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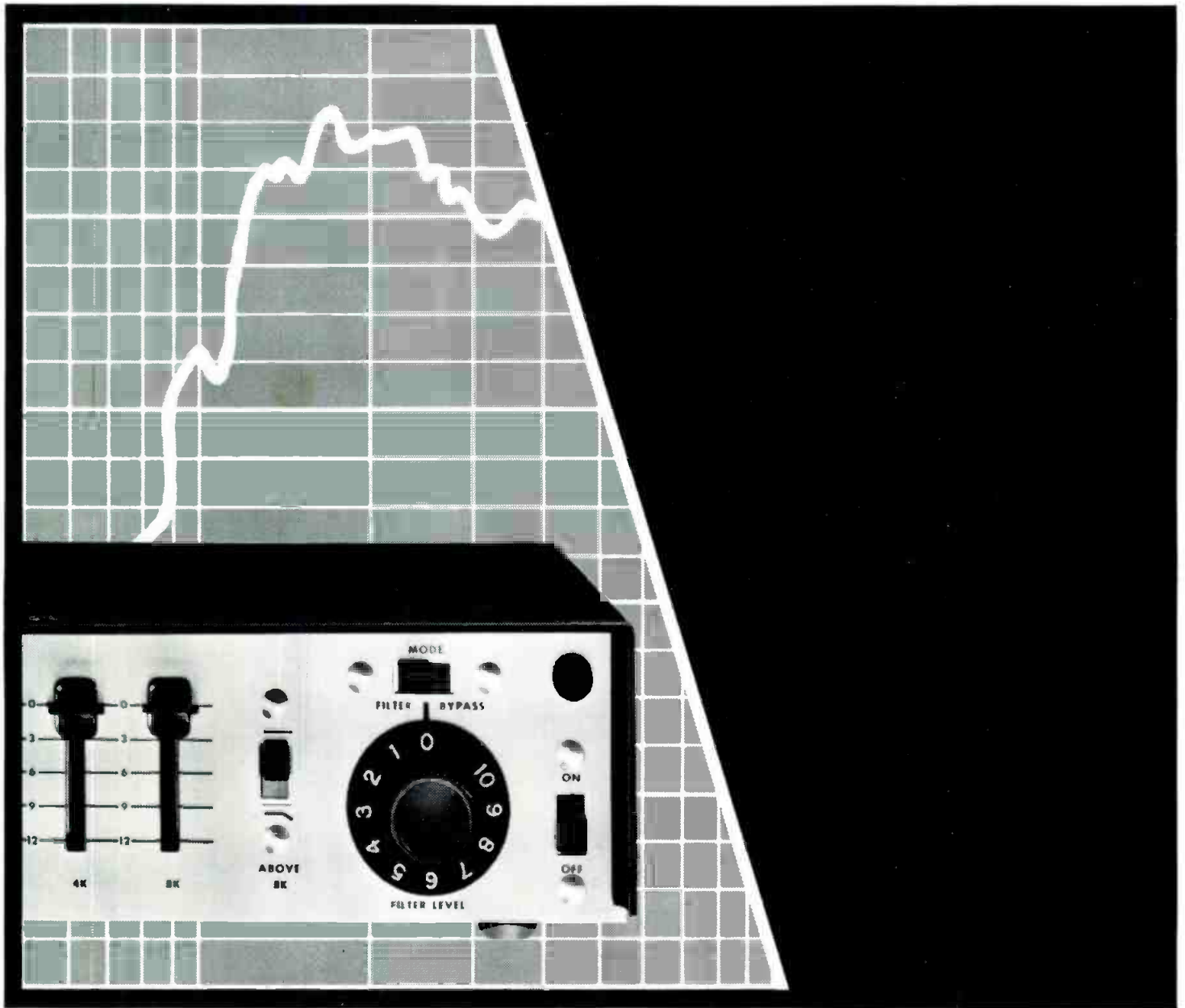
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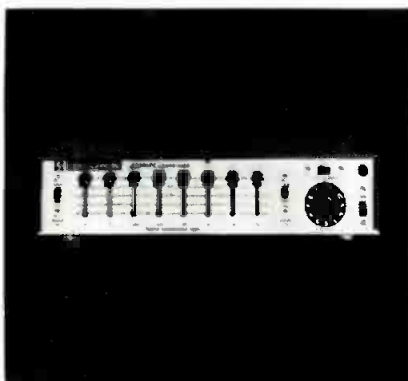
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COMING NEXT MONTH

● Don Davis will conclude his two-partner on Impedance begun in this issue. Start it on page 38 and finish it in the May issue. It is a definitive statement on the perplexing problems of impedance and impedance matching.

We came back from the Audio Engineering Society's 47th Convention and Exhibition held in Copenhagen, Denmark with pictures and an interesting story on what's happening in European audio. A sidelight trip from the Convention took us to the Orto-phon laboratories where disc recording equipment is manufactured as well as the plant in which this company makes its phono cartridges. This will be the subject of a *db* VISITS in addition to the AES report being prepared.

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

ABOUT THE COVER

● The woodcut depicted is part of a series of 137 old German woodcuts entitled the Triumph of Maximilian. The series celebrates the dreams and aspirations of Emperor Maximilian 1459-1519. Mindful of the energy shortage this caravan is getting an early start for Los Angeles.



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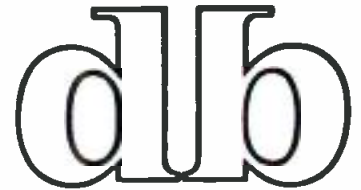
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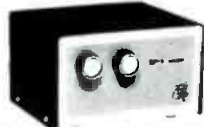


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letters

The Editor:

Gilfoy Sound is extremely fortunate in having two Studer tape recorders, a B-62 in portable case and an A-80 in console. Both of these machines were purchased last year from Gotham Audio Corporation, who has been the sole importer of Studer for many years. Over these years, Willi Studer has grown tremendously and as of January 1, 1974, Studer opened its own sales and service offices in the United States, Willi Studer of America, located in Depew, N.Y., a suburb of Buffalo.

Now Studer is well known for its standard of quality, but as luck would have it, our A-80 developed a cold solder short in the head nest about three weeks ago. We called Steve Temmer at Gotham and he advised us to send the heads directly to Studer of America for service. By the way, this set of heads were of the wider gap European standard type which affords better s/n ratio but is not standardized with American machines. We didn't hear anything for the first few days after sending the head stack off airmail-special-handling. Indeed, we found out that the post office was somewhat slower than they should have been. In the meantime, our main mastering machine sat gathering dust here in Bloomington, Indiana, which is a long way from any kind of professional help!

Last Saturday, my chief engineer, Mark Hood, got a call from Bryan Tucker, the Studer representative in Chicago. Mr. Tucker announced that he and Bill Woods, president of Studer of America and Bruno Hochstraser, Studer engineer, were ready to climb into the Studer private plane



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and fly to Bloomington, Indiana to get our machine back in operation immediately. Bryan also asked if it would be all right to install a new head stack, made to American specifications.

Two hours later, the three men from Studer landed at the Bloomington airport and were driven to my studio without any sightseeing delays. And only two hours later, the Studer gang was on its way home and Gilfoy Sound was back in operation. Indeed, this kind of service, stemming from well-founded pride and reputation, deserves full credit in the recording industry. One funny sideline—engineer Hochstraser did a great deal of muttering of technical stuff, in Swiss-German, of course. None of us could understand that German, but I am convinced that the Studer A-80 knew every word.

Jack W. Gilfoy
Gilfoy Sound Studios, Inc.
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STANTON

John M. Woram

THE SYNC TRACK

● Each year at this time, *db* seeks to expand its horizons somewhat, to cover some aspect of the audio scene beyond the confines of its usual format. It would be hard to pick a more appropriate topic than that curious psycho-electronic phenomenon known popularly as the Watergate Syndrome.

For years, musicians and producers argued that advancing technology encroached on the creative process. For just as many years, technologists have claimed this was not so; that technology was merely a tool, placed at the disposal of the recording art.

In the light of current events, there seems to be little point in continuing this fiction. Obviously, technology *is* taking over the creative process, and, in the highest circles, may have already taken over completely. Fortu-

nately, there is a remedy for the problem, which will be described later.

Consider the tape recorder for example. Years ago, an untrained operator could put some tape on a machine, press the record button, and not have to worry about what would happen next. Then came stereo, and later three-, then four-track recorders. Some skill was now required, but the operator remained master of the machine.

But as multi-track technology evolved, perceptive observers began to sense that something was not quite right. At times, the machines actually seemed to be taking over. Unexplained clicks and pops would appear on the tape as the record button was pressed, or when the machine stopped. Sometimes, tape speed would decrease

toward the end of a reel, indicating that the machine was conducting its version of a slowdown strike.

Still later, sophisticated logic circuits began appearing in many machines, but, as any honest technician can tell you, these circuits are rarely influenced by the wishes of the operator. Instead, the machine functions according to the whims of some overheated i.c.

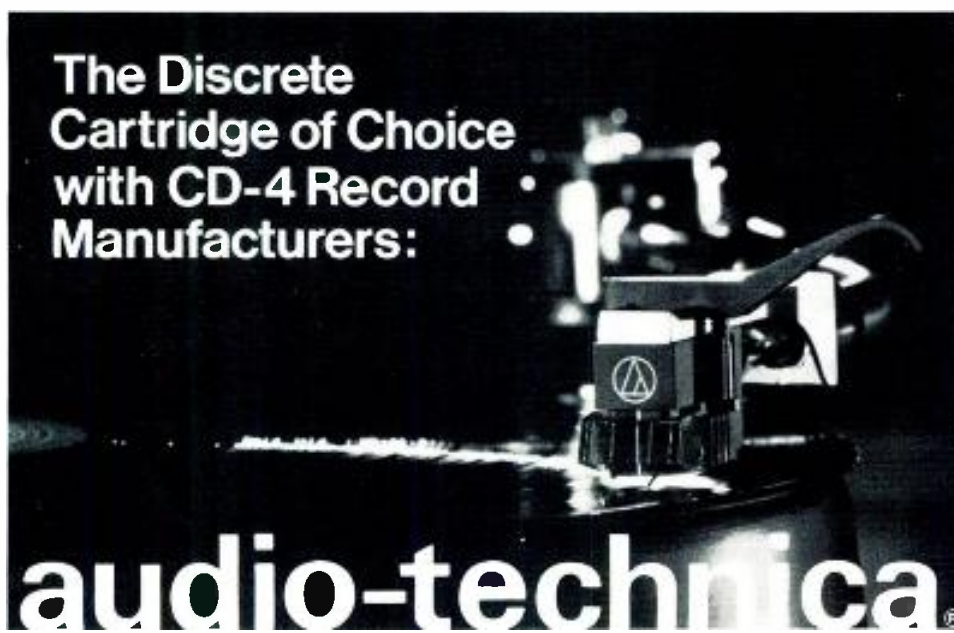
At least one manufacturer claims he actually doesn't want to build these elaborate circuits into his product, but that his automated circuit assembly device is self-programming and beyond his control. Moreover, of the few design engineers left on his staff, none recall how to wire a switch so that it will start and stop a machine in the old fashioned manner.

According to a recent report, one multi-track studio is doing quite well by operating its latest tape recorder as a game of chance. For a dollar, clients are invited to press a button and guess what the machine will do. The studio is making a fortune.

One would think that the White House would step in with some sort of appropriate legislation to prevent things from getting out of hand. After all, since the President seems to be such a devoted amateur tape recordist, we might reasonably look to him for guidance.

Here, we come to crux of the Watergate Syndrome, for it appears as though the President himself is an innocent victim of the dreaded "Woods' Hole Effect," a devastating side effect of Watergate. Tape experts are well acquainted with this apparently uncontrollable phenomenon, in which recorded messages are mysteriously erased without human intervention. Even more baffling, the authorities are at a loss to explain why these erasures only occur during the more significant portions of the recorded program.

Worse yet, to the layman the erasures may appear to have been deliberate, thereby casting unfair suspicion on anyone known to have been near the suspect tape recorder. However, the truly objective enquirer will soon realize that Woods' Hole is completely beyond the control of man, since the erasures invariably occur well into the program. An erasure at the beginning or end of the tape might be ascribed to operator error, but when the lost segment is somewhere towards the middle of the program, it must be either a manifestation of Woods' Hole, or an intentional wipe-out by an unscrupulous person. Since the President himself has assured us, "I'm no crook!," the Woods' Hole Effect is



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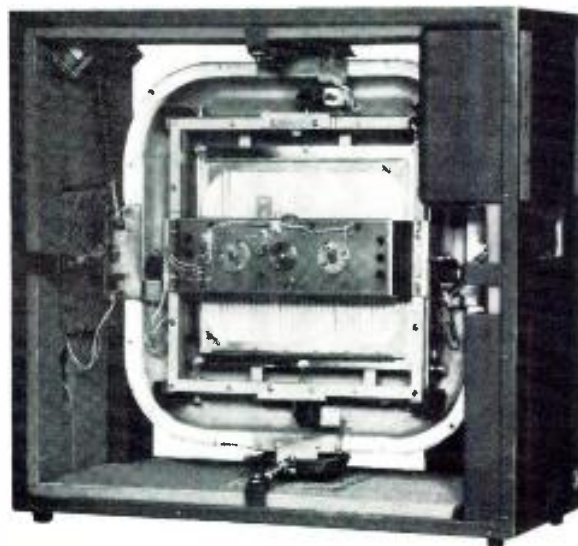
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therefore the only other possible alternative.

Fortunately, as mentioned earlier, there is a remedy—if not a cure—for the problem. Simply record all important programs, such as presidential wire taps, on several machines simultaneously. Since it is a well known fact that this curious phenomenon will not manifest itself on two machines at the same time, the continuity of programs—especially those essential to the nation's interest—will be guaranteed.

It is, of course, beyond the scope of this report to describe why it is so important to record private conversations, since this a scientific journal and, as is well known, morality has little relevance to science or politics. (For further study on this point, the reader is referred to his morning newspaper.)

In any case, once we agree that the tape recorder is our friend, we may come to appreciate in time that two tape recorders are even better friends, and so on. And, when tape recorded conversations eventually become an important part of the American way of life, we may find that we actually enjoy a greater degree of privacy than at present. This should be obvious to anyone who thinks about it.

To explain, secretly-recorded conversations are like any other novelty record. Everyone wants to hear one, possibly two, but as Mr. Nixon might say, "When you've heard one, you've heard them all." And he should know.

So, by publicly recording everything in duplicate, the novelty aspect will soon wear off, and instead of having thrill-seeking committees demanding even more tapes, it will become increasingly difficult to get anyone's attention with a hot tape. By and by, no one will listen to anything, and our privacy will once again be assured.

By saturation recording, the Woods' Hole Effect will become an insignificant problem. And, the increased demand for tape and tape recorders will create more jobs within our industry.

As an aside, the vendor who wins the White House account will have an unprecedented advertising advantage. Think of the market potential of a noise reduction system, "as used in the oval office". Of course, the dignity of the office of President would not permit higher endorsements, but perhaps Mr. Nixon could be prevailed upon to discuss his favorite editing techniques at an informal luncheon for studio owners interested in contributing to a fund to rewire the White House for quad.

As an interesting sidelight to the Watergate Syndrome, the President points the way to a sweeping re-assess-

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ment of the art of criticism, specifically, the record review.

We have all read reviews in which the critic finds fault with the artist's interpretation. The critic, being a respected authority, will inform us that the artistic rendition suffers from one shortcoming or another, and we are all very much wiser for having read the review.

