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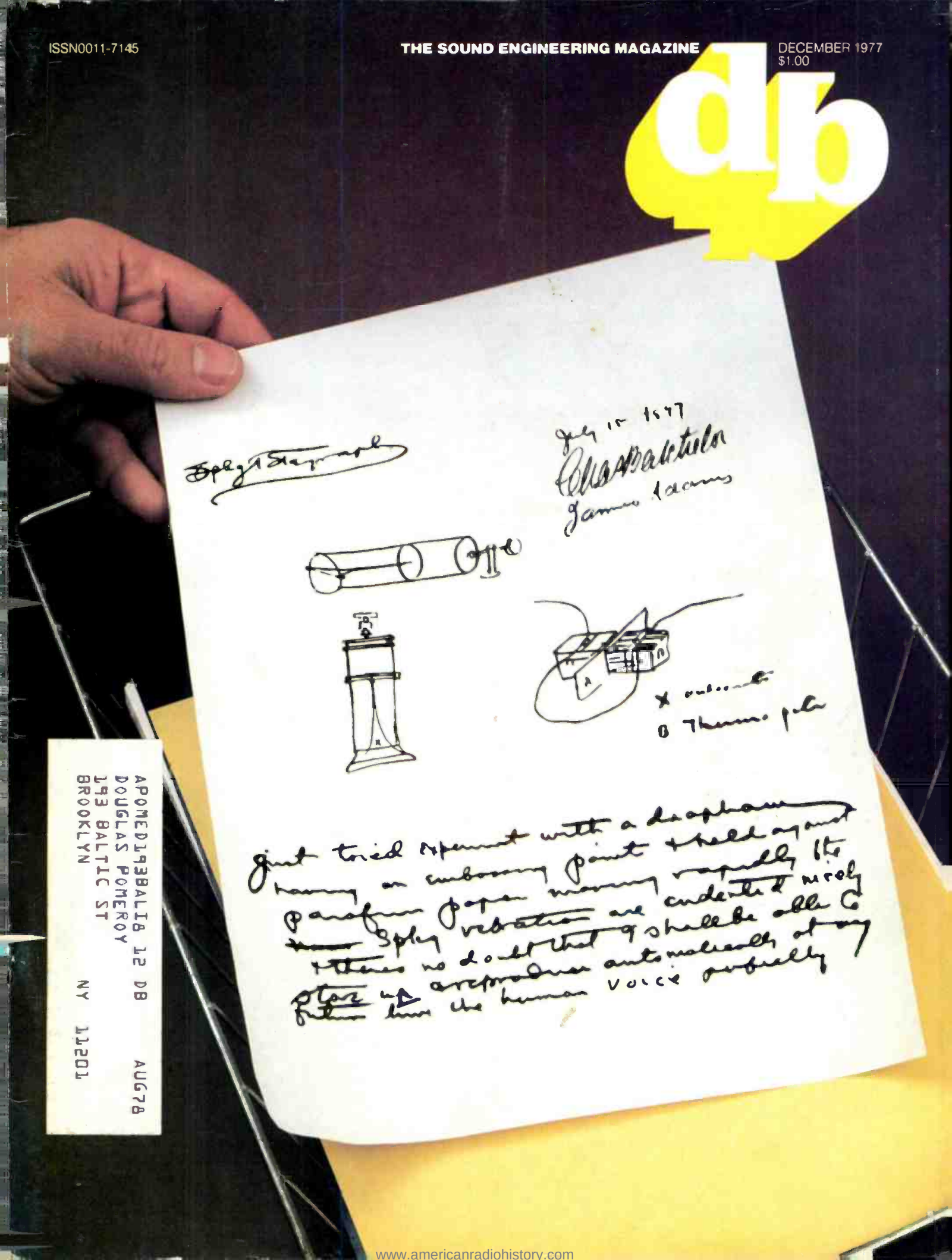
