is much information here that will be useful to just about anyone in the audio business. There are some twenty pages on the decibel notation systems, within which the various reference systems are explained, as well as the difference between the dBm and the vu. The following three chapters cover *Loudspeaker Directivity and Coverage, The Acoustic Environment,* and *Designing for Acoustic Gain.* These will be of most interest to the p.a. specialist.

Later, the chapter on *Installing the Sound System* will prove valuable to anyone who has suffered through ground loops and impedance mismatches. Grounding and shielding techniques are clearly described, and the reader can understand what is being said, and why.

In Chapter 8, *Equalizing the Sound System,* we learn what sound system equalization is and what it is not. Apparently Mr. Davis takes a dim view of those who think of it as a means of covering up all the little atrocities that have been misdesigned into the system.

If the equalizer in out switch makes the unlikely change from total unintelligibility to startling clarity, one may safely have second thoughts about, a) the design of the sound system, b) the design of the room, or c) both.

MATERIAL FOR BEGINNERS

Subsequent chapters cover *Instrumentation, Sample Design Applications, and Specifications.* This latter chapter should be of particular interest to the beginning sound system specialist who needs some guidance in getting his act together.

The book concludes with eleven appendices. There's an excellent section on *Recommended Installation Techniques,* showing both how to, and how *not* to tie, wrap, terminate and solder.

And just to make sure you've been paying attention, the last two appendices are a series of test questions and answers.

All in all, this is a welcome addition to the audio man's bookshelf.

MUSICAL ENGINEERING

However, if you want a little something more than a book or two, how about a four-year degree granting course in Musical Engineering? The curriculum would include courses in music theory and practice, electronics, acoustics, and recording techniques. And when you graduate (if you do) you'll know a little something about what happens on *both* sides of the microphones.

No, this is not the April Fool column—it's for real. The University of Miami is setting up such a program, so run—don't walk—to the nearest mailbox for more information. The address is Mr. Bill Porter, Director of Recording Services, School of Music, University of Miami, Coral Gables, Florida 33124. ■

CORRECTIONS

The following errors appeared in *The Signal Path,* by Walter Jung, in our December issue. On p. 34, "2n-1" should read 2^n-1. On p. 35, Figure 7A, R1 is a 10k resistor. On p. 35, Figure 7B, the IN914 diode is reversed. On p. 37, Figure 8E, +15V goes to pin 7 of A1, not 1.

MARTIN DICKSTEIN

● In a talk given just a few months ago, Mr. Hubert Wilke, President of Hubert Wilke Associates, New York City, described some of the most modern audio-video facilities his company designed recently. The topic *Design and Engineering of Tomorrow's AV Facilities* fits nicely into the overall subject of the state of the art of audio-visual-video systems covered at the IGC conference in Boston.

Mr. Wilke mentioned a marriage that took place in the recent past between communications and electronics. He called it "communitronics." He said that "we are only in the honeymoon stages of this marriage and the birth of offspring in the development and implementation during the years ahead will test the best technological minds for generations to come."

He showed slides of some of the installations his firm designed in which the screens, the lecterns with built-in remote control consoles, the sliding walls, the equipment, the lighting in the room, and the curtains at the windows were all considered in the operating plans made before the construction had even begun. It's the only way.

For example, in the New York headquarters building of Time Magazine, the client desired a multi-use presentation, training, and screening room. Mr. Wilke said that "the client was interested in utilizing both front and rear projection. Normally, when a client says they want front and rear projection, it is because they really don't know which they want and they are trying to hedge their bets. In this instance, however, Time had a good reason for both. Since the room was to serve not only a variety of presentation needs, but would also be used as a screening room for the viewing of t.v. commercials and p.r. films, we indeed had a multi-use room that serves two separate functions not mutally compatible."

Mr. Wilke continued with the thought that a rear projection arrangement is usually preferable for presentations of any type so "that you can maintain good room lighting and yet not wash out the image on the screen. The speaker and audience can maintain eye contact and as anything worthy of note is communicated, the audience will be able to see well enough to take notes . . . Perish the closed eyelids during a presentation that follows a heavy lunch with a martini or two. Not only out go the lights, but out goes the audience. So for presentations, we most always recommend rear projection."

The room itself consisted of a normal front-projection system from a booth, using both 16mm projector and 2 x 2 slides. To use the same set of equipment for rear projection, the audience turns around to face the projection booth, and out of the ceiling comes a recessed flexible rear projection screen, spaced twelve feet from the booth. "With a push from the remote control, the screen lowers to a fixed point, framing the alcove . . . We have dual image rear projection . . ."

In RCA's corporate Board Room in Rockefeller Center, New York, there were several problems. The light from windows fell on the screen (rear projection), the first ceiling light by the screen had to be turned out to prevent it from hitting the screen, and the screen was to be hidden until the last moment before presentation. The projectors were also to be left off until time for showing. The "environment button" was incorporated into the design of the remote control panel on the lectern. One push and the window curtains closed, the overhead light over the screen went off, the panel doors in front of the screen opened automatically, and the projectors went on. The lights over the audience stayed on for eye contact and note taking. (The buttons on the panel are lit or off depending on the state of the total system.) Side-by-side slide images, center film, and random access slides are all controlled at the lectern.

Similar designs created for Kodak, Exxon, Xerox, and others all permit multiple image showings with controls of different types engineered for the user's desires and all tend to make for creative presentations. The one ingredient no design can build into any system is the presenter. This is a case of an on-the-job problem. No matter how great and flexible the design to keep the show moving, if the presenter sounds (and looks) like *he's* falling asleep, don't expect the audience to do anything different. The material being shown may be of great interest to the speaker, but if he can't get it across, any and all of the creative ingenuity is down the drain.

Then there's the other side of the story, the fellow who loves to click away at slides, and talk, and talk. He loses sight of the fact that some time must be permitted to allow some of the material to sink in. Perhaps he compares pauses, no matter how slight, with sin. He's afraid to stop even to breathe.

Other people who are forced to present because of the nature of their business, sometimes feel that any technical visual aids will get in their way. They become so nervous that they forget what they have to say because they are thrown by the apparent complexity of the controls. They're deathly afraid of electronic devices of any kind.

There are many more examples with which you may have come into association during your school days: recording sessions, audio-visual installations, etc. If your business is installing a v. each of these may turn out to be a money maker for you if you can handle it. As an example, you find a place that has video for playing cassettes of commercials the company has made so they can be demonstrated for their executives. Maybe you can put in a system like this. You meet the man who will be responsible for showing the cassettes. A nice person, but a lot on the nervous side . . . hands and arms flying, big smoker . . . whatever. You see an opportunity to introduce the subject of a closed circuit, inexpensive, recording set up. Maybe even black-and-white to start with. Here's a chance for this man to see for himself what he looks like when he presents. He might even get points with his superior if the upper boss has the fall-asleep approach to speaking. The situations may not be real, but the need for a simple system just to have the presenters train themselves is worth the cost many times over when the improvement is noticed. The number of executives who may have backed into viewing themselves on little systems bought to train lower echelon personnel is legion. Many industrial firms have set up video studios for the purpose of having top men get a look at themselves with a speech they have to make to the board, or to the West Coast office, or to the big man, or . . . It may seem simple and old-hat to you, but then you're in the business. They're not!

The remote control lectern also has the ability to tie a speaker down to a single position during his whole talk because he has to push buttons to keep the show going. He has to look at his script, then at the controls and sometimes at the audience, too, if he is to keep eye-contact. Here's another way you can be of help. You help yourself, too, if you can come up with job-site recommendations to keep the speaker from freezing. Sometimes, a remote control box with some of the remote controls of the lectern are a help. Maybe a lectern mic is the reason for a stiff presentation. The speaker has to stay "on" to be heard. Here the lavalier comes in handy.

Systems are designed according to the desires of the end user, the client. He (or she) discusses the needs, the ways the room is to be used, the type of presentations that will go on in the room, but there are usually variations betwixt the original lip and the final flip. Not always, but many times, attempts are made to involve the user directly. It always helps. If you are the presenter, you know some of your own problems or should get to know them. See if you can get the designer to lose as little (in the translation to plans) as possible. If you are the contractor, using your head will get you points for the future. There are always a few things that require on-the-job coordination and maybe some suggestions. If you sell special equipment, see how it will fill a need, maybe not even known yet to the client. If you are a prospective client, you, too, can help yourself. Think ahead. What will you need in the future that you should put in now and save money later? The communitronics marriage is moving right along. We're all part of it, somehow, believe it or not. You too! ■

db new products & services

STEREO MOVING-COIL CARTRIDGE

• EMT XSD-15 hand-made stereo moving-coil cartridge is built into its own shell which fits tonearms using the international plug-in configuration. A magnifying lens in the shell simplifies cueing. Each cartridge comes with its own B&K chart showing its frequency response curve from 20 Hz to 20 kHz, FIM distortion, output voltage, and channel separation.
Mfr: Gotham Audio (Distributor)
Price: $300.00.
Circle 50 on Reader Service Card

LIGHTWEIGHT PORTABLE CONSOLE

• Trouper III console contains modules weighing 20 pounds apiece and measuring 15½ x 19 in. Three modules create a 28-input board. Each input contains a level control, solo switch, 3-band equalizer, monitor and echo send, led peak indicator, mic pads, and group assign switches. Outputs include subgroup level controls, with solo switch and equalizers; house, echo receive, and monitor control. The console also contains a preview system with switchable meter and peak indicator, headphone jack, headphone level control, and preview selector switch; announce level controls, as well as two auxiliary receive controls for line inputs.
Mfr: Uni-Sync, Inc.
Circle 51 on Reader Service Card

BI-POLAR POWER SUPPLY

• Adjustable d.c. voltages from ± 14 to ± 16 V at 4 amps are provided by model 7000 power supply. The unit operates off 115 VAC, 60 Hz input power and includes crowbar overvoltage protection (limiting the output to 18 volts), foldback type current limiting, and inter-locked output protection. Other features include remote sensing, resettable power line circuit breaker, an overload indicator, and front panel voltage adjusting controls.
Mfr: Modular Audio Products
Circle 53 on Reader Service Card

PASSIVE EQUALIZER

• As a passive device, no noise is introduced by model 4004 one-third ocative audio equalizer. All filter sections are designed for low distortion; the manufacturer claims an absence of hard clipping at high level. Each filter is a double-tuned constant-K section with two precision lc pairs. The adjustment range is zero through – 15 dB by calibrated front panel controls. High-cut and low-cut adjustable filters are used for spectrum finishing. A socket is provided for plugging in a crossover network to give a bi-amp output.
Mfr: White Instruments, Inc.
Price: $760.
Circle 52 on Reader Service Card

ACOUSTIC CONTACT PICKUP

• Lightweight acoustic pickup Inertial Accelerometer D642 easily attaches to any instrument, including guitars, basses, violins, banjos, drums, and pianos. The device is claimed to reproduce true tone quality without distortion even when an amp is used at full power. Gain is built in. Frequency response is 5, more than 15,000 Hz. The pickup comes with four extra adhesive seals, foam protective pads, extension cord and a dome that lets with musician vary the response curve.
Mfr: Dyna Magnetic Devices
Price: $39.95.
Circle 54 on Reader Service Card

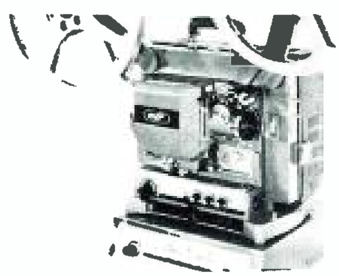
SEARCH AND CUE COMPUTER

• Tape can be automatically returned to any one of 16 locations stored in the memory of model 400-RSM computer. Using an all digital technique, the computer continually calculates the optimum tape velocity and prevents the recorder from overshooting its destination. All input data is obtained from a single optical pickup mounted under the tape deck. Output signals are fed to the tape transport remote input socket. Applications include multi-track overdubbing and mixdowns, live recording, duplicating, as well as on-the-air radio programming.
Mfr: Oliver Audio Engineering
Price: $1,495.
Circle 55 on Reader Service Card

VARIABLE PITCH CONTROL

• Increased flexibility in recording speed is made possible with A700 variable pitch control. The device facilitates the continuous sweep variation of tape speed over ±7 musical half tones. Therefore, together with the three standard speeds, the complete range of 2.5 to 5.6 in/sec.; 5 to 11.2 in/sec.; and 10 to 22.5 in/sec can be achieved. A built in sync light indicates "On Speed" at all whole, and fraction of a whole, speed selections.
Mfr: Revox Corp.
Price: $85.00.
Circle 56 on Reader Service Card

SOUND/FILM SYNCHRONIZATION



• The Digital Interlock synchronization system incorporates sound along with a silent film through the use of a step drive motor driven from a power unit within an electronic console which generates pulses or signals. The step drive motor is fitted within the casing of any standard 16mm or 35mm projector to undertake the function of the existing drive motor. (The projector can also be used conventionally when so modified.) The system can also be used with sprocketed sound tapes, using two standard film projectors, one for sound and the other for film projection. If the synchronization signal is derived from one track of a tape recorder, the film projector will be held in exact synchronization with the moving tape. Using a multi-track tape, several languages can be applied. Where two or more projectors are synchronized, the film speed can be varied up to 50 frames per second in forward or reverse. Lip synchronization can be obtained, using a cassette tape recorder, without putting a magnetic stripe on a silent film.
Mfr: Elf Audio-Visual, Ltd.
Circle 57 on Reader Service Card

CALENDAR

MARCH

2-5 **Audio Engineering Society, 53rd Convention.** Hotel International, Zurich, Switzerland.

7-12 **Audio-Visual Institute for Effective Communications.** Indiana University, Bloomington, Indiana. Contact: Audio-Visual Institute, 3150 Spring St., Fairfax, Virginia 22030. (703) 273-7200.

21-24 **National Association of Broadcasters Convention.** Chicago, Illinois. Contact: NAB, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500.

APRIL

5-9 **Acoustical Society of America.** Washington, D.C.

22 **Acoustical Conference.** Hungarian Society for Optics, Acoustics, and Cenematography. Budapest, Hungary.

26-27 **Acoustical Problems of Light-Structure Construction of Buildings.** Acoustical Commission of the Hungarian Academy of Sciences. Budapest, Hungary.