Now, Mr. Nixon has shown us that it may indeed be that the critic's own interpretation may be at fault. In describing his very own recorded work, the President revealed that although he certainly knew what he meant

when he said what he said, other people might think that he meant something else when they in turn hear what he says that he said.

Could anything be more clearly put? As the nation's number one critic, Mr. Nixon's word is certainly unimpeachable. (?—*Editor's Note*). So, the implications are clear. As a recording artist, Mr. Nixon *knew* what he meant, even if there is not another man in the Nation's Capitol who would interpret his words in the same manner.

Now then, if there is no one within the entire U.S. Government who can

make the proper sense out of a simple recorded conversation, how shall we expect a mere record reviewer to comprehend what an artist intended in performing a piece of music?

Clearly, the very concept of the record review must be re-examined in the light of Mr. Nixon's recent enlightening thoughts.

We shall look forward to more instructive thoughts from the President, and perhaps in time he could be prevailed upon to publish a little blue book of Presidential Perspectives that would serve as an inspiration to us all.

As a study guide for those seeking additional background information for a better understanding of the Watergate Syndrome, the reader is referred to an early paper by the researchers Gilbert and Sullivan, entitled, "Things are Seldom what they Seem." And in the meantime, dedicated researchers continue to probe the mysteries of the Watergate Syndrome, and it is hoped that, in time, our tape machines will all be returned to normal. Happy April! ■

Midwest Acoustics Conference

At the eighth annual Midwest Acoustics Conference to be held May 18 at Northwestern University, in Evanston, Illinois, experts in tape and disc reproduction will discuss the future roles of tape and disc reproduction. Impartial judgement criteria will be developed by speakers whose affiliations permit obvious objectivity: Ernest Schonthal, of Bruel & Kjaer, will speak on *Amplitude and Spectral Characteristics of Music from the Standpoint of the Concert Listener*. Well known scientist-musician Marvin Camras, of IIT Research Institute, will expose the *Critical Parameters of a Music Program Record Playback Medium and One's Sensitivity to Deviations from the Ideal*.

Current disc and tape performance and quality levels will be explained by John Bitner of Wakefield and Douglas Thornton, Maniton Systems. Panel discussions, which will be open to audience participation, will also include technical representatives from the principal manufacturers and patent holders of noise reduction systems, tape and disc record and playback systems, as well as independent consulting engineers. An unusual feature of the conference is the expected disclosure of a state-of-the-art advance in disc recording. A variety of disc and tape equipment will be displayed and demonstrated at the sessions. Advance registration is \$4.00. Write Midwest Acoustics Conference, c/o H. Messerschmidt, Western Electric Co., 4513 Western Avenue, Lisle, Illinois 60532. ■

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Norman H. Crowhurst

THEORY AND PRACTICE

● In my letter responding to John Pritchett's in the January issue, I complained about one particular facet of the problems in American education: that educators always believe they are

in possession of all possible alternatives. If you work at handling audio for educators, converting instruction to the mediated form, you undoubtedly know what I mean, only too well!

A while ago I made a report, investigating an "excellent" project that spent three million dollars of tax money producing a single multi-media course to replace conventional material taught by instructors. I can only presume that the measure by which it was rated excellent was its power to absorb three million dollars. Anything costing that much must be good!

The course contained sixty lesson-sized segments. As a development project, the aim was to put the contents of the course into a variety of media, including audio tape, video tape, and single-concept films, in addition to more conventional self-study texts. As part of the experiment, the students also listened to a lecturer. The project was committed to supplying, as one of its purposes, research data to determine what relationship exists between the choice of medium used, student preferences, and the resulting rate of learning.

To educators, the fact that material is being used for research constrains them to not change anything because they fear any variation in content influenced by the nature of the medium might invalidate data about the relative effectiveness of the media involved. For example, at one stage a professional t.v. newscaster hired to do the videotape mediation was instructed to read the subject matter in a monotone. This direction was based on the hypothesis that a student limited to reading self-study text has no indication where emphasis should be placed, so he should not have any when he watches someone read the same material on t.v.!

If the reading of text is to be the only mode employed, when such a flexible medium as t.v. is available, I'd rather have Orson Wells read it to me, any day, than someone who leaves out all the emphasis and pauses. How about you?

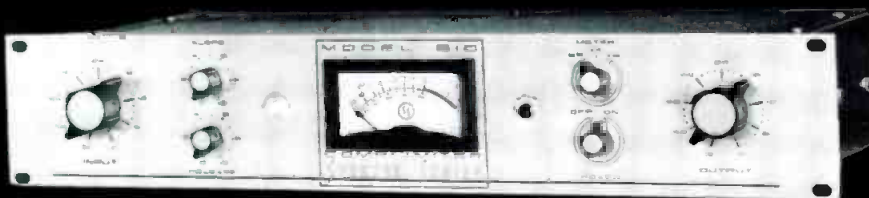
Watching people at this project, arduously insuring that nothing changed but the medium, a contrast in my memory came to mind: a film shown at a professional society meeting, right after World War II. This was an animated film put together by Disney Studios for training men in the forces in the use and maintenance of radar and electronic guidance systems.

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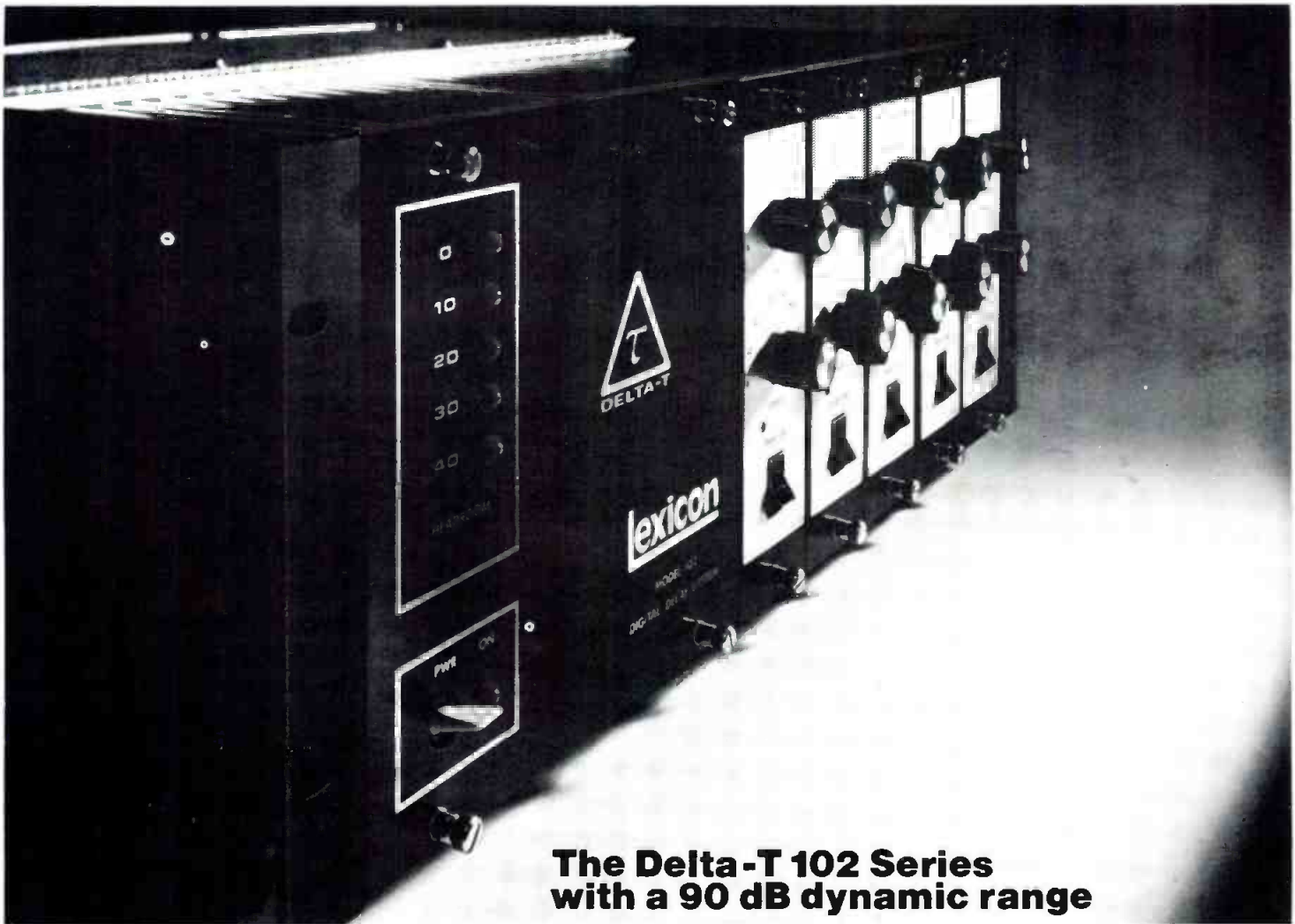
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this remarkable piece of animation started from knowing nothing about what voltage and current are, to a conclusion which had developed a pretty good basic concept about the different ways in which electromagnetic systems can be applied to navigational guidance. How long do you think that would take in conventional classes?

About a year ago, I met a man who had trained with that film during World War II. He still remembered it as vividly as the day he saw it. Could you say as much for classroom instruction?

While viewing the project of which I am speaking, I thought about how the same kind of thing could be done today. In those days, Disney's artists must have spent thousands of man-hours putting it together. Nowadays, modern video techniques could create the same kind of thing, almost as fast as a good, creative instructor could dream it up.

So why isn't that kind of thing being done? Many media installations at our institutions of higher learning possess highly sophisticated equipment, the use of which is usually limited to providing "artistic" fades and pans of the instructor while he merely presents the same old stuff that has been used for "centuries!"

With all that expensive equipment available, why could not its sophistication be used to *create* something that contributed usefully and particularly to the learning process, rather than merely making the presentation look more like something you might see on commercial t.v. at its dullest?

These "media specialists" usually take some existing text on the subject to be converted, then work on how each bit can be handled to put precisely the same piece into media form. They have been indoctrinated into a very specific notion of *reinforcement*, in which the student is subjected to hearing and seeing the same set of words simultaneously. You've seen it done on *Sesame Street* and similar programs.

A common technique the mediator uses is to give the student visuals on paper, in the form of beginnings of sentences he will hear on the audio. He is then expected to stop the audio and copy down the rest of the sentences. This is merely a translation of the inferior process that most teachers use all the time, whereby the student learns to respond correctly without understanding a word of it!

Some time ago, we reviewed a piece of instruction about complex numbers. While the audio read from a textbook, the visual presentation ex-

posed successive parts of the same page. Imagine how boring it was to listen to the product of $a + jb$ into $c + jd$ multiplied out, a step at a time. The student could do that much better from a book, if it must be presented that way at all. These mediators showed no imagination whatever!

I would have to presume, without evidence to the contrary, that these mediators knew nothing about complex numbers. Worse, they did not want to know. They merely had a chore to do: get that damned stuff mediated!

So what could you do, if you were involved in something like that? What if you didn't know the subject either? It is very helpful, whether or not you know the subject, to try to put yourself in the position of a student. If you are going to help others understand something, first you must understand it yourself. So the first thing to do, in preparing any instructional material, is to instruct yourself.

Why don't educators do that? I could theorize about that, but it would not help. But it is no use saying, as most educators do, "That is the way it's always been taught. Those who 'get it' do, those who don't, don't."

What stops many who work on such projects, is that not knowing what it's about, they are afraid to show their ignorance. So they allow the same process to go on, to cast the poor students' ignorance in concrete! Realize this: if you don't know it, you are in an ideal position to imagine yourself a student, who doesn't know it either—that is why he needs the instruction!

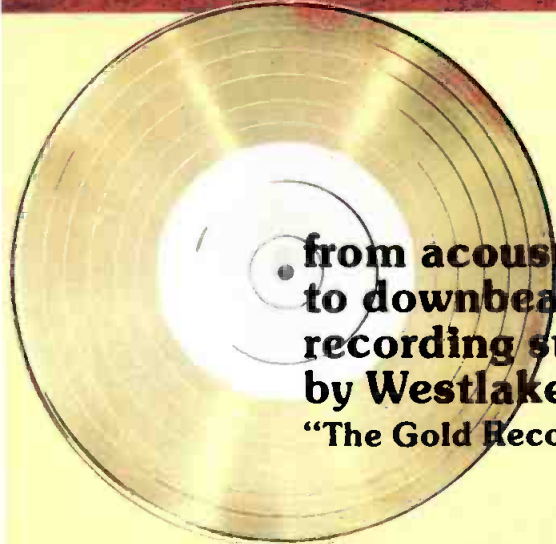
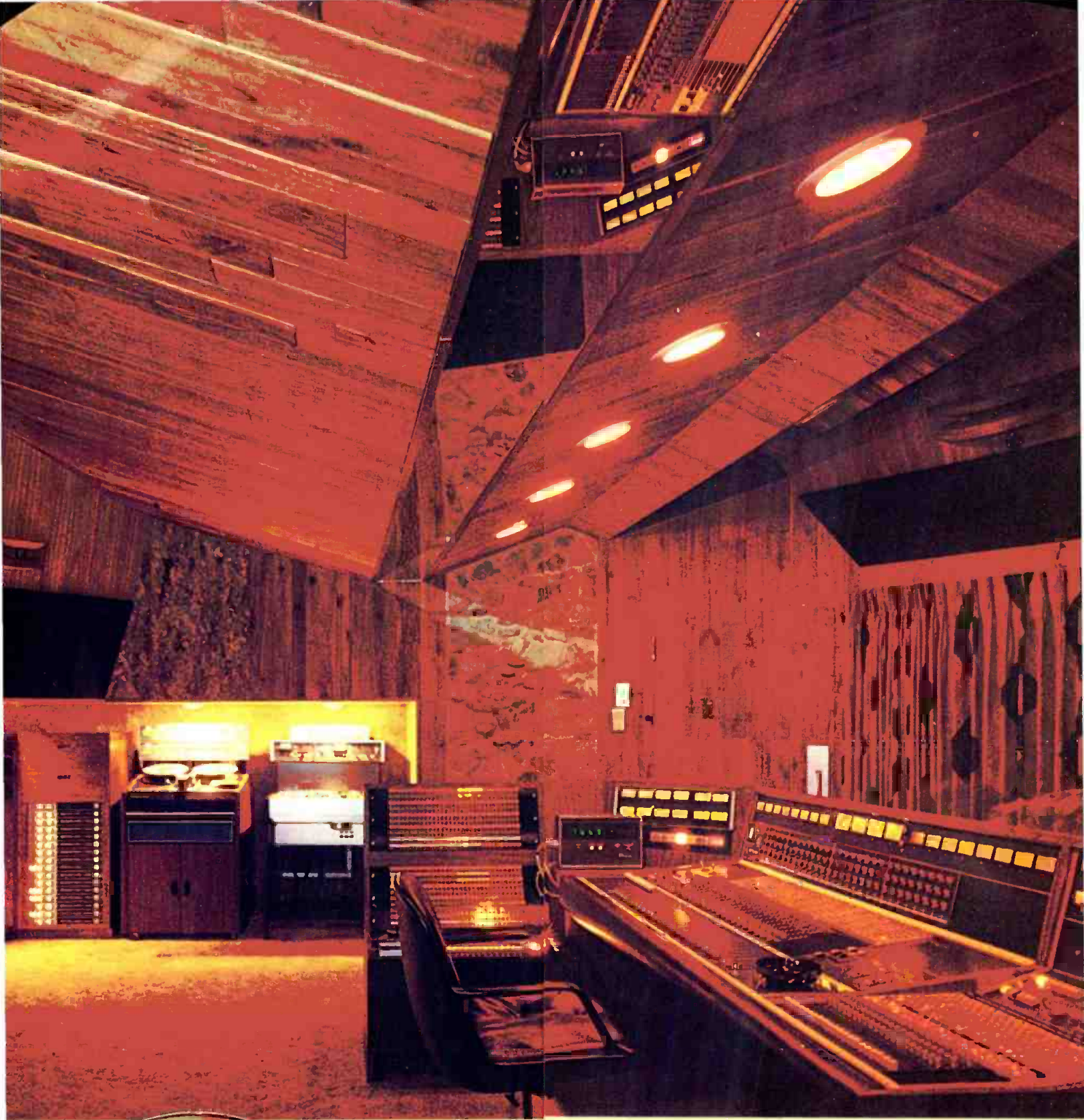
So you find out what it's all about. What is it you do to achieve that? That is what the student will probably need to do. Your job is to find a way to facilitate that happening, with the media.