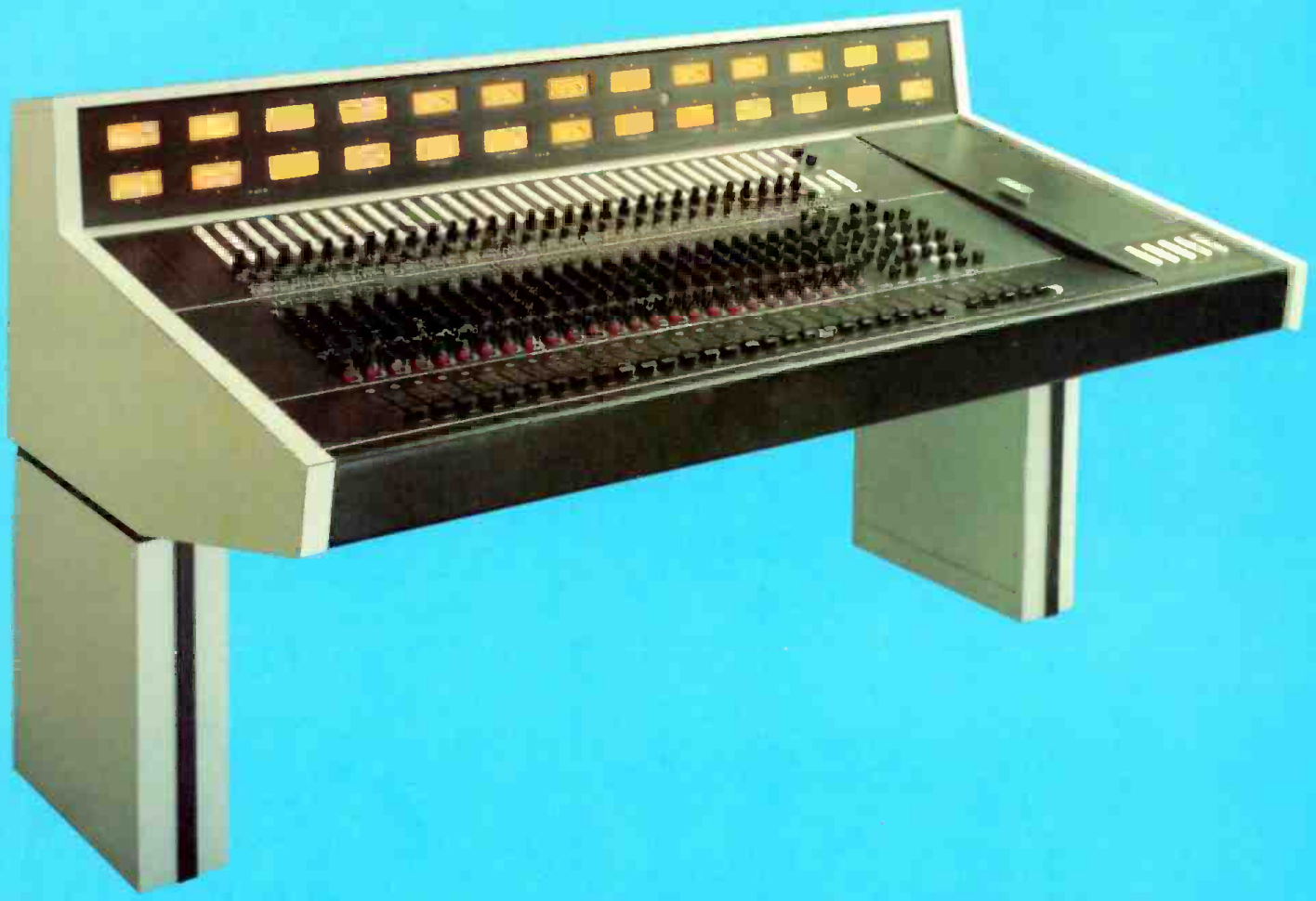
THE SOUND ENGINEERING MAGAZINE