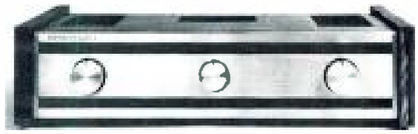
MAY

1 **Midwest Acoustics Conference.** One-day meeting covering signal processing and data reduction technology for solving technical and legal problems in acoustics. Norris Center, Northwestern University, Evanston, Ill. Contact: H. O. Saunders, Rm. 24A, 225 W. Randolph St., Chicago, Ill. 60606. (312) 727-4331.

4-7 **AES Show.** Los Angeles, Cal.

28-31 **Sound and Vision '76.** Birmingham, England.

SWITCHING AMPLIFIER



• "Class D" amplification, using transistors which turn on and off a half-million times every second, is produced by the DSP (Digital Signal Processing) switching amplifier. The unit delivers 250 rms watts per channel under any line conditions, a.c. or d.c., from 96 to 240 volts, with no thermal degradation. The elimination of large heat sinks has made it possible to reduce the size of the amplifier to 18¾ x 4½ x 12 inches; it weighs 35 lbs.
Mfr: Infinity Systems, Inc.
Price: $1,850.
Circle 58 on Reader Service Card

COMPRESSION DRIVER

• Designed to be incorporated in new or existing loudspeaker systems where power handling capability is important, Gauss model 4000 compression driver includes a throat diameter of 2 in., 16 ohms nominal impedance, a usable frequency range of 500 to 12,500 Hz, and flux density of 20,500 Gauss. The weight is 29 pounds.
Mfr: Cetec Audio
Circle 59 on Reader Service Card

ADD-ON NOISE REDUCTION

• The shift in tape hiss and degradation in program quality which may accompany the change from studio recordings to those made in the field is diminished by the use of model 192 bolt-on noise reduction system designed to be used with the Nagra IV-S portable stereo tape recorder. The two-channel switchable record or playback system combines 30 dB of broadband noise reduction with a 10 dB increase in tape recorder headroom. It requires no level matching.
Mfr: dbx
Price: $600.00
Circle 60 on Reader Service Card

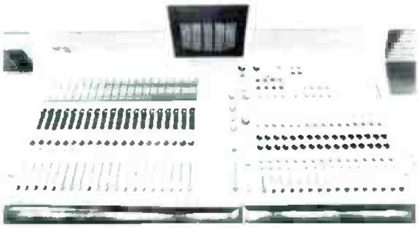
MIC SNAKES

• These portable multiconductor cabling mic snakes feature tinned copper conductors and color-coded polypropylene insulation. They are cabled in pairs, with Switchcraft A3M and D3F connectors. Concentric wire mesh strain relief with rubber clamp down collar eliminates crimping or twisting. Shield (drain wire) integrity is maintained throughout as well as foil shield continuation to within one inch of the terminating conductor.
Mfr: Audio Transport Systems
Circle 61 on Reader Service Card

AUTOMATED BROADCAST SYSTEM

• Completely computer-controlled broadcast system 3000 uses the computer as a decision making device as well as for memory. The system can be used for programming, instant reformatting, as well as other applications, such as billing. It automatically provides print-outs of verified logging, has an automatic re-start in case of power failure and a memory storage capability of up to seven days of operation. It has 16 source channels, featuring solid state operation.
Mfr: Spectra Automation
Circle 62 on Reader Service Card

CUSTOM CONSOLES



• Eclipse series consoles (Type I and Type II) feature flexible components, suitable for individual needs. All consoles are provided with inputs from 16 to 48 and 16/24 or 32 outputs. Features include 4 echo and 2 cue channels, simultaneous quad-stereo and mono mixdown, random access group submasters, graphic equalization on all inputs, 2 preset mute buses, solo with echo and panning, patching, producer's desk, etc. Optionally available is *mixlog*, a device that accurately logs positions of faders, echo sends and pan pots for future reference on a mix. Eclipse Type I has the monitor/mixdown section on the right for easy operation. Type II is a more compact model, with the pan pots directly above the inputs.

Mfr: Sphere Electronics

Price: $27,802-$34,677.

Circle 63 on Reader Service Card

THREE-WAY LOUDSPEAKER

• Aiming for accurate delineation of input signals, model one speaker is a quality product. It employs two 10-inch woofers, a 1½ in. high dome radiator and two piezo-ceramic super tweeters. The acoustically coupled woofers are mounted in a resistive reflex enclosure, and the mid-range high dome radiator is driven by a powerful magnetic system. Frequencies from 10,000 to 23,000 Hz are reproduced by two piezo-ceramic tweeters mounted front and rear, capable of handling up to 35 volts rms with claimed ultra low distortion. The unit has no voice coil. The crossover network uses components rated 2 or 3 times above the necessary power handling requirements.

Mfr: Sidereal Akustic

Price: $499.00.

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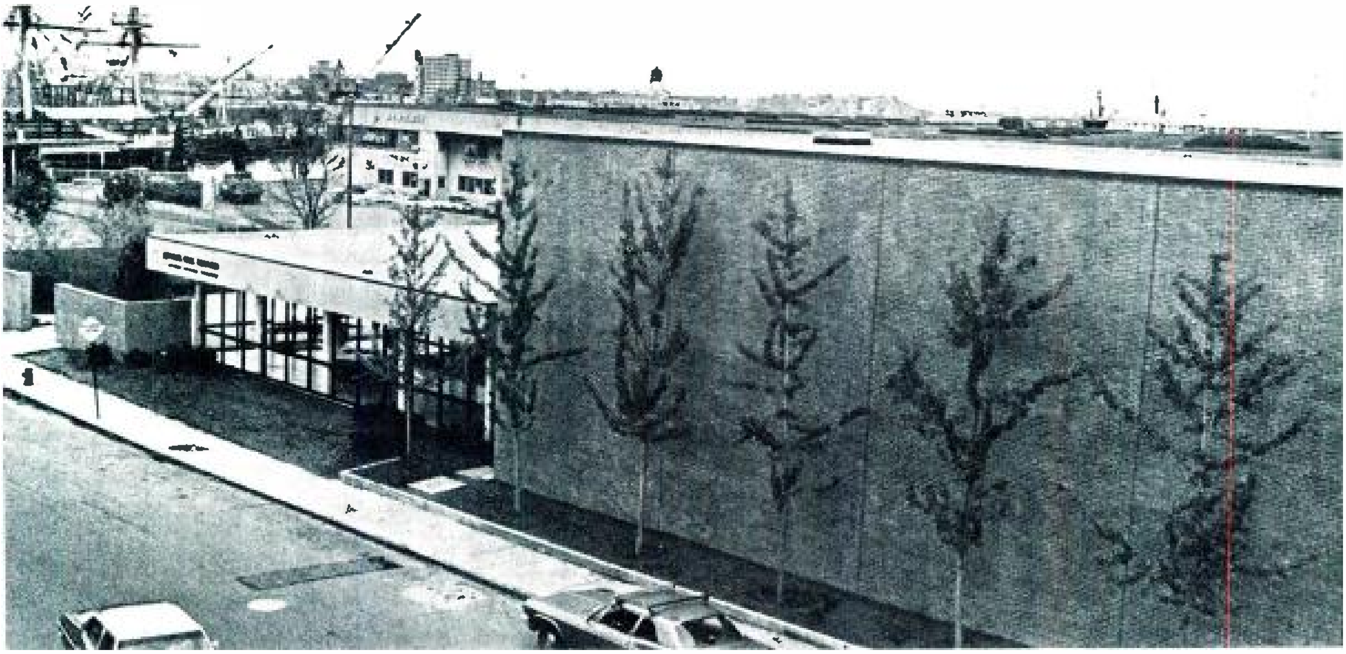


Bunker Hill Pavilion at Charleston, Mass.

MARTIN DICKSTEIN

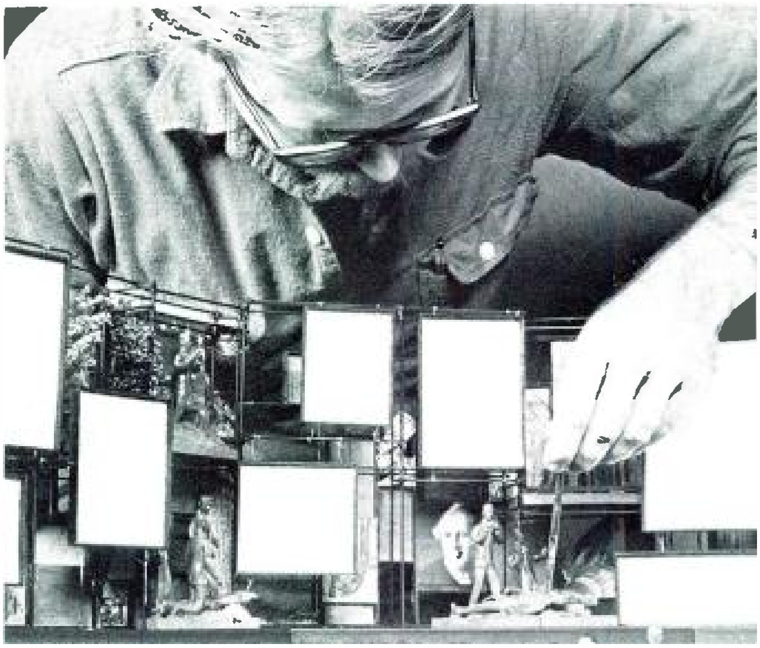
The Whites Of Their Eyes

The Battle of Bunker Hill, brought to life in an ingenious multi-media presentation, is an educational experience for the kids and a technical feast for engineers.

All photographs have been supplied through the courtesy of the Raytheon Co., White Oak Design Co. and A. V. Services.

WELCOME to the Bicentennial Year, 1976—the 200th anniversary of the United States. On July 4th, the country will celebrate the official date of its birth, but a great deal took place before the historical day arrived to make the event happen at all. Most of the events leading up to the Declaration of Independence took place in New York, New Jersey, and Pennsylvania, but it all began in Massachusetts,

A manikin of British lieutenant Colin Townsend is one of 22 life-size figures.



Jay O'Stine of White Oak Design puts finishing touches on a model of the "all around" auditorium where the presentation is housed.

in the vicinity of Boston. It is in this same location, not far from the monument set up to commemorate the Battle of Bunker Hill, that the first major audio/visual display has been set, up on a permanent basis, to depict one of the most important incidents in the story of the struggling colonies to free themselves from foreign rule. There are others, just completed or nearly so, in other major cities where it all took place, but it is this one in Boston they will have to beat for historic accuracy, technical ingenuity, and sheer dramatic impact.

HISTORICAL BACKGROUND

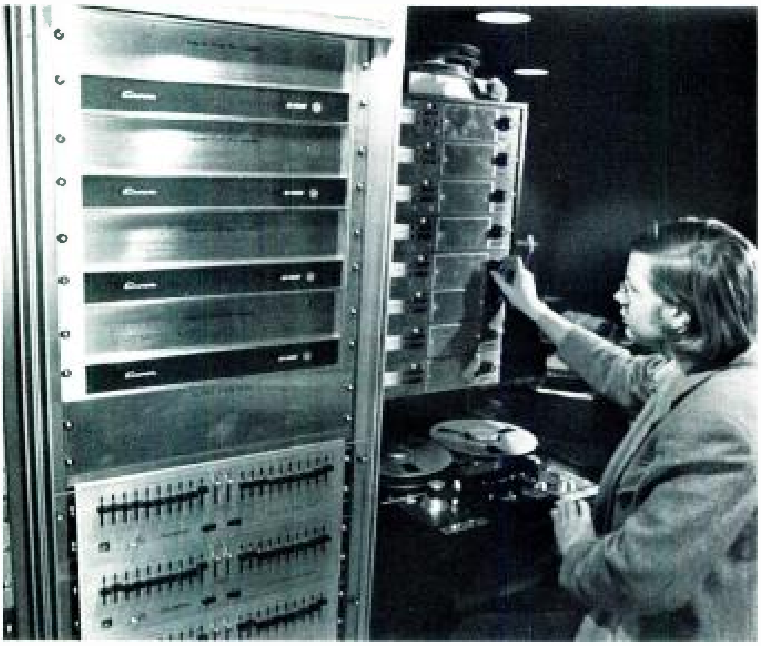
In order to understand the audio/visual undertaking itself, some of the background of the depicted event is a must. The Boston Massacre in 1770, the Boston Tea Party in 1773 and the closing of the Port of Boston led up to the desire of the colonists to resist any such further activity by the British. In August, 1774, the stores of guns and ammunition accumulated by the local farmers were raided by the Redcoats, and the first battle of resistance almost took place at that time, but the gathering of 10,000 farmers at Cambridge Common disbanded without incident. It was learned that the British had plans to go after the stores of arms in Lexington and Concord. The British had two choices of where to strike first—either march first and then cross the water, or go by boat first and then march. The two lanterns in the Old North Church tower told of the decision to move by water first, but Paul Revere had already rowed across the river right under the cover of the British ships so he did not even need the now famous signal. He alerted the local people, and when the British, after failing to find the stores, started to retreat, the colonists took a position and each side fired on the other. The "shot heard 'round the world" started the war. This was April, 1775.

The British were determined to make up for their ignominious routing by the colonists. The gathered forces of the colonists added up to 15,000. Aiming to prevent a move by the British, they moved toward a small spit of high land jutting out into Boston harbor. The town of Charlestown was on this small place of land, as was Bunker Hill. Leaving men along the way, including 900 soldiers up the hilly ground, the colonists dug in where they stood—on Breed's Hill, not Bunker Hill which they had just passed—and started to build a fortress. This was on the night of June 16, 1775. The British on board the ships did not know of the work. Although the troops in the city of Boston heard the sound of building, they decided to wait until morning before doing anything.

In the morning, the British on the warships saw the wall and began a cannonade. One of the colonists went for water during a lull in the bombardment. A shell caught him before he could go far. He was buried on the spot, the first American casualty of the battle. Along the beach, a small fortification protected by a low stone wall was hastily erected.