Never think of yourself as "just the audio man." Think of yourself as part of a creative team, whose job is to turn out the best possible instructional material. Then you can inject your concerns by suggesting to others on the team, "If I were a student being expected to learn this . . ."

If you show interest and start making such suggestions, any group worth their salt will see, almost immediately, that it would be better to put out material that will do a superior educating job, than merely to "translate" existing material into mediated form, usually losing something in the process.

To turn out superior material requires that all involved know the objectives of the unit being put together. Each should find that out for himself.

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Then a production conference would be in order, an idea generating session, the more informal the better, at this stage.

This will release everyone engaged on the project (although it may take some quite a while, because they have lived in their cocoons for so long) from the inhibition that confines each to merely doing his job. This confines him to merely following rules about the kind of visual appropriate, the speed of the audio, and all that jazz, while giving no attention whatever to the process that may be going on in the student's head!

It helps if you have someone who knows the subject the unit is intended to teach. But do not assume, if no one does, that therefore you can do nothing but "translate!" You, too, can learn, and you'd better, if you want to produce something by which others can also learn.

If you stumble over statements in the text from which you derive this instruction, of which you cannot make sense, *never* assume that the student will know what it means! That it is in print signifies that the author *may* have known what he meant. Maybe no student who ever studied that book ever understood that piece. So why be so stupid as to religiously translate that piece of incomprehensible matter into mediated form?

As a technical writer, one piece of philosophy has contributed to my success: if an editor, first, or any reader, second, does not know what I mean, then I have not said it plainly enough! That seems obvious, doesn't it? Yet you'd be surprised how many authors will want to argue such matters. Some authors will argue that they said it perfectly plainly for any normal person to understand. So the editor or reader who doesn't must be stupid.

If someone has difficulty with it, most likely it needs changing.

You may not always have time to wait for editor or reader reactions before you rewrite. An excellent discipline that may save the need for that, is to write your material, then set it aside for a day, a week, or a month—the longer you can spare, the better. Then take it out and read it again, carefully.

You will discover that the art of putting of words on paper possesses no intrinsic magic. You may find that something you wrote, not so long ago, requires you to stop and think about what you meant. Whether you have to stop only a moment, or perhaps for longer, the fact that you need to think at all, should provide you with a clue: that piece probably needs rewriting.

Of course, at times you may say

something designed to make your reader think. Okay—we hope so! But be sure that you say it plainly enough, so his thinking will be devoted to pursuing the thought you intended him to, not to trying to find out what you meant!

The same disciplines that guide a writer can help in putting together instructional materials. I have found them tremendously helpful in the work I have been doing with Educational Research Associations. In that case, I happen to be the writer. But I welcome comments, questions or criticisms from the audio man, or from anyone else. And if I'm working with a team that doesn't want that kind of help, there are others that welcome it! ■

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Mfr: Broadcast Electronics

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Mfr: Instrument Systems Corp.

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Mfr: Burwen Laboratories

Price: \$85.

Circle 57 on Reader Service Card



INDIVIDUAL MICROPHONE CHANNEL EQUALIZER



● The degree of equalization of the bell shaped response of Model 3000 is individually selectable in twelve discrete steps from -12 dB of dip to $+15$ dB of boost on Model 3000. The unit has three independent overlapping frequency ranges, 50 Hz to 500 Hz; 300 Hz to 3 kHz; and 1.5 kHz to 15 kHz—each with its own continuously variable center frequency and bandwidth controls. The equalizer also has voltage controlled equalization in-out switch and a led indicator for use with automated programmers. *Mfr: Modular Devices, Inc.*
Price: \$325.

Circle 58 on Reader Service Card

TELEVISION AUDIO CONTROL



● Additional functions and controls designed for television use have been added to this manufacturer's recording studio console, with the special designation of Model 1204-TV. Features include eight monitor muting switches to help prevent feedback from studio microphones; direct feed switching which bypasses the bus assignment and output sections of the console, permitting it to be utilized for production work while the station is on the air; two special input channels, each accepting eleven line-level pushbutton switchable sources. Inputs may be instantly switched from vtrs, film chains, cassettes, turntables, or remote lines. There are four mixing buses, which can be used for simultaneous development of different mixes. Other features include stepless conductive plastic faders, redundant power supply re-set and indicator system, and echo chamber send available on each input channel.

Mfr: Cetec, Inc.

Circle 59 on Reader Service Card



The new Revox A700 — \$1695
we couldn't make it cheaper
we couldn't make it better

Circle 29 on Reader Service Card

ELECTRONIC TUNING FORK



● Integrated circuits have made possible the compact size of EMT-117TS tuning fork. The self-powered hand held device with a self-contained loud-speaker emits an oboe-like tone tunable precisely in one Hz steps from 435 Hz to 445 Hz. The unit has a connector which allows external 9V powering and which feeds the audio signal to larger speaker systems when required.

Mfr: *Gotham Audio Corp.*

Price: \$370.

Circle 55 on Reader Service Card

HIGH RESOLUTION 180 mHz FREQUENCY COUNTER KIT



● A phase-locked frequency multiplier makes it possible for IB-1103 frequency counter to read to 180 mHz with a high resolution. Pushbutton selection permits multiplication by 1 (direct), 10, 100, or 1,000. An input frequency of up to 10 kHz can be measured down to 0.001 Hz. A temperature compensated crystal oscillator generates the base, and three pushbuttons provide 1 millisecond, 100 millisecond and 1 second gate times. Input sensitivity is 50 mV to 120 mHz and 100 mV to 180 mHz. A rear panel switch permits bypassing the internal oscillator to allow use of any external time base up to three volts. Cold-cathode display tubes provide 8½ digit readout with range lamps for mHz, kHz, and Hz. Indicators are provided for gate, over-range, and unlocked operating conditions. The manufacturer estimates time needed for assembling as about seven evenings.

Mfr: *Heath Company*

Price: \$379.95.

Circle 56 on Reader Service Card



We've been hiding our light under a bushel —

● C1616/C2424 CONSOLE

A year ago we studied the other two low cost recording consoles and we built a unit without their shortcomings. We also put in a few extra goodies, like semi-parametric equalizers on each input. We have installations in Atlanta, Washington, Wilkes-Barre, Denver, Lancaster, and more coming. Compare before you buy your new console. Circle 15 on Reader Service Card.

● MOM'S WHOLESOME AUDIO MICROMIXER

If you're into PA or stereo recording requiring lots of inputs with EQ and reverb, you might want to look into our MicroMixer. Circle 16 on Reader Service Card.

● ORTOFON DISC CUTTING EQUIPMENT

With installations in Nashville and Chicago, Ortofon has really got their thing together. Write or call for more information.

● SCHOEPS MICROPHONES

We've got some new hand held condenser microphones — both cardioid and omni patterns — that are absolutely pop free. Circle 17 on Reader Service Card.



GATELY ELECTRONICS, Inc.

57 West Hillcrest Ave.
Havertown, Penna. 19083
215-449-6400

1907 Division St.
Nashville, Tenn. 37203
615-327-1746

Circle 17 on Reader Service Card

DIGITAL AUDIO DELAY LINE

● With a single audio input, up to 499 milliseconds of 12 bit quantized audio delay may be routed into a maximum of five outlets with TM 499 digital audio delay line. The time machine offers integral low-level muting circuitry, pre- and de-emphasis equalization, and input compression. It is capable of providing from 0 to 499 milliseconds of selectable one millisecond delay increments. 60 millisecond delay circuit cards with a front panel indicator can be built up along with the requisite output channels. The delay and output modularity allows a specific "building block" approach. The components are packaged in a totally modular mainframe, occupying 5¼ inches of rack space.
Mfr: Quad/Eight Electronics
Price: \$695-\$3,495.

Circle 38 on Reader Service Card



LARGE-MOULDED STRAIGHT HORN



● A 240 Hz flare rate gives EC 250 horn pattern control down to 400 Hz. The horn, for 1¾ inch x 18 inch threaded drivers, can also be used as an HF unit with folded bass horns. Dispersion at 1 kHz is 45 degrees H x 30 degrees W.

Mfr: Community Light & Sound
Circle 40 on Reader Service Card

RADIO PAGING RECEIVERS



● This tiny receiver, weighing only six ounces, can be carried in a pocket. CR, designed to be used with Page-master components, emits a beep when an assigned code is transmitted. Up to 1,100 units can be serviced within the transmitting area. The unit features silicon transistor circuitry and a contactless mechanical filter which insures triggering only at the coded signal. Circuitry is crystal-controlled superheterodyne a.m. It is powered with a long life mercury battery.

Mfr: Lear Siegler, Inc.

Circle 45 on Reader Service Card

TITANIUM-BONDED STYLUS



● A new economy version of the Shibata stylus, for use in the playback of discrete four-channel records utilizes a titanium bonding technique. The new tip requires less square rod diamond material than the present stylus, yet is reported by the manufacturer to exhibit the super lapping and fine polishing of the more expensive full nude diamonds. It is hoped that this new process will be reflected in quality economy cartridges.

Mfr: JVC America, Inc.

Circle 46 on Reader Service Card



The New Revox A700 — \$1695
turn your dreams into reality
at your nearest Revox dealer

Circle 29 on Reader Service Card

HIGH FIDELITY TRANSDUCER



● Using a crossover network and spectral balance switch which permits three repeatable spectral energy profiles, Model LST-2 permits the user to select the energy output best suited for room acoustics and program material. According to the manufacturer, the geometric design of the cabinet, along with the characteristics of the drivers in the three planes results in uniform dispersion at all frequencies. Included in the unit is a ten inch suspension woofer, three 1½ inch mid-range hemispherical dome radiators, and three ¾ inch hemispherical dome tweeters.

Mfr: Acoustic Research, Inc.

Price: \$400.

Circle 52 on Reader Service Card

PROGRAMMABLE POCKET-SIZED CALCULATOR

● One program containing up to 100 steps or many programs totaling 100 steps, can be recorded on a single tiny card used in HP-65 calculator. Users may write and edit their own programs or use prerecorded programs developed for the calculator, which solve many frequently encountered engineering problems. There are 51 keyboard functions preprogrammed into the machine. Prerecorded programs include: finding L or C to resonate with a known L or C at some frequency; computing the impedance of an arbitrarily long ladder network containing series or shunt R, L, and C, a transmission line impedance transformer, and S to Y parameter conversion and vice-versa; calculating six Fourier coefficients for any number of data points. The user may perform branching, logic comparisons and conditional skips in his programs. Mathematical functions encompass logarithms, square and square root, exponential, factorial, reciprocal, and trigonometric functions. The calculator can add and subtract in degrees, minutes, and seconds format, as well as in units of time. It will work in



degrees, grads and radians and will convert octal-based integer numbers to decimal-based integer numbers and back. Programs devised may be stored for later recall. A led display can be set up to show results in either fixed or scientific notation. The program can be changed or edited at any time; it is not necessary to rewrite the entire program when an error is made.

Mfr: Hewlett Packard

Price: \$795.

Circle 53 on Reader Service Card

TONE GENERATOR



● Designed for compatibility with audio automation systems, CD25G 25Hz tone generator is intended for insertion of the standard 25Hz audio automation actuating tone, operating with all audio sources at output levels up to +8 dBm. A start button places the tape transport in motion and the tone button applies the 25 Hz tone and stops the transport after a pre-determined adjustable period of tone application. An internal gating circuit mutes the audio to eliminate bias pops and other start/stop noises on the finished tape. The unit contains a 25 Hz tone filter and bridging input. It fits standard 19 inch racks, allowing for 1¾ inch EIA mounting.

Mfr: Control Design Corporation
Circle 54 on Reader Service Card

NEW!

AUDIO LEVEL OPTIMIZER FOR AM, FM, TV

gives you

PROTECTION FROM PEAKS
HIGHER AVERAGE PROGRAM LEVEL
GATED TO ELIMINATE AUDIBLE EFFECTS



ONE UNIT - ONE LOW PRICE - \$680

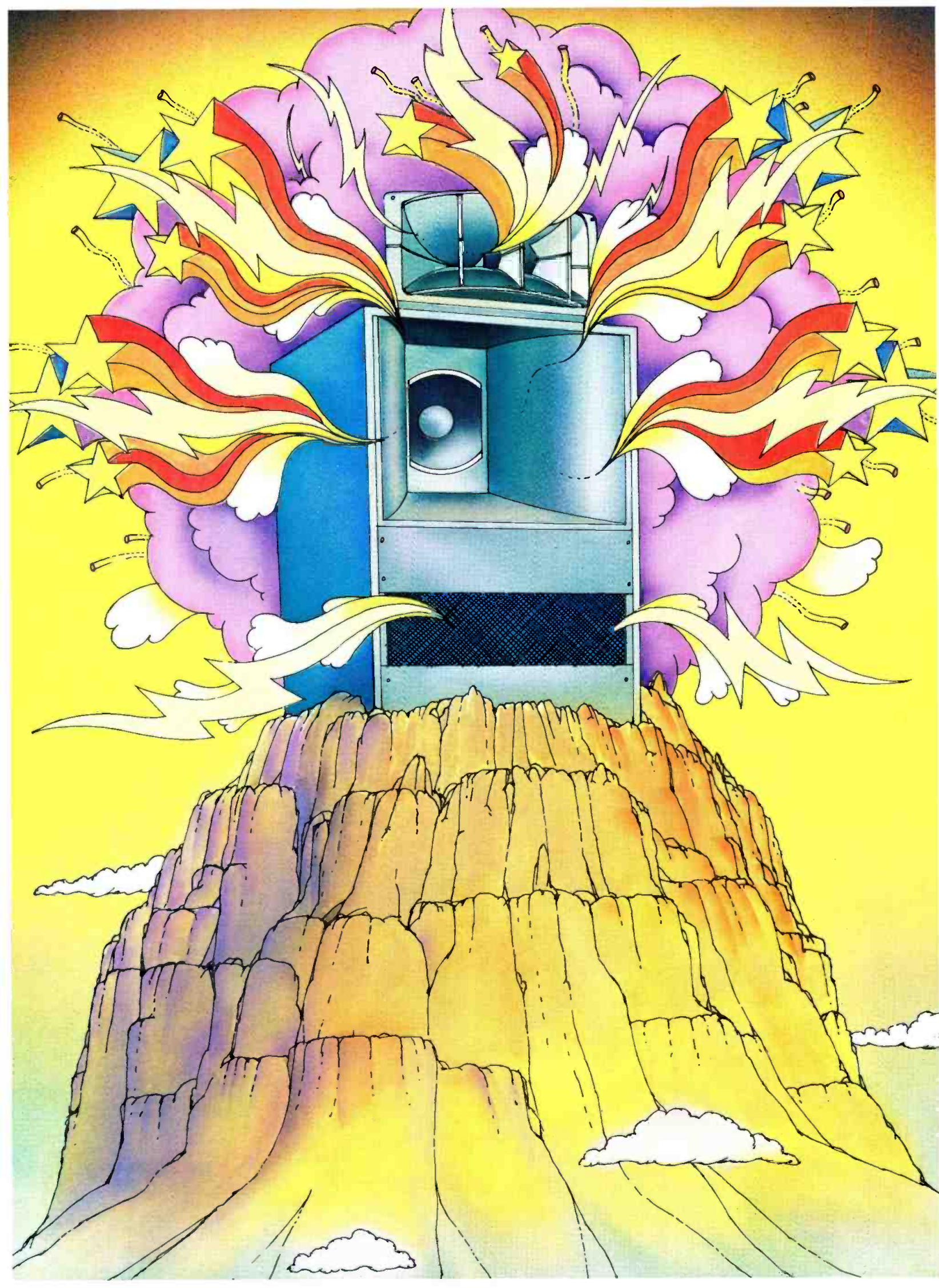
■ Selectable peak limiting and average compression functions ■ Fast peak limiting—no clipping ■ Gated operation with Gain Hold, Hold and Release, Hold and Fade functions ■ Adjustable limiting symmetry for full carrier modulation ■ Built-in Frequency Selective Limiter for FM and TV optional for \$25.



