ISSN 0011-7145

db

THE SOUND ENGINEERING MAGAZINE

MARCH 1974 $1.00

We repeat.

Being the best in duplicating equipment isn't easy.

That's why we at Electro Sound design our professional tape duplicating system to be both durable and versatile. Long lasting hardware. Mono through eight channels; reel, cassette and cartridge formats. And Quad, too!

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Whether you duplicate retail music, broadcast syndications or "spoken word" cassettes, Electro Sound has a system for you. After all, the giants who pioneered the industry, as well as those just joining it, are using Electro Sound systems in 30 countries.

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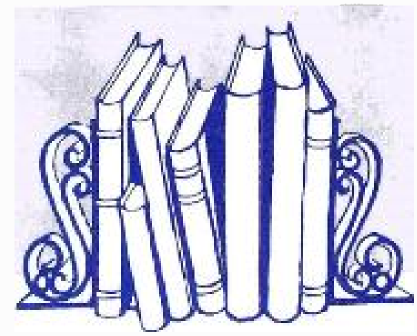

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E.P.M. Parabolic Microphone

What is it?
The Dan Gibson EPM Parabolic Microphone is a device designed to gather high-quality sound from a distance. The EPM is to sound recording what the telephoto lens is to film.

What models are available?
The EPM comes in two basic versions: the Electronic and the P-200. For ultra-critical sound recording such as music recording, the Electronic is recommended. For less critical work, such as surveillance or nature photography, the P-200 is the most economical route.

What are the general features of both EPMs?
Both the Electronic and P-200 EPMs feature a ¼"-20 mounting thread in the handle. This allows easy adaptation to tripods or camera mounts. The "dish" size is 18¾". The recordist can easily see his "target" through the transparent shield and a built-in sight is provided to accurately pinpoint sound.

What are the features of the EPM Electronic?
The Electronic operates from two easily obtainable 9 volt transistor radio batteries. Its built-in modular circuitry produces amplification of the signal and a feed to the high-efficiency monitoring headset which is included. Virtually flat response from 250Hz. to 18,000Hz. is accomplished by the internal electronics. The effective recording range, under ideal conditions, is up to ¾ mile. The EPM Electronic comes with its shielded output cable "pigtailed."

Output impedance of the Electronic is a nominal 150 to 600 ohms (low-impedance). An equalization switch for "speech" and "music" effectively changes the roll-off characteristics for recording under different conditions. A low frequency built-in tantalum wind filter eliminates unwanted sounds below 150Hz.

How does the P-200 differ from the Electronic?
The physical characteristics of the P-200 are identical to the Electronic. The P-200 has no electronics. Sound output from the specially designed and focused microphone module is fed directly to the "pigtailed" output cable. The P-200 may be wired for high or low impedance. Sound monitoring from the P-200 must be done from the input device, since there is no provision for direct headset monitoring as in the Electronic.

What are the best input devices?
Any high quality tape recorder may be used wtth either the Electronic EPM or the P-200 EPM. A simple cassette unit will adequately record all but the most critical sound. For super-critical motion picture recording, a location syncronous recorder, such as a Nagra, Arrivox-Tandberg, Stellavox, etc. is recommended. Dut to susceptability to acoustical feed-back, the EPM Parabolic Microphones are not recommended for public address system use, unless the audience is isolated from the sound source.

What are some of the applications of the EPM?
The EPM may be used for feature and commercial films, interviews, press conferences, etc. It eliminates the need for lavalier mikes, microphone booms and the clutter of microphone cables. All film applications, of course, apply equally to VTR, CCTV and radio.

EPM's are ideal for school and training applications. The subject is more at ease, more confident and less inhibited without the distracting presence of close or moving equipment.

In the industrial or commercial fields, EPM Parabolas can be used in conference rooms, in research and development situations, and in industrial equipment analysis. Surveillance and security are prime uses.

The Gibson Parabolic Microphones were originally designed for environmental recording. In addition to the above applications, they are unsurpassed for nature and wildlife recordings.

Model P-200
$119.50 with case

Electronic Model
$299 with case

Specifications

Microphone: Controlled dynamic with large diaphragm.

Frequency response: Electronic: 250-18,000Hz. ± 5dB. P-200: 300-10,000Hz. ± 5db.

Cable: High quality, 100% shielded. Terminated in "pigtail." May be wired for balanced or unbalanced output as required by user.

Shield: Diameter 18¾". Made of non-resonant transparent, high-impact plastic. Temperature range —10°F to 104°F.

Headset: (Electronic model only) High quality, lightweight, high efficiency. Cushioned earcup to seal out extraneous noise.

Carrying case: High density styrofoam. Vinyl covered. Temperature range —10°F to 104°F.

Weight: Electronic: 5½ lbs. P-200: 3½ lbs.

Send check or M.O. to:

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P.O. Box 35, Great Neck, N.Y. 11021

Please send me ____ Model P-200 @ $119.50 and/or ____ Electronic Model Parabolic Microphone @ $299.00. N.Y.S. residents add 7% sales tax. I enclose $__________.

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COMING NEXT MONTH

● Oscar Burke concludes his penetrating study of the decibel. These two parts combine to make the reader authoritative on the deepest usage of the decibel as an audio tool.

Don Davis returns to our pages with a two-parter beginning in April called IMPEDANCE MATCHING FOR THE SOUND ENGINEER. There is some math involved, of course, but the usual Don Davis lucid explanation of the subject matter can be expected.

Early May (the 7th through the 10th) is Los Angeles AES Convention time, so the April issue is the pre-show issue and will have the usual schedule of events, list of papers to be given, and exhibition map.

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

● Our cover is a reproduction of an Egyptian arched harp, lute, double oboe, and lyre. This is from a tomb painting found in Veset (Thebes) and has been dated as having been painted circa 1420-1411 B.C.

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THE SOUND ENGINEERING MAGAZINE

MARCH 1974 VOLUME 5, NUMBER 3

db is listed in Current Contents: Engineering and Technology,

db, the Sound Engineering Magazine is published monthly by Sagamore Publishing Company, Inc. Entire contents copyright © 1974 by Sagamore Publishing Co., Inc., 980 Old Country Road, Plainview, L.I., N.Y. 11803. Telephone (516) 433 6530. db is published for those individuals and firms in professional audio-recording, broadcast, audio-visual, sound reinforcement, consultants, video recording, film sound, etc. Application should be made on the subscription form in the rear of each issue. Subscriptions are $6.00 per year ($12.00 per year outside U. S. Possessions, Canada, and Mexico) in U. S. funds. Single copies are $1.00 each. Controlled Circulation postage paid at Harrisburg, Pa. 17105. Editorial, Publishing, and Sales Offices: 980 Old Country Road, Plainview, New York 11803. Postmaster: Form 3579 should be sent to above address.

letters

The Editor:

The January issue of **db** contains an article entitled Low Cost Four Channel Remote Box. The unit is built around an AA-300 printed-circuit amplifier.

A check with the manufacturer showed that the AA-300 is out of production and no longer available anywhere.

However, the AA-100 is available. This unit has slightly less gain, a higher input impedance, and an on-board gain pot. The response is 100 to 12 kHz, whereas the AA-300 went to 20 kHz.

The complete address of the manufacturer is:
RHA Audio Communications Corp.
625 60th Street
West New York, N.J. 07093

James Murphy
Chief Engineer
WAJR
Morgantown, W. Va.

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Introducing the new "C." Our best AG-440 yet.

Introducing the Ampex AG-440C. Latest model in an unbroken line of the world's most respected professional audio recorders. From the company that produced the very first professional audio tape recorder and has always been the standard of excellence against which all others are measured.

Ever since we produced our first AG-440 unit, delighted users have been kind enough to share with us their ideas to make a great machine even better. It was user suggestions that helped us design the AG-440B, and it was user suggestions again that inspired the new AG-440C.

Users requested **improved tape handling,** so we installed sapphire tape guides for less skew, tighter phase stability, and improved high frequency/high amplitude performance.

Users requested **easier editing,** so we redesigned the transport to allow tape spilling without going through the tension arm.

Users requested **motion sensing,** to allow them freedom to push any transport command button at any time, without fear of breaking the tape or stripping a gear. We installed the extra circuits and controls to make this possible.

Users requested **automatic monitoring in Sel-Sync mode,** so we made the switchover from output to input channel automatic whenever the Sel-Sync command is "record."

Users requested **more linearity at the high end,** so we extended the high frequency response as far as we could. Now the AG-440C is the world's flattest machine — from 30 to 25,000 Hz.

Users requested **pushbutton record/playback selection** for each channel. The knobs are gone, the buttons are in their place. And you can read the indicators all the way across a studio.

Users requested **stationary capstan mode.** Now you can cue up for a fast start almost as well as with a disk turntable.

Users requested **detent channel setup** for quick, positive return to preset levels following calibration. We complied.

There are a lot more than the eight improvements we listed above, and a few of the new wrinkles came from our labs as the result of continuing research programs. The overall result is the very best professional tape recorder available for broadcast, production, mixdown, or general utility soundwork.

Learn all about the user-designed AG-440C. Send for our free brochure titled BY SPECIAL REQUEST. It'll make you want to join the worldwide club of satisfied Ampex user/designers. Write or call today.

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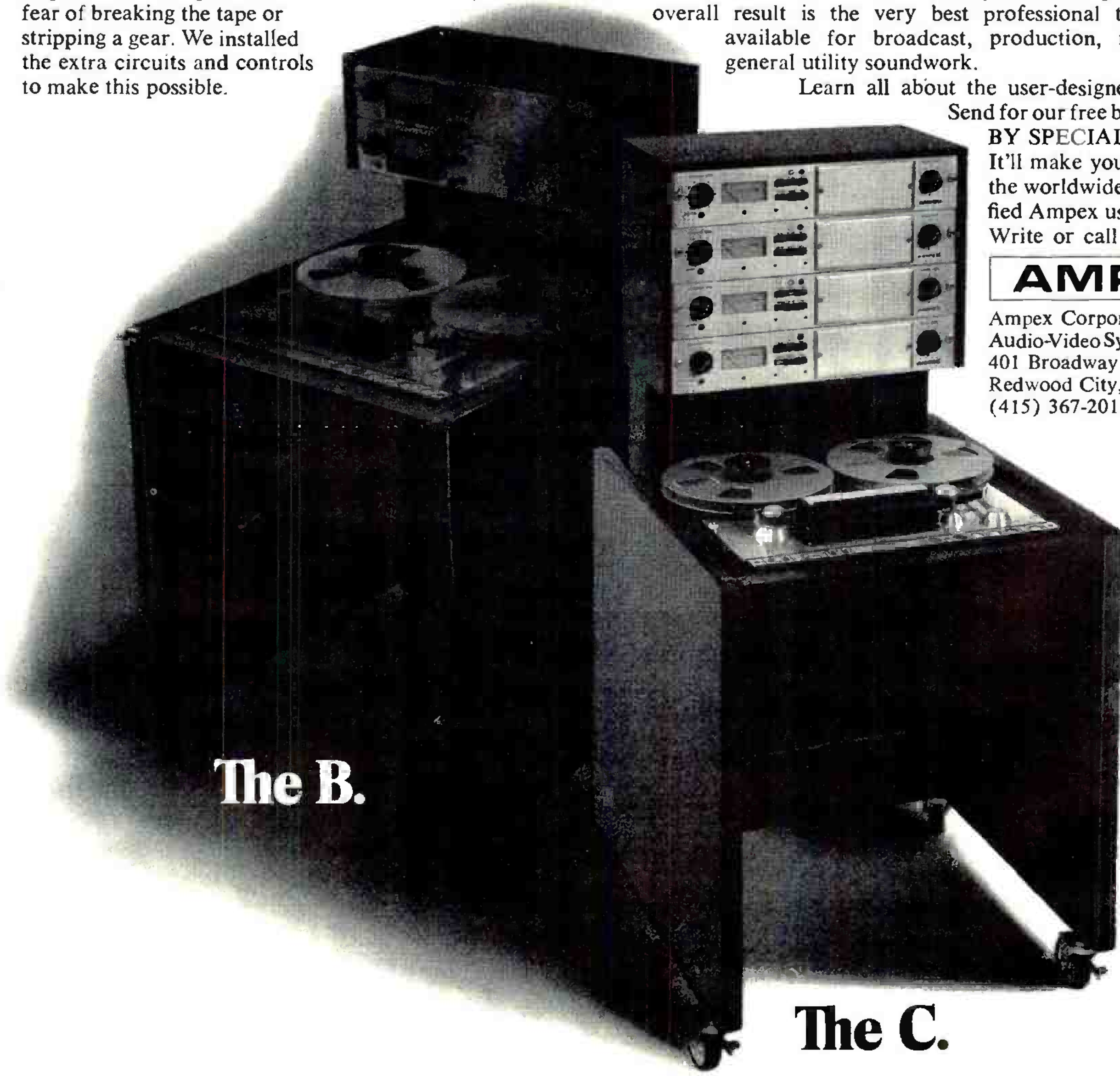


Circle 30 on Reader Service Card

Norman H. Crowhurst

THEORY AND PRACTICE

● This is being written just before Christmas, although you will probably not be reading it until spring is making the countryside look young again. By one of those flukes that occasionally happen in publishing, the piece in the December issue was written only shortly before this one. As I sit down to write this, I have just been answering several suggestions about what I "ought" to do, for which I am always thankful.