The British soldiers started their move uphill, with crack troops moving along the beach. It was early afternoon—the temperature was about 90 degrees. In the town, people took high places to watch the battle. The British moved along the beach. When they reached a stake stuck in the ground about forty feet in front of the wall, the crack shot marksmen of the colonists, hiding behind the wall, opened fire.

The trick here was that the colonists had formed three lines, one above the other, to be able to fire steady volleys: first, the kneeling soldiers in front, then the next row crouching, then the third row standing. The British ran. They tried twice, charging up the main hill, but with full uniform and 100 pounds of pack on their backs, they didn't make it. On the third try, with coats and packs on the ground, they finally got the colonists to run. The decision behind the fortress wall to make every shot count and not to fire "until you see the whites of their eyes," cost the British over 200 of their top fighting men, and over 800 wounded. The colonists lost over a hundred men, with more than 300 wounded. The Americans lost



John Jacobsen of White Oak Design checks up on the 7-channel Ampex 440-8, used for digital audio cues.

the battle, but they had proved to themselves—and the British—that they could fight. The British won, but what? Only a small hill, for which they paid heavily in casualties.

So, a diversionary tactic became a full fledged battle fought on a spot for which it was not named nor where it was originally intended to be fought. This, then, is the story of Breed's (not Bunker) Hill.

THE BUILDING

Much of the history-rich Boston area could have served as the focal point of the audio-visual display conceived by White Oak Design, Inc., of Boston, but the decision was to portray this most important battle. The idea was presented to the Raytheon Corp. of Lexington, and they agreed to fund the undertaking. A non-profit foundation was set up and the Bunker Hill Pavilion was built at a cost of $1,500,000. Research of old documents turned up reports by people who saw the battle, letters by participants, and a tremendous amount of detail regarding clothing worn, the plans, the armaments used, and the people involved. This material was gathered under the supervision of former M.I.T. Professor Douglas P. Adams of Cambridge and Thomas L. Davis. Every detail necessary to create the most authentic program possible was used. In fact, almost every spoken word in the show comes from documented evidence.

The construction of the 10,000 square foot building took exactly one year from beginning to end. The brick structure has some special features which take into account modern day problems, not even thought about in colonial times. Reinforced concrete with insulation is used to soundproof the interior against the sound of the expressway which runs just outside the walls and the roar of aircraft coming and going at Logan International Airport, just across the river. (Today, in a similar maneuver, the British Men of War would have to pass the airport to get to their positions for the battle.)

The audience area is about 40 feet square and can hold up to 150 standing people. At a height of about 15 feet off the floor, the projection booth is suspended independently of the building roof to eliminate the effect of roof deflection on the precise registration of the show projectors when the roof is loaded with snow. The booth protrudes from the rear wall over the audience area. The architects were Anderson, Beckwith, Haible & Reeve and the general contractors were A. J. Martini Co.

THE SHOW

Once the show was conceived, John Jacobsen, Steve Rich, Tim Curnen and O'Jay Stine, all of White Oak Design, set about getting the script written, the special effets worked out, the lighting and sound figured out, and the details of the production in working form. The consulting firm of Hubert Wilke, Inc. of New York, was asked to design the audio-visual aspects of the show. They worked very closely with the show creators to set up plans and specifications that would portray the material of the program to the best advantage. Audio Visual Services, Inc., New York, engineered and supplied the sound and projection, as well as the control systems of the program. Recording and mixing was done at Intermedia Sound, Boston.

The presentation was designed to include the audience in the action. Sets were arranged to go almost all the way around the standing visitors—a part of the show even takes place behind the people. With the enclosed projection booth overhead, there is no distraction caused by changing lights and the operation of projectors. The main portion of the viewing area consists of a total of fourteen screens, of different sizes and shapes, in irregular groups, one cluster having perhaps threee screens, another with two, another with only one. There is a total of six groupings in all, at differing levels and positions. The space between the screens is filled with paintings and settings of pertinent people and places, and a total of 22 life-size figures in groups and positions relating to the story. The detail of the figures, the clothes, the guns, the incidents depicted are historically accurate and made with great precision.

When the audience enters from the rear, the room is dark except for a diffused light from above, illuminating the audience floor area. On a single large screen there is a projection of a proclamation of martial law in Boston. A general background sound is heard of horses, children, people—the audience has the sensation of being in the midst of the town. The lights fade, the image on the screen disappears, the sounds stop, and a voice begins with the background, leading up to the events to be seen. The story is continued by a seated figure on one side who is reading a letter he just wrote. As he tells his side of the story, as a British soldier, the faces of the generals mentioned come up on screens.

The narration moves to a Yankee soldier on the other side of the diorama and again, images help tell the story As the events unfold, the show is all around the audience, both visually and aurally, on screens and figures, and behind as well, recreating the burning of the city of Charlestown by the British before the battle. The effect of movement is created by varying dissolves on screens and timing of projection. Authenticity of detail is enhanced by the dramatic images and life-size figures illuminated as dimly or intensely as required. Strobe lights and effects of gunfire and flames are cleverly intermixed to simulate realism effectively. A specially written ballad is sung and played through the program to help keep the fast pace and the narration moving. Although the show is less than twenty minutes long, it seems to cover a tremendous amount of history quickly and excitingly.

THE TECHNICAL ASPECTS

The ingenuity of the audio-visual system design and its execution are what make the program as effective as it is. The projectors are Kodak Carousels mounted on six Optical Radiation Xenographic 512C units. Each unit consisting of a xenon light source with two slide projectors mounted on the front of the housing, covers a single screen configuration. The light output of each unit is 5,500 lumens at a nominal color temperature of 5,400° K. A mechanical dissolve system is incorporated within the light source housing, since the xenon lamp cannot be turned on and off as needed. With the same light used on both projectors, the light housing of the projectors is modified to permit straight-through illumination of the outside source. An advantage of using one light source for the two projectors in the system is that the illumination remains constant when the dissolve is activated, instead of having the variation that can occur with each projector having its own lamp. The horizontally-mounted xenon bulbs have a rated life of 2,000 hours. The projection room is specially cooled and ventilated to assure proper operation of the equipment.

Inasmuch as the screens have different shapes and are clustered in unique configurations, the slides also had to be made specially for the presentation. A total of over 500 slides is used in the 12 drums. Since dissolve action must be accurate, the registration of slides in paired projectors must be precise. Slides could not be used in the standard horizontal format, so special masks were made for each slide. The mask shape depends on the screen configuration to be covered. In the single screen, the slide takes the shape of the screen. Where two screens are used, the masking permits openings to correspond. In three-screen application, the mask again matches.

Yet another innovation was required in making the slides. With the angles of projection varying and steep (9½ degrees off the horizontal in one case), the keystoning at the throw distance used would be unacceptable. The masking was also shaped to eliminate the keystone effect and to ensure that the image fills the screen accurately. The effect of having the screens slightly tilted downward toward the audience was also taken into account. The dissolve rates of the Xenographic are from one to six seconds, with quick cuts also possible. The control system for the dissolve units extends this capability to permit fades in 2, 4, 6, or 8 second intervals. With the single light source, and accuracy of slide registration, the varying rates of dissolves during the show are very effective.

The artwork created for the slides to depict scenes or troop movement toward or away from the audience is exceptional; the facial expressions up close are amazingly real. In order to be able to replace slides as needed, the original masters are not used, even in duplication. A separate set of masters has been set up for duplication purposes. The originals will be used only when the processing masters need replacement.

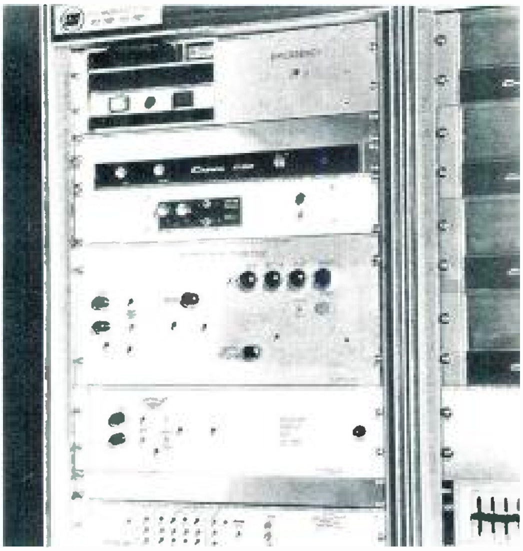
SOUND EQUIPMENT

The sounds of the background city originate on a ¼-in. cartridge tape played on an International Tapetronics deck. This permits continuing the preliminary sounds as long as needed for the audience to enter the theater. The tape begins automatically when the show is over, and stops playing when the attendant outside the room, in the audience entrance area, has allowed the next group of people in. The sounds are fed to all speakers to avoid any real direction to the effect. With the activation of the show from the control panel, the 1-in. show tape begins. An Ampex 440-8 is used for this tape. All channels but number 5 are used for sound, voice, music, and effects throughout the program.

The audio is fed from the tape deck preamps to Soundcraftsman equalizers through Crown D150 dual amplifiers to Altec 604E speakers in utility housings. The equalizers are dual 10-frequency units. Since speakers are mounted around the periphery of the audience, within the sets at the screen locations and, over the heads of the people, on the ceiling under the protruding projection room, the room had to be tuned very carefully to eliminate ringing and standing waves. Each equalizer/amplifier combination was set up together for each of the speakers (each amp feeds its own speaker, hard-wired, with no switching) according to location. There are a total of ten speakers, six around the show area, and four above. Each of the six units is fed by a single amp, the cluster by two amplifiers. (Dolby noise reduction is used between tape preamps and equalizers.) No attempt is made to locate the speakers near screens or the life-size figures. Separation of speakers is sufficient to bring the attention of the audience to the active area and realism is maintained without any attempts at specific "speaking" figures or screens.

CONTROL SYSTEM

The control signals for activating lights and projectors come from track 5 of the 1 inch tape. These trigger the FS-255 Audio Digital System, developed by A. V. Services, Inc., N.Y., the a/v system installer. Of the total capability of 255 channels, only 37 of them are utilized. Each projection unit requires six signals (cut, dissolve timings of 2, 4, 6, or 8 seconds, and shutter—to block the light on the projector to be darkened or *vice versa*). One



Audio digital control and Synch System automatically monitor every step of the program.

channel is used for lighting cues to activate a completely separate system provided by Capron Lighting of Boston.

The control system consists of an Audio Digital Controller, programmer, automatic punch, and accessory edit controller. The control console for originating the signals resembles a button system on a push-button telephone. By pressing the desired combinations, an eight-level binary code is sent to the punch, which puts the signal on a paper tape. The console also has readouts to indicate the tape position, by step number, and the cue channel. When the tape is played back, the signals of the punched holes are fed through the controller, first for test only if desired, then to put the audio signals on the control track. (The controller can be operated directly by the programmer if desired.) Once it is determined that the show is all set, the paper tape can be discarded. (The edit controller is used for timing changes by use of a keyboard.) If it is desired to change the cues on the tape, or to re-establish a paper tape again, the audio signals can be fed back to punch another paper tape. Making duplicate punched tapes is also possible with the automatic punch. (The speed of the total control system is 100 closures per second.)

In order to be sure of the precision of all cues, sounds, balance, and synchronization, the producers made up long running sheets for the entire program. Sound signals were indicated by channel and time. A master sheet showed cues, sound, lights, and effects by times so that every signal was exactly matched to every other. Long hours were spent to make the show work as it would have to in order to be effective. The result is obvious in its accuracy to the smallest detail and technical ingenuity.

AUTOMATION

Precautions were also built in should any operating problem come up. The show is automatic once it is started. That is, the program tape starts, the background cartridge stops, and the action continues until conclusion. At the end, a quarter-inch of oxide is scraped from the audio tape. This is sensed by a light-sensitive device, which automatically starts the background tape and switches it into all channels, turns on the lights, signals the slide trays to move until a microswitch on each projector is activated by a raised piece mounted on the side of the drum in the zero position, opens the shutter on projector 4 to show the first slide seen when the audience enters, and starts the audio/control tape to rewind.

At the beginning of the tape, another blank space is scraped to stop the tape. This is also a unique setup—the speed of the tape would cause damage if the brakes were suddenly applied. Instead, the speed is slowed down gradually as the supply reel becomes close to full. When the brakes are finally applied, the tape is travelling rather slowly. Since the tape now has to get over the scraped stop position during the starting procedure, a delay relay is used to cut out the light-sensitive device until after the open spot has passed and the oxide is in progress.

An automatic emergency system is also installed. If someone is working on the system during the holding period, a switch is thrown on the control panel in the control room which illuminates a warning amber light on the control room panel and on the one near the audience area. This indicates to the starter that a hold is in progress. When the work is completed, the switch is returned to normal, and the show light (green) goes on again. In the event of trouble, the system can be stopped, a red light goes on, all lights go on, and the show is automatically reset to the beginning. A similar situation can occur if the emergency announcement microphone (one in the office and one in the control room) are activated. An operator in the control room has a monitor system which permits him to hear all audio channels during a show, and the background material during hold period. The system can be checked quickly this way and troubles corrected quickly.

The building (which opened on the 200th anniversary of the Battle of Bunker Hill) has been leased for 20 years. This means the show will go on, and on. It is the largest of any audio-visual programs for the Bicentennial in the Northeast and certainly deserves serious consideration during a trip in that area. (It is located just 200 yards from the ship *Constitution*, another sight to see in the same area.) A nominal fee is charged at the *Whites Of Their Eyes* presentation to cover operating costs; the operating foundation is non-profit. It is the first to open in the celebration year, and will definitely be the most outstanding for some time to come. No trip to visit the places where the Bicentennial began can be made without first seeing where the history of the independence of this country started. ■

Punch-tape control units provide audio cues for recording on the one-inch show tape.

DANIEL QUEEN

Psychoacoustics

There's a beautiful symmetry between hearing and all our other senses.

MOST READERS of this magazine will be familiar with such concepts as the Hass, or *precedence effect* in the application of time delay to sound systems or in methods to fool the senses into thinking that something is originating as a "virtual" source. Yet, how many of us have thought about the similarity, of these psychoacoustic phenomena—that is, phenomena associated with our hearing sense—to peculiarities of our other senses?