INOVONICS
INCORPORATED

1630 Dell Ave., Campbell, CA 95008 Phone: (408) 374-8300

Circle 33 on Reader Service Card



Altec, we challenge you.

Any company that achieves a position of leadership must be prepared to meet the challenge of innovation. In the recording industry, this is a particularly crucial factor – because constantly evolving musical material demands ever newer and better recording techniques.

For nearly 30 years, one name has dominated the studio monitor market. Altec. In 1973, Altec had more than twice as many speakers in recording studio use in the U.S. than its nearest competitor. And nearly as many as all other brands combined. (Source: Billboard's 1973 International Directory of Recording Studios.) That's leadership without question.

Now someone is about to challenge that leadership. Us.

Our first step: introduce three all-new monitor loudspeakers. They're a whole new breed, designed for tomorrow's recordings. And they exceed the performance characteristics of every monitor ever made. Including Altec's.

They're packed with improvements and specs guaranteed to satisfy the goldenest of ears. Improved accuracy and definition. Better transient response. Flatter frequency response. Greater bandwidth. Greater power handling. And much more.

Add to all that our 37-plus years in the field of sound reproduction, and we think we're ready to challenge the leader.

Even if we have to do it ourselves.

ALTEC

the sound of experience.

1515 S. Manchester
Anaheim, Calif. 92803

The challengers.

From front to back, it's the 9849A, the 9846-8A and the 9848A. If you listen for a living, you should know more about them.

Write or call. We'll send you all the facts and figures.



Circle 34 on Reader Service Card

A Note From The Publisher

The July, 1973 issue of **db** contained a number of microphone ads which observant readers probably noted were quite different from the ads usually run by manufacturers of microphones. For those of you who did not see that issue, or don't remember it, we are reproducing the ads here in reduced form. You may ask why staid microphone manufacturers last July suddenly became frivolous, thought provoking, or just plain funny. There is an explanation—and it isn't due to anything they ate, drank, or smoked.

It all started when someone (possibly a reader) commented on the cut and dried format of microphone ads. It's true that microphones have an interesting shape; they sometimes create an eye-pleasing layout. But it seemed there must be more to a microphone than just being splashed across a page with a dull description appended to it—some secret inner meaning to the very idea of a microphone. So we conducted a contest, encouraging the ad agencies who prepare microphone ads to do something creative with no holds barred, as long as they were held within the bounds of good taste. The one-third page ads were run in the July special microphone issue.

As you can see, when freed from constraints most agencies produced very unusual ads. We hope they resulted in reader interest, as well as intriguing the advertising people. Winners were judged by the number of reader inquiries resulting from the ads, with an additional professional appraisal made by an advertising agency unconnected with any of the manufacturers involved.

The results were extremely close, so close in fact that there was almost a dead heat among all entries. Nevertheless, on the basis of reader inquiries and third-party judgment of artistic qualities, the following results were announced:

First Prize: Gotham Audio

Second Prize: Turner Microphones

Third Prize: Electro Voice

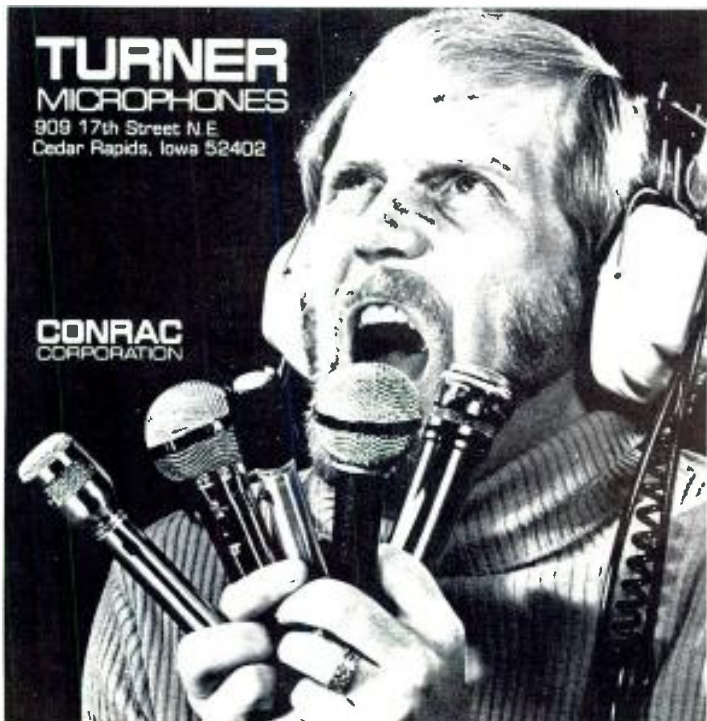
We hope this contest brought some levity to our readers, some brightness to our pages, and some sales to our advertisers. After all, life isn't made up of frequency response, polar patterns, and input overload. Or is it?

THE WINNING ADS AS THEY APPEARED

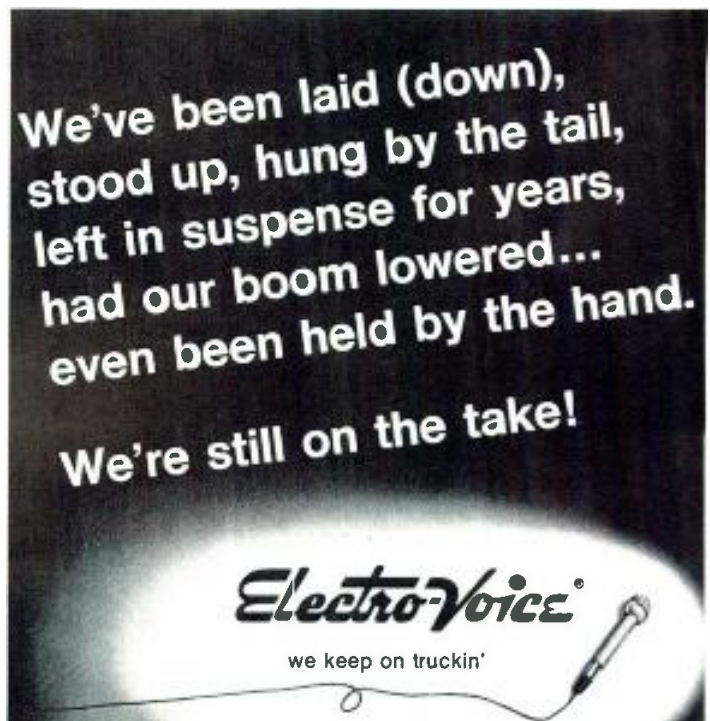
FIRST PRIZE



SECOND PRIZE



THIRD PRIZE



The Decibel: Basics, part II

This is the concluding part to the definitive study of the decibel in audio that was started last month.

WE HAVE DEFINED the decibel as the logarithm of the ratio of two powers. Consequently, the manufacturer in such cases must be comparing the output power of his product with some other power value. This other value is understood to be the common reference or zero level value. Unfortunately, this common reference can also be a source of confusion, due to the fact that through the years different values have been used. Therefore, zero-level could refer to 1 milliwatt, 6 mW, 12.5 mW or even 50 mW; and when considering high impedance microphones, the reference could be 1 volt. An attempt has been made to clear up some of the confusion by using the notation dBm when the reference level is 1 milliwatt across 600 ohms and dB6m for a reference level of 6 milliwatts across 500 ohms. The notation dBV for microphones signifies decibels referred to 1 volt.

Example 12: A directional television antenna is listed as having 9 dB gain.

$$\text{db} = 10 \log P_1/P_2$$

where P_1 = pick-up power of directional antenna
 P_2 = pick-up power of standard point source antenna with equal response in all directions.

$$9 = 10 \log P_1/P_2$$
$$0.9 = \log P_1/P_2$$
$$8 = P_1 \qquad P_2 = \text{unit power}$$

This means that the directional antenna, when properly oriented, has 8 times more gain in a specific direction than a standard point source reference antenna.

Example 13: A high impedance microphone has a rating of -57 dBV. Find its open circuit voltage.

- Solution: 1. The understood reference level is 1 volt for a sound pressure level of 1 dyne per square centimeter.
2. The rating is a minus value, therefore the output level is less than the reference level and thus becomes the denominator of the ratio in the dB equation.

$$\begin{aligned} \text{dBV} &= 20 \log E/E_0 \\ 57 &= 20 \log E/E_0 \\ 2.85 &= \log E/E_0 \\ E/E_0 &= \text{antilog } 2.85 \\ E_0 &= E/\text{antilog } 2.85 \\ &= 1/7.1 \times 10 \\ &= 0.0014\text{V} \end{aligned}$$

In both the above examples of decibel notation and usage we have been expressing gain or loss in terms of power. Each notation expressed power directly as P_1 and P_2 or as E_1/E_2 when the corresponding resistances were equal, thereby maintaining the power equation. However, you will often find that manufacturers and engineers add to the decibel confusion by expressing *voltage gain in dB*. In other words, they sometimes use the dB equation: $20 \log E_1/E_2$ without regard to *resistance* values. Since in many cases the input and output resistances of a network or component are not equal, the expression no longer represents a power relationship. Under these conditions the solution merely indicates voltage gain in dB!

Of course, if the distinction were clearly noted in specifications, the confusion would be alleviated. Nevertheless, let's make sure we understand the nomenclature. To begin with *dB gain (or loss)* or *dB power gain* are expressions that should be used in reference to actual power comparisons, using power ratios or the voltage ratio when the resistances (input and output) are equal. On the other hand, *voltage gain in dB* should be expressed when $20 \log$ (voltage ratio) is used as the equation, when the associated resistances are not equal, and no corrective measures are used to compensate for the unequal resistance values.

An example may clarify understanding.

Example 14: A 50 watt amplifier requires 0.5V input for rated output. If the input resistance is 40,000 ohms and the output resistance is 8 ohms, find the power gain in dB and the voltage gain in dB.

$$\begin{aligned} \text{Power gain: } P_{in} &= E_{in}^2/R_{in} = 0.5 \times 0.5/40,000 \\ &= 0.25/40,000 = 6.25 \times 10^{-6} \end{aligned}$$

$$\begin{aligned} \text{dB gain} &= 10 \log P_o/P_{in} = 50/6.25 \times 10^{-6} \\ &= 10 \log 8.0 \times 10^6 \\ &= 10 (6.9031) \end{aligned}$$

$$\text{Power gain} = 69 \text{ dB}$$

Voltage gain in dB:

$$\begin{aligned} E_o &= \sqrt{P_o R_o} = \sqrt{50 \times 8} = \sqrt{400} = 20\text{V} \\ \text{dB gain} &= 20 \log E_o/E_{in} \\ &= 20 \log 20/0.5 \\ &= 20 \log 40 \\ &= 20 (1.6021) \end{aligned}$$

$$\text{Voltage gain} = 32 \text{ dB}$$

By now, it should be clear that most of the haze surrounding the decibel is due to poor definition of associ-

ated terms, such as v_u , phon, dBV, dBm, etc., as well as misleading terminology and non-uniformity in rating and referencing. Consequently, if we understand the association of terms and comprehend reference values and their usage, the misleading terminology will drift away from the haze.

Microphone manufacturers use a special type of decibel notation in their rating of microphone output. Their method is not strictly uniform, as can be noted by the microphone specifications at the very beginning of this article.

1. 58 dB below 1 mW per 10 microbar signal at 200 ohms
2. 50 dB below 1 volt/dyne/cm²

To thoroughly understand these statements, we must consider some basic facts.

Although transmission lines may be thousands of feet long in sound distribution, they are nevertheless considered "short lines" because the shortest audio wavelength is long compared to its transmission line. Therefore, we need not consider characteristic impedance, retardation time, etc., such as would be necessary for miles and miles of telephone line. This means that the defining characteristic of our "short line" is the *impedance* to which it is connected. In other words, a low impedance line is so called, not because of any inherent quality of the line itself, but because it is connected to a low impedance load from a low impedance source. A high impedance line is a pair of wires connected to a high impedance load.

How does all this effect microphone ratings? Like this—the fluctuating pressure of air molecules upon the diaphragm varies the output of the microphone. In order to have a meaningful yardstick by which to rate the outputs of various microphones, a standard unit of pressure was needed. The pressure reference most often used is the *bar*, but a 10-bar reference is also quite common. Many manufacturers consider the bar as the cgs unit of pressure, equivalent to one dyne per square centimeter. Thus, microphones are usually rated as so many decibels below a zero reference power or voltage level for a zero reference pressure level.

As you probably know, microphones are classified, in general, according to their impedance, as low or high. Low impedance microphones are used for long runs (75 feet-2000 feet-), while high impedance microphones are used for short runs (to 75 feet). In a low impedance load, the voltage is low and the current high. Since power is proportional to current squared, line loss could be a substantial percentage of the total power output. Therefore, output power is an important factor in the consideration of low impedance microphones. Consequently, these microphones are usually rated in decibels below a reference power level (1 mW, 6 mW) at a reference pressure level (microbar, bar).

To determine the output of a microphone from its decibel rating two things must be kept in mind.

1. The decibel rating must be expressed in terms of the reference pressure. If a change in pressure occurs, the new rating can be found by:

$$\text{dB}_R = 20 \log B/B_R$$
 where dB_R = decibel output rating at new pressure
 B = new pressure
 B_R = reference pressure

2. Determine microphone output power by using our standard decibel equation 1.1:

$$\text{dB} = 10 \log P_R/P$$

$$\begin{aligned} \text{where } P_R &= \text{reference power} \\ P &= \text{output power} \end{aligned}$$

Example 15: Opening spec #1) 60 dB below 1 mW per 10 bar signal.

$$\begin{aligned} \text{dB} &= 10 \log P_R/P = 10 \log .001/P \\ 60 &= 10 \log .001/P \\ 6 &= \log .001/P \\ 10^6 &= .001/P \\ P &= .001/10^6 \\ &= .001 \text{ microwatts} \end{aligned}$$

For a 300 bar signal:

$$\begin{aligned} \text{Output rating} &= 20 \log B/B_R = 20 \log 300/10 \\ &= 20 \times 1.477 \end{aligned}$$

$$\text{Output rating} = 29.54 \text{ dB}$$

$$\text{Output} = -60 + 29.54 = -30.46$$

$$\begin{aligned} P &= P_R/(\text{antilog dB}/10) \\ &= .001/(\text{antilog } 30.45/10) \\ &= .001/1.12 \times 10^3 = (1/1.12) \times 10^{-6} \end{aligned}$$

$$\text{Power output} = .893 \text{ microwatts}$$

High impedance circuits are characterized by high voltage and low current. Consequently, high impedance microphones are rated as to their voltage output. The rating is based upon decibels below one volt per microbar pressure, and our standard decibel equation (power expressed in terms of voltage, impedance being equal) is utilized to find the open circuit voltage output.