This magazine is subtitled "The Sound Engineering Magazine," for which reason it seems that what I write here should in some way be connected with sound engineering, as well, as in some way being concerned with the relationship between theory and practice. However, as I have commented before, readers respond much more enthusiastically when I write about education.

Not that writing about education necessarily precludes it's also being about engineering. There are several interconnections that I have addressed from time to time. Most obvious, perhaps, is the fact that the audio man's art is used fairly extensively in education, and could usually be used more effectively, although the fact that it is not may be the fault of educators rather than engineers. So that facet gets discussed.

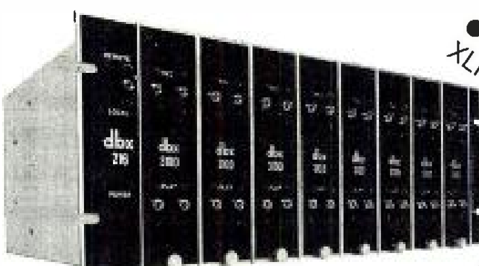
A little less obvious—but they keep intruding into the picture—are the engineering contradictions I receive, which would not arise if those who wrote them had been better educated to think things through for themselves. So I get sidetracked into the educational topic again, to comment on that.

Recently another observation triggered the same kind of association. Our family likes to watch the t.v. program, *The Price is Right.* In one of the little contests on that show the contestant has thirty seconds to guess the correct price, while the MC keeps saying "higher" or "lower," as relevant. Once in a while, a contestant does very well and wins the merchandise by following the MC's directions. More often contestants miss out by seeming to go crazy, guessing in very haphazard fashion, while the MC tries hard to help them by emphasizing *higher* or *lower*, as the case may be.

At first we attributed it to the excitement putting the contestant into a "flap." But as we studied their mistakes more carefully, it seems there is another explanation. These contestants have no idea of the significance of numbers over ten—that is, if they have two or three digits. Thus to them, $299 sounds like more than $300, because it has those 9s in it, and 9s are much bigger than zeroes, aren't they!

I sometimes make that kind of mistake in alphabetical indexing. For instance, the other day I was looking for a name that began with "Bur . . ." and found myself thinking I had gone beyond it when I came to a name beginning with "Bry . . ." It was the "y," but I did not notice the "r" sitting between. But I never make that kind of mistake with numbers. I would never make the mistake of thinking that 259 was bigger than 275, for example, which would be a corresponding kind of error.

noise reduction takes a giant step forward with the dbx 216



With the dbx 216 professional tape noise reduction system, you get every one of these advantages over less advanced approaches:

- **in excess of 30 dB of noise reduction** which gives you an extra safety margin and lets you forget about noise build-up even in 24 channel applications
- **10 dB headroom improvement** eliminates tape saturation or tape recorder overload worries
- **100 dB dynamic range** makes level setting less critical
- **no pilot tones or level matching required,** just turn on and record
- **true RMS level sensing** guarantees perfect code/decode tracking and transient reproduction throughout the record and playback cycle
- **simultaneous record and playback functions** eliminate mode switching, remote control necessity, etc.
- **spare two-channel module** supplied with a 16-channel system reduces down-time to near zero
- **complete cable assemblies** with prewired mating XLR connectors make installation a simple 30-minute plug-in operation
- **expandable modular design** allows purchase of as few as four channels, with easy subsequent expansion to 8, 16, 24, or any number of channels
- **typical 16-channel simultaneous record/playback noise reduction system** with spare module and cables, ready to install costs $8,200
- **available from** professional audio dealers or the factory

dbx, Incorporated, 296 Newton Street, Waltham Massachusetts 02154

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However, I might make that kind of mistake if it was a telephone number or a machine part number instead of a count or a price. In other words, if I am looking at numerals as identifications rather than as values, I see them differently. What does this tell us? It could be that most people do not read prices as values, just as a sort of label. Very few check their change, possibly for the same reason.

I'm often asked for material on good teaching practices, particularly relevant to engineering, especially dealing with this business of seeing things clearly and accurately. According to educator Carl Salser, the most efficient approach is to use individualized instruction so the teacher is freed to deal with specific difficulties instead of trying to keep the whole class at the same place in their studies. And this is in **db**'s ball park in several ways. Not only are properly trained individuals necessary for the right functioning of engineering situations, but the very materials used in in individual instruction—such as cassettes and recordings—are often the direct business of audio people.

Individualized instruction, like any other form, can be misused. This brings us to the core of the matter, the instructor. What is the proper role for the teacher and other members of the educational fraternity if today's system is to really fulfill the expectations that taxpayers somewhat legitimately have somewhere back in their grey matter?

What my own mind keeps coming back to is that a good teacher can allow a whole classroom full of students to *study* individually without needing to have a special form of individualized *instruction*. True, as Carl insists, having good individualized instruction makes doing that much easier, but it only works *if that is what the teacher wants to do anyway*, which all too often is not the case. The fact is, most teachers are plain scared of the notion of having a whole roomful of students, each studying something different from all the others.

Let me use an analogy. If you know how to drive, you can drive along any highway in the United States. You do not need to have memorized the entire road map of the United States, before you can leave your own front door, do you? The important things to learn are how to drive, on different kinds of highway, in different types of vehicles, in different weather conditions, how to read road signs, and how to read a road map.

With that kind of preparation, your drivers' ed instructor can sign you out, have you pass your state's driving

test, and off you go on your own, wherever you want to go. Why can't learning be like that?

Honestly, can someone give me a reason why it can't? Because I really believe it can be like that. In a great variety of situations, I have found that approach works, every time. Just help the student to learn how to find out what he needs to know or do, and he can learn anything he wants to. I don't have to know all the stuff he expects to learn, before I can let him loose on it, any more than the Dallas drivers' ed instructor needs to know Chicago before he can let someone he has previously taught to drive take a plane to Chicago and rent a Hertz car there!

When the teacher starts to view his role that way, he will cease to worry if he finds he does not know something the student is trying to learn. It's the student's task to find that out, not the teacher's. What the teacher needs to know is *how to go about finding out*. But teacher does not have to *do* the finding out. In fact, it is better if he lets the student do that. Students will have difficulties, of course. That is why they have to learn. It still is, or should be, the job of teachers to help them with those difficulties. The teacher needs to know the *game plan* for good learning, *not* all the answers. Instead of which, most teachers have their own game plan, which usually has nothing to do with learning, unfortunately.

With some teachers, if the student can somehow get hold of the correct answer, from the back of the book, from another student, or somewhere, and then fudge something that looks like working, he has it made. So that becomes the game plan. The student will never in a million years learn to solve a problem that way, but he *will* get those necessary passing grades!

This has become so much an integral part of the system that, as I commented previously, when a good teacher starts to encourage a student who is apparently good—meaning he has always gotten passing grades—to find out how to solve problems for himself, the poor student does not know "what teacher expects of me." That is a game plan the student has never encountered before!

Perhaps some readers are more aware of the truth of this than I am, because I still have trouble believing it—it is so different from the way I learned what school taught me. Nowadays, it appears, the straight-A students are the ones who acquire all the known "game plans:" the teacher who expects it done this way, that way, whatever. This is because teachers who do not think, and do not

Martin Dickstein

SOUND WITH IMAGES

● Some months ago, this column was devoted to a two-part discussion on the care of audio/visual equipment. The second segment dealt with 16mm projectors, and several questions were raised as originally voiced by equipment users who felt that they would appreciate getting more maintenance hints from the audio/visual suppliers. One of the questions that had come up had to do with whether it was better to run a projector's fan after the lamp was off following a showing or whether it made any difference at all to the life of the lamp. We then requested that our readers let us know of their experiences.

Among the answers came a letter from William A. Kingman, Chief Engineer of Stations KTHO and KTHO-FM, South Lake Tahoe, California. He makes some very interesting and enlightening comments on the subject, and is most qualified in this matter, as you will see. We thank him for the letter and his permission to use the major portion of it.

"It has been my experience that cooling of a projection lamp cannot be excessive. Common life expectancy of a projection lamp runs 10-15 hours; by leaving the cooling fan running until the vented air is no longer hot, I have experienced almost double the normal lamp lifetime many times. I equate this to the case of automobiles: when you turn the ignition off, cooling circulation ceases and the engine temperature literally skyrockets. In projectors, this effect can be seen sometimes in the form of a bubble or lump on the projection lamp's glass where it becomes so hot as to be soft: Bell & Howell 16mm sound projectors seem to be particularly prone to this situation if not permitted adequate cooling by fan after the lamp is turned off. It is not possible to cool the lamp below the ambient room temperature (unless the air is from a cooler source than the room), evidenced by the fact that a thermometer held in front of a fan does not show a temperature change.

"Assuming proper projector cooling design, probably the two most influential factors in lamp life are adequate 'after cooling' to avoid the sky-rocket-heat effect, and proper line voltage to the lamp. A mere difference of 5 percent in line voltage can change lamp life by 50 percent. By running the projection lamp at 5 percent under its rated voltage, it may last 50 percent or more longer than normal. However, it will deliver 10-15 percent less light output (lumens). We can't get something for nothing! Some projectors now provide switchable voltage levels for the lamp to extend lamp life; the switch labelled 'Low' and 'High' is the typical case (Eastman Kodak). Ideally, the lamp should be started at low voltage and then adjusted *up* to the desired output.

"Another important point in extending the life of a projection lamp is avoiding line voltage surges. Most projectors are wired so that the lamp cannot be turned on without the cooling fan (projector motor) operating first. In older projectors, the separate two 'Motor' and 'Lamp' switches were wired in series for this purpose; many new machines use a common 3-position switch with lamp voltage supplied in the third position. The reasons for this are twofold: the lamp cannot operate without cooling, and the a.c. cannot blow the lamp with excessive voltage. Whereas the 3-position switch projectors protect themselves, the 'Motor' and 'Lamp' separate switches on older projectors can be operated erroneously with exactly the opposite result—a destroyed lamp. For example, an operator turns on the 'Lamp' switch first and nothing happens; then he turns on the 'Motor' switch and an enormous a.c. surge hits both the motor and lamp simultaneously! Moral: *Always* turn on the motor *first*, and always turn *off* the motor *last*.

" . . . I would like to note another aspect of 16mm sound projectors: the sound head. In many respects, the optical sound system resembles the methods of the magnetic tape recorder in obtaining proper adjustment, in terms of azimuth and zenith, and, to the analogous extent, head gap. It has been my experience that the sound head receives less attention than the other items maintained in most 16-mm projectors, yet its proper adjustment is as rewarding as cleaning a clogged tape head or replacing a flattened phonograph needle!

"Essentially, the very narrow slit of light from the sound exciter lamp must be adjusted to the optical sound track just as the narrow gap of a tape head must be aligned to the magnetic lines of a tape for proper playback for maximum high-frequency audio response and output level. And the optical sound head is just about as touchy as the tape playback head! Different projector makes have different approaches to accomplish the same goal, physically and logistically, but the common principle remains that of focusing the slit of light precisely on the sound track. Most projectors have a form of lock nut or tightening screw which anchors the position of the sound lens. With this setting loosened slightly, very carefully but *slightly* adjust both the *proximity* and *rotation* of the sound lens with respect to the film's surface while the projector is running and you are listening for maximum high-frequency response. Far preferable to this ear-shot method would be the use of a standard test film of recorded high frequency tones while observing the output on a vtvm or vu meter, just as with an alignment tape.

"But, again, there are exceptions, and one is especially unique to film alone: emulsion side. While a tape always presses its oxide side surface to the playback head, the equivalent *emulsion* of film may or may *not* be on the surface side of the sound head. Therefore, where a projector may be adjusted for optimum performance on a film whose emulsion side presses against the sound drum surface, another film with its emulsion on the opposite side (A-wind versus B-wind) will be both out-of-focus on the screen and out-of-focus to the sound head, both to the extent of the film's

Circle 27 on Reader Service Card

thickness. The effect on the sound reproduction is not quite as obvious as threading the wrong surface of a tape across the playback head, but the cause is the same—the recorded sound is not 'focused' precisely on the playback head. This problem is as common as the number of reels of film with emulsion surfaces on opposite sides.