I have always been curious about the ubiquitous factor of sixteen that we find in the minimum frequency discernible as a tone, the minimum flickerless frame rate for motion pictures, and (as a reciprocal) the maximum fusion time for echoes. Similarly, there seems to be a short time —about a millisecond—coincident in the maximum separation of impulses from separated sources before localization moves to the first of them, and the almost identical visual phenomenon of distraction due to flashes and of backward masking.

Even more curious is the fact that the lowest discernible sound frequency perceived by our ears as tone—not pulses—is the same as the lowest discernible vibration frequency perceived by our sense of touch.

Many of us had been exposed to the concept of critical flicker frequency as applied to film and had always suspected that this phenomenon somehow related to the other senses. Yet, as if as a testimonial to continuing education, the answer turned up in a recently introduced undergraduate general biology text. All fond hopes that the phenomenon was due to some sophisticated programming of our higher brain centers disappeared as the text pointed out that the phenomenon is common to all vertebrates down to the lowliest fish—as well as to all our senses.

Let us review the transient behavior of human hearing. The precedence effect has been described by many observers, usually in terms of localization and echo perception. In general, the data says that our hearing sense will place the location of a sound which originates from two sources (such as two separated loudspeakers) somewhere between the sources. The exact location depends on the relative intensities of the sounds from each source and their relative times of arrival. However, when the sounds from the sources are separated in time by more than approximately one millisecond, localization will always be at the first source.

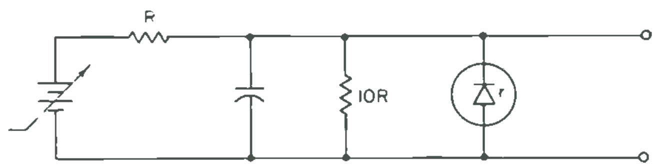


Figure 1. The electrical analog of a sensory receptor membrane.

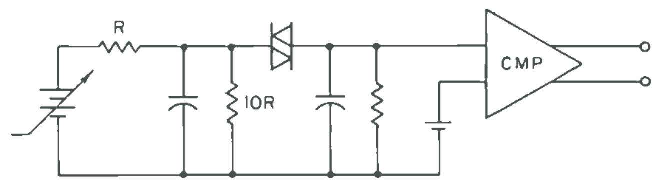


Figure 2. The electrical analog of a sensory-neural junction.

ECHO FUSION

The second phenomenon is that of echo fusion. This effect causes an echo arriving at the listener within about 63

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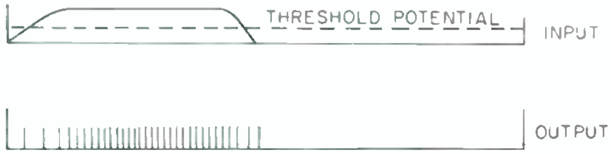

Figure 3. A time record of sensory excitation. Stimulus causes a rise of receptor "generator potential" until it exceeds threshold potential, whereupon it creates pulses of "action potential" in a nerve.

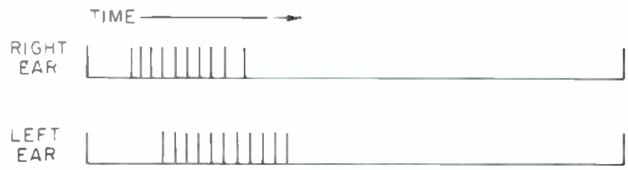

Figure 5. A nerve pulse trains for a real or simulated right-side sound stimulus.

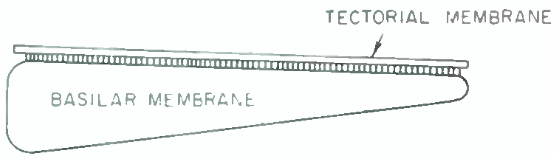

Figure 4. A schematic representation of the hearing receptor mechanism. Relative motion between the basilar membrane (which is excited) and the tectorial membrane produces stress on the hair cells (the sensor-neural transducers).

milliseconds of the direct sound (or the first sound heard) to fuse with the first sound, reinforcing it in loudness, but not changing its information content in terms of localization. Sounds arriving after about 63 milliseconds are usually heard as discrete echoes. The exact fusion time seems to vary somewhat with the frequency content of the original sound, and the physiological condition of the listener.

If someone wanted to build an electrical analogue of this sensory pattern, he could use the simple circuit shown in FIGURE 1. The capacitor shown can charge rapidly up to the limit determined by the zener diode but must discharge slowly. Any pulse coming in during the charge time will contribute to the charging, but any pulse coming in after the zener voltage is reached will only extend the time before discharging.

Now, if we take out the zener diode and put in, instead, a negative resistance device followed by a comparator, we have the circuit of FIGURE 2. What happens now is shown in FIGURE 3. As the charging pulses come in, nothing comes out of the comparator until enough charging pulses of sufficient intensity have come in to bring the voltage on the capacitor up to the breakover point of the negative resistance device. At this point, a sufficient voltage will be produced to cause the device to fire, outputting an impulse. If pulses continue to come in, the output device will continue to produce these impulses. As long as the input pulses continue to maintain the potential across the capacitor, output pulses will be produced by the comparator. However, once the input pulses stop, the capacitor will discharge, stopping output pulses until a new set of input pulses causes the capacitor to charge again.

THE HUMAN COMPUTER

According to this representation, which is close to actuality, the stimulus is carried along the nerve fibres to the brain as a pulse train. The intensity of the stimulus is acutally a function of the number of pulses in that train—disgustingly similar to the operation of an analogue-to-digital converter. The input pulse to the circuit is the result of some change in a sensor. In the case of hearing, it is a change in stress upon the hairs of the hair cells located along the basilar membrane in the cochlea.

FIGURE 4 shows a diagram of the human hearing sensor. At the point where the sound coupled from the ear drum into the cochlea enters, the basilar membrane is thick. It becomes thinner and lighter as one moves further out upon it. For this reason, the thick part will resonate sympathetically with low frequencies and the thin part with high frequencies. Thus, hair cells located along the basilar membrane will be stressed only by the frequency to which the adjacent portion of the membrane is sensitive. From each hair cell, a nerve fiber enters the auditory nerve bundle and is connected into the hearing center in the brain. Thus, each nerve fiber transmits pulses only associated with a particular band of frequencies.

It is easy to see from this that if the capacitor is charged by pulses at a certain frequency and other pulses enter before the capacitor discharges below the trigger point of the negative resistance device, rather than there being a sensation of a separate stimulus, there will be, instead, a sensation of greater intensity. Since a reflection can consist of only those frequencies that were in the direct sound, it is obvious that the direct sound arriving first will provide the intiation of the stimulus; reflections arriving before the capacitor discharge will only intensify the stimulus.

How then does localization occur? In FIGURE 5, we have plotted the potentials associated with the two ears. Each, of course, has its own nerve fibers and its own entry into the hearing centers in the brain. Pulses must come in to charge the capacitor up to initiate output pulses from the comparator. Since the pulse arrives first at one ear and then the other, when the pulses are of equal intensity, output pulses will be initiated from the ear closest to the sound source first. The brain will receive signals indicating the difference in distance from the sound source.

Now what happens if we initiate the same stimulus from the two separated sources? As shown in FIGURE 5, the pulses will now arrive in a manner which modifies the time of initiation of output pulses. The amount of modification will depend on the relative intensity of the sources and their relative time of arrival. However, the sources, in order to interact in this way, must both provide pulses to the ear during the "charge" time.

CRITICAL BANDS

It is interesting to note that this phenomenon also can explain the manner in which masking takes place in so-called critical bands. If the capacitor associated with a particular frequency band is already charged, another stimulus at the same frequency will only contribute to an addition of intensity, whereas a stimulus of a different frequency will excite a different capacitor and give the sensation of additional stimulus, causing the new stimulus to be audible.

A similar situation exists in vision, except that instead of hair cells, the receptors are the rods and cones in the retina in the eye—each of which also is connected to a single nerve fiber pressing in the optic nerve bundle to the visual center in the brain. Similarly, the receptors of the sense of touch are connected by their own individual nerve fibers back to the brain. It should be noted that the brain has an "addressable buffer" called the *thalamus*, which enables the brain to sort and select in its effort to concentrate.

OUR INTERNAL ELECTRICITY

Now that we have described the circuit in FIGURE 2, can we actually show that it exists in the human body and particularly around its sensory receptors? The fact is that the body actually does have a complex set of solid state rectification and negative resistance devices. They are electrochemical in nature and their carriers are ions (sodium and potassium) rather than electrons. The junctions of these devices are permeable membranes which separate fluid-bearing tissues. The sensory receptors function by stressing these membranes in a manner which changes their permeability, therefore allowing positive ions to flow from one fluid to another—resulting in a change of charge in the fluid.

In the schematic of FIGURE 2, both the charge resistor and the discharge resistor are actually the same membrane, but, because this type of membrane is *differential*, ions flow through it in one direction more readily than in the other direction. Thus, the rapid charge and slow discharge associated with the phenomenon is explained.

It is also readily seen how such a membrane can act as the negative resistance device we have described. One membrane exists, in effect, at the input to the receptor cell, allowing the input stimulus to charge the cell and another membrane exists at the interface of the receptor cell and the nerve cell, causing the production of nerve pulses. These receptor cells and their associated membranes are remarkably similar for all the senses and explain the also remarkable similarity in the characteristic stimulus times.

It is also clear that anything that will affect the electrolytic balance of the body fluids will affect these characteristic times. Many well-known substances are known to affect the chemical balance (or homeostasis) of the body—among them, alcohol and drugs. The chemical balance is also known to be affected by the time of day, the amount of sleep that one has had, and by diet. It is easy to see why observed times can vary over a fairly wide range among individuals. It is also clear that, without careful physiological controls, many of our psychoacoustic experiments will be subject to great error and contradictory results.

A little imagination would suggest also that artificial acoustical effects, particularly involving a stereo or quad reproduction, might be sensed differently by persons with different life styles, thus contributing to the communications problems which we know exist in the entertainment and recording industries. ■

PHILIP C. ERHORN

Scientific Calculators

Can't make up your mind which calculator to buy? Here are the facts, the whys and the wherefores, to help you make a wise choice.

SECOND-GENERATION hand-held scientific calculators, now appearing on the market in increasing numbers, far outshine older "electronic slide rule" types. Most original versions lacked either scientific notation, parentheses keys, or both, seriously limiting calculating power and readout capability. They are being dumped at low prices, but are in no way a bargain compared to the full scientific models. Actually, prices on all scientifics have dropped impressively several times this past year, with many new models priced well below $100. Further price reductions may be imminent, as will be seen further along.

A word of warning in this respect. If you are considering purchasing one of these intriguing, diminutive gems of technology, you will get just what you pay for. There is no substitute for quality. The cost of repairs to a bottom-line model may make it feasible to throw it away and buy another. Reputable manufacturers are not interested in this kind of market, although they are making every attempt to appeal to the vast student market, while still offering a reliable product at an affordable price.

BASIC TYPES

There are two basic types of hand-held scientifics. The predominent one uses an algebraic entry system (AES), not to be confused with our professional society of the same initials! The other employs reverse Polish notation (RPN) as introduced and popularized by Hewlett-Packard in all their scientifics, and now being adopted by a few other manufacturers.

Pictures speak more loudly than words, so two typical keyboard layouts are reproduced here, through the courtesy of MOS Technology, Inc., a prime supplier of a full line of logic chips to the calculator industry. These keyboards, utilizing forty single-purpose keys, illustrate identical calculating facilities for each of the two logic systems. A single logic chip provides all functions, with a 200 decade calculating and readout range. Included are all the basic trig, log, and convenience keys to tackle almost any problem with comparative ease and without reference to a book of tables.

The algorithms necessary for developing the equivalents of such tables are built right into the calculator logic. In the course of solving problems, the display may blank out for a second or two while the logic pursues some difficult algorithm. Note that the RPN keyboard is distinguished by its ENTER key and stack roll key. The AES keyboard includes nested parentheses keys and an EQUALS key.

The 4-register operating stack peculiar to RPN calculators affords access to accumulated data or intermediate results, for either review or register exchange purposes. The stack roll key [↓] facilitates the operation. AES calculators offer only a register exchange key [X↔Y] which allows interchange of the entry (display) and prior result registers.

Certainly most audio engineers should find these basic scientific features quite adequate for their problem-solving needs. Of course, calculating power and convenience will be increased (price too!) as more features, such as conversion, statistical, combinatorial, probability, and programming keys, are added to the basics. Nevertheless, there are many more considerations before you can make a decision properly. For example, just what is RPN and how does it work?

HOW THEY WORK

RPN is a parenthesis-free method of notation perfected in relatively recent years by Polish logician Jan Lukasie-

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SCIENTIFIC NOTATION: Although data may be entered and displayed in standard notation with a full floating decimal point, scientific notation (powers of 10) is most convenient for handling very large or very small numbers. The calculator will compute and display numbers over a 200 decade range from $\pm 1.0000000 \times 10^{-99}$ to $\pm 9.9999999 \times 10^{99}$. The diagram shows the display format for scientific notation:

Mantissa — Exponent

−1. 2 3 4 5 6 7 8 −05

Decimal — Exponent Sign
Decimal Point
Integer
Mantissa Sign

The last two digits on the right end of the display are used for powers of 10 (exponents). To illuminate them, press the Enter Exponent, EEX key: To enter the number 35,000,000 in scientific notation, move the decimal point 7 places to the left, and multiply by 10^7 (3.5×10^7):

Enter	*Press*	*Display*
3.5	EEX	3.5 00
7		3.5 07

To change the sign of the mantissa, press the +/− key (change sign) before pressing EEX. If the +/− key is used after pressing EEX, the exponent sign will be changed. To enter the decimal number 0.0000462 in scientific notation, move the decimal point 5 places to the right, and multiply by 10^{-5} (4.62×10^{-5}):

Enter	*Press*	*Display*
4.62	EEX	4.62 00
5	+/−	4.62 05

If the equals key is now pressed, you will see the number revert to standard notation, 0.0000462.