Example 16: Opening spec. #2) 54 dB below 1 volt/dyne/cm²

$$\begin{aligned} \text{dB} &= 20 \log E_R/E_0 \\ 54 &= 20 \log 1/E_0 \\ 2.7 &= \log 1/E_0 \\ 1/E_0 &= 5.07 \times 10^2 \\ E_0 &= 1/5.07 \times 10^{-2} \\ &= .00197 \text{ volt} \end{aligned}$$

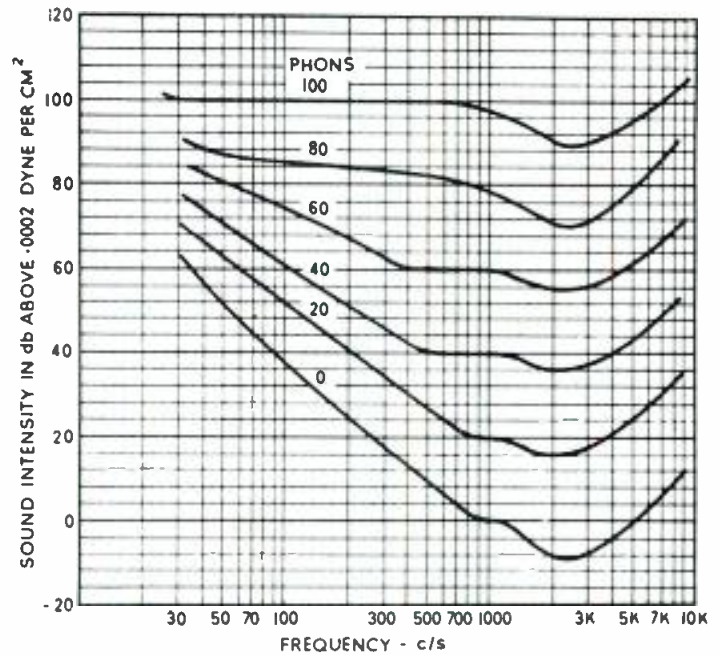


Figure 3. The Fletcher-Munson curve.

Now that we understand microphone specifications and ratings, we need only investigate the other few audio units of measurement to penetrate any remaining haze that may exist as to their relationship to the decibel.

As you now know, the decibel is a unit of measure that indicates a change in sound intensity. When this intensity is referenced to a power of 1 milliwatt dissipated across 600 ohms, the decibel expression is then equated to dBm:

$$\begin{aligned} \text{dBm} &= 10 \log P/.001, \text{ where } P \text{ is the sound intensity.} \\ \text{dBm} &= \text{decibels referenced to 1 milliwatt} \end{aligned}$$

Example 17: Opening spec. #3) 8 dBm

$$\begin{aligned} \text{dBm} &= 10 \log P/.001 \\ 8 &= 10 \log P/.001 \\ 0.8 &= \log P/.001 \\ 6.35 &= P/.001 \end{aligned}$$

$$P = .001 \times 6.35 = .00635 \text{ watts}$$

Therefore 8 dBm = a power ratio of 6.35 milliwatts above the reference level of 1 milliwatt.

Decibel then, or plain dB, is expressed when our reference level is 6 mW across 500 ohms and dBm refers to 1 mW across 600 ohms.

One of the unique features of decibel notation is that it correlates an electrical characteristic and a physical response. Keeping in mind that such notation usually refers to sine wave signals, the electrical and physical correlation is nevertheless useful for monitoring signal levels in transmission lines and throughout the broadcasting process.

But audio signals of speech and music are not simple sine waves; they are complex waves, of which the instantaneous value is the algebraic sum of all fundamental, harmonic, and sum and difference frequencies. In order to measure and compare the relative amplitudes of these complex signals, telephone and broadcasting engineers, in 1939, designed a special meter. Since the function of this meter was actually to indicate the rms level or volume of complex waves, it was calibrated in volume units and called a *vu meter*.

The volume unit (vu) is also logarithmic and its standard reference value is 1 milliwatt in a resistance of 600



Circle 41 on Reader Service Card

ohms. It is, therefore, numerically equal to dBm, that is, a 1 vu change is equal to a change of 1 dBm. Keep in mind, though, that the difference between vu and dBm is in their application. Vu can be a measure of complex signal levels, or *sinusoidal*, wave forms, whereas dBm specifies steady tone (*sinusoidal*) audio output.

The equation for finding the value of vu is as follows:

$$vu = 10 \log P / .001$$

Example 18: Opening spec. #4 -4 vu

$$4 = 10 \log .001 / P \quad (\text{Minus value is}$$

$$0.4 = 10 \log .001 / P \quad (\text{less than refer-}$$

$$2.56 = .001 / P \quad (\text{ence value)})$$

$$P = .001 / 2.56 = .00039$$

$$= 390 \text{ microwatts}$$

Minus 4 vu represents a power level 390 microwatts below the 1 milliwatt reference.

From a practical standpoint, since voltage can readily be measured in an operating circuit, the following modified equation may be useful.

$$vu = 20 \log E / 0.775 + 10 \log 600 / R$$

where E = rms value of signal voltage

R = resistance across which signal is measured

.775 and 600 = voltage and resistance parameters of reference power

Due to the design and ballistics of the vu meter with the high rise and slow fall of the pointer movement, this special meter will indicate 10 dBm higher on sinusoidal signals than on program material. Since audio tests and measurements are normally performed with steady signals and expressed in dBm, in order to arrive at safe operating

values for vu meter monitoring, 10 dBm should be subtracted from manufacturers' specifications. For example, if a line amplifier is rated for +20 dBm output, its operating level in volume units should be +10 vu.

The *phon* is a cousin to the decibel. It is a measure of the *loudness* of sound as perceived by the human ear; as the decibel is a measure of the *intensity* of sound as perceived by that same organ. The ear responds logarithmically to sound intensities. A sound of 10 units seems just as much louder compared to a 1 unit sound as a 100 unit sound seems to 10 units, even though the absolute intensity difference is 90 units in one case and only 9 units in the other. This means that for the ear to sense twice as much sound from an audio amplifier delivering a 10 watt pure tone, the power output or intensity would have to increase logarithmically (10^2) to become 100 watts.

The loudness of sound is a function of frequency as well as amplitude. The ear responds differently to different audio frequencies. The Fletcher-Munson Graph, FIGURE 3, which relates decibels and phons to frequency, shows the comparison in ear response of various loudness levels at different frequencies. Each curve shows the increase or decrease in dB sound intensity necessary to create the same loudness at a given frequency. As you can see, at 1000 Hz the sound intensity increases linearly from the threshold of hearing to the sensation of feeling. Therefore, at this reference frequency we have a loudness scale according to which an increase in the intensity of sound at the source produces a corresponding (linear) increase in sound intensity to the ear. This scale represents loudness levels expressed in phons, where zero phons at 1000 Hz represents 10^{-16} watts per square centimeter or .0002 dynes/cm². ■

Orban/Parasound Reverb:

THE LIVE ONE

It's one of the more pleasant aspects of being on the road. It gives reliable studio-quality reverb without hauling ten-ton concrete echo chambers or two-ton steel plates. Our 9 lb., 1-3/4" rack mount unit has been redesigned to interface more easily with semi-pro equipment (like many PAs) and its spring delay line locks instantly from the outside to protect against the inevitable jolts and jounces.

Of course, it's also quite content to sit motionless in your studio, quietly solving your space and/or budget problems. And giving you the kind of quality you didn't think a spring could deliver.

The Orban/Parasound Model 106C is a modest, but well-engineered device offering a built-in FET limiter and a four-frequency mid-

range peaking equalizer. Not to mention a +20 dBm balanced output and 115/230 volt international power capabilities.

The Orban/Parasound Reverb: it's live enough for anyone. Even the Grateful Dead. (Or for that matter, any one of a hundred other recording studios, broadcasters, and travelling professional shows.)



ORBAN/PARASOUND

680 Beach St., San Francisco, Ca. 94109. (415) 776-2808 or contact your local Orban/Parasound distributor.

Nobody ever made a monitor that could match this sound.



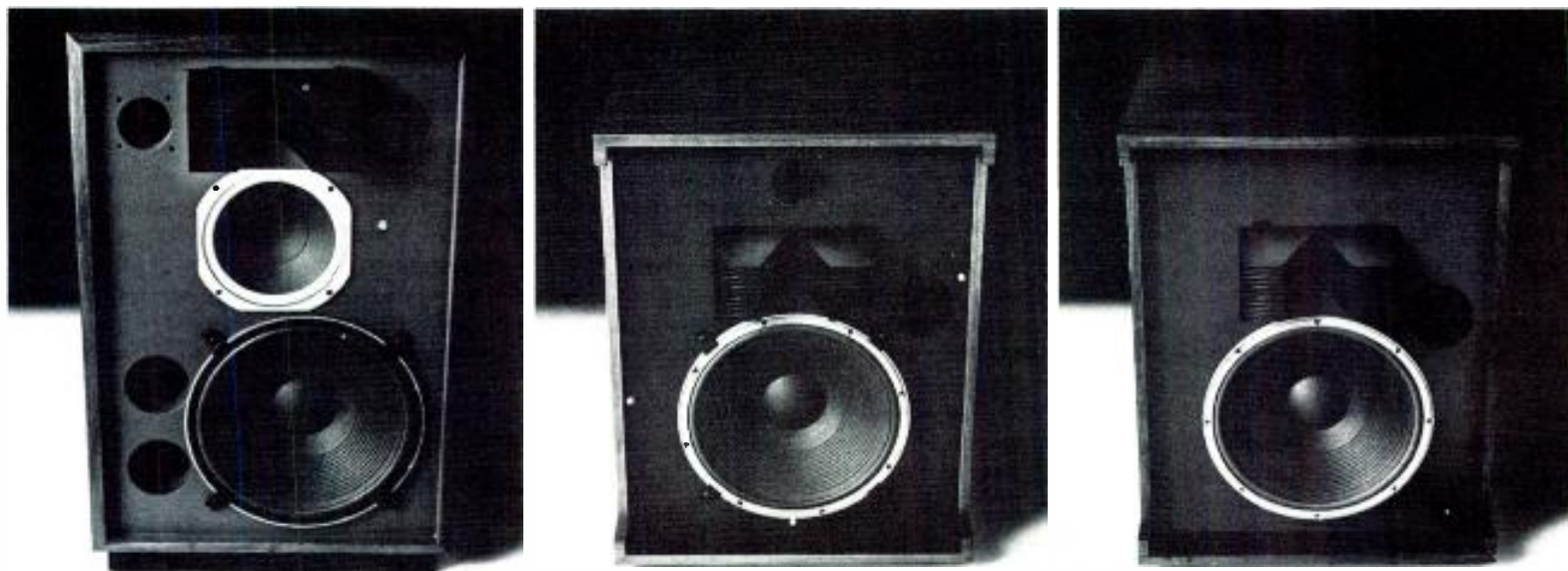
Type of System	4-way
Components	(2) 15" low frequency loudspeakers (1) 12" midrange loudspeaker (1) High frequency compression driver with horn lens (1) Ultra high frequency compression driver
Frequency Response	30 to 20,000 Hz \pm 3dB
Sensitivity (SPL at 30' 1mW)	46.5 dB
Power Output (SPL at 10 ft.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

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

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

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

Until now.



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

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

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

Hearing is believing. Come hear what you can do.



48th AES Convention and Exhibition

ON THESE PAGES, we present the essential program and an exhibition map of the Audio Engineering Society's 48th Convention and Exhibition to be held at the Los Angeles Hilton Hotel. The dates are May 6 through May 10, 1974.

Schedule of Events

Mezzanine, Los Angeles Hilton

REGISTRATION

Monday May 6 —1:00 to 5:00 P.M.
(Set-up and Exhibitors)
Tuesday May 7 —8:00 A.M. to 8:00 P.M.
Wednesday May 8 —8:30 A.M. to 8:30 P.M.
Thursday May 9 —9:00 A.M. to 5:00 P.M.
Friday May 10—9:00 A.M. to 5:00 P.M.

EXHIBIT HOURS

Tuesday and Wednesday, May 7 and 8
1:00 P.M. to 9:00 P.M.
Thursday and Friday, May 9 and 10
11:00 A.M. to 5:00 P.M.

DEMONSTRATION ROOMS

Foy, St. Louis, Dallas, Hartford, New York, Buffalo, Boston, Detroit, Washington, Cleveland, Mission, Studio A, Panel Room (All on Mezzanine Level)

TECHNICAL SESSIONS

Golden State Room, Sessions A, C, E, G, J, L, O
Los Angeles Room, Sessions B, D, F, H, K, M, N

TUESDAY, May 7

9:30 A.M.—A—Digital Techniques in Audio
9:30 A.M.—B—Audio in AM/FM/TV Broadcasting
2:00 P.M.—C—Disc Recording and Reproduction
2:00 P.M.—D—Transducers
7:30 P.M.—E—Electronic Music
7:30 P.M.—F—Education in Audio

WEDNESDAY, May 8

9:30 A.M.—G—Quadraphonics
9:30 A.M.—H—Motion Picture Sound
2:00 P.M.—J—Sound Reinforcement and Architectural Acoustics
2:00 P.M.—K—Magnetic Recording and Reproduction