"Mass-duplicated prints are often wound 'opposite' emulsion as compared to your own original footage, readily evidenced by the need to refocus the image between films . . . but what about focusing the *sound* image? Unfortunately, very few projectors include this vital adjustment in their operating designs (short of making the complete alignment adjustment described above, certainly impractical for daily operation). The early model Eastman Kodak Pageant 16mm home-type sound projectors included an ingeniously simple focusing control labeled 'Fidelity' for precisely this purpose, which worked very well. It was a simple sliding lever which produced very obvious results from film to film. But Kodak eliminated this feature many years ago, either because of cost or because most people just didn't understand it and used it as a tone control! (It *might* exist still on the special Audio-Visual models—I can't confirm this.) It would be a boon to film audio if all projectors would include a sound focus control as Kodak once tried, but just as important would be *using* it!

"I hope that I may have contributed some useful information for your article someday, Mr. Dickstein. 16-mm sound projectors have been a hobby of mine since 1950."

We should like to suggest to our readers that one easy way to make use of the operating fan to cool the projector while the lamp is off is to try to rewind the film on the projector (not through the normal film path but in the speedy rewind position) rather than on table rewinds. It's easier on the arm, and faster, and will cool the lamp at the same time.

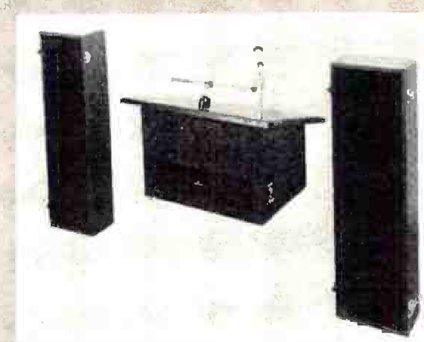
All we can add to this is that you certainly have contributed, Mr. Kingman, to the interest and enlightenment of all our readers. We thank you again for sharing your experiences and special knowledge with the rest of us.

We hope that those of our readers who have had special experiences and have gained in knowledge will contribute likewise so that we can all share in some of the thoughts and ideas you may have in any phase of the audio/visual/video fields. ■

NEW PRODUCTS AND SERVICES

PORTABLE PUBLIC ADDRESS SYSTEM

● This is a complete system, including a lectern containing the electronic circuitry, with a lamp that mounts on the top, and two microphones, one a lavalier model and the other a conventional swivel-neck mic that attaches to the lectern. The lectern also contains a storage area. Known as the Port-address, the system provides four individually controlled inputs, two for the microphones, a low-level input for a phonograph and a line input for a tape recorder or movie projector. The two loudspeakers attach together to become a single unit with an integral carrying handle.



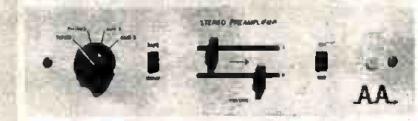
Mfr: Electro-Sound
Price: $749.00
Circle 35 on Reader Service Card

OPEN REEL TAPE DECK

● Application of speeds of 15 and 7½ inches per second and accommodation of 10½-inch reel capacity characterizes model TC-755 three-motor open reel tape deck. A servo-control motor adjusts immediately to any live voltage changes; closed loop dual capstan tape drive; Ferrite heads, with high dimensional accuracy. The deck also has a total mechnism shut-off and a mechanical memory capability that works with an optional timer to engage the tape drive mechanism at pre-set time, even in the absence of the operator. Other features include a record equalization selector and accessible bias switching for optimum performance from any type of recording tape, variable playback volume control with detents to pre-set the playback level for monitoring, two pro-type vu meters, mic/line mixing, adjustable tape height guides and a three-position microphone attenuator switch, as well as a four-digit tape counter.

Mfr: Superscope (Sony)
Price: $799.95
Circle 36 on Reader Service Card

STEREO PREAMPLIFIER



● Known as the Zero-Distortion Preamp, this unit is designed without tone controls; all tone controls and other response filtering should be accomplished in the equalizer. All high-level amplifiers have been removed, resulting in the absence of non-linear elements and making possible a circuitry which is resistive at all settings of the controls. Specifications include unity-gain on high-level inputs, no error from tone controls, flat frequency response (to d.c.), phono noise of —76 dB, equalization accurate within ± 0.5dB, and phono distortion of 0.05 percent. The Zero-Distortion Preamp can drive any equalizer or power amplifier if the input impedance is 50k or greater.
Mfr: Ace Audio Co.
Price: Kit: $69.95: Wired:$87.50.
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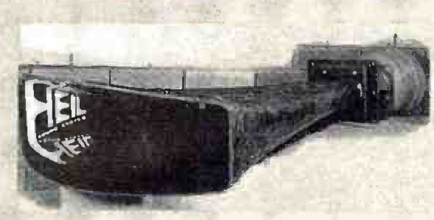
LONG THROW HORN

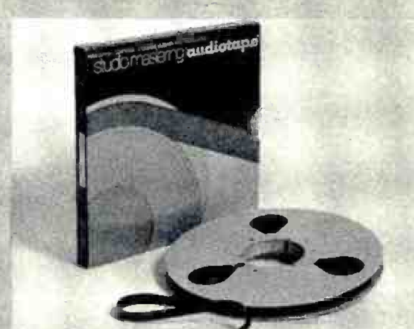


● This throw horn is forty inches long and carries 300 Hz power. Useful for focusing on back walls. Comes with a heavy duty carrying case.
Mfr: Heil Sound Systemn
Circle 37 on Reader Service Card

HIGH POWERED AMPLIFIERS

● These new amplifiers, Mark 111C and Mark 111CM, incorporate a relay protection circuit which guards the loudspeaker in the event of amplifier failure; if any d.c. or very low frequencies appear, the amp will be disconnected from the load until the problem is solved. Inferior tuner muting circuits, "flicking" the stylus clean, or dropping the needle on the record will also disconnect the loudspeaker. Both units have a rated output of 200 watts rms/channel into eight ohms. They also feature a thermal cut-out for high temperature protection, two B+ and two B− fuses; and an a.c. line fuse. They will deliver full power (40V rms) into one ufd/8 ohms at 20 kHz at less than .1 percent distortion. The amplifiers are reported not to oscillate under any load conditions, regardless of phase angle. 98 percent of all wiring has been eliminated, through the use of interconnecting P.C. boards.
Mfr: Scientific Audio Electronics, Inc.
Circle 39 on Reader Service Card

HIGH-OUTPUT, LOW NOISE PROFESSIONAL MASTERING TAPES

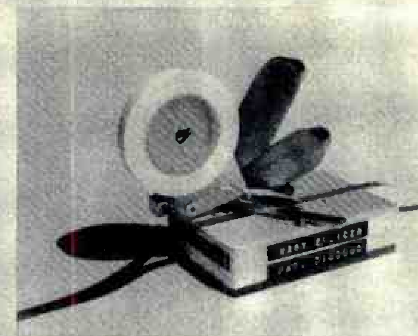


● A new iron oxide, a new binder system, and a new dispersion process are incorporated into models 2506 and 3607 mastering tapes. The tapes are reinforced by back-coating to protect them during handling and storage. They are available in two base thicknesses and lengths, both made in ¼ inch, ½ inch, one inch, and two inch widths. 2506 has a base of 1.5 mil polyester and is 2500 feet long. 3607 is 3600 feet long with a base of 1.0 mil polyester. Reel diameters for both tapes is 10½ inches.
Mfr: Audio Devices, Inc.
Circle 40 on Reader Service Card

COLOR CODED ZIPTAPE

● This cartridge of over 1,000 inches of tape is now available in the NEMA code of colors in addition to the previously offered white tape with alphabetical and/or numerical symbols. The tape is plasticized and pressure sensitive with high tac adhesive for instant use. The dispensing unit has a capacity of ten individual cartridges, each with a built-in spooling device. The tape is reasonably oilproof, waterproof, acid resistant; its vinyl coated surface will allow any vinyl marking instrument to be used. It will withstand temperatures to 270 degrees Fahrenheit.
Mfr: The Zippertubing Co.
Circle 41 on Reader Service Card

SEMI-AUTOMATIC TAPE SPLICER



● Model TS 250 semi-automatic ¼-inch magnetic tape splicer is designed to cut and position a measured portion of splicing tape with no contamination to weaken the splice. Separate non-magnetic stainless shears cut the tapes and a nylon holder, which can be raised out of the way, holds the 7/32-inch splicing tape. A .240-inch dovetail groove is hand-machined into an aluminum base. All parts are adjustable.
Mfr: NRP
Price: $49.95
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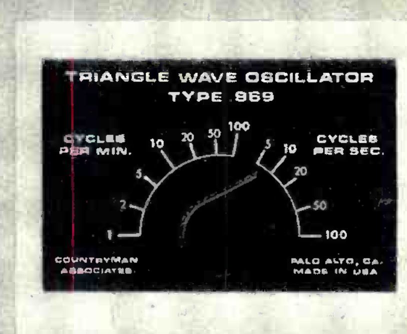
TRIANGLE WAVE OSCILLATOR



● Phasing, rotating sound and reel flanging effects can be created automatically by plugging type 969 oscillator into models 968 or 968A phase shifters. Powered continuously for one year by a self-contained nine volt battery, the oscillator covers a frequency range from one cycle per minute to one hundred cycles per second.
Mfr: Countryman Associates
Circle 42 on Reader Service Card

CASSETTE DUPLICATING SYSTEM

● Over 10,000 C-30 copies in eight hours can be duplicated by model 1200, which runs a 3¾ inches-per-second master tape at 120 inches-per-second. The master unit will handle up to twelve four-rack reel-to-reel or reel-to-cassette slaves. Each slave accommodates a 10½ inch reel and runs at 60 inches-per-second to conform with the master's 32:1 speed ratio. Using a ¼-inch master tape, the master has automatic load and unload features to cut setup time and can be run completely unattended. Test jacks are included on the front panel of the master for use in testing and alignment and for patching two systems together. Bias and equalization are adjustable for chromium-dioxide or other high-coercivity tapes.
Mfr: Audio/Tek Inc.
Price: $6,750
Circle 45 on Reader Service Card

DIGITAL CLOCK

● Form C contact closures on model DC24 digital clock adapt it for a variety of broadcast timing applications, through various optional boards. A reset board provides approximate time corrections up to four times per hour. Optional boards include a net joint board which offers exact time corrections either once or twice per hour and an oscillator time base and battery backup board which maintains exact time independent of line frequency variations or power interruptions. Controls on the front panel enable the operator to halt the clock altogether, advance the seconds counter rapidly, advance the minutes counter rapidly, or light the led display momentarily when operating on battery.
Mfr: Sparta Electronics Corp.
Price: $475 (with reset board) Net join board: $100. Oscillator/battery backup board: $125.
Circle 46 on Reader Service Card

UNIQUE WOOFER

● A full range two way loudspeaker system, model L-500A, incorporates a unique woofer with cone material which is stiff, enabling it to move like a piston at bass frequencies, yet is soft and self-damping at high frequencies to prevent cone breakup. It also incorporates a soft suspension so that it has a low resonant frequency and can move with high efficiency and accuracy. Coupled with this woofer is a one-inch diameter soft-dome tweeter that weighs 0.2 grams and operates in a magnetic field of 15,000 Gauss. It is claimed that break-up is prevented by suspending the tissue dome by its own sealed acoustic chamber and by damping out resonances with damping fluid. Available in walnut or white.

Mfr: Braun (Distributor: Analog + Digital Systems, Inc.)
Price: $129
Circle 47 on Reader Service Card

CUSTOM CONSOLES

● Several new versions of the Centurion series custom consoles are being offered, a monaural 12-mixer version (Centurion I), a 6-mixer stereo (Centurion IV) and a 6-mixer mono (Centurion III). These new models join Centurion II, the stereo (quadriphonic capable) 12-mixer version. Six-mixer mono or stereo extender panels have also been devised for the series, giving up to 18-mixer capacity in a single system. Available options in all models include slide or rotary attenuators, interchangeable mixer modules, digital clock, etc. The consoles feature electronic pushbutton switching, motherboard-type construction, and replaceable or additional mixer modules.

Mfr: Sparta Electronic Corp.
Circle 48 on Reader Service Card

CLAMP METER

● Volts, amps, and resistance can be measured by models 300/600 and 1200 clamp meters. The meter is clamped around one conductor and the current read on the graduated scale. Current ranges to 1200A, voltage ranges to 600V, and resistance measurements to 5,000 ohms are standard. The clamp meter also comes equipped with lead wires for voltage measurements, a special adaptor for resistance measurement, and a carrying case. Model 300/600 measures wire sizes to 1.02 diameter and model 1200 measures wire sizes to 1.889 diameter.