You can mix data in scientific notation with data in standard notation, including memory operations. The calculator will convert for proper calculation:

$$12345 + 8.76 \times 10^6 = 8772345$$

Important: Do not confuse ordinary exponents with powers of 10:

$$2^5 = 32. \qquad 2 \times 10^5 = 200{,}000.$$

wicz. As it is applied to hand-held calculators, the arithmetic operations are entered after two or more operands (numbers or parenthetical expressions) have been entered. For example: $(2 \times 3) + (4 \div 5) \times (5 - 2) = ?$

Press	*Display*
2 Enter 3 ×	6.
4 Enter 5 ÷	0.8
+	6.8
5 Enter 2 −	3.
×	20.4 Ans.

OR

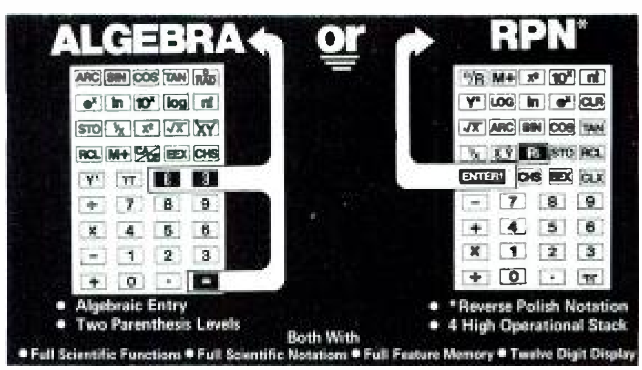
Press	*Display*
2 Enter 3 ×	6.
4 Enter 5 ÷	0.8
5 Enter 2 −	3.
×	2.4
+	8.4 Ans.

Notice that intermediate answers are displayed each time you press a function key and no equals key is needed. Only numbers and results are stored. The first answer is incorrect because the problem was entered without regard for the algebraic rule of hierarchy. This states that exponentiation must be done before multiplication and division, which in turn must be done before addition and subtraction. Parentheses must be employed where any part of this rule is excepted. While it is not necessary to enter parentheses with an RPN calculator (there are no parentheses keys) hierarchy must be observed between the parenthetical expressions, and so the answer 8.4 is correct.

Not surprisingly, the AES calculator will come up with the wrong answer (20.4) if the problem is entered as stated. To arrive at the correct answer (8.4) on either calculator, the problem should be stated as: $(2 \times 3) + [(4 \div 5) \times (5 - 2)] = 8.4$ Ans.

ALGEBRA-WITH-HIERARCHY

There are a few scientifics available which include built-in algebraic hierarchy. These include the Canon F-7, offering seven nested levels of parentheses plus hierarchy; all the Novus scientifics, offering hierarchy with RPN; and the Texas Instruments SR-50(A) and SR-51(A) which



The two types of keyboards used in the calculators discussed in this article.

The Melcor 635. Note the forty-key layout utilizing all single-purpose keys. This unit can display exponents even though they are not shown on the readout.

The Kingspoint SC-60. All basic scientific functions are directly available with the forty keys used. The shift key must be used to utilize supplementary convenience functions.

The Hewlett-Packard 25. The smallest of the calculators shown, this unit nevertheless performs all functions and is additionally fully programmable even though it has only thirty keys—almost all of which are triple purpose. Two shift keys (f and g) must be used to make basic scientific functions accessible.

offer internally programmed sum-of-products capability with hierarchy, but no parentheses keys, in an effort to compete directly with RPN.

This approach can often backfire. Without the option of parentheses keys, the internal hierarchy can work against you: (2 + 3) × 4 = 20, but the TI scientifics will treat the problem as if it were written: 2 + (3 × 4) = 14, which is, of course, another problem. Additionally, the internal storage registers of the very popular SR-50(A) are limited, and tackling a product-of-sums, or many other types of fairly complex problems will often entail using paper and pencil, along with the memory, for recording intermediate answers. The otherwise very thorough instruction booklet fails to point out the real extent of such limitations.

Ordinary algebraic logic with nested parentheses is far more obvious to use in any kind of problem, and eliminates the nasty tendency for mental laxity which I fell into with the programmed, hierarchal logic calculators, frequently leading me into some very wrong answers! I'm happy to note that the new, magnetically programmable TI SR-52 includes keys for nine nested levels of parentheses, along with its internal hierarchy.

ENTER VS EQUALS

Borrowing an example from a now obsolete H-P publication entitled *Enter vs Equals*, we can observe a very interesting comparison of keystrokes between an RPN scientific, such as the most diminutive HP-21, and an AES scientific such as the Melcor 635:

$$[(2 + 3) \times (7 - 4)] + [\log \sqrt{(5 + 8) \times (9 - 2)}] = 15.979521$$

RPN

Press	*Display*
2 Enter 3 +	5.
7 Enter 4 −	3.
×	15.
5 Enter 8 +	13.
9 Enter 2 −	7.
×	91.
√X	9.539392
Log x	0.9795207
+	15.979521 Ans.

AES

Press	*Display*
[(2 + 3) ×	5.
(7 − 4)	3.
] +	15.
[(5 + 8) ×	13.
(9 − 2)	7.
]	91.
√X	9.539392
Log x	0.9795207
=	15.979521 Ans.

With the RPN calculator, no parentheses need be entered (remember, there are no parentheses keys) although you must keep track of them in your head. This is succinctly demonstrated by the final keystroke +, entered many keystrokes after its actual position in the problem.

You will notice a striking similarity in keystrokes between the AES calculator and the RPN calculator. As a matter of fact, the necessity for pressing the √X and Log x keys following the entry of the operands is actually RPN! It is also clear for both entry systems, despite advertising claims to the contrary, that when transcendental functions are involved in a problem, you cannot enter the problem from left to right, just as it reads. The last batch of keystrokes certainly points this up.

With this type of AES calculator, any two-variable function key (+, −, ×, ÷, Y^X) during chain calculations, completes any previous function instructions, the same as EQUALS, as well as instructing the calculator what the next function will be.

With this fact in mind, the problem may be mentally simplified as follows, reducing the total number of keystrokes from 30 to 24:

$$2 + 3 \times (7 - 4) + \log \sqrt{[5 + 8 \times (9 - 2)]} = 15.979521$$

Press	Display
2 [+] 3 [×]	5.
(7 [−] 4)	3.
[+]	15.
[5 [+] 8 [×]	13.
(9 [−] 2)	7.
]	91.
[√x]	9.539392
[log x]	0.9795207
[=]	15.979521 Ans.

Learning this type of procedure is no more unorthodox than absorbing the methods of RPN. With a few evenings of practice, you will become proficient with either type of calculator, and its instruction booklet.

Within the practical limitations of the 4-level operational stack in RPN scientifics, and two-nested levels of parentheses plus operational storage registers for four numbers and three functions in most AES scientifics, problems involving multi-levels of parentheses usually must be tackled from the inside out, in sections, just as we were taught in high school algebra and trig classes. Of course those few calculators, such as the Canon F-7, offering more than two levels of parentheses can be very convenient in avoiding this sectionalizing mode of attack. However, even they do not guarantee that the problem may be entered from left to right, just as it reads.

MULTI-PURPOSE KEYS

Solving problems of a far more complex nature than those used here to demonstrate similarities and differences between AES and RPN calculators will not faze the basic scientifics. However, the addition of conversion and/or statistical, etc. convenience keys means that some of the keys now become dual-purpose. The second function is reached via a *shift* key. Recently, 10 addressable memories and/or five or more levels of parentheses have been included in a few models, in particular the Kingspoint 6010, Melcor 655 and Melcor SCP-700. The chip affording these goodies interfaces readily with the basic logic chip, as does the ultimate programmer chip, just now being offered.

Bear in mind while making a choice, that any calculator which uses multi-purpose keys to hold down costs, or to make it very compact physically, or because it offers increased convenience functions, will actually be less convenient to us. If you are fumble-fingered, use eyeglasses, or need to use the extra features only occasionally, remember that a 35 or 40 key, essentially single-purpose layout is hard to beat.

The recent trend by Hewlett-Packard towards miniaturized scientifics such as the HP-21 and HP-25, demands a keyboard using both dual-and triple-purpose keys. This definitely increases chances for errors in entering data. Operations will be slowed because you must look carefully in order to press the correct keys. One or more shift keys must also be pressed in order to get at all the many features offered on these multi-purpose keyboards. Get your eyeglass prescription updated or you will have trouble reading the light blue designations on the sloping front surfaces of the H-P compacts. Not to mention the tiny decimal points on the miniature LED red display. They are almost invisible in bright ambient light.

READOUT DISPLAYS

Speaking of readouts, you will find that the larger, brighter fluorescent displays are showing up in some of the new scientifics. Obtained primarily from the Orient, they have not been promoted aggressively, and have been in short supply. They usually come in shades of blue-green, far more pleasing than the eye-fatiguing red of the usual small LED displays.

Leds are solid state devices, while fluorescents are thermionic, with a finite life, and subject to mechanical shock such as dropping. So far, liquid crystal displays (lcds) have not been satisfactory for calculators. Most recently, two new technologies, electrochromic and electrophoretic displays, are being urgently worked out by several manufacturers, and could be a factor in hand-held calculators in the next two years. Meanwhile, if you have any eye problems, stick with the fluorescents.

PROGRAMMABLES

The final step up from the basic scientific calculator is actually in two steps. Both steps lead to programmable units, but the ultimate product is the relatively expensive, magnetically programmed scientific represented by the HP-65 and the newer, less expensive SR-52 from Texas Instruments. The SR-52 promises even more features and convenience than the HP-65. While these calculators may be programmed step-by-step, they both offer the rather incredible facility (for a hand-held unit) of being able to program instantly by the insertion of a simple magnetic card. A selection of cards is part of the package, although you can make your own. In addition, H-P offers a very extensive library of cards to choose from. TI will no doubt quickly follow suit.

As you read this, Melcor will be introducing their new SCP-700, a manually programmable scientific to compete with the HP-55 and 25, and the Novus 4525. At a breakthrough price of $79.95, there will be serious repercussions throughout the industry, and another round of price reductions will have to take place. This substantial calculator is highly serviceable, and uses a 3-chip set offering algebraic logic with five levels of parentheses, 10 independent addressable memories, and 72 programming steps with direct and conditional branching. While it does not include some of the convenience features of the HP-25 and HP-55, it does offer a 40 key layout for maximum ease of operation.

Note that in all these calculators which can only be programmed step-by-step, the program is lost when the calculator is turned off. This seems a small price to pay for the great convenience offered.

POWER SUPPLY

Be sure that your new scientific uses a rechargeable NiCd battery pack, preferably field-replaceable, such as those used in all TI and HP models, or in a plug-in cassette pack as in the Canon F-7. The cost of throw-away alkalines can be very significant over a period of time. NiCd's can be recharged hundreds of times, and a spare pack is indispensible when you are travelling.

The a.c. adaptor charger supplied will let you use your calculator on a.c. However, some manufacturers advise minimizing a.c. usage in order to avoid shortening of the battery life through possible overcharging. Be guided by the particular instructions provided in the instruction booklet.

INSTRUCTION MANUALS

You will find that there is a tremendous difference in the quality of the instruction booklets or manuals packed with scientific calculators. Most manufacturers seem to feel that they should be shirt pocket size, and the average booklet of this type is very basic, leaving entirely too much to your imagination. Many are readable only with a magnifying glass, particularly the calculating examples. They often contain mistakes and much oriental English. On the whole, such booklets do a serious injustice to the calculators which they describe.

Others, although inexpensively produced, are far better. They have been written by someone who not only knew math, but who was also psychologically in touch with the possible problems of the end consumer. Fortunately, a few of the larger manufacturers not only make a high quality calculator, (for which you will naturally pay a higher price) but also produce a high quality instruction manual, definitely not shirt-pocket size! Hewlett-Packard and Texas Instruments manuals are outstanding. They also offer supplemental books filled with typical calculating examples.

WARRANTY

Be sure to read the warranty. It tells you just what to do (and sometimes what not to do) in the unlikely event that you find a problem or two in the operation of your new calculator. Virtually all foreign-made as well as domestic scientifics have adequate stateside service facilities to back up their warranties. You will find the construction of most models to be quite exemplary, despite the trend to ever lower prices. This is a bonus of solid state technology.

TEST BEFORE YOU BUY

Before you buy, try to borrow a scientific so that you can work out some of the problems in the instruction booklet. Or visit the calculator counter in a convenient store where you may stand a good chance of being allowed to play with several calculators and their instructions long enough to firm up your decision. Unfortunately, most sales people do not have the background in math to offer much practical help.

After you buy, treat your new calculator as a valuable tool. Don't leave it lying around your lab or office. They are highly volatile, and will disappear almost instantly! You might like a very inexpensive and handy calculator desk stand, the Cummins CalConvertor, found at most calculator counters. Unfortunately the HP-21, 25, and 65 can't be fully used with any such desk stand.

Following is a brief listing of proven calculators in the various categories, to be found at most calculator counters right now:

BASIC SCIENTIFICS

Melcor 635
Kingspoint SC-20
Kingspoint SC-44(F)
H-P 21 (RPN)
Rockwell 63R
TI SR-50 (A)
Novus 4520 (RPN)

STEP-BY-STEP PROGRAMMABLES

Melcor SCP-700
HP-25 (RPN)
HP-55 (RPN)
Novus 4525 (RPN)

SCIENTIFICS PLUS CONVENIENCE FEATURES

Canon F-7
H-P 45 (RPN)
Melcor 650 and 655
Kingspoint SC-60 and SC-6010
TI-SR-51(A)
Corvus 500 (RPN)

MAGNETICALLY PROGRAMMABLES

TI SR-52
HP-65 (RPN) ■

SIDNEY L. SILVER

The Dynamic Control Of Sibilant Sounds

De-essing techniques require awareness of the nature of speech, careful timing, and exact control.

MODERN, SOHISTICATED sibilant control devices perform a useful function in automatically controlling sibilant voice levels in film, tape and disc recording operations. Performance specifications have greatly improved, so many of the difficulties associated with older units, such as gain "pumping," breathing effects, and audio holes have been virtually eliminated in the new designs.

These anti-sibilance devices, or *de-essers*, were first introduced in the motion picture industry to handle an annoying problem—the inherent susceptibility of optical sound tracks to sibilant distortion. Cinema sound engineers found that the use of volume compressors to solve dynamic range problems would tend to accentuate sibilant sounds and upset the normal spectral balance between high- and low-frequency speech components. This phenomenon, which has been termed "spectral energy distortion," manifests itself as an unpleasant harshness accompanying the sibilant consonants. At times, these sibilant levels are strong enough to severely overload the audio system, producing intolerable spitting sounds across most of the voice-frequency band.