THURSDAY, May 9

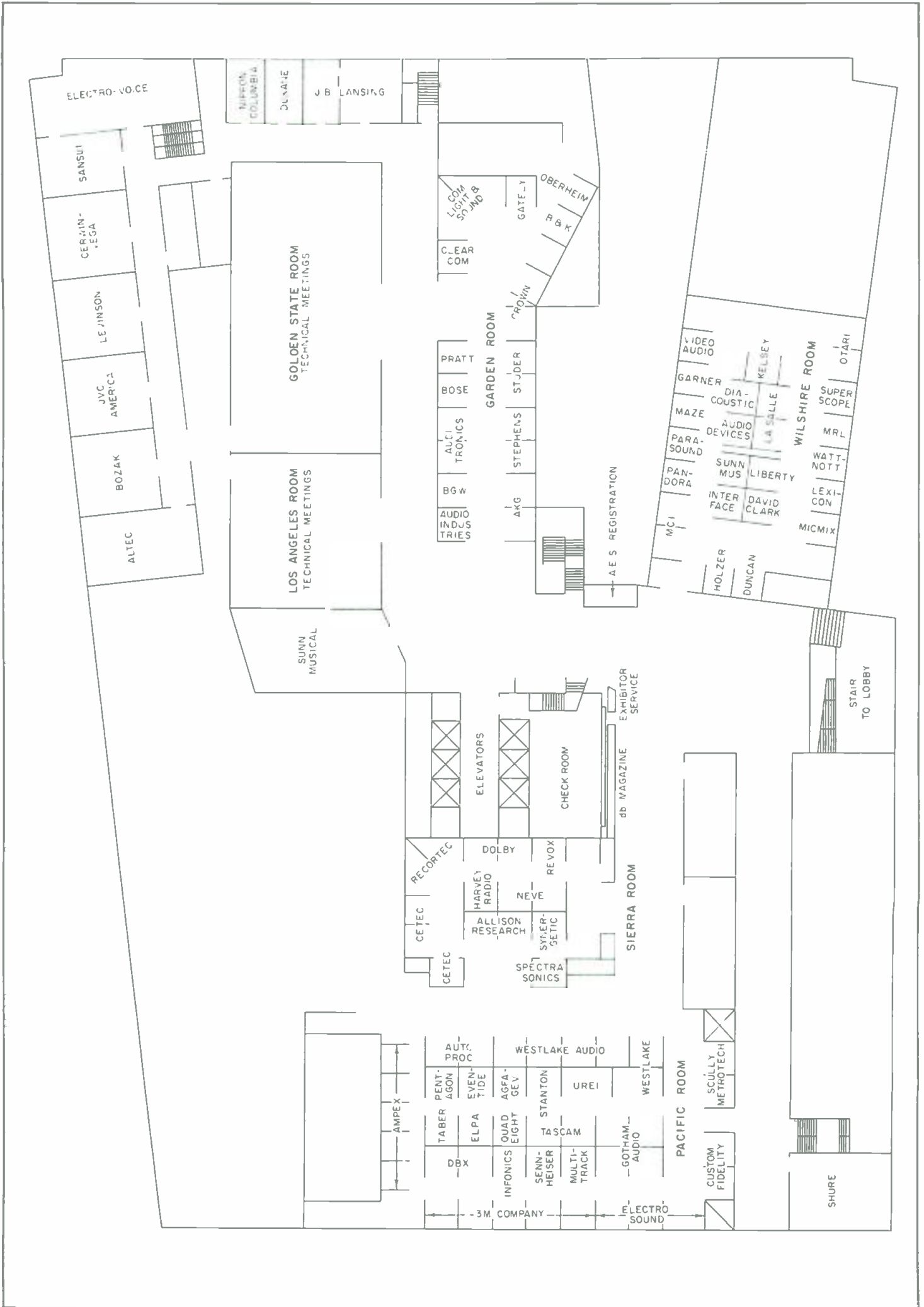
9:30 A.M.—L—Signal Processing
9:30 A.M.—M—Acoustical Noise Control and Studio Design
No afternoon sessions—an opportunity to visit the exhibits
7:00 P.M. Social Hour—Los Angeles Room
8:00 P.M. Awards Banquet—Golden State Room

FRIDAY, May 10

9:30 A.M.—N—Audio Instrumentation and measurement
No afternoon sessions—visit the exhibits until 5:00 P.M.
7:30 P.M.—O—Recording Studio Workshop

SOCIAL AND CULTURAL ACTIVITIES

A program of activities is planned for those not directly involved in Convention activities. There will be a meeting at 9:00 A.M. each day, where coffee will be served, before commencing the day's outing. Suite number will be posted. Chairwoman: Mrs. Ethelyn Glancy



Impedance Matching for the Sound Engineer, part I

Impedance matching is vital to the correct flow of audio information. And though it seems that things are cut and dry, often they are not. The author, an authority on the subject, uses basic math to lead you along to a thorough understanding of the relationship of impedance in to impedance out.

IMPEdance, next to the decibel, is probably one of the most often used terms in the audio engineer's vocabulary. Again, in common with the decibel, the word *impedance* rarely can be even defined properly by its user. Even less often is it handled correctly in sound systems.

This is an industry where many of the best practitioners are largely self taught. Yet, a sampling of questions based on a practical system problem immediately stumps a majority of the recent electrical engineering graduates from state universities. Therefore, more discussion of common practices and mispractices can be profitably carried on.

IMPEDANCE DEFINED

What is impedance? Is it resistance? Sort of, reply some. Many a technician has put an ohm meter across the voice coil of a 16 ohm loudspeaker impedance and been surprised to read 4.5 ohms or less. What has he read with

the ohm meter? The d.c. resistance of the voice coil. Fine—is it the impedance? No.

Now, let's get a "bridge circuit" to read the a.c. resistance (R) of the loudspeaker. Is this the impedance? No. but it's part of the impedance.

Then, what is impedance? According to the *Modern Dictionary of Electronics* published by Howard W. Sams, impedance is defined as: "The total opposition (i.e., resistance and reactance) a circuit offers to the flow of alternating current. It is measured in ohms and its reciprocal is called admittance."

What are these words, *opposition* and *reactance*? We all know what resistance is. Opposition means resistance, restraint, hindrance, etc. From this we can conclude that in alternating current circuits there exists some other resistance-like component and this additional restraint which adds to that of the a.c. resistance is called *reactance*.

The word reactance has in the dictionary, as a synonym, the word, opposition.

Reactance comes in two flavors: capacitive reactance (X_C) and inductive reactance (X_L). X stands for reactance and the sub C means capacitance and the sub L signifies inductance. These two familiar companions should alert

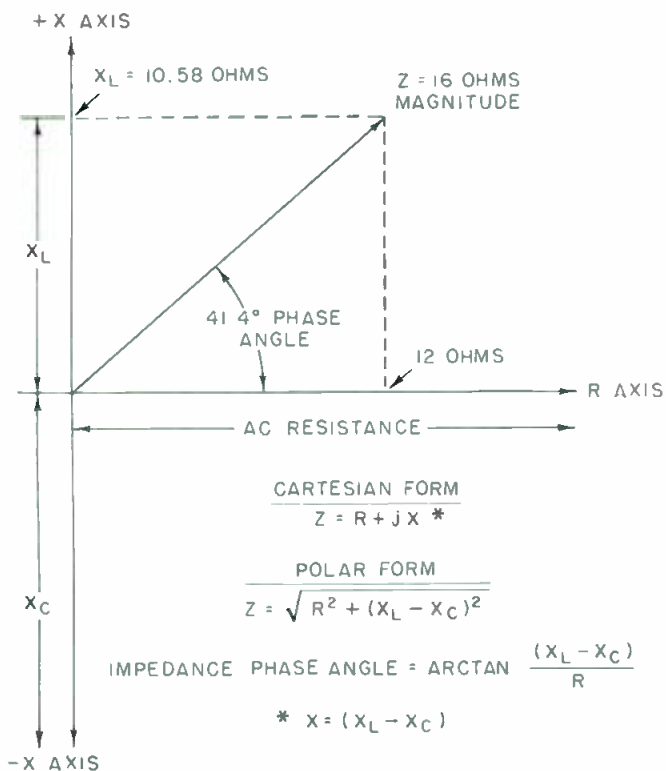


Figure 1. Calculating impedance.

the engineer to the awareness that reactance varies with frequency, whereas a.c. resistance tends to stay the same with frequency (certainly over the audio range).

Now, let's add one more term to our collection and proceed to measure an impedance. Let's call impedance (Z). With this addition, we can now list the terms we have developed:

- R = a.c. resistance
- X = Reactance ($X_L - X_C$) = X
- X_C = Capacitive reactance
- X_L = Inductive reactance
- Z = Impedance

If we now measure voltage and current in a real circuit,

Figure 2. An open circuit voltage compared to a matched circuit. A rule is: A source is working into its rated impedance when that impedance causes a 6 dB drop in level when placed across an open circuit voltage.

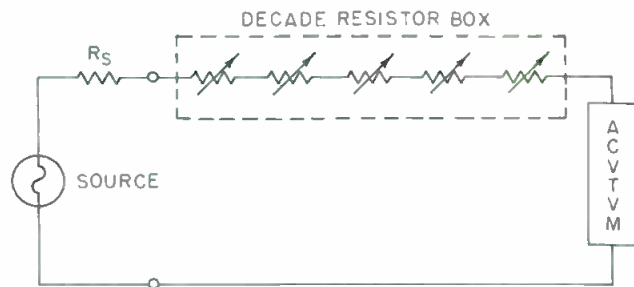
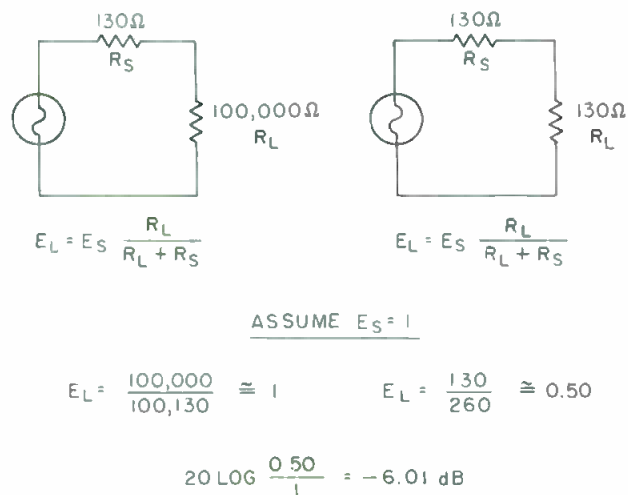


Figure 3. Finding impedance with a decade resistor box and an a.c. v.t.v.m. To do this turn the decade resistor box to its highest resistance (i.e. 100,000 ohms). Then read the open circuit voltage on the a.c. v.t.v.m. Next adjust the decade resistor box downward in resistance until the a.c. v.t.v.m. is 6 dB below the reading for open circuit. Finally, the total resistance reading of the decade resistor box now equals the magnitude of the source impedance.

we will find that when inductor-like devices are in the circuit, the current lags (in phase) behind the voltage and that when a capacitor-like device is in the circuit, the current leads (in phase) the voltage.

MAKING REACTANCE VISIBLE

By setting up a standard way of plotting reactances we can visually see plots of their action and interaction. Our old friend from high school days comes to the rescue with rectangular coordinates. Translated into electronics, it means the components that are 90 degrees apart in phase are represented by vectors that on a plain sheet of paper are 90 degrees apart. (See FIGURE 1.) From FIGURE 1 we can write the following formulas for impedance:

Cartesian Form

$$Z = R + jX \quad X = (X_L - X_C)$$

This describes how to plot the action on the chart shown. The j tells us that X is 90 degrees away from R.

Polar Form

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\text{Impedance phase angle} = \arctan \left(\frac{X_L - X_C}{R} \right)$$

These equations describe how to obtain the magnitude of the impedance vector and the phase angle between it and 0 degrees on the a.c. resistance axis.

It can be seen by inspection of FIGURE 1 that when phase angles are small, the impedance value approaches the a.c. resistance value, and conversely, when phase angles are large the reactive component must be carefully measured. The performance of transformers, loudspeaker voice coils, etc., are examples of conditions that exhibit large phase angles. Link circuits, passive attenuators, etc., normally exhibit small phase angles. In most normal audio work it is the magnitude of the impedance (the length of the vector Z) that is of importance in terms of building out, terminating, or matching impedances. Only rarely will the typical audio engineer have good reason actually to measure the phase angle, but he should know what it is.

Let's first look at an open circuit and a matched circuit. (See FIGURE 2.) As the circuit and the equations clearly show, a quite normal source in a sound system (many mixers have 130 ohm outputs) which is devel-



Figure 4. A standard type of impedance bridge.

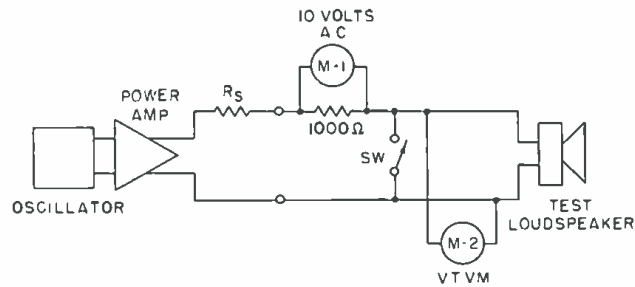


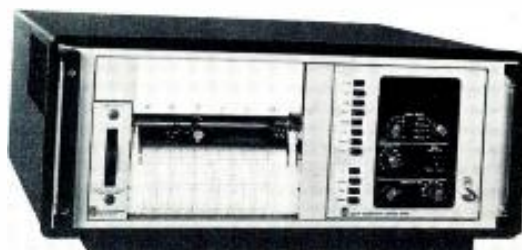
Figure 5. The constant current method of measuring loudspeaker impedance. First, close S_w and adjust power amplifier gain for a 10 volt indication at $M-1$. Then open S_w and read $M-2$ voltage. Finally, multiply $M-2$ voltage $\times 100$ to obtain impedance (values to 100 ohms. Impedance of a loudspeaker ≤ 100 ohms, Power amplifier nominal output impedance = 8 ohms).

oping 1 volt across an open circuit (very high load impedance compared to the source impedance) will drop 6 dB in level when a load impedance equal to the source impedance is provided. This is one of the reasons dynamic microphones rated at 150 ohm input impedance are connected to mixers that present essentially an open circuit termination (usually 3,000+ ohms) in order to improve the signal-to-noise by approximately 6 dB. This also means, however, that in the construction of microphone pads (used when the performer's acoustic input to the

microphone results in an electrical output that would overload the input of the mixer at the very first stage) it is necessary to make them bridging-type pads. That is, the microphone looks into 3,000+ ohms but the first stage of the mixer looks back at 150 ohms.

Our first way of measuring the magnitude of the impedance Z is shown in FIGURE 3. When it is desired to know the magnitude, ζ , the inductive reactance X_L , the capacitive reactance X_C , and the phase angle of each, then the standard CRL type impedance bridge is the ob-

Figure 6. A typical graphic level recorder.



At last, a studio mastering tape that's better than the one everybody's been using.

A while ago, someone came along with a new tape that, admittedly, was a better mousetrap. But it was not the ultimate mousetrap.

There were problems with that tape, good as it was. Problems which we at Audio Devices have been able to solve.

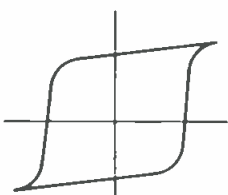
First problem:

How do you get even more energy out of each particle?

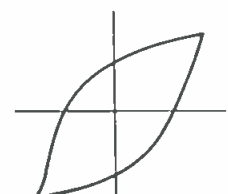
Solution:

By improving the dispersion.

Poorly dispersed particles clump together causing magnetic losses due to interaction and energy cancellations.



Hysteresis loop of Audiotape HOLN.



Hysteresis loop of poorly dispersed tape.

The new Audiotape HOLN has higher output and lower noise than the tape you switched to years ago. The new Audio tape iron-oxide particles deliver more energy.

Second problem:

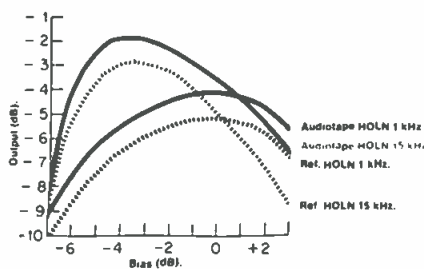
How do you reduce print-through?

Solution:

Uniform particle size and dispersion are part of the solution.

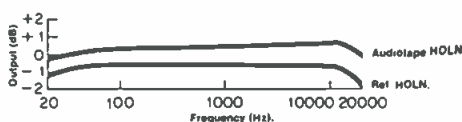


Output vs. bias.



Scully 1 recorder at 15 ips. Input level 0 dB.

Frequency response.



Scully 1 recorder at 15 ips. Bias 0 dB. Input level 0 dB.

Audio's secret processes are the other part. The results aren't secret, though: Audiotape HOLN has reduced print through by at least 2 dB, and typically 3 dB over the tape you switched to a few years ago.

Third problem:

How do you reduce headwear?

Solution:

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Fourth problem:

How do you improve handling and storage reliability?