Mfr: Panasonic (Matsushita Electric Corp. of America)
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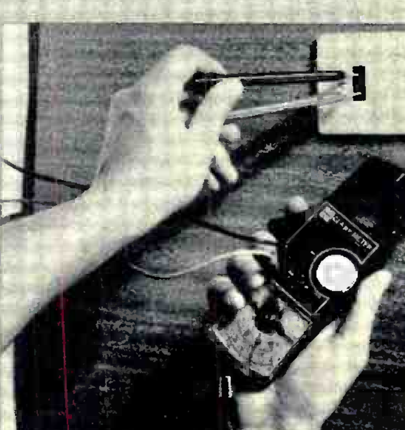
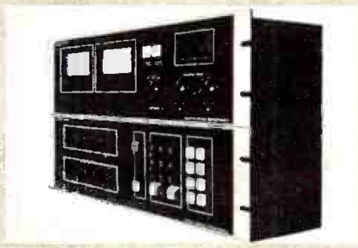


STEREO POWER AMPLIFIER

● Two ohm loads can be handled by model 250 amplifier, a smaller version of model 500R, from the same manufacturer. Model 250 has modular construction, with each channel on its own removable heat sink assembly. Other features include SCR crow bar circuitry, and a high speed circuit breaker. Each output stage uses six 15-amp single diffused power transistors. The unit is packaged in a cabinet having a 5¼ inch high rack panel.
Mfr: BGW Systems
Price: $429
Circle 50 on Reader Service Card

MODULAR AUTOMATION CONTROLLERS



● CD28 series of modular automation controllers can be inserted into existing systems without extensive rewiring. The basic system handles up to 2,000 events and twelve audio sources with full random access. Accessory extended memory modules expand the system to 8,000 events of pre-programmed broadcasting. To program the system, a standard input keyboard is utilized for data entry in-plays to the mos memory; led displays show the event number, function, and program source. All CD28 units interconnect by plugging them in to one another. A temperature control tunnel promotes cool air flow through the control logic.
Mfr: Control Design Corporation
Circle 51 on Reader Service Card

LOW DISTORTION EQUALIZERS

● Two models, Mark 700 and Mark 2700 equalizers, offer low distortion tone control systems, designed to alter the frequency response, octave-by-octave of any sound system. Mark 700 incorporates eleven stereo level controls, ranging from 40 Hz to 20 Hz. Each control automatically varies both channels simultaneously. The Mark 2700 features eleven separate equalizer level controls for each channel. Both units have 22 toroidal LC bandpass filters with 12 dB/octave slopes; dual range: variable to ± 16 dB or ± 8 dB; 0 dB center detent position on all equalizer level controls; EQ defeat switch; 600 ohm output impedance.
Mfr: Scientific Audio Electronics
Price: Mark 700: $550; Mark 2700: $600.
Circle 52 on Reader Service Card

DOUGLAS C. MYERS

An Integrated Circuit Headphone Amplifier

Broadcast engineers take note. This article tells you one way to get the disc jockey to handle the audio the way it should be done, rather than the way he thinks it is to be handled.

In broadcast and recording equipment, the monitor is typically the most neglected component. Program material is moved from source to destination with the utmost of care, but provisions for the fellow in the driver's seat are only an afterthought. The circuit developed here provides a simple, low-cost module which may be used for a variety of high quality monitoring purposes.

At my facility, the need for improvement in the monitor system was pointed out when an announcer complained about distortion in a tape recorder. A quick listening test showed no noticeable distortion, so I asked him to record with the idea of doing an A to B comparison. He promptly lowered the carefully adjusted inputs to the record amplifier, switched off the console vu meters, opened the mic pot and masters to maximum, and began shouting at the mic.

I tactfully asked if he could give me some pointers on his recording technique.

He always turned the vu meters off, it seemed, because they made an annoying click as they banged against the stops and it was necessary to turn the pots to maximum so he could hear what he was saying. After he had the head-

Douglas C. Myers is chief engineer of WGSA and WIOV in Ephrata, Pa.

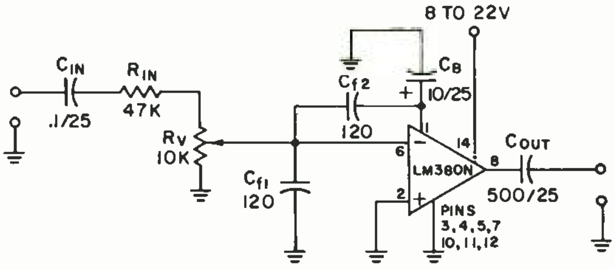


Figure 1. A general purpose monitor amplifier.

phones properly adjusted, it was only a matter of turning the recorder input controls to calibrate them to the headphones.

Since I spend considerable time testing for noise, distortion, and response in our studios, my reaction was predictable—this was a particularly ignorant procedure to be used by a supposed professional. On reflection, though, I had to admit that he was probably doing his best to work with what he had. After all, his job was to produce sound—not vu's. And while meters make a useful tool, the only meaningful way to evaluate the final product was to listen. So I decided to work on the headphone levels. (Just in case ignorance *was* involved, I gave my views on overdriving equipment—he seemed more interested in the prospect of turning up the phones, however.)

Since any amplifier purchased or designed for this problem would have to be applicable to all four of our audio consoles and several remote setups, I decided on a general approach. The ideal amplifier would have the following features:

1. High input impedance—to prevent circuit loading. The ubiquitous headphone jack is usually bridged across the line to be monitored and requires high impedance phones.
2. Ability to drive a wide range of headphone impedances—which means that the circuit must have a low output impedance.
3. Ability to drive small speakers—for remote applications and cueing.
4. Floating input—for bridging balanced or unbalanced lines.
5. Low current drain, wide supply voltage range—the unit should be able to tap existing power supplies and be capable of battery operation.
6. High quality—since we're producing a quality product, the monitor should reflect these standards with wide frequency response, low distortion and noise, etc.

Commercial units to meet these specifications are readily available—but unlimited budgets are not. Besides their prohibitive cost, most of the units were supplied as circuit cards and chassis which had to be wired and constructed anyway. On the other hand, the circuit of FIGURE 1 requires less construction than some of the commercial units, yet fits the bill rather nicely. Its cost is low and, with quality components, it is trouble free. The complete amplifier may be mounted in a variety of enclosures from the inside of existing equipment to a small construction box. The potentiometer and the input/output jacks are the limiting factor since the rest of the circuit fits comfortably on a 1½ inch square circuit board.

The LM380N is an integrated circuit manufactured by National Semiconductor. It will deliver 2.5 watts to a speaker, sports a low 0.2 percent distortion, flat frequency response from 0 to 100 kHz, an input impedance of 150 kilohms, and a voltage gain of 50. Voltage required is 8 to 22 Vd.c., and only 7 mA quiescent current is drawn. All in all, this makes a nice starting point for a general-purpose amplifier.

The i.c. is supplied in a standard dual-in-line package, 14 pins. The center three pins on either side comprise a heat sink and should be soldered to a square of grounded copper foil 1½ x 1½ inches for proper device dissipation at full power. However, for driving headphones and small speakers, no heat sinking is required and these pins may be merely grounded.

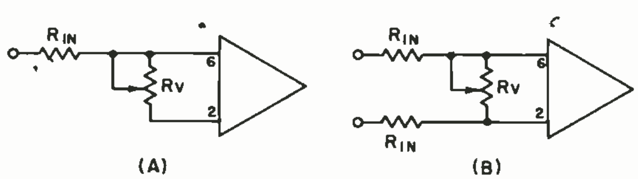
Input considerations are fundamental. Since the voltage gain of the i.c. is fixed at 50, it is only necessary to attenuate the input voltage for the desired output gain. In FIGURE 1, voltage attenuation (with the control at maximum) is approximately equal to $\frac{R_v}{R_{in} + R_v}$ (the 150k i.c. impedance shunted across R_v may be ignored, for $R_v = 10$ k, but for larger control resistors, the shunt value of R_v and 150 k should be substituted for R_v in the expression). This yields an attenuation of 1/5 (or close enough with the standard values used) times a fixed gain of 50, for an overall voltage gain of 10. This will prove adequate for most applications.

FIGURE 2 shows alternate input arrangements. The network of 2(A) may be used when input impedance must be high. With R_v at 2.5 megohms, the input impedance of the amplifier will be approximately R_{in} + 75 k (worst case). If maximum sensitivity is needed, R_{in} may be eliminated. FIGURE 2(B) illustrates a balanced input with the volume controlled by a single pot. Input impedance is a minimum of 2 × R_{in}. All amplifiers are shown as inverters, but reversing the pins 6 and 2 will result in non-inverted outputs. Either pin may be referenced directly to ground without regard for the offset compensation normally demanded by differential inputs.

C_{in} (FIGURE 1) in addition to providing d.c. isolation, is used to roll off low frequencies. Our automated radio station uses 20 and 25 Hz control tones which drive monitors into distortion if not attenuated. The 0.1 μF capacitor provides a gentle rolloff with the 3 dB point between 35 and 40 Hz. For more critical listeners who aren't bothered by this particular problem, the input capacitor may be eliminated if fed from a d.c.-isolated circuit (across a program line, at a monitor jack, etc.). If d.c. isolation is needed, the cutoff may be lowered by using a larger cap or increasing R_{in} (and R_v proportionately). Since a doubling of either value will halve the 3 dB cutoff frequency, calculations are simplified.

To minimize the effects of our a.m. transmitter, capacitor C_{f1} was shunted across the input to ground. In the breadboard stage, this value was 270 pF, but it was found that rf signal strength was sufficient to back-bias the emitter-base junctions of the input stages (see FIGURE 3, i.c. schematic). A high-frequency capacitor C_{f2} from the input to pin 1 eliminates this problem, but now two shunts

Figure 2. Alternate input arrangements. At (A) is the circuit for maximum input impedance while at (B) a conventional balanced input is shown.



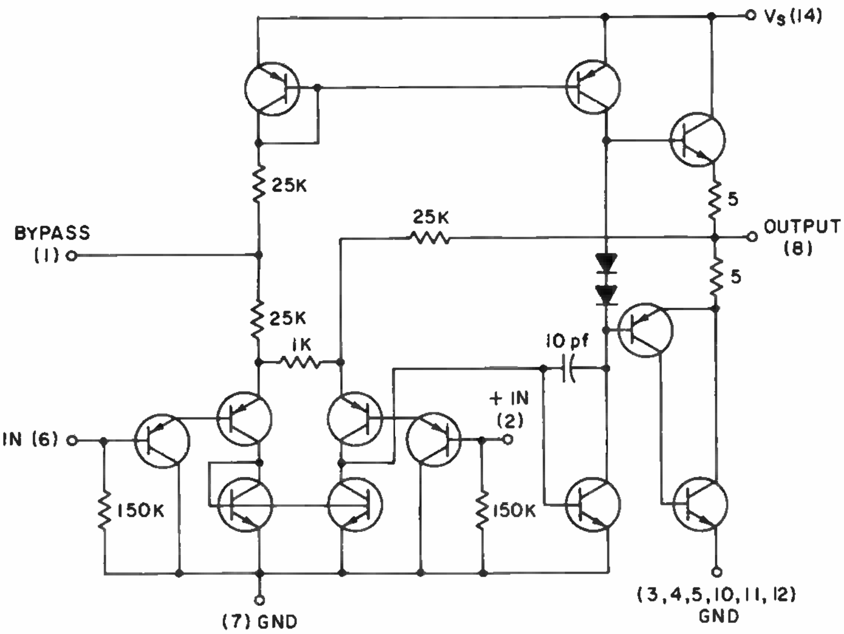


Figure 3. The schematic of the integrated circuit.

pass the audio to ground (C_{f1} and the series value of C_{f2} and C_b), so values have to be halved. The value of these capacitors is non-critical except that a significant increase will begin to attenuate the audible high frequency response. Values shown maintain response to above 30 kHz.

Output impedance of this amplifier is unmeasurably low, making it suitable to drive any load. The output capacitor is made large to maintain bass response when driving low impedance loads.* The d.c. voltage at output pin 8 is one half of the supply voltage, but the voltage rating of the capacitor should be equal to the supply for absolute protection.

A handy feature of this i.c. is the provision at pin 1 for a power supply decoupling capacitor. A small value electrolytic (or even a large value disc) eliminates any audible problem from the power source. With just 5 mFd from pin 1 to ground, 60 Hz hum is rejected 30 dB and 120 Hz (and higher frequencies) are rejected 40 dB. Although this capacitor is not strictly needed with an adequate power supply, it is strongly recommended—especially if more than one amplifier shares the same supply.

This amplifier works best when powered as close to its 22 V maximum as possible, since maximum output before distortion is then possible. In practice, though, this circuit has been powered by a nine-volt battery with no audible difference. For fixed installations in existing equipment, it should be possible to tap into an existing 8 to 20 volt supply since the current drain is low.

Because of the nearly ideal characteristics of this circuit, it can be applied to a variety of purposes in addition to monitoring. As shown in FIGURE 1, it makes a handy line driver when coupled through a transformer. To eliminate some of the response problems associated with transformers, a series buildout resistor may be used to match the primary impedance as in FIGURE 4(A). Often, the only way to eliminate transformer related problems is to get rid of the transformer. FIGURE 4(B) shows two i.c.s in a bridge configuration which will drive a balanced load. In FIGURE 4(C), advantage is taken of the low output impedance to construct a distribution amplifier. The buildout resistors match impedances to the loads driven and isolate the various lines.

This amplifier should prove to be a versatile tool for the audio professional. It is inexpensive enough to be used for those trivial applications, yet transparent enough to be used even in demanding studio applications. ■

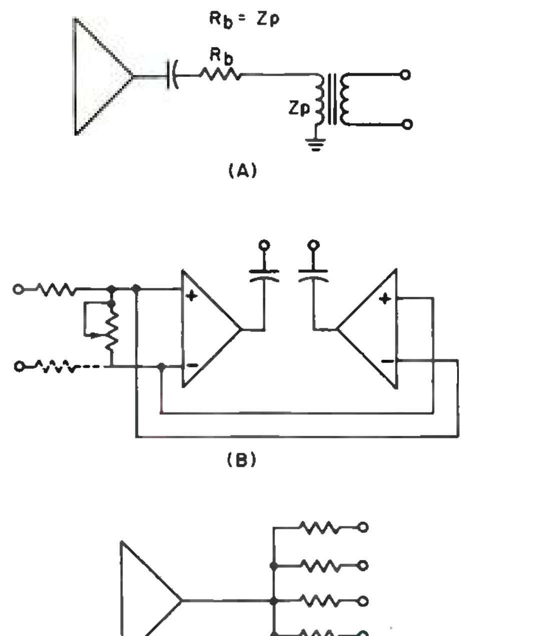


Figure 4. At (A) is the series buildout resistor used to match the primary impedance, at (B) are two i.c.'s in a bridge configuration, and at (C) advantage is taken of low output impedance to create a distribution amplifier.

**Manufacturer's data notes that oscillations may occur under some load conditions (when used to drive speakers) which may be corrected by adding a 2.7 ohm resistor and a 0.1 μFd capacitor in series from pin 8 to ground. I have not experienced any problem with such oscillations, however.*

Circle 28 on Reader Service Card

Circle 14 on Reader Service Card

A. OSCAR BURKE

The Decibel: Basics, part I

The decibel is too often taken for granted as to its meaning, and just as often the thought is wrong. The author takes you through the uses of the decibel and the mathematics behind the usage. Part 2 next month will conclude this basic guide to the dB.

- *60 dB below 1 mW per 10 microbars signal at 200 ohms*
- *54 dB below 1 volt/dyne/cm²*
- *8 dBm*
- *Minus 4 vu*

DO THESE STATEMENTS mean something specific to you? Perhaps not; if you are an audio neophite your understanding of dB, dBm and vu may be still somewhat hazy. Well, don't be discouraged, let's just take time out to unveil the mystery surrounding the decibel.

It is important that this haze be cleared away because as you have probably already found out, a reference to "dB" occurs quite often in audio and electronic literature. It is the basic unit regularly used today by audio engineers and technicians for measuring and comparing sound levels and intensities. As you progress in audio, television, radio or any electronically oriented field, you will find the decibel used to specify the performance of antennae, amplifiers, attenuators, filters, microphones, transformers and a host of other equipment and components. Consequently, an early understanding of the decibel may possibly eliminate substantial confusion later on.

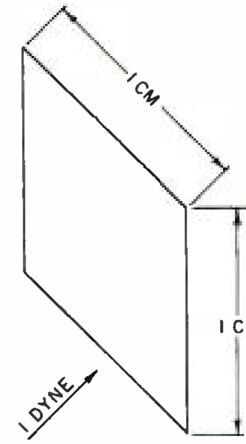
For our discourse it will behoove us to clarify some audio terminology and physical relationships as they are attributed to audio measurement.

To begin with, when an audio response is registered in the human brain, it is due to the fact that a force has acted upon some unit (piano string, valve, etc.) causing that unit to vibrate. The vibrating unit in turn disturbs the air molecules in accord with its vibrations. When the movement of the air molecules is at, or above, a definite speed or velocity at the time they impinge upon the ear drum, we experience the sensation of sound.

The physicists' basic unit of force in the centimeter-gram-second system is the *dyne*. The classical definition of the dyne is "the force, which acting upon one gram of matter, will give it an acceleration of one centimeter per second for every second the force acts." Practically speaking, the force of one dyne is approximately equivalent to the weight of a small size postage stamp.

In audio work, where we use devices upon which force or pressure is distributed over a given area, such as the diaphragm of a microphone, an ear drum, or the cone of a speaker, we find that "sound pressure" is a conveniently descriptive term. "Dyne per square centimeter" (or that force approx. equal to the weight of a postage stamp acting upon an area 0.155 square inches) is defined as the basic unit of sound pressure. Measurement shows that 0.000204 dynes (a force two ten thousandths the weight of a postage stamp) per square centimeter is the least sound pressure discernible by the human ear.

The ear is constantly under pressure of the surrounding



One dyne.

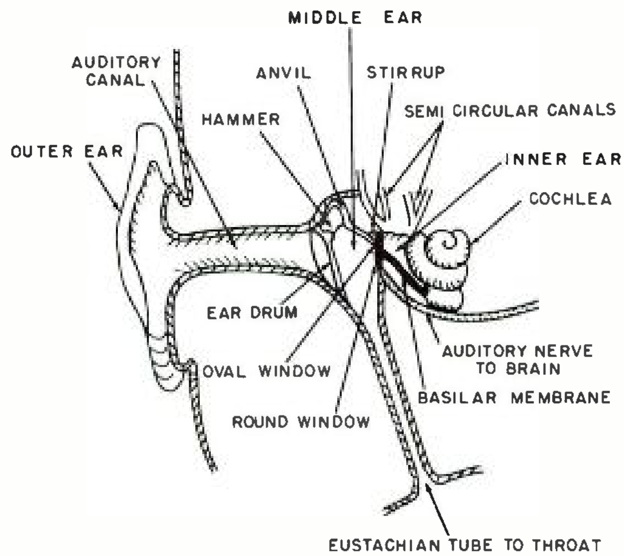


Figure 1. The internal construction of the human ear.

atmosphere. Consequently, any sudden variation (air-molecular velocity movement) of the ambient atmospheric pressure produces sound.

Atmospheric pressure is measured in terms called *microbars,* one microbar being approximately equal to one-millionth of the normal atmospheric pressure. This, in turn, is equal to our dyne per square centimeter. Since one microbar equals one dyne per square centimeter, it follows that one bar equals one million dynes per square centimeter. (Note that normal atmospheric pressure equals 1,013,250 microbars.)

This brings on to our last audio term which is an expression of sound intensity, known as *watts per square centimeter.*

A loudspeaker produces sound pressure vibrations, as does a tuning fork or piano string. The magnitude or intensity of the molecular air movement depends upon the energy imparted due to the work produced. In other words, sound intensity depends upon sound energy. The expression for sound intensity in air when we relate it to electric power, is "watts per square centimeter." At the threshold of hearing (or zero dB) the transmitted sound produces 10^{-16} watts of energy to each square centimeter of the ear.

But hearing, like all human sensory perception, is non-linear. That is to say, a physiological response such as hearing, sight or pain is not directly proportional to stimuli, such as sound, light, or pinch.

For example, if you light a candle in a dark room your eyes will respond to the light, transmit the stimulus to your brain, which registers one candle light. If now you wish to double the light in the room, you must light another candle, thus producing two-candle light. If we again decide to double the room light, we must light two more candles, giving us a total of four candles for the second increase. If we decide a third time (1, 2, 3-arithmetic progression) to double (2x) the existing light (eye response) we must add four lighted candles (units of stimuli).

Notice that the change in response is uniform, 1-2-3-4 . . . . . , but the unit quantity of stimulus is doubled each time, 1-2-4-8-16-32. Stimulus increases in accord with the following progression:

Stimulus $= S^0 + S^1 + S^2 + S^3 + S^4 \ldots$

Since response is to be doubled, $S = 2$

Then $2^0 + 2^1 + 2^2 + 2^3 + 2^4 =$ geometric progression

Where 0 1 2 3 4 = change in response

And $1 + 2 + 4 + 8 + 16 =$ unit quantity of stimulus

The above is a geometric progression which registers upon our senses as an arithmetical series. A system of mathematics which provides this conversion automatically is called *logarithmic.* The decibel, as we shall see, is a form of logarithm.

The ear, like the eye (and candle light) is a human sensory organ whose audio response is naturally non-linear. The total ear comprises a system, the function of which is to transmit vibrations to the brain. One of the major links in this transmission train is called the *cochlea,* a spiral tube filled with fluid. Vibrations are transmitted by the fluid to nerve endings along the basilar membrane and thence to the brain.

So, as we can see from FIGURE 1, air vibrations enter the outer ear, stimulate the anvil and hammer of the middle ear, which acts as a transducer to change air vibrations to fluid vibrations in the inner ear.

The degree of auditory response is therefore determined by the intensity of fluid vibrations in the inner ear; these vibrations are proportional to the *logarithm* of the loudness rather than directly to the loudness.

So far we have twice made reference to logarithms. Therefore, we shall now review the basic principles involved in the mathematics of logs.

First of all let us realize that log, like plus or minus, is mathematical language indicating what operation is to be performed. When the subject under consideration is exponents, then the mathematical terminology is logarithm.

If we take any number N and multiply it by itself, we say that N is taken as a factor twice. The product of $N \times N$ is called the square of N and is expressed as N^2. If N is taken as a factor three times, the product of $N \times N \times N$ is called the cube of N.

Example 1: Let $N = 10$

$$10 \times 10 = 10^2 = 100$$
$$10 \times 10 \times 10 = 10^3 = 1000$$

In the language of logarithms, the number N used as the factor is called the *base.* The number of times N is multiplied by itself or taken as a factor is called the *power* and is indicated above and to the right of the base number. This power indicator is called an *exponent.*

Consider the following:

10	$= 10 \times 1$		Log 10 $= 1$
100	$= 10 \times 10$	$= 10^2$:	Log 100 $= 2$
1000	$= 10 \times 10 \times 10$	$= 10^3$:	Log 1000 $= 3$
10,000	$= 10 \times 10 \times 10 \times 10$	$= 10^4$:	Log 10000 $= 4$

Note that each succeeding number in the above series is a multiplication of ten times the preceding number and can be expressed by the integer 10 raised to the next numerical power. Consequently, it must be realized that the log (or exponent) to the base 10 of a number between 100 and 1000 lies between 2.0 and 3.0

TABLE 1

A SHORT TABLE OF LOGARITHMS

N	1	N	1	N	1
1.0	.0000	4.1	.6128	7.2	.8573
1.1	.0414	4.2	.6232	7.3	.8633
1.2	.0792	4.3	.6335	7.4	.8692
1.3	.1139	4.4	.6435	7.5	.8751
1.4	.1461	4.5	.6532	7.6	.8808
1.5	.1761	4.6	.6628	7.7	.8865
1.6	.2041	4.7	.6721	7.8	.8921
1.7	.2304	4.8	.6812	7.9	.8976
1.8	.2553	4.9	.6902	8.0	.9031
1.9	.2788	5.0	.6990	8.1	.9085
2.0	.3010	5.1	.7076	8.2	.9138
2.1	.3222	5.2	.7160	8.3	.9191
2.2	.3424	5.3	.7243	8.4	.9243
2.3	.3617	5.4	.7324	8.5	.9294
2.4	.3802	5.5	.7404	8.6	.9345
2.5	.3979	5.6	.7482	8.7	.9395
2.6	.4150	5.7	.7559	8.8	.9445
2.7	.4314	5.8	.7634	8.9	.9494
2.8	.4472	5.9	.7709	9.0	.9542
2.9	.4624	6.0	.7782	9.1	.9590
3.0	.4771	6.1	.7853	9.2	.9638
3.1	.4914	6.2	.7924	9.3	.9685
3.2	.5051	6.3	.7993	9.4	.9731
3.3	.5185	6.4	.8062	9.5	.9777
3.4	.5315	6.5	.8129	9.6	.9823
3.5	.5441	6.6	.8195	9.7	.9868
3.6	.5563	6.7	.8261	9.8	.9912
3.7	.5682	6.8	.8325	9.9	.9956
3.8	.5798	6.9	.8388	10.0	1.0000
3.9	.5911	7.0	.8451		
4.0	.6021	7.1	.8513		

As we progress, we realize that the idea of logarithms is basically an extended system of the powers of 10. If we express a number, 76,090, in the power of ten form, we have 7.6090×10^4. Considering that every number can be expressed as ten raised to a power, refer to TABLE 1, which is a short listing of logarithms (or numbers with their exponents which to the base ten is equivalent to that number). Finding 7.6, which is as close in accuracy as this table permits, we read the exponent (or log) .8808. This means that the number 7.6 can also be expressed as $10^{0.8808}$. Therefore, to find the log of the number 76,090 we first express it as a number between 1 and 10 multiplied by the proper power of ten (7.6090×10^4). Next, by using a slide rule or a table of logarithms, we express the resulting number (1−9) as a power of ten. (Note: $10^0 = 1$ and $10^1 = 10$). Thus $7.6090 = 10^{0.8808}$ and since the base 10 to understood in all common logarithms calculations we can omit writing it, we then have 7.6090 = 0.8808. Since one of the time saving tenets of logarithms permits us to add exponents, our number can be written as $76{,}090 = 10^4 \times 10^{0.8808} = 10^{4.8808}$. Converting to logs, we omit writing the 10 and thus we have log 76,090 = 4.8808.