In order to deal with this problem, frequency-dependent program conditioners have been developed to de-ess or dynamically control high-level sibilant peaks so that the compressed output of the system retains most of the naturalness of the original voice. During past years, de-essers have not been utilized extensively by the tape and disc recording industries because of their failure to meet the high standards set by quality-conscious recording studios. But now that de-essing devices are available without the undesirable side-effects that plagued the earlier versions, there appears to be no valid reason why large quantities of recorded vocal material are still being released with raspy sibilant sounds.

Sidney L. Silver is on the supervisory staff of the Telecommunications Section of the United Nations, where he is in charge of sound and recording.

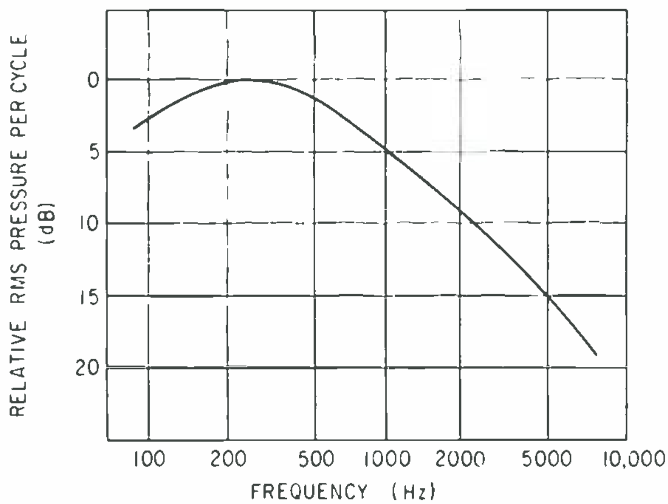


Figure 1. The spectral energy distribution curve for speech.

In recording operations, the difficulty arises because of the large amount of volume compression often applied to vocal tracks to raise the apparent loudness of the finished record. Also, the practice of using *presence* equalization to enhance the listening value of many recorded singing voices tends to boost sibilant levels excessively. There is no doubt that these speech processing methods could be utilized to maximum advantage by incorporating some form of dynamic sibilance control into the system.

But even in situations where uncompressed speech sounds are recorded and vocal dynamics retained, over-emphasized sibilance is often observed, especially during close-miking work. Some voices, for example, have whistling tones which generate sibilance distortion when using certain microphones, while others do not sound sibilant at all.

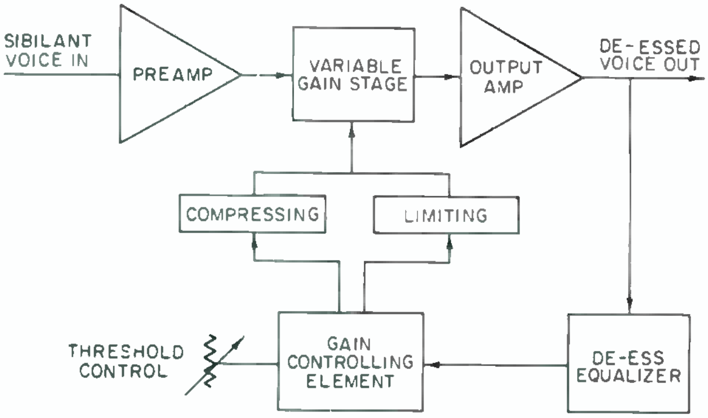


Figure 2. A simplified block diagram of a de-esser system using control-path equalization.

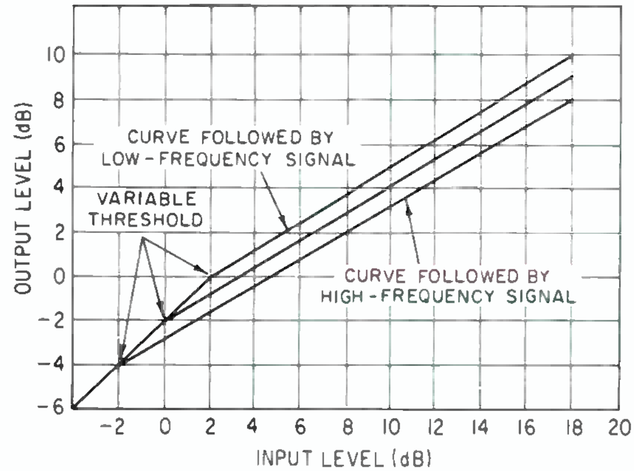


Figure 3. The compression characteristic of a de-esser indicates threshold sensitivity as related to various frequencies.

Subjective experiments have confirmed that a more natural and pleasing reproduction of the speaking voice and singing voice can be achieved if the tendency toward exaggerated sibilance is minimized. Before discussing in detail the various de-essing techniques available to the recording engineer, it would be useful to review some of the acoustical properties of sibilant sounds.

THE NATURE OF SIBILANCE

From the standpoint of acoustics, speech may be regarded as a continuously changing sequence of complex waves that vary widely in spectral composition and overall level as a function of time. The vowel sounds carry most of the energy of the voice, while the sibilants (as well as other consonants) provide most of the information needed for high intelligibility. To generate a sibilant sound, an air stream is forced through a narrow constriction formed by the articulators at some point along the vocal tract. When the air column reaches a sufficiently high velocity, the resultant friction causes the air to become turbulent and a high-frequency hissing sound is created. For example, the sibilant consonant *s*, as in the word *see*, is characterized by a harsh, rushing sound formed by the tongue against the upper gum ridge. If while this sound is being produced, the tongue is lowered slightly and the vocal cords brought into play, the acoustic output becomes a voiced *z*, as in the word *zoo*. A lower-pitched hiss results when the tongue is placed against the hard palate to form the unvoiced *sh* sound, as in the word *she*. Then if the air outlet is adjusted for a less restricted opening in the vocal tract and the vocal cords actuated, the sibilant output becomes a voiced *zh*, as in the word *azure*. Depending upon the size, shape, and positioning of the articulators during the production of speech sounds, there will be some individuals with pronounced sibilant voices and others with only moderately sibilant vocal characteristics.

There are other speech sounds which have similar resonant conditions as the sibilants, differing only in duration and intensity. These are the unvoiced stop consonants produced by making a complete closure in the vocal tract, building up pressure, and then abruptly releasing the air. The resultant explosive sounds, exemplified by all of the consonants in the word *pitch*, are sharp transients which, unlike the sibilants, cannot be sustained. All of these vocal sounds described above, whether sibilant consonants or unvoiced stop consonants, are a constant source of annoyance to recording engineers.

SPECTRUM LEVELS IN SPEECH

As a basis for understanding the fundamental aspects of sibilance control, it is important to have a knowledge of the spectral energy distribution of speech signals. Speech is staccato in nature, the amplitudes and frequencies varying continuously, with pauses between syllables, words and sentences. Moreover, there are characteristic differences between the speech sounds of men and women, as well as individual variations in voice patterns. The problem of determining the relative energy content must therefore be approached statistically by performing sampling measurements of the voice in specific frequency bands covering the entire speech spectrum.

On this basis, Dunn and White[1] accumulated data on the rms pressure patterns of normal conversational speech, indicative of the power or energy levels. From this data, a smoothed-over curve was derived (FIGURE 1), representing the average spectral energy distribution of the measured rms pressures reduced to a one-hertz band. It can be clearly observed that most of the speech energy is concentrated in the low-frequency range below 1000 Hz. For the average individual, it can be assumed that the ratio of strong vowel sounds to weak consonant sounds is about 20 dB. This is an important consideration because the equalization characteristics of de-essing devices take into account this speech energy curve in the suppression of sibilants (This will be discussed in a later section).

The foregoing data deals with the objective aspects of statistical voice signals but provides no direct information as to the manner in which the hearing mechanism evaluates the loudness of speech. Experience has shown that the ear integrates speech sounds over a period of time, so that loudness perception is proportional to the rms value, or actual energy level, rather than the peak levels of the voice. As far as the listener is concerned, the frequency response of the auditory system is characterized by a pronounced peak in the 3500 Hz range at moderate listening levels. This increased sensitivity of the ear in the sibilant region means that speech intelligibility will not be impaired even though the information-bearing consonant energy level is appreciably below that of the vowel energy. Because of this compensating effect, however, high-frequency vocal sounds are particularly bothersome to the listener in situations where sibilance is grossly exaggerated.

ANTI-SIBILANCE TECHNIQUES

In vocal-pickup arrangements, there are certain corrective measures that can be taken with regard to microphone selection and orientation, so as to reduce the audible effects of excessive sibilance and explosive sounds. One point to consider is the action of the air stream from the mouth (and nose) on the generating element and casing of the microphone, producing unwanted breath noises accompanying the speech sounds.

For close talking and close-singing work, therefore, omnidirectional microphones may be preferred because of their inherently low sensitivity to breath puffs and accentuated sibilance, as compared to their cardioid counterparts. Here an advantage is gained from the fact that the undesirable components of the air velocity are considerably more directional than the speech sounds being transmitted with them. By having the soloist performer work across the omni microphone rather than directly into it, say, 45 degrees off-axis, the effects of breath noise can thus be diminished. This can easily be accomplished without taking too much "edge" off the high-frequency response of the pickup. Breath noises can also be suppressed by covering the entire microphone with a suitable acoustically transparent shield. Such a breath screen will produce a high degree of attenuation to breath-excited pressure variations, while only slightly affecting the speech sounds arriving at the microphone.

In general, these procedures are effective in reducing many explosive vocal sounds, but do not always work successfully when the "essiness" of strong sibilant sounds is perceptually dominant. Although the sibilants are concentrated in the high-frequency vocal region (about 3500 Hz), there are secondary component peaks extending more than an octave above and below that range. Under these conditions, attempting to suppress high-level sibilant peaks by acoustical or electrical filtering would lead to coloration of the voice signals. The best approach is to control automatically sibilant levels by frequency-sensitive compressor action, where gain reduction is selectively applied to the entire range of speech components without any apparent roll-off of high-frequency response.

GENERALIZED DE-ESSER SYSTEMS

Let us first consider how sibilants are affected when a conventional volume compressor is used to reduce the dynamic range of voice signals. Recall that sibilant consonants are composed of high-frequency components with low-level energy, while the vowels are predominantly low-frequency components with high-level energy. Consequently, there is a good probability that the high-frequency sibilants will not be powerful enough to trigger compressor action to the same extent as the low frequencies.

As an example, suppose that a speech sound is initiated with a sibilant consonant and followed by a vowel. In accordance with the voice energy curve shown in FIGURE 1, the compressor will not be actuated by the initial consonant but rather by the subsequent vowel. The resultant effect is that the relative spectral energy distribution will be altered so that the amplitude of some sibilant sounds is substantially higher than that of the vowels.

Over-emphasis of these sibilants will occur during the time the compressor happens to be in a state of equilibrium due to relatively long pauses or widely fluctuating levels. In the most extreme cases, the sibilant overload will give rise to a form of frequency-selective amplitude distortion which the ear perceives as an unnatural splatter of sibilant sounds. Once recorded, this condition cannot be corrected

Figure 4. The Orban/Parasound model 516EC Dynamic Sibilance Controller provides three independent channels for de-essing.

by any fom of signal processing during reproduction. It can be avoided if the compressor is made to follow a frequency-*versus*-level curve that matches the spectral characteristics of the vocal sounds.

Various schemes have evolved over a period of years for de-essing speech signals for recording. At the present time. it is common practice to introduce compact-size compressor limiter combinations into separate vocal microphone channels ahead of the main audio mixing console. Included in each unit is a built-in facility for switching a de-ess equalizer into the control circuit. allowing the mixer to select what he considers to be the proper amount of de-essing for each microphone.

FIGURE 2 shows a simplified block diagram of a sibilance control system using level compression and peak limiting to provide frequency-selective gain reduction in the de-essing mode. Here the speech imput is channelled through a preamplifier. a variable-gain stage (vgs), and an output amplifier. both amplifiers providing the necessary operating levels and isolation for the vgs. In operation, a sample of the output signal is passed to a de-ess equalizer to emphasize the high-frequency components. The equalized audio is then applied to a gain-controlling vgs derived from the program material. Circuit parameters of the gain controller determine the timing characteristics of the control signal and its effect on the threshold level.

In effect. the system is a closed loop type of control which. being degenerative, acts to reduce system gain as the frequency-dependent program level is increased above a certain threshold. Since de-ess equalization is used in the closed loop. there will be a progressive rise in gain with increasing frequency above the verge of compression. As shown in FIGURE 3. each frequency component follows a different compression characteristic, so that gain reduction is made relatively greater for high-frequency sounds. Hence. normal energy distribution of the voice signals is restored at the output. This holds true because the de-ess equalizer characteristic is based on a complementary version of the speech energy curve given in FIGURE 1.

In practice, it has been found that much better results can be obtained by using a steep-rising curve in the high-frequency vocal region with a slope of say, 18 or 24 dB per octave. This configuration enables the de-esser to differentiate between the sibilants and high-level low-frequency components, thereby eliminating the possibility of spurious triggering by low-frequency information.

It should be noted that the appropriate timing characteristics and compression slopes for de-essing and normal volume compression are not the same. Therefore, merely connecting a high-pass equalizer in the control circuit of a standard compressor does not mean necessarily that the de-essing function will be performed satisfactorily. Unless the available attack and release times and compression ratios can be adjusted for optimum sibilance control, gain reduction action may produce waveform distortion. Furthermore, in situations where the operating levels are apt to fluctuate widely, *e.g.*, cinema dialogue, stage presentations, etc., a proportionately greater amount of de-essing would be perceived on loud sibilant sounds than on weak ones.

To offset these limitations, a commercially available dynamic sibilance controller has been developed (FIGURE 4) which automatically adjusts its threshold level in proportion to the peak level of the program material. In effect, the control threshold is able to track the high-frequency peaks where de-essing starts to occur. so that the de-essing action remains essentially constant with changes in program level. Depending upon the setting of the threshold control. this relationship is maintained for input levels varying over a range of 15 dB. The device is equipped with three independent de-essing channels. allowing the operating parameters of each unit to be optimized to the individual vocal source.