Solution:

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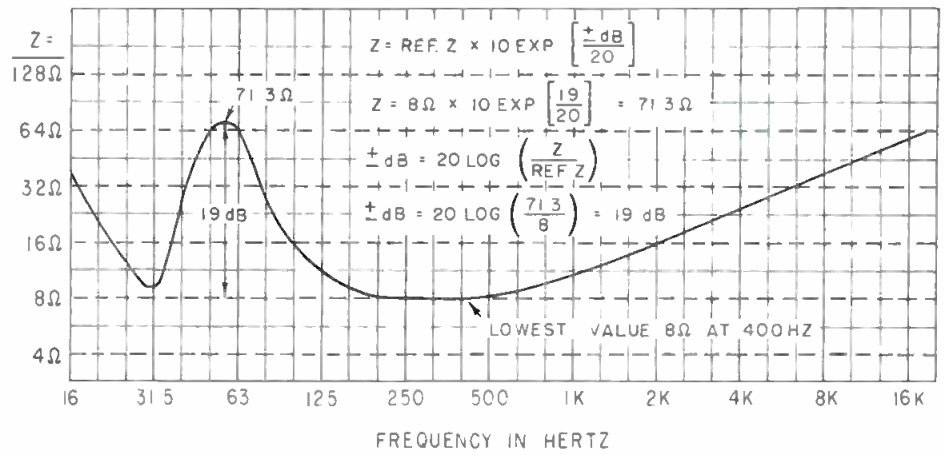


Figure 7. A typical automatic impedance plot.

vious choice. FIGURE 4 shows a standard rugged reliable unit used by literally hundreds of sound engineers today. It has provisions for external oscillator connections as well as a 1,000 Hz internal oscillator. Since it can measure R directly as a.c. resistance and can measure L and C, it is easy to convert to X_L and X_C via

$$X_L = 2\pi fL$$

and

$$X_C = \frac{1}{2\pi fC}$$

Where

- f = the frequency in Hz
- L = the inductance in henries
- C = the capacitance in farads
- X_C = the reactance in ohms
- X_L = the reactance in ohms

From the knowledge of R, X_L , and X_C , the phase angle can be calculated from the formulae given at the beginning of the article.

THE CONSTANT CURRENT METHOD OF MEASURING ZETA

FIGURE 5 illustrates the circuit for measuring Z by what is called the "constant current" method. The amplifier used as a test source is made into an essentially constant current output generator. The 8 ohm tap of a conventional power amplifier usually has an actual output impedance well less than one ohm. Through the use of the 1,000 ohm resistor in series with the test load, such a generator is created.

Many manufacturers use a graphic level recorder (See FIGURE 6) in place of an M-2 meter and obtain automatic impedance plots, such as that shown in FIGURE 7.

Calibrating to any reference Z, the dB difference between the reference Z and any other Z can be calculated by:

$$Z = \text{Reference } Z \times 10 \exp \frac{\pm \text{dB}}{20}$$

and, if the impedance is known, to find the dB difference between it and the reference Z, then:

$$\pm \text{ dB difference} = 20 \log \frac{Z}{\text{Ref. } Z}$$

FIGURE 8 describes an exceptionally efficient and easy-to-build impedance tester designed by Ed Lethert of

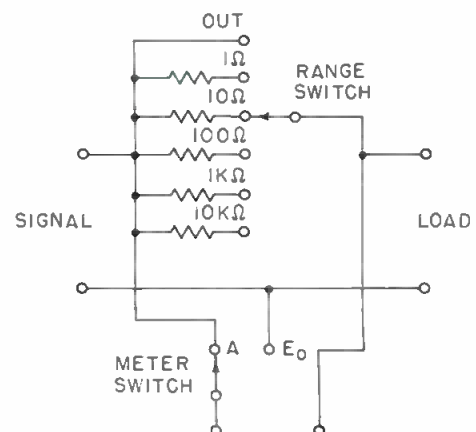
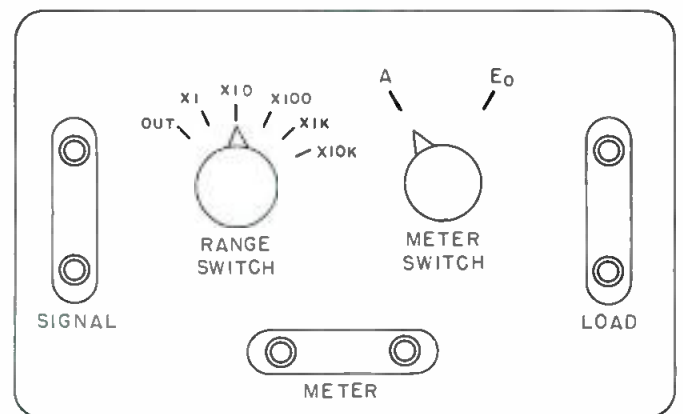
Northwest Sound Service, Minneapolis, for use in installing and maintaining motion picture theater sound systems. There are direct reading impedance meters such as the one made by Sennheiser Electronic Corporation, in West Germany. This unit includes three oscillator frequencies and a set of charts for finding X_L and X_C , if desired. Magnitude, Z, is read directly on the meter.

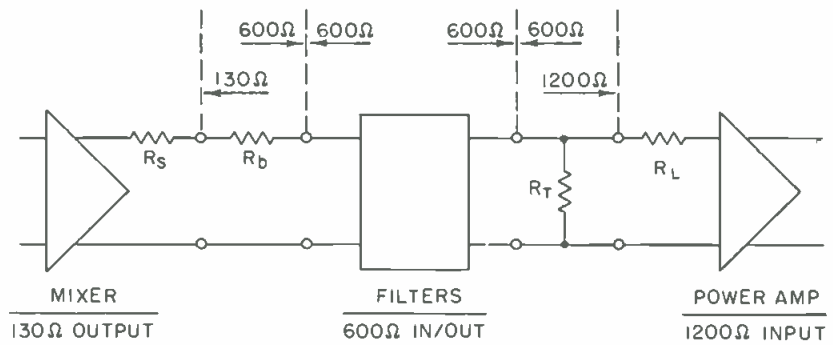
Loudspeaker designers are particularly fond of the GRZY impedance bridge, now available only on the used equipment market. In any case, there are today rapid, accurate, and reliable measuring tools available to the professional audio engineer.

USING IMPEDANCE MEASUREMENTS IN IMPEDANCE MATCHING

Having obtained the measurement, what do you do with it? The most frequent use of an impedance measurement

Figure 8. A direct reading impedance measuring device.





R_S = THE INTERNAL SOURCE Z (AS MEASURED)
 R_b = THE BUILD-OUT RESISTOR VALUE
 R_T = THE TERMINATING RESISTOR VALUE
 R_L = THE POWER AMP INPUT Z (AS MEASURED)
 R_D = THE DESIRED INPUT Z

$$R_b = R_D - R_S \quad \text{EXAMPLE: } 600 - 130 = 470 \Omega$$

$$R_T = \frac{R_L - R_D}{R_L - R_D} \quad \text{EXAMPLE: } \frac{1200 - 600}{1200 - 600} = 1200 \Omega$$

$$R_b \text{ INSERTION LOSS} = 20 \text{ LOG} \left(\frac{R_D}{R_S + R_b + R_D} \right) = 20 \text{ LOG} \left(\frac{600}{130 + 470 + 600} \right) = -4.32 \text{ dB}$$

$$R_T \text{ INSERTION LOSS} = 20 \text{ LOG} \left(\frac{R_D}{R_S + R_D} \right) = 20 \text{ LOG} \left(\frac{600}{130 + 600} \right) = -2.50 \text{ dB}$$

Figure 9. Calculation of build out and termination resistor values and their insertion losses.

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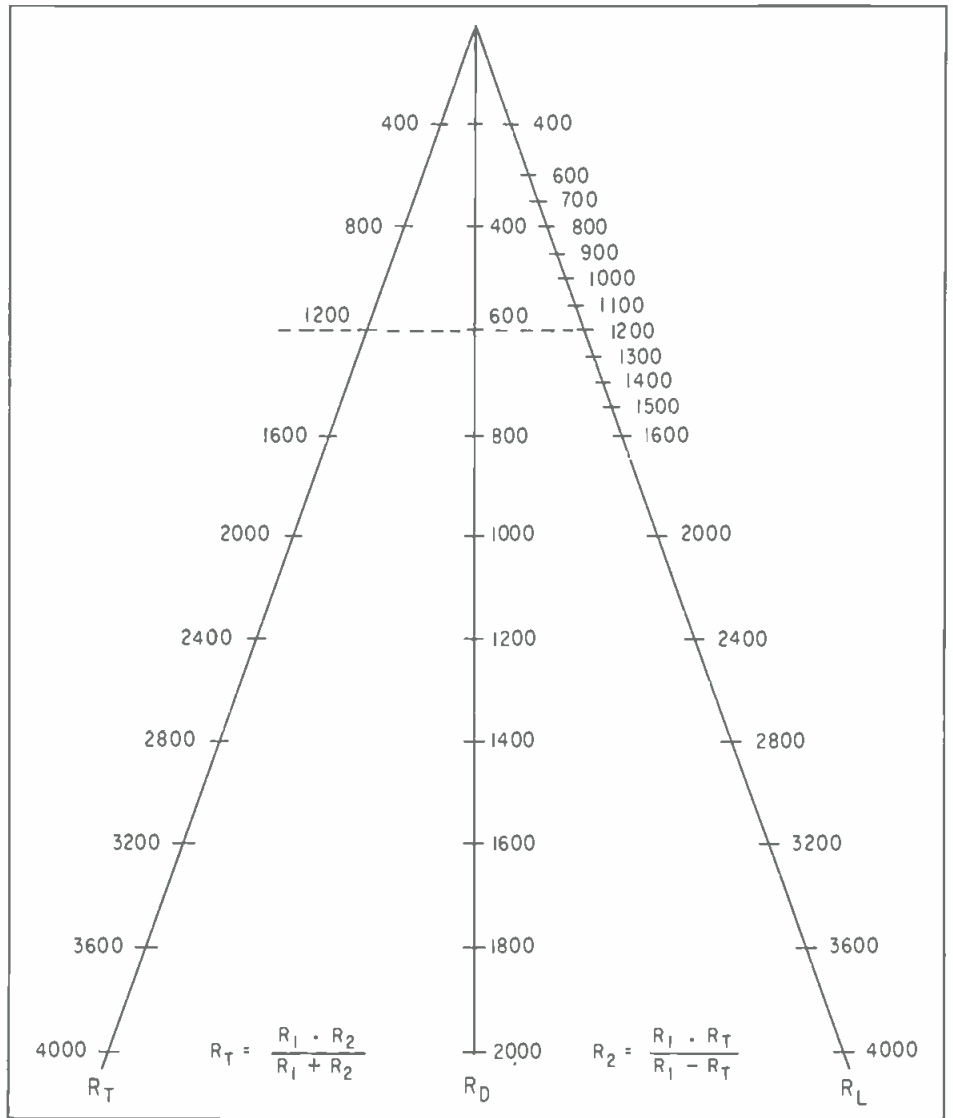
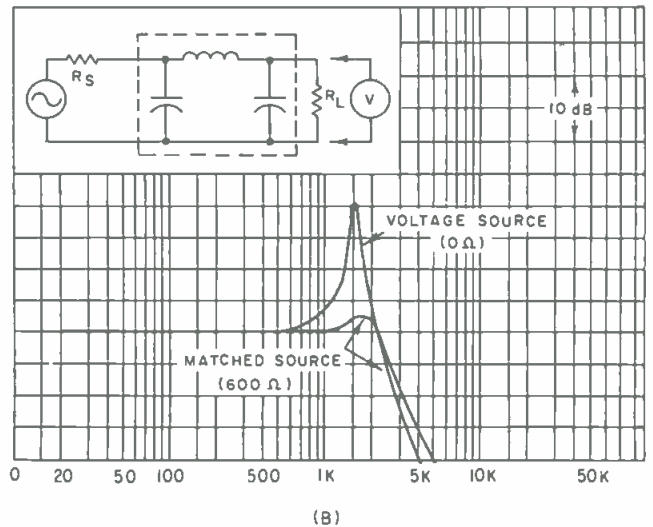
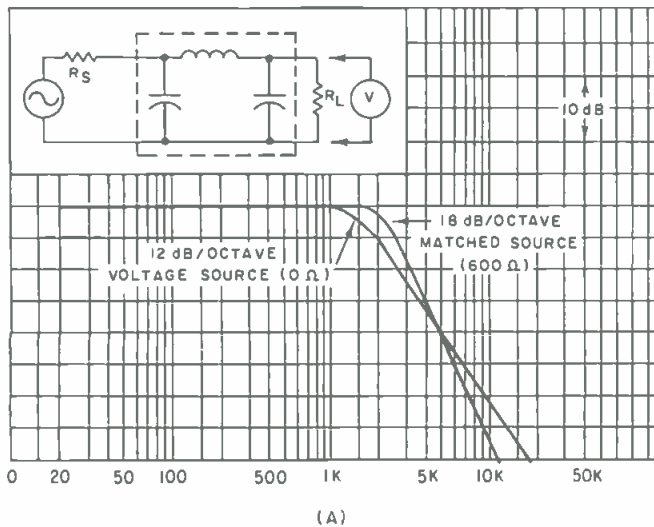


Figure 10. A nomograph for calculating terminal resistance.

is in matching the measured value to some desired value. FIGURE 9 illustrates a quite typical daily situation for the sound system installer. A set of passive equalizers is placed in a link circuit between a mixer and a power amplifier. The output of the mixer is labeled 600 ohms. Don't you believe it, however. A quick Z measurement

reveals it is really 130 ohms. The passive filter set needs to be fed from a true 600 ohms. 470 ohms in series with 130 ohms adds up to 600 ohms. (Balanced circuits would have half this value divided in each leg.) This is fine, but we have added extra loss in the circuit. How much is it when we go to adjust gains and losses for the system

Figure 11. At (A) is seen a PI network matched load, while at (B) is shown a PI network infinite load ($R_L = \infty$).