As you can see, the logarithm consists of two parts, the number before the decimal, which is called the *characteristic,* and the portion after the decimal, called the *mantissa.* The characteristic is the power of ten when the numerical expression is reduced to a number between one and nine times ten to a power. The mantissa is the power of ten of the reduced numerical expression. Note that the characteristic is calculated from the number of digits before or after the decimal point in the expression.

TABLE 2

Number	Power of Ten	Characteristic
.0001	10^{-4}	−4
.001	10^{-3}	−3
.01	10^{-2}	−2
.1	10^{-1}	−1
1.	10^{0}	0
10.	10^{1}	1
100.	10^{2}	2
1000.	10^{3}	3
10000.	10^{4}	4
100000.	10^{5}	5
1000000.	10^{6}	6
1,760,000	1.76 x 10	6

Therefore, to find the logarithm of a number, two steps are involved. First, find the characteristic by rewriting the expression as a power of ten, then remembering that 10^0 equals 1 and 10^1 equals 10, find the power of ten, or mantissa, of the remaining number part by using the slide rule or log table. The logarithm of the original number is the sum of the two parts, characteristic and mantissa. The mantissa, being a number between 0 and 1, (from 10^0 and 10^1) is always a decimal and is always positive.

Example 1: $76.0 = 7.60 \times 10^1$: characteristic = 1
7.60 = .8808 (from TABLE I): log 76.0 = 1.8808

Example 2: $7{,}609 = 7.609 \times 10^3$: characteristic = 3
log 7609 = 3.8808

Example 3: $760{,}900 = 7.60900 \times 10^5$:
characteristic = 5
log 760,900 = 5.8808

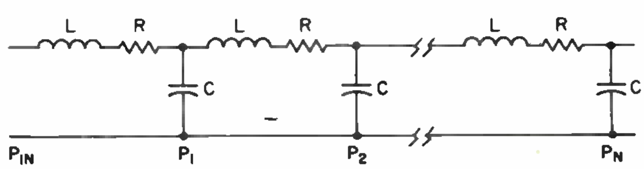
Example 4: log $.007609 = 7.609 \times 10^{-3}$:
characteristic = −3
log .007609 = −3.8808

The reverse action to finding the logarithm is calculating the *antilog.* That is, finding the number when the logarithm is known. This procedure is also carried out in two steps. First, let us remember that if the logarithm is between 0 and 1 then the antilog must be a number between 1 and 10. Such antilogs can be found directly from a slide rule or table of logarithms. Next, for a logarithm greater than one, the characteristic indicates the power of ten by which the antilog of the mantissa must be multiplied to obtain the original number.

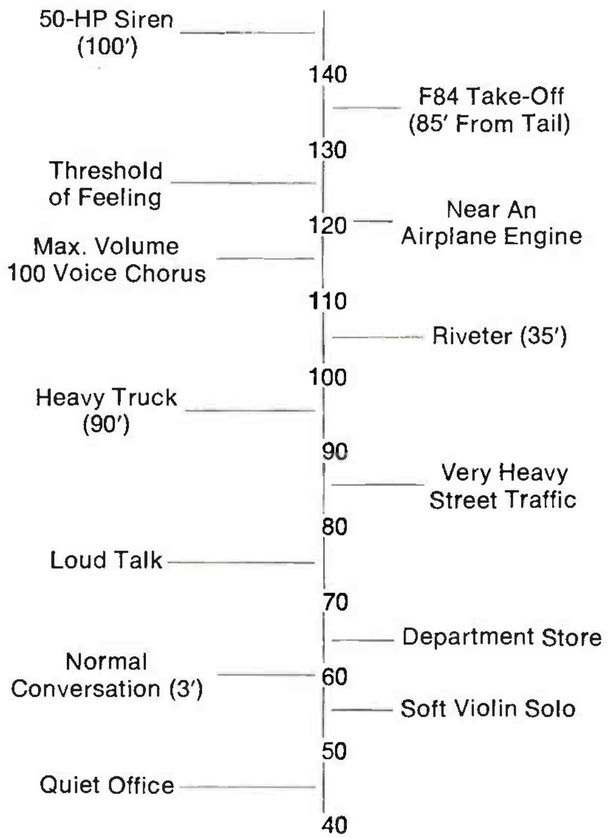
Example 5: Log 3.8088 Find antilog.
Antilog 3.8808:
characteristic = 3 = 10^3
mantissa .8808 = 7.609
antilog = $10^3 \times 7.609$ = 7,609

This resumé on logarithms was necessary because the decibel is actually a logarithmic ratio. Furthermore, logarithmic (decibel) notation readily lends itself to the extremely wide range of measurement required for audio. From the whisper of a summer breeze to the roar at the muzzle of a 9 inch gun is a range not easily noted or readily perceived.

Figure 2. The equivalent circuit of a transmission line.



RELATIVE INTENSITIES
OF DIFFERENT NOISE LEVELS



The equivalent circuit of a transmission line is represented in FIGURE 2. It indicates that a transmission line consists of equal sections, each of which presents an equivalent power loss to a line signal. From FIGURE 2 we see that P_{in} represents the input power and P_1 represents the power input minus a unit of power lost. Similarly, P_2-P_1 equals the power at P_2 minus a second unit of power loss.

Mathematically speaking, we have:

$$P_1/P_{in} = K$$
$$P_1 = KP_{in}$$
$$P_2 = KP_1 = K \cdot KP_{in} = K^2P_{in}$$
$$P_N = K^N P_{in}$$
$$K^N = P_N/P_{in}$$

Taking log of both sides:

$$N \text{ Log } K = \text{Log } P_N/P_{in}$$
$$N \text{ Log } P_1/P_{in} = \text{Log } P_N/P_{in}$$
$$(\text{Substituting } K = P_1/P_{in})$$

Which means that the total line loss, P_N/P_{in}) can be calculated by multiplying the number of line sections *N* by the logarithm of the power ratio.

If we consider the power loss in a one mile section of specified telephone cable, we can define this loss as one *transmission unit,* as telephone engineers did many years ago. We now have a basis for expressing attenuation (minus) or gain (plus) in all types (passive and active) of audio equipment. For example, the loss thru a pad could be equivalent to six miles of "standard cable" or as the old telephone engineer would say, minus 6 tu's.

In later years, it was agreed between the broadcasting and telephone industries to define the power ratio as equal to ten, and name the quantity the "Bel" after Alexander Graham Bell, inventor of the telephone.

$$\text{Let } P_1/P_{in} = 10$$
$$\text{Then Log } P_1/P_{in} = 1 \text{ Bel}$$

However, practical experience proved the bel as too large a unit, so it was divided by ten to become the more common unit of measurement known as the *decibel*. This unit is practically equal to the original "standard mile."

So . . . 1.1

Equation 1.1: decibel (dB) $= 10 \text{ Log}_{10} P_1/P_2$
where dB equals the number of decibels and P_1 and P_2 are respectively the output and input powers, or, P_2 is a reference power to which P_1 is being compared.

Equation 1.1 simply says that the number of dB is equal to ten times the number of ten factors in the ratio of output power to input power.

Power Ratio	No. of 10 Factors	No. of Bels	No. of Decibels
1,000,000	10^6	6	60
100,000	10^5	5	50
10,000	10^4	4	40
1,000	10^3	3	30
100	10^2	2	20
10	10^1	1	10

Notice that the decibel is not a direct measurement such as the pound, mile or second. It is simply a measure of changes in power coincident with the natural ability of the human ear to perceive these changes. It is strictly a relative measurement, depending not only upon the amount of change, but also upon the original sound intensity.

If an amplifier delivers a pure tone at two watts and we wish to double the apparent sound level or loudness, the power level would have to be squared. If we increased the sound level five times ($2^5 = 32$) the acoustic power would have to be increased by 30 watts (total power 32 watts). On the other hand, if we begin by listening to a six watt pure tone, then increase the power level by 30 watts (total power 36 watts) we have actually only doubled our apparent sound level—$6^2 = 36$. In other words, a 30-watt power increase in one case increased the sound five times, while in the other case the same 30-watt drive only *doubled* the apparent sound level (loudness).

At this point, you have probably noticed or realized that, by changing the base, a single number can be expressed as more than one logarithm.

Example 6: $\text{Log}_2 64 = 6$
$\text{Log}_4 64 = 3$
$\text{Log}_8 64 = 2$

However, to eliminate confusion and the overwhelming number of systems and log tables that would result, mathematicians have evolved two systems for general use. One is the *Naperian* or natural system which uses 2.71828 as its base; the other is the common, or *Briggs System* that uses ten as its base. The latter system is, of course, the one with which we are concerned.

Example 7a: 30 watt power increase
2 watts to 32 watts

$$\begin{aligned} dB &= 10 \log 32/2 \\ &= 10 \log 16 \\ &= 10 \log 1.6 \times 10^1 \text{ (characteristics} = 1) \\ &= 10\ (1.225) \\ dB &= 12.25 \end{aligned}$$

Example 7b: 6 watts input to an amplifier
36 watts output

$$\begin{aligned} dB &= 10 \log 36/6 \\ &= 10 \log 6 \text{ (characteristic} = 0) \\ &= 10\ (0.778) \\ dB &= 7.78 \end{aligned}$$

These examples further verify that the decibel is a relative measurement, depending on the amount of change as well as the original intensity.

Now, to truly understand the decibel one must basically recognize its dual concept:

1. Gain or loss measurements by comparing the power content of two signals.
2. Power rating of equipment as compared to a standard reference.

Consequently, referring back to equation 1.1, we should always consider P_2 as the reference power to which P_1 is being compared.

In considering the basic decibel application of measuring gain or loss it must be understood that an electrical component or network develops gain when its power output is greater than the power input. On the other hand, a loss is developed in an electrical network when its output power is less than the input power. For example, if a single dipole antenna is replaced by a parabolic antenna what is the power gain in dB directed toward the main station? A power amplifier has a rated output of 50 watts with an 0.5 watt input. What is the gain of the amplifier in dB? To solve these problems in terms of decibel gain or loss, we form a ratio of the powers involved, find the logarithm of that ratio and multiply by ten. If the component or network exhibits a loss, we indicate the loss with a minus sign in front of the decibel value. Therefore, if P_2 is always the smaller power level, we can eliminate mathematical complications and use common sense to determine whether our dB value represents a gain or loss.

Example 8: An amplifier has an output of 3 watts when the input is 1 milliwatt.

Solution: A gain is realized since the output power is greater than the input power.
Gain $= 3/.001 = 3000$
To find gain in decibels, we take the logarithm of the power ratio and multiply by ten.

$$\begin{aligned} \text{Gain} &= 10 \log 3000 \\ &= 10 \log 3 \times 10^3 \text{ (characteristic} = 3) \\ &= 10\ (3.477) \\ &= 34.77 \end{aligned}$$

Example 9: A vestigal sideband filter is installed in a television transmitter. What is the insertion loss if the power output is reduced from 40 kW to 29 kW?

Solution: It is obvious that a loss developed; therefore, the answer should be preceded by a minus sign. Remember we always make the largest power the numerator.

$$\begin{aligned} dB &= 10 \log P_1/P_2 \\ &= 10 \log 40/29 \\ &= 10 \log 1.38 \\ &= 10\ (0.14) \\ &= -1.4 \end{aligned}$$

In working with electronic equipment. one rarely takes power measurements nor does one usually have direct reading power measuring equipment handy. On the other hand a voltmeter is standard equipment and current, voltage, and resistance readings are usually easy to obtain.

Since power and voltage are related by:

$$P = E^2/Z \cos\theta$$

we can write our decibel equation as follows:

$$N_{dB}\ 10 \log \frac{(E_1^2/Z_1) \cos\theta_1}{(E_2^2/Z_2) \cos\theta_2}$$

One rule of logarithms states: "The logarithm of a product is equal to the sum of the logarithms of the factors." Therefore, we can write:

$$N_{dB} = 10 \log (E_1/E_2)^2 + 10 \log Z_2/Z_1 + 10 \log \cos \theta_2/\cos \theta_1$$

Another rule of logarithms states: "The logarithm of any power of a number is equal to the logarithm of the number multiplied by the exponent of the power." Therefore, we can write:

$$N_{dB} = 20 \log E_1/E_2 + 10 \log Z_2/Z_1 + 10 \log \cos \theta_2/\cos \theta_1 \qquad 1.2$$

Where E_1 and E_2 are the rms values of signal voltage with E_2 being the reference voltage, Z_1 and Z_2 the impedances across which the associate voltages are measured, Z_2 being the reference with θ, the angle of Z_1 and θ_2 the angle of Z_2.

If we use current measurements in our analysis, we use the expression $P = I^2Z \cos \theta$ in our original equation and we have:

$$N_{dB} = 20 \log I_1/I_2 + 10 \log Z_1/Z_2 + 10 \log \cos \theta_1/\cos \theta_2 \qquad 1.3$$

In this case I_1 is the rms value of signal current; I_2 the rms value of current to which I_1 is being compared and the other parameters the same as described above.

Under most circumstances Z_1 and Z_2 are considered resistive. Thus, there is no operator to produce a phase shift between the voltage and current, so the power factor $\cos \theta$ becomes unity. Since the log of 1 equals zero the cosine term drops out, and we have:

$$N_{dB} = 20 \log E_1/E_2 + 10 \log R_2/R_1 \qquad 1.4$$

If the two resistances are of equal value, the resistive term drops out, and we have:

$$N_{dB} = 20 \log E_1/E_2 \qquad 1.5$$

Example 10: The voltage to the first stage of an amplifier is 0.4 volts. When the level control is increased the voltage becomes 0.8 volts. What is the gain in dB?

Solution: Gain $= 20 \log V_1/V_2$
$= 20 \log .8/4 = 20 \log 2$
$= 20 \ (.3010)$
$= 6$ dB

Example 11: An a.m.-f.m. tuner delivers 0.2 volts to the 40 kilohm resistive input of an amplifier. The output is 10 volts across 8 ohms resistive. What is the gain in dB?

Solution: Gain $= 20 \log E_1/E_2 + 10 \log R_2/R_1$
$= 20 \log 10/0.2 + 10 \log 40{,}000/8$
$= 20 \log 50 + 10 \log 5000$
$= 20 \ (1.6990) + 10 \ (3.6990)$
$= 33.9 + 36.9$
$= 70.8$ dB

The second aspect of decibel notation is utilized for equipment specifications. It is common practice for manufacturers to express the power handling capabilities of their equipment in terms of dB. For example, an amplifier manufacturer may claim that the undistorted output power of his amplifier is 40 dB, while a microphone manufacturer may report that his Model X microphone is rated at −74 dB. (*To be continued next month.*) ■

Circle 25 on Reader Service Card

db Visits—dbx

YOU HARDLY GET airborne when leaving New York's LaGuardia Airport when you find you are touching down at Boston's Logan Airport. From there it is a short drive to the neat laboratories and manufacturing facility of dbx, Incorporated.

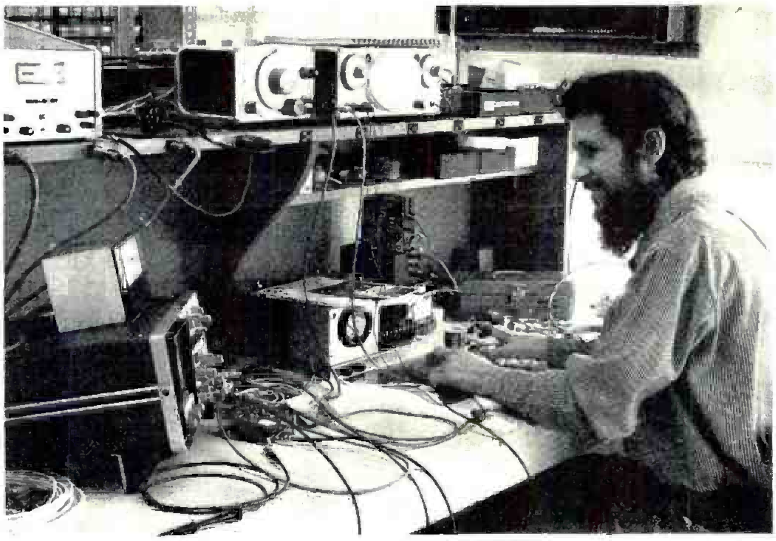
dbx, Incorporated has come a long way in a relatively short time. It was formed as a Massachusetts corporation in April, 1972 by David E. Blackmer and Zaki Abdun-Nabi. Both had previously worked together as instrumentation engineers at Ebsco during the late 1950's, working in precision telemetry equipment. Both subsequently left Ebsco to form new companies. Zaki-Abdun-Nabi left in 1963 to found Janus Control Corporation with which he remained as president until 1969. Janus had earlier become an acquisition of Tyco Laboratories and had been renamed the Tyco Instrument Division. (It is in the business of manufacturing numerical controls for the machine tool industry.)

David E. Blackmer became founder in 1960 of the Instrumentation Laboratory. He was vice president of research and development for some ten years before leaving to found dbx in 1971. During his active participation at Instrumentation Laboratory he was involved in the development of such products as blood gas analyzers, flame photometers, and atomic absorption spectrophotometers. He has some eighteen patents granted on electronics and instrumentation products. By the time he left Instrumentation Laboratory, the company had successfully gone public and had achieved an annual sales volume of over $20 million.

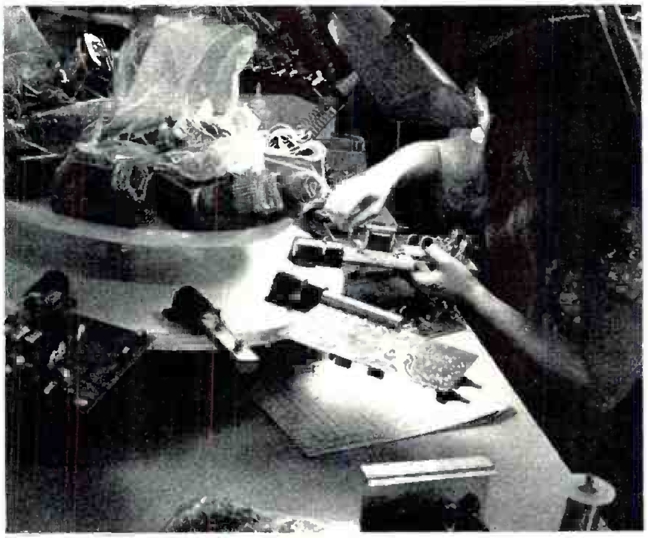
Dave Blackmer's decision to found a company in the professional audio field did not come about by chance. He had worked in recording studios in the 1940's and had designed equipment for recording and broadcast applications.

The first product from the new company, issued in 1971, was the Model 81 dB meter, distinguished primarily by its ability to indicate an 80 dB dynamic range on a single unswitched scale. This product was followed by the Model 117 dynamic range enhancement device for restoring dynamic range to records, tapes and f.m. broadcasts, their first product for the consumer audio field. At the same time development work and first products appeared embodying the dbx professional noise reduction system, now gaining wide acceptance in the recording industry. Their latest achievement has been to have an independent record company, Klavier Records, issue stereo discs that have been dbx encoded. When played back through a decoder, the elimination of characteristic disc sound produces a tape-like quality.

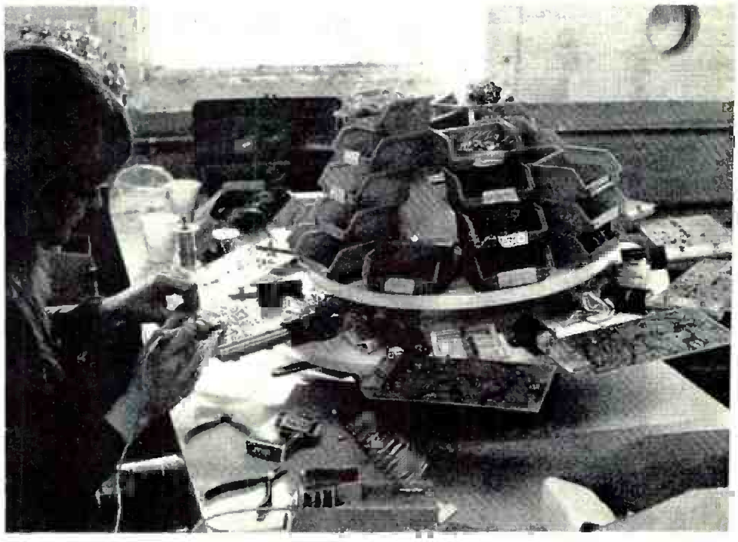
dbx, Incorporated moved into its present quarters, 8500 square feet in a two-story brick building in May, 1972. This move was done with eight employees and big plans. That those plans are well founded is attested to by the fact that over sixty people are now employed and the company now has a product line of over thirty products in professional and consumer audio as well as OEM and industrial instrumentation. The company remains privately held. ■



Research is an ongoing project at dbx. Here chief engineer C. Renee Jaeger does his thing.



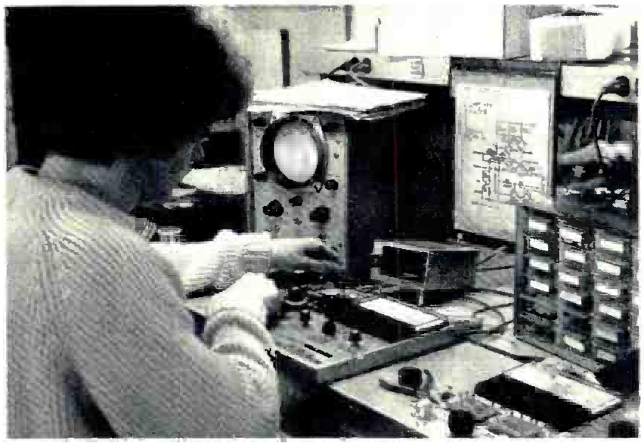
This photo illustrates the use of a carousel to rotate the component to be assembled using circular assembly line with the construction done by one assembler.



The carousel concept is also used to present a variety of components to an assembler during the construction of a p.c. circuit.

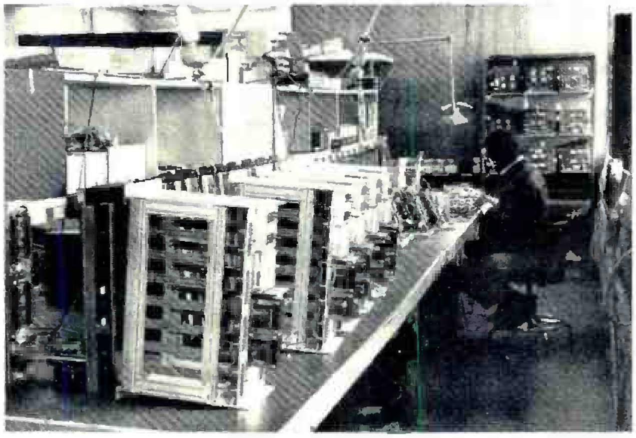
Units are being completed at this station, while behind it, completed circuit boards are stored awaiting the production of the system for which they might be destined.

Portions of the dbx system are preassembled into cans and potted at this station. This is the heart of the VCA used in the noise reduction system.



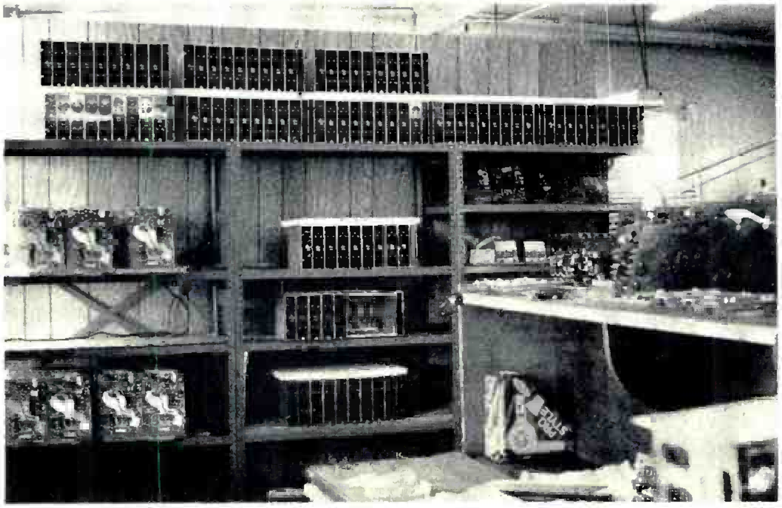
Finished VCA modules are individually tested at this position. Testing is done before and after assembly into cans.

A line up of frames awaiting assembly into finished noise reduction systems. These frames accept slip in noise-reduction modules.



A general view of the production area. You can see the heavy use of the carousel system which is much praised by dbx as both efficient and effective in reducing production defects.

Finished dbx noise reduction units at the end of the line share shelf space with circuit cards. As demand for the system continues to grow, dbx is finding it necessary to increase production steadily.



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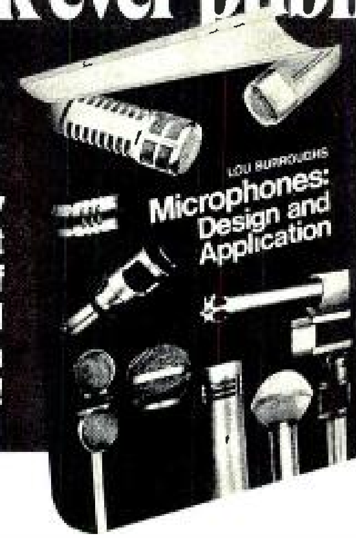

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PEOPLE, PLACES, HAPPENINGS

● Youth is the word for a new recording center recently opened in Indianapolis at 1330 N. Illinois by the **Talun Record Corporation,** whose executives are all under thirty. The center contains the firm's new Music Mother sixteen-track studios as well as offices and creative facilities for its two record labels, music publisher, and audio production firm. The Music Mother offers quadriphonic mixing and a full line of M 79 3M tape machines. The studio contains a twenty four-track Auditronics board, twenty channels of Dolby A (including the M 16) four AKG echo chambers, four M 79 tape machines, and quadriphonic Sentry III monitors. In addition for providing facilities for young music, according to **Tom F. Hirschauer, Jr.,** Talun vice president, the firm is conscious of its responsibility toward young students and has offered free use of its facilities for tours and seminars to local schools. They also hope to get into educational recording.

● Prestigious **EMI Group** studios located throughout the world will be supplied with custom-built consoles from **Rupert Neve, Inc.** as the result of a half-million dollar order recently received. The 16-track and 24-track consoles will be installed at EMI studios in London (the well-known Abbey Road), Cologne, Singapore, Wellington, N.Z., Paris, and Stockholm.

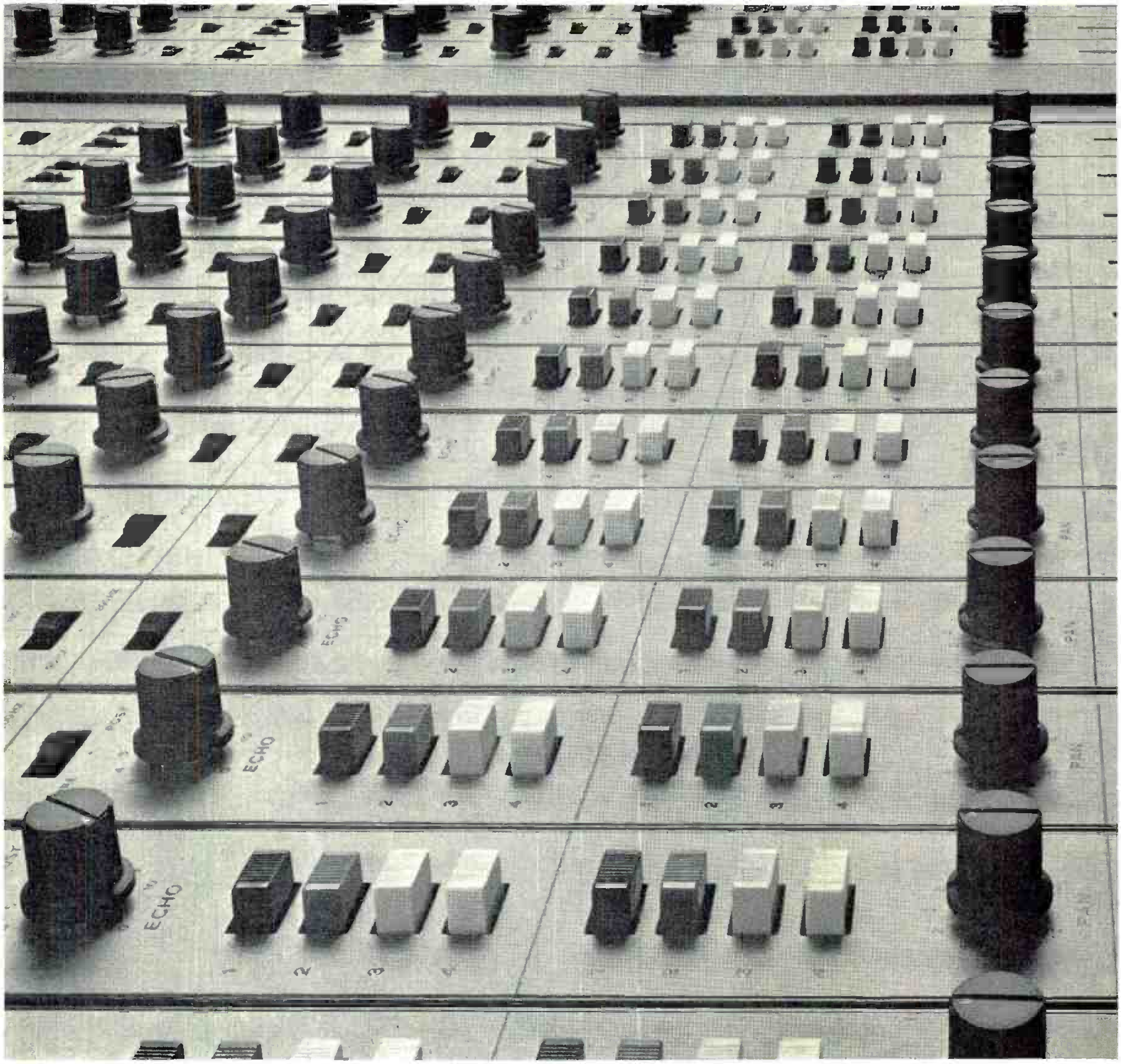
● Flexible service is promised by **Minot Sound Studios,** headed by **Ron Carran,** recently opened in White Plains, N.Y. Minot offers on-location recording, sound system installation, and the use of a music and special effects library. Recording equipment available includes MCI recording console, AKG reverberation chambers and a Dolby noise reduction system, all under the supervision of professional musicians.

● **John A. Mattis,** known for his part in the development of linear integrated circuits and the monolithic phase-locked loop while an electronic design engineer with the **Signetics Corporation,** has been named manager of the linear-products marketing group of Signetics. The position will encompass the guiding of the development of this new form of circuitry and its marketing for such uses as automobile speed control systems and in four-channel stereophonic systems. In addition to creative designing work, Mr. Mattis has published a number of technical articles in the electronic trade press.

Carter

● Portland, Oregon will be served by a new commercial sound recording studio, **Spectrum Studios, Inc.,** located at 905 SW Alder. Partners in the venture include **Mike Carter, Lindsey McGill,** and **Lee McCormick,** all of whom come from **Northwestern, Inc.** Facilities will include three sound studios, for recording and duplicating audio for radio and television commercials, music mastering, film sound, audio-visual programs, and multimedia productions.

● A new company, specializing in European products has been formed by the **Hervic Corporation/Cinema Beaulieu.** Called **Hervic Electronics, Inc.** the new branch will be headed by **George A. Rose** in the post of executive vice president for marketing and sales. According to Mr. Rose, the company will offer highly sophisticated systems and components from England, France, Germany, and Switzerland. The initial line will be the Ditton Series loudspeakers manufactured in England by **Rolla Celestion, Ltd.** which will be sold on a franchise basis. Other projected lines will include microphones, recorders, including sync recorders for movie cameras, changers, amplifiers, integrated stereo components, amplifiers, integrated stereo receivers and headphones. Main offices for the new company are located at 1508 Cotner Avenue, Los Angeles, California 90025.



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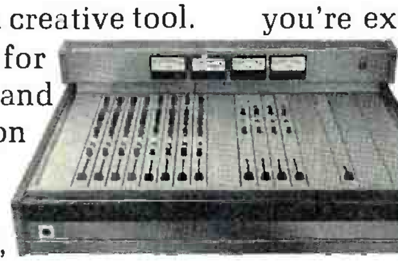

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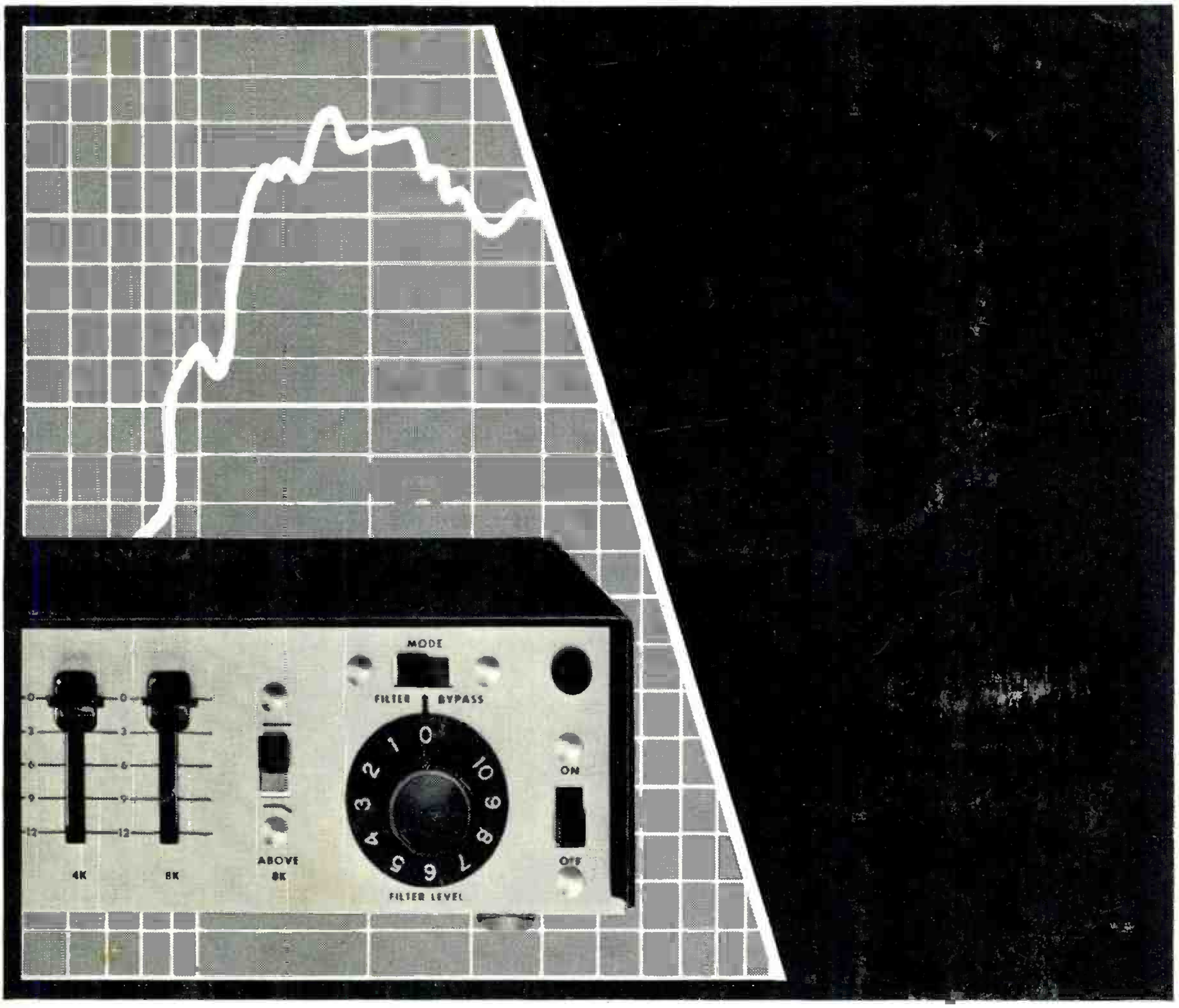

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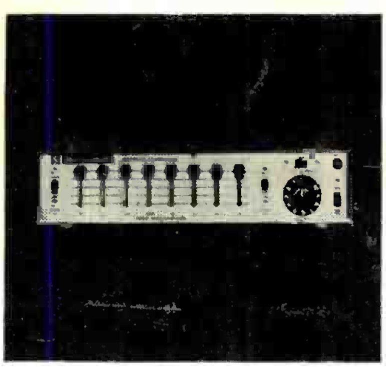

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