TIMING CHARACTERISTICS

De-essing devices are characterized by a fairly rapid reduction of gain at the onset of high-frequency sibilant peaks and a relatively slow restoration of gain after the peaks have subsided. Ideally. these units should provide frequency-sensitive compressor action with negligible spectral energy distortion and have attack and release times that ensure a smooth inaudible transition between the gain-reducing state and the constant-gain condition. The attack time should be fast enough so that compressor action is effective on the leading edge of transient sibilant peaks without the danger of overshoot.

If the transients persist over a sustained period, serious waveform distortion will result during the brief intervals before gain reduction takes place. However. it has been observed experimentally that the average listener will not be able to detect such distortion if it lasts for less than 10 ms. On the other hand. too long an attack time will permit the steep wavefront of short sibilant bursts and explosive sounds to be overemphasized at the beginning of words and syllables. with system gain being subsequently lowered on succeeding portions of the voice signals. For proper de-essing action. an attack time on the order of one millisecond will allow sufficient time for sibilant transients to decay without any adverse effects being perceived.

The problem of release time is a more complex one governed by the type of program material involved, *i.e.*, speech or singing, and also the subjective judgment of the operator. For these reasons, de-essers sometimes provide a choice of recovery time values. With an extremely short release time. the rise in system gain between words and syllables tends to exaggerate breath noises on certain sibilant consonants prior to the resumption of vocal signals. Also. gain recovery may occur during a sibilant peak rather than after it. so that the final portion of the transient is accentuated.

To avoid this type of distortion, recovery time should be postponed until practically all of the sibilant peak has experienced gain reduction. Operating with too slow a recovery time will cause the program material to undergo prolonged gain reduction following some isolated sibilant peak, with gain restoration taking place too late to be effective against immediately occurring peaks. In general. satisfactory de-essing can be achieved if the new gain. and hence release time. is held for approximately 15 ms before it is allowed to recover. ■

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COMPLETE BOSE SOUND REINFORCEMENT SYSTEM. 1801 amplifier; active equalizer; 4 model 800 speakers; includes Formica rack mount, cooling fans, hard shell case, speaker cables. Used for store display. $1,800. Also 4 JBL 90-degree, 2 JBL 60-degree radial horns, all with 2482 drivers; all in cases. $720 pair. All for $2,000. Mortorola PZT superhorns, $7.00 each. **Custom Audio Services, State College, Pa. (814) 237-1351.**

FOR SALE: MCI JH-416 18-in/out console; latest model with large producer area; $18,600. Replacing with new MCI 528 automated console. 604Es with electronic crossovers. amplifiers and enclosures; $400 each complete; new, list $850 each. **Sound 80, Inc. 2709 E. 25th St., Minneapolis, Minn. 55406. (612) 721-6341.**

CONSOLE: Spectrasonics custom console; 24 input, 16 bus. 24-track monitor; 6 echo returns; 2 cues; 16 light beam vu meters; total of 80 slide attenuators; many gold records. looks and operates like new. Original written S/S bid: $59,080. Sell for $17,750. Photo enclosed. Financing available. Contact: **Brian, Paramount Recording Studios, Los Angeles. (213) 461-3717.**

COMMUNITY LIGHT & SOUND professional sound reinforcement products. **Brandy Brook Audio, P.O. Box 165, Seymour, Conn., 06483. (203) 888-7702.**

THE AUDIO AMATEUR: The quality constructor's quarterly teaches, publishes tested construction projects, transmission lines, electrostatics with 900W direct drive tube amplifier, electronic crossovers, mixers, preamps, 9 octave equalizers. Detailed equipment modifications, maintenance, kit reports. $7 year. Free prospectus tells all: **Audio Amateur, Box 176d, Peterborough, N.H. 03458.**

(continued)

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B.B.C. REFERENCE MONITORS, PRE-EQUALIZED J.B.L./Altec monitors; Dahlquist phased arrays; I.M.F. transmission lines; Infinity electrostatics; Crown/McIntosh 16Ω/bridged bi-amps; Scully/Revox A-700 recorders; Micmix/Parasound/Multi-Track reverbs; Eventide flangers/omnipressors; Lexicon digital delays; dbx/Burwen N.R. companders; Little Dipper hum/buzz notch filters; Cooper Time Cube echo send; moving coil Denon/Ortofon; B&O/Rabco straight line arms/cartridges; Studer/AKG/Sennheiser condensers; Beyer ribbons, U.R.E.I. comp/limiters/crossovers; Gately pro-kits; Q.R.K. turntables; White equalizers; 1000s more. **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**
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MAXELL TAPE. All widths. Write NOW and SAVE! **N.A.B. Audio, Box 7, Ottawa, Ill. 61350.**

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STUDIO SOUND—Europe's leading professional magazine. Back issues available from June '73 through June '75. $1 each, postpaid. **3P Recording, P.O. Box 99569, San Francisco, Ca. 94109.**

CENTRAL MUSICIANS' SUPPLY. Instruments and sound equipment for the professional. All major brands; sound reinforcement systems custom designed; home studio recording equipment. See our pricelist before you buy. **DJ's Music Limited, 1401 Blanchan, La Grange Park, Ill. 60525. (312) 354-5666.**

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AVAILABLE SERVICES. Milam Audio Co. specializes in every phase of professional studio wiring, from complete systems to individual pre-wired parts and components. Available from stock: patch bays, custom mic panels, multi-paired cabling and harnesses, etc. **Milam Audio Co., 1504 N. 8th St., Pekin, Ill. 61554. (309) 346-3161.**

CORNERS, handles, hard-to-find hardware, much more. Catalog, 25¢. **Headtronix, Box 31012, Dallas 7, Texas 75231.**

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DYNAMIC MOTIONAL FEEDBACK mono disc cutting systems. Complete with drive. feedback, and feedback-playback monitor amplifiers and cutterhead. All systems guaranteed. Spare cutterheads available for exchange/repair. **Albert B. Grundy, 64 University Place, New York, N.Y. 10003. (212) 929-8364.**

NEW YORK'S LEADING PRO AUDIO/VIDEO DISTRIBUTOR for audio, video, broadcast, public address, and hi-fi systems; representing over 130 audio/video manufacturers, featuring such names as Ampex, Scully, Tascam, Sony, J. B. Lansing, Neumann, Altec, McIntosh, AKG, Dynair, Crown, Shure, UREI, 3M, and other major brands; the largest "in stock" inventory of equipment, accessories, and parts; competitive discount prices; factory authorized sales, service, parts, systems design, installation. Write for free catalog! **Martin Audio/Video Corporation, 320 W. 46th St., New York, N.Y. 10036. (212) 541-5900.**

TUNED ROCK P.A.s. Customized high intensity touring/permanent installation sound systems, including narrow band (5Hz!) feedback suppression, detailed regenerative response Acousta-Voicing/environmental equalization (± 1 dB at your ears), room design / measurement / treatment ≤ 15% articulation loss of consonants; **1000s** of customized professional products, including fiberglass horns, consoles, comp/rms/peak limiters, 18 dB continuously variable electronic crossovers, digital/acoustic delays, omnipressors, flangers, reverb, echo, doubling/tripling effects, P.A. noise reduction; piezo transducers; frequency shifters from J.B.L./Altec pro, Tascam, U.R.E.I., Eventide, Gately, Studer, Beyer, Crown, Community, Mom's Audio, McIntosh, Bozak, Allen & Heath, Gauss, Cetec, Electrodyne, Multi-Track, Parasound, White, etc. All shipped prepaid/insured. **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**
Inventors/Engineers

NEW MODELS: Ampex AG440C 2-track, servo capstan motor; Scully 280B; used AG440Bs; used Scully 280, 8-track, new heads, in console, excellent condition; Sennheiser mics. Immediate delivery from stock. **Malaco Recording, Jackson, Miss. (601) 982-4522.**

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

WHATEVER YOUR EQUIPMENT NEEDS —new or used—check us first. We specialize in broadcast equipment. Send $1.00 for our complete listings. **Broadcast Equipment & Supply Co., Box 3141, Bristol, Tenn. 37620.**

MICROMIXERS—16 inputs, E.Q., monitor mix, mic pad, mute, etc. P.A. and stereo versions. Write for literature. **Gately Electronics, 57 W. Hillcrest, Havertown, Pa. 19083. (215) 449-6400.**

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FREE ROOM EQUALIZATION with purchase of 1/3 octave filters. This is **not** a misprint. **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**

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MCI . . . DOLBY. Two great names! Two great products! For authorized factory representation in the progressive Midwest, contact: **Jerry Milam, Milam Audio Co., 1504 N. 8th St., Pekin, Ill. 61554. (309) 346-3161.**

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3/M 16-track tape recorder, M-56, $14,500. Perfect. **Paul. (312) 225-2110.**

TASCAM REVERBS—$500; Tascam mixing consoles—$2,350; Tascam ½-inch recorders; $1,990; Tascam 8-track recorders—$3,490. All shipped prepaid/insured, including free alignment/equalization/bias/calibration. **Music & Sound, Ltd., 11½ Old York Rd., Willow Grove, Pa. 19090. (215) 659-9251.**

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AMPEX SCULLY TASCAM, all major professional audio lines. Top dollar trade-ins. 15 minutes George Washington Bridge. **Professional Audio Video Corporation, 342 Main St., Paterson, N.J. 07505. (201) 523-3333.**

Neumann recording console, 18 input, $14,000 (originally $35,000). Scully 8-track with remote control, can be expanded to 12 tracks, $7,000. Neumann lathe with Westrex 2-B mono system plus accessories, reasonable. Pentagon cassette duplicator, reel/cassette, cassette/cassette, $1,000. Ampex AG-500 stereo, $1,250. Ampex PR 10 stereo, $600. **Paul. (312) 225-2110.**

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Complete with plug-in Butterworth filters of your specified frequencies and with 6, 12, or 18 dB/octave attentuation; regulated power supply; bi-amp or triamp for monaural, stereo, or quadriphonic systems. Other options: electronic summer for single woofer stereo; VLF noise filters. For OEM and home builders: Series 500 and 600 Hi-pass and Low-pass filter pairs. Also regulated power supplies. Write for brochure. **DeCoursey Engineering Laboratory, 11828 Jefferson Blvd., Culver City, Ca. 90230.**

MCI input modules, $550.00 each. Tested and Guaranteed. **Paul. (312) 225-2110.**

ALTEC/H-P 8050A 1/3 octave band CRT display audio analyzer. Ideal for room equalization, $2,800. **Lewis S. Goodfriend & Associates, 7 Saddle Rd., Cedar Knolls, N.J. 07927. (201) 540-8811.**

16 x 16 CUSTOM CONSOLE, Spectrasonic components, $12,500. Four Shure M67s, four M63s, one M68, one M688 stereo mixed with four pan pots assembled as four-track console, $800. **Fifth Floor Studios, 517 W. Third, Cincinnati, Ohio 45202. (513) 651-1871.**

Copies of db

Copies of all issues of **db—The Sound Engineering Magazine** starting with the November 1967 issue are now available on 35 mm. microfilm. For further information or to place your order please write directly to:

University Microfilm, Inc.
300 North Zeeb Road
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WANTED

WILL TRADE SYNTHESIZERS for professional audio and video equipment. New Electron Farm—CBS Buchla synthesizers for: multi-track decks and electronics, amplifiers, monitors, microphones, mixing consoles, etc., video decks, cameras, monitors, etc. **Gregory Kramer, Electron Farm, 135 W. Broadway, New York, N.Y. 10013. (212) 349-0098. Los Angeles (213) 396-6339.**

WANTED: SONY ECM-22 and ECM-377 microphones. **Blue Diamond Co., Box 102C Chubbic Rd., R.D. 1., Canonsburg, Pa. 15317. (412) 746-2540.**

INTERESTED IN BUYING complete studio. Contact **Bradley Recording Company, 531 N. Howard St., Baltimore, Maryland 21202.**

WANTED, J.B.L. pro dealers to handle high end multi-channel consoles on exclusive basis. Designed to augment J.B.L. pro line of speakers and amplifiers. **Theatre Sound, Inc. P.O. Box A.Q., New Haven, Conn. 06525.**

WANTED: Studer model A-80. **Paramount Recording Studios. (213) 461-3717.**

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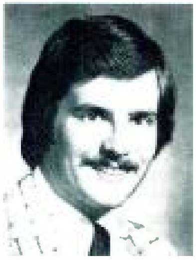
For major N.Y.C. studio, expanding staff. Send resume to **Box 11, db Magazine, 1120 Old Country Rd., Plainview, N.Y. 11803.**

db people/places/happenings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BETHUNE

• A number of personnel changes have made news at the **Koss Corporation**, of Milwaukee, Wisconsin. **Cedric R. Bastiaans** has been promoted to vice president, engineering. Mr. Bastiaans, who was formerly chief engineer at the company, came to Koss from Westinghouse. **Jeffrey T. Martin** has been named regional sales manager for the company's stereo headphone products. **Michael A. Makowski** and **Russell Wells** have joined Koss as consumer products salesmen in the midwest territory. **Dan Reep,** coming from the Milwaukee Gear Co., has assumed the position of director of industrial relations. **Joseph J. Chladil, Sr.,** previously manager of new product development, has been promoted to the position of manager of new product development and engineering.

• **Robert F. Burnett** has been named sales manager, retail market, for the Magnetic Audio Video division of the **3M Company**, St. Paul, Minn. Mr. Burnett has been with 3M since 1961.

• **Revox Corporation** and **Lamb Laboratories** of Syosset, N.Y. have put together mobile recording studios which can be rented through Revox dealers. Two sizes are available, a mini studio which contains the basics, and a maxi studio, comprising a more complex assortment of equipment. The combination can also be purchased.

• A patent for a new process, "Transcan," has been awarded to **Goldmark Communications Corp.** of Stamford Conn. Transcan optically transforms picture images recorded on widescreen motion picture film without distorting them to fit viewing windows of home television sets. The process uses a special "Panamorphic" lens developed in conjunction with **Panavision, Inc.,** of Hollywood.

• A new national American headquarters for Danish-based **Bang & Olufsen** has been established at the Regent Industrial Center in Elk Grove Village, Illinois. The new facility will house corporate offices, training and showroom facilities, as well as serve as a distribution hub.