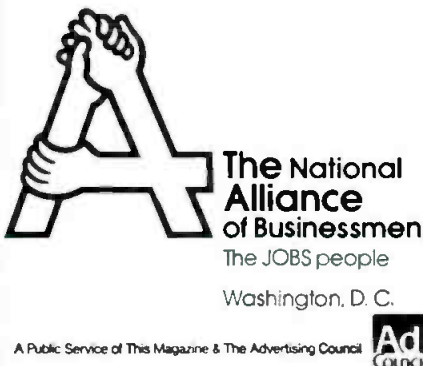




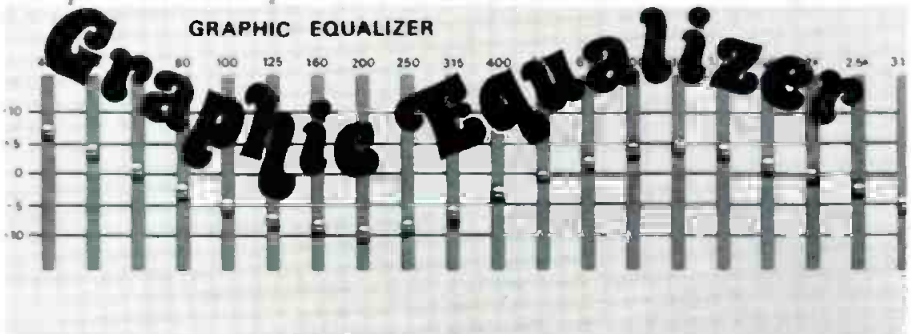
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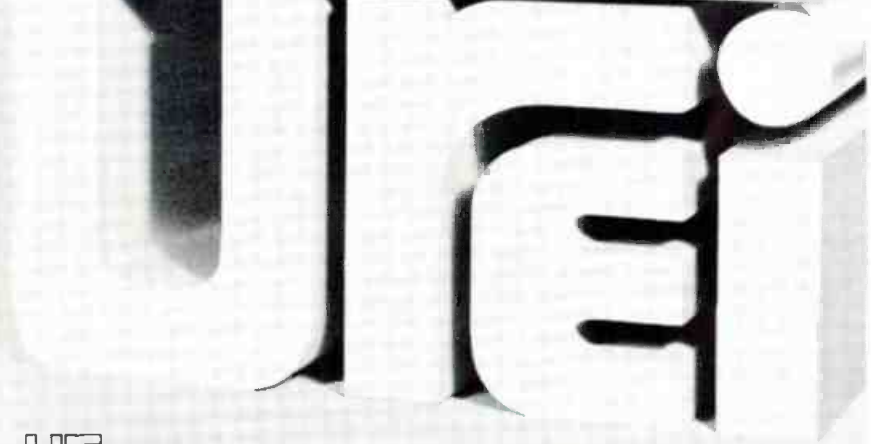
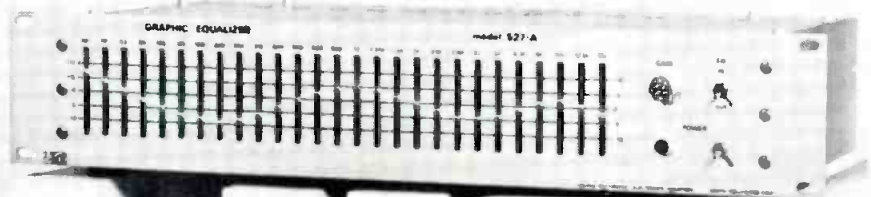


The Most



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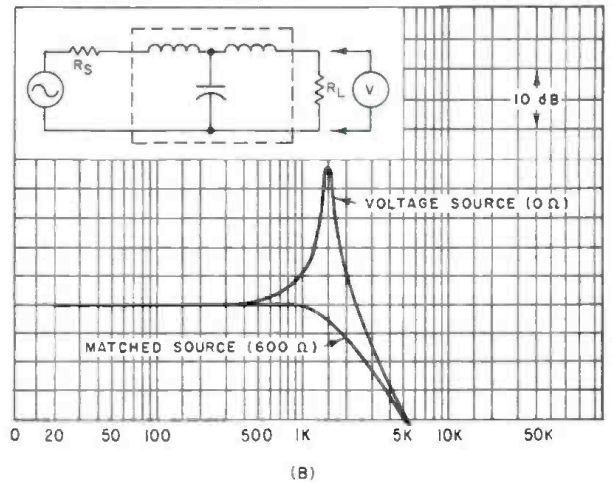
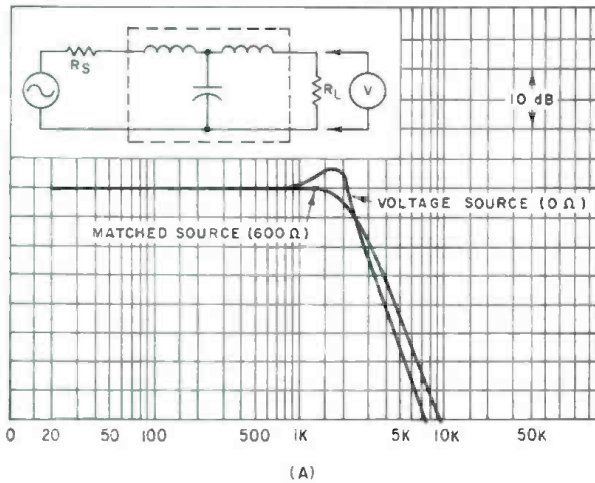


Figure 12. At (A) a T network matched load; at (B) a T network infinite load ($R_L = \infty$).

as a whole? Going back to FIGURE 8, the solution is worked out at the bottom of the illustration.

Now, we have an additional problem. The output of the passive filter set should also see 600 ohms. The input to the power amplifier is also labeled 600 ohms and it should be that value. Most often it is not, due to the way the gain potentiometer is wired. A quite typical case is the 1200 ohms shown in FIGURE 9. Because this input Z is higher than the desired Z , it should be shunted with a terminating resistor. FIGURE 9 shows the calculation and FIGURE 10 is a nomograph showing the solution of the same problem by placing a straight edge from R_L across R_0 to read R_T . Again, FIGURE 8 shows the calculation of the loss caused by the insertion into the circuit of this terminating resistor.

CONSEQUENCES OF FAILING TO PROVIDE MATCHING

In the case of passive filters, equalizers, and attenuators, failure to provide detailed buildouts and terminations is shown in FIGURES 11, 12 and 13.

FIGURE 11(A) shows a low-pass "pi" filter. This is not a constant impedance network, since at some high frequency the capacitors across the input and output legs will become the equivalent of a short circuit. High-pass filters exchange the positions of the inductors and capacitors, and in that case would present a very low impedance at some low frequency.

In the case of the three element circuit shown in FIGURE 11(A), each element should provide 6 dB per octave of attenuation for a total combined attenuation of 18 dB

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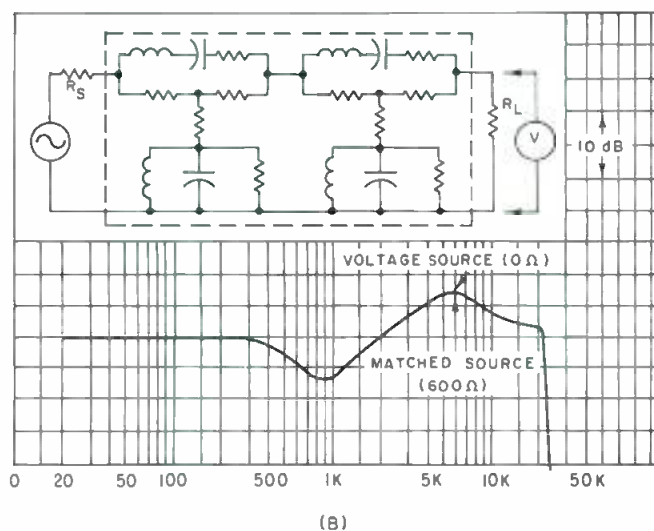
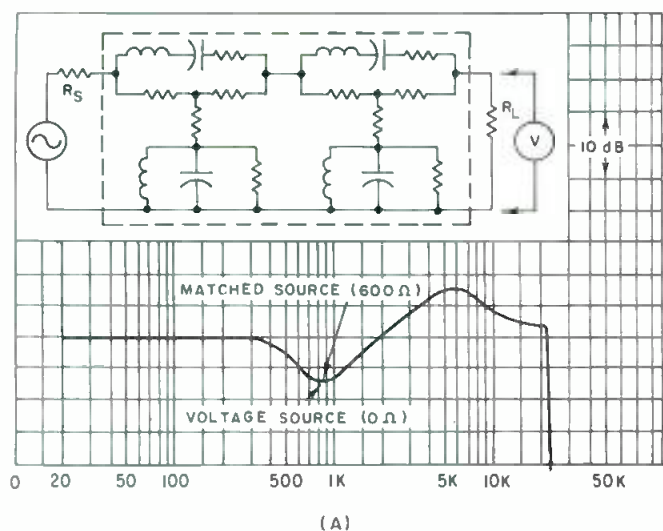


Figure 13.

per octave. This would be true whenever the filter was connected to a matched source (assume it sees a matched load).

If this filter were to be connected to a zero impedance source, then the input capacitor of the filter would have no effect since, by definition, the output voltage of a zero impedance source is not affected by load. In this case, our filter would be reduced to a two element filter of the "L" type providing only 12 dB per octave of attenuation.

A side effect of connecting some amplifiers to such a load without using build-out resistors would be the increase in intermodulation distortion from signals appearing on the slope of the cutoff region where the filter represents a downward mismatch to the amplifier.

Now, let's look at the effect of changing the termination of the filter since, in the cases above, we assumed it was properly terminated. FIGURE 11(B) illustrates first the condition of being attached to a matched source, but an infinite load impedance. A +3dB "bump" is the penalty paid for this failure to shunt this high impedance with a proper value terminating resistor.

If we were, however, to ignore both the build-out resistor and the terminating resistor and arrive at the condition where the filter was driven from a zero impedance source and loaded with an infinite impedance load, then the upper curve in FIGURE 11(B) is the type of "out of control" situation we can encounter. If we examine the diagram for this filter, we can see that this is a logical outcome of the failure to match impedances correctly. The series inductance and the output capacitor of the filter form a series resonant circuit across the output of the generator. The current and resonance are limited only by the coil "Q." Since the output voltage appears across one leg of the series resonant circuit, output voltage, like current, is limited only by coil Q. When a load is placed across the output, this tends to reduce Q and limit voltage rise. If the source resistance is raised from zero, it will limit current in resonance, hence limit voltage rise across the output.

What can we learn from this basic example? That a simple "pi" filter needs to have both its input and its output impedances matched carefully if its design parameters are to be properly employed.

FIGURES 12(A) and 12(B) go through the same exercise again, only this case the circuit examined is a "T" network.

FIGURE 12(A) shows the results of connecting the filter to a matched load and first measuring it with a matched source attached and then with a zero impedance source attached. In this case, the zero impedance source causes a rise of approximately +3 dB prior to cutoff. This is

caused by the resonance of the first two elements of the filter.

FIGURE 12(B) shows the drastic effects of operating this filter without proper termination. If the source is matched, but the output is not, the attenuation rate is reduced from 18 dB per octave to 12 dB per octave. If this filter is left with an infinite load impedance and also connected to a zero impedance source, then the unhappy effects of the upper half of FIGURE 12(A) are the result.

Once again, we can learn from these examples that "pi" and "T" networks should be carefully matched to their source and output for smoothest response and accurate ultimate attenuation.

Our third example is the "bridged-T," constant impedance network with limiting action. This circuit family has a very widespread usage today in room-sound system equalizers. Because the resistors in these networks sufficiently control coil Q, the response of such a circuit is virtually unchanged by mismatch of source or load impedance.

FIGURE 13(A) and 13(B) show how the response of these circuits are unaffected by zero impedance sources or infinite impedance loads. It is still wise to build-out and terminate such circuits because the usual practice is to employ either "pi" or "T" networks in the same link circuit for cutoff filters, etc.

Having examined these sample cases, we can now list three main reasons for making impedance measurements in audio link circuits:

1. To aid in gain calculations.
2. To calculate the proper build-out resistor value.
3. To calculate the proper terminating resistor value.

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PEOPLE, PLACES, HAPPENINGS

● An international sales agreement has been signed, designating **Westlake Audio**, of Los Angeles, as distributor of tape recording systems manufactured by the Swiss **Studer Franz Ag.** The most advanced Studer unit, 24-track model A80/VU-24-2, will be available through Westlake. Demos can be arranged by contacting Westlake.

● A major sale of interest has been made by the **Ampex Corporation** who have sold its 150th MM-1100 second generation multichannel audio recorder/reproducer to **Compact Video Systems**, of Burbank, California. The milestone sale was part of a system amounting to more than \$500,000. The MM-1100 is the only commercially available audio recorder/reproducer which will accommodate 16-inch tape reels using two-inch audio recording tape. Ampex was the pioneer in this field, producing the first such instrument, MM-1000, in 1968.

● **The Society of Broadcast Engineers** celebrated their tenth anniversary at the NAB convention in March. Inspiration for the formation of the organization came from an editorial written by **John H. Battison**, who served the first two terms as its president. The first official meeting was held in Chicago in April, 1964. The thirty two chapters of the society across the country serve their members in various ways. New developments in broadcast technology are disseminated through the organization's journal and other educational efforts are furthered. The society is interested in enhancing the position of broadcast engineers in general and in aiding the advancement of both the experienced technician and the novice. Hospitalization, major medical policies, and term insurance at group rates are offered to members. The SBE mailing address is P.O. Box 88123, Indianapolis, Indiana 46208.

● **Audio-Video Concepts, Inc.**, of Washington, D.C. has announced the appointment of **Bill E. Smith** as production supervisor, managing all phases of the firm's studio operations. Mr. Smith has had a career as a performer, music teacher, and electrical engineer. Before joining Audio-Video, he was associated with the **Jordan Kitt Music** company.

● **Rex C. Bradford** has been named manager of digital head engineering by **Nortronics Company, Inc.**, Golden Valley, Minn. Mr. Bradford will be in charge of a group which has responsibility for the development and design of magnetic heads for computer peripheral equipment. Before joining Nortronics, Mr. Bradford worked as a consulting engineer with **Magnetic Head Corporation** and then in a private capacity. He was previously with **International Business Machines Corporation**.

● **Broadcast Electronics, Inc.**, of Silver Spring, Maryland, and **Audio Interface Systems, Inc.**, Birmingham, Alabama, have jointly announced a long term agreement whereby all Audio Interface production facilities will be converted fully to the production of Spotmaster electronic products. The full manufacturing output of Broadcast Electronics facilities and those of Audio Interface will be marketed and serviced by the Broadcast Electronics organization.

● **TEAC Corporation of America**, of Montebello, California, has signed an exclusive U.S. distributor contract with **Kensonic Laboratory, Inc.**, Japanese manufacturer of Accuphase electronic audio equipment. Scheduled to be on the market this spring are three models, P-300, a high powered 300-watt rms main stereo amplifier, C-200, a pre-amplifier that will accept any kind of input, and T-100, an a.m.-f.m. tuner.

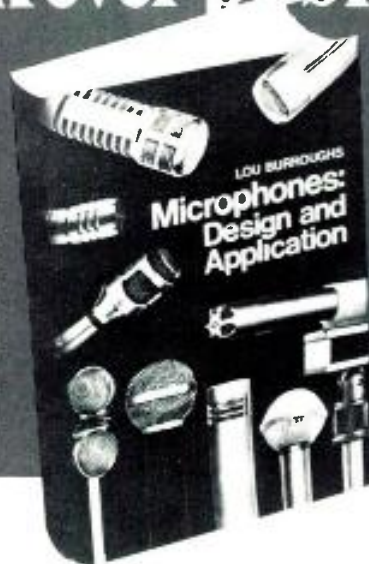
● The tape duplicating division of **Superscope, Inc.** of Sun Valley, California, has been awarded a one-year contract with the American Forces Radio Network to reproduce on tape 84 hours of programming weekly for airing on U.S. Navy ships. American Forces Radio programming is put together from original shows recorded by disc jockeys at the network's headquarters and studios in Hollywood. The new program will be distributed to a total of 580 ships.

● An enlarged program of scholarship aid for graduate and undergraduate study in the academic year 1974-75 has been announced by the **Society of Motion Picture and Television Engineers**. Amounts up to \$5,000 will be awarded to qualified graduate students for study and research in the sciences and technologies related to the production of motion pictures. Two grants for undergraduate students will also be available. To be eligible, a student must have completed two years of college and be presently enrolled in or admitted to a recognized college or university with the objective of a degree in one of the related fields, such as the sciences of optics, acoustics, electronics, and chemistry. Business, management, and standardization, relating to these fields, will also be considered. Application forms may be obtained from SMPTE Headquarters, 862 Scarsdale Ave., Scarsdale, N.Y. 10583.

● Announcement has been made by **Superscope**, of Sun Valley, California of the appointment of **Gene Block** as national sales manager for special tape products. Mr. Block's particular area of interest is the educational "Story Teller" tape series, which he hopes to expand to reach 25,000 retail outlets. Prior to coming to Superscope, Mr. Block was associated with **Columbia Records**, **Gulf-Western**, and his own firm, **Creative Marketing Consultants**.

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