DECEMBER 1977
$1.00

db



The Only Quiet One



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*No *meaningful system* noise specifications given.
**No *system* noise specifications given.
Note: All noise data taken from manufacturer's published specifications.

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Coming Next Month

- In January we start off with a re-examination of the four-channel scene —the broadcast, recording, and playback prognosis and report.

- First-off, there is a report by Len Feldman detailing the proposals before the FCC for broadcast standards. He explains what they do and how, and what stage the FCC is at, and how a.m. stereo is likely to affect the future of four-channel broadcasting.

- Peter Scheiber is a name known to all in four-channel sound. He has contributed an article on the current state of SQ capability, exemplified by his new professional SQ decoder.

- Developments in qaudriphonics are fast breaking, and we are sifting through others that have come in to round out this issue.

- In addition, we will complete the story started by Harold Lindsay in this issue, bringing the Ampex involvement in audio tape recording from its beginnings right up to the present.

- Coming in January in **db**, the Sound Engineering Magazine.

About The Cover

- In this re-creation by Art Director Bob Laurie, we see the hand of Edison passing his phonograph invention design to his assistant. It has been stated by historians that Edison's inscription "Kruesi, Make This" was probably added some months later to the drawings by a history-conscious Edison. See page 26 for the complete drawings.

db

THE SOUND ENGINEERING MAGAZINE

DECEMBER 1977 VOLUME 11, NUMBER 12

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

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db Calendar

JANUARY

5-8 **Winter Consumer Electronics Show, Las Vegas.** Las Vegas Convention Center/Las Vegas Hilton. Contact: Mr. William Glasgow, Show Manager, Consumer Electronics Shows, 1 IBM Plaza—Suite 3626, Chicago, Ill. 60611 (312) 321-1020.

9-Feb. 3 **Recording Workshop,** covering recording, record production, and the business of music. Contact: The Recording Workshop, Appalachia Sound Studio, Rt. 8, Box 525, Chillicothe, Ohio 45601. (614) 663-2544.

16-18 **Management Seminar, "Increasing Productivity in Manufacturing,"** New York City. Contact: Heidi Kaplan, see below.

23-25 **Management Seminar.** Houston, Texas. Sponsored by New York University. Contact: Ms. Heidi E. Kaplan, Information Services Manager, New York Conference Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

24-27 **Modular VTR Workshop.** Contact: Smith, Mattingly Productions, Ltd., 515 Kerby Hill Rd., Oxon Hill, Md. 20022. (301) 567-9265. Workshop at above address.

FEBRUARY

6-8 **NYU Management Seminar, "Increasing Productivity in Manufacturing,"** Los Angeles, Ca. Contact: Heidi E. Kaplan, Dept. 14NR, New York Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

13-15 **NYU Management Seminar, "Project Management for Engineers,"** San Francisco. Contact: See above.

14-16 **Synergetic Seminar,** Seattle, Wa. Sea Tac Red Lion, 18740 Pacific Highway S. (206) 522-1533 or contact: Synergetic Audio Concepts, P.O. Box 1134, Tustin, Ca. 92680.

13-15 **NYU Management Seminar, "Management of New Technology Projects,"** Los Angeles. Contact: See above.

15-17 **Smith-Mattingly Workshop, "Electronic Editing,"** Smith-Mattingly Productions, 515 Kerby Hill Rd., Oxon Hill, Md. 20022 (Washington, D.C. area) (301) 567-9265.

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calendar (cont.)

17-19 **Midwest Film Conference.** Marriott O'Hare Hotel, Chicago, Ill. Contact: 10th Annual Midwest Film Conference, P.O. Box 1665, Evanston, Ill. 60204.

22-24 **Synergetic Audio Seminar,** Holiday Inn, 1101 Shoreway Dr., Belmont, Ca. 94002. (415) 846-0550 or contact: See above.

27-Mar 1 **NYU Management Seminar, "Effective Communications for Engineers,"** Chicago, Ill. Contact: See above.

28-Mar 3 **A.E.S. Convention