• Two appointments have been announced by **James B. Lansing Sound, Inc.** of Los Angeles. **Bill Robinson** has assumed the position of national sales manager, consumer division, and **Dick May** is filling the newly established position of product manager. Mr. May will be responsible for new product development.

• The recent appointment of **Ed Bethune** as vice president of engineering has been announced by **Infonics, Inc.** of Michigan City, Indiana. Mr. Bethune comes from **Aleph Industries.** Infonics has appointed **Cassette Systems,** of Woodstock, Maryland, as the mid-Atlantic regional service center for Infonics tape duplicator equipment.

• Trundling through the Colorado Rockies is a truck, bearing a complete mobile recording studio, an affiliate of **Road Runner Recordings,** based at Evergreen, Colorado. The mobile unit is available for 4-16-track recordings on location.

• **Joseph S. Tushinsky** of **Superscope, Inc.** was honored recently at the second Audio Hall of Fame awards dinner held in Los Angeles. Sponsors of the dinner were **Time, Audio Times,** and **Stereo Review magazines.** Proceeds of the dinner went to the City of Hope.

• **Richard P. Goodwin** has been appointed plant manager of **National Tape Service** in W. Caldwell, N.J. National Tape Service is a subsidiary of **RKO General** of New York. Mr. Goodwin was formerly project engineer for **Mastro Industries.**

• **Audio Magnetics Corp.,** of Gardena, Ca., has announced the promotion of **Mary A. Keller** to the position of vice president of industrial relations. Ms. Keller's responsibilities will focus on labor relations. She was previously associated with **Transcontinental Music Corp.**

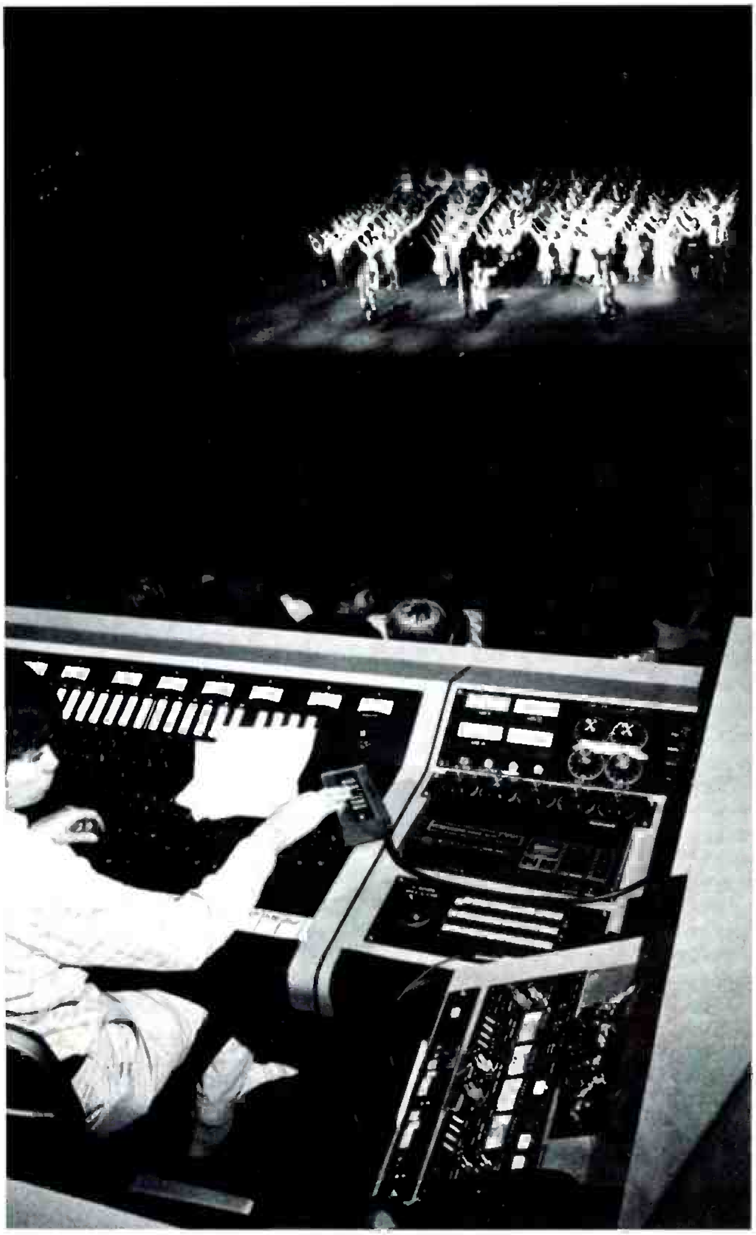
• **Juan C. Gregorio** has joined **McMartin Industries,** Inc. of Omaha, Nebraska. Mr. Gregorio will be involved in the development and design of new a.m. and f.m. broadcast transmitters. He comes to McMartin from **Sparta Electronic Corp.**

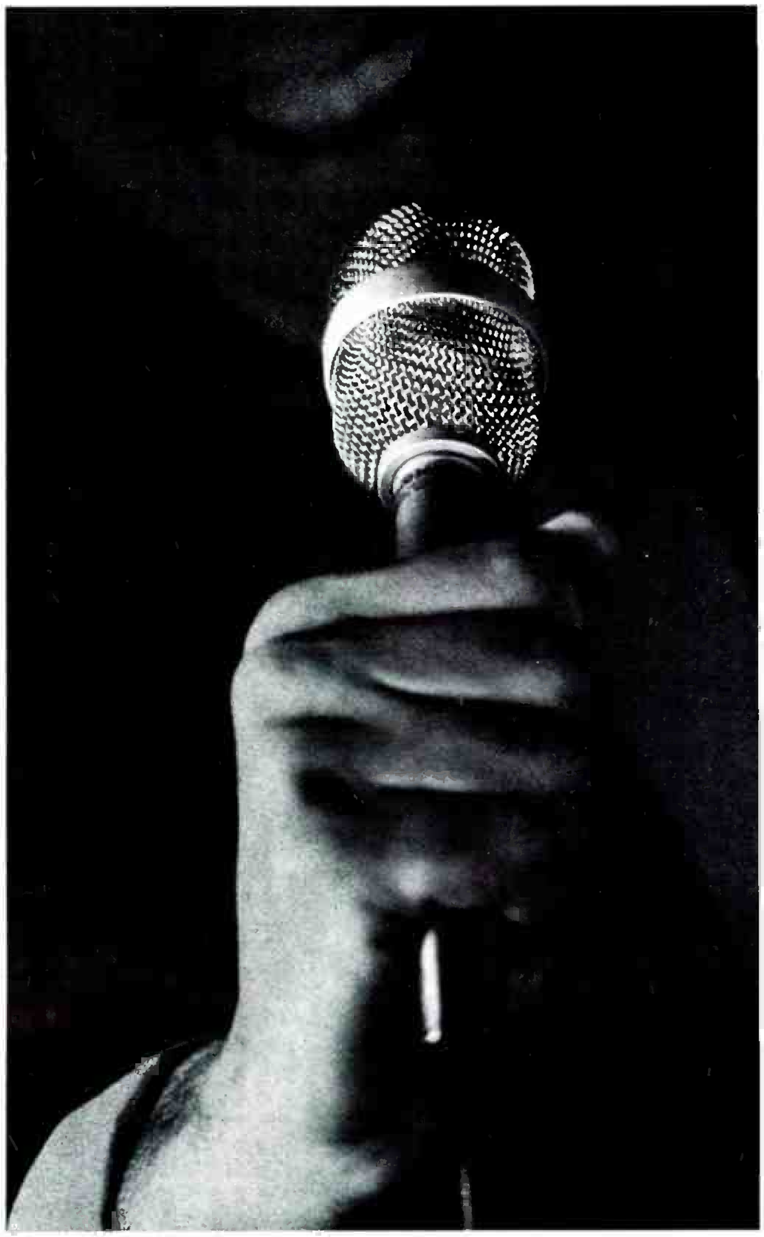
• **Frank Rush** has been appointed as senior field sales engineer in broadcast video sales for the **Ampex Corporation.** Based in Bethesda, Maryland, Mr. Rush will handle the territory of Pennsylvania, Maryland, District of Columbia, Virginia, and West Virginia. **Rollin Stanford,** based in Hackensack, New Jersey, will succeed Mr. Rush as sales engineer for distributor products.

• A new head office and laboratory has been opened by **Dolby Laboratories, Inc.** in San Francisco at 731 Sansome St. The new telephone number is (415) 391-8892. This facility will replace the New York office, which has closed out, and also encompass some of the functions of the London office. The new office will handle research and development, new market development, licensing and U.S. sales. San Francisco executives will comprise **Dr. Ray Dolby,** president; **David Robinson,** vice president, engineering; **Ioan Allen,** vice president, marketing; **Ian Hardcastle,** vice president, licensing; and **John Gladysiewicz,** vice president, finance and administration. **George Schowerer,** operating from New York, will supervise East Coast Dolby projects.

• A ranch-ype building in the lush Mother Lode country of Northern California serves as the new headquarters for the **Herold Broadcasting Company** (KVML/KROG), of Sonora, Ca. The station beams to territory made famous in Gold Rush days, fabled Tuolumne, Calaveras, and parts of other adjacent counties.

• PSI Industries of Rye, N.Y., a new corporation owned prinicipally by **S.A. Nastro,** has purchased **Preferred Sounds, Inc.** from **Longine-Wittnauer. Jerry H. McPherson** will serve as president of Preferred Sounds. Vice-president of marketing is **John W. Barry,** coming from the **Infodex Cassette Corp.**





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The Model 5,

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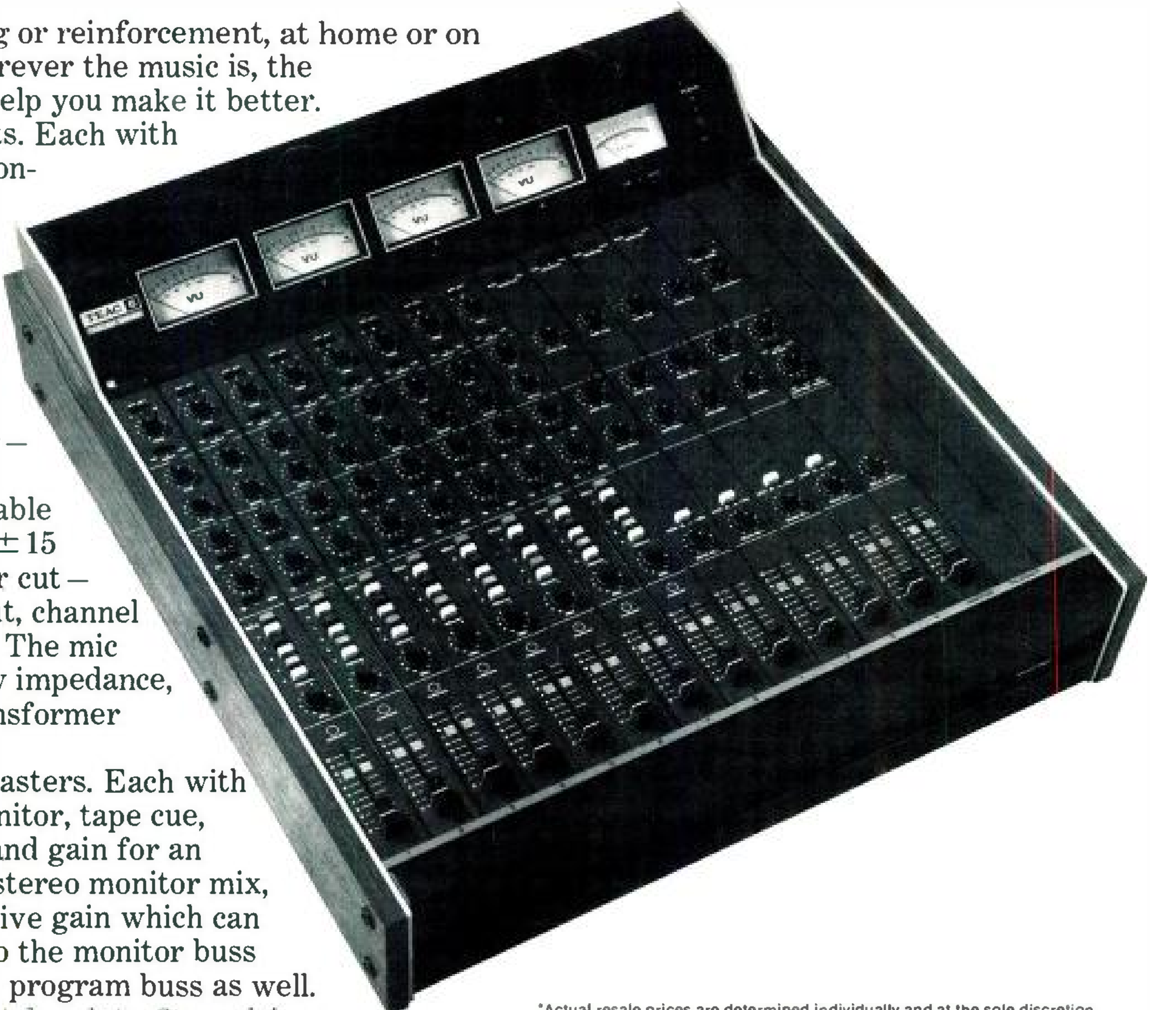

For recording or reinforcement, at home or on the road, wherever the music is, the Model 5 can help you make it better.

Eight inputs. Each with attenuation controls, LED overload indication, two foldback sends—one before and one after the EQ and fader—two bands of EQ—4 selectable frequencies, ±15 dB of boost or cut—solo, direct out, channel assign & pan. The mic inputs are low impedance, balanced, transformer isolated.

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Fully modular, portable, and quiet (the equivalent input noise is 125 dB). So if you have more talent than money, check out the Model 5 at your nearest TEAC Tascam Series dealer. Just call toll free (800) 447-4700** for the name and location of the one nearest you.
**In Illinois, call (800) 322-4400.

*Actual resale prices are determined individually and at the sole discretion of authorized TEAC Tascam Series dealers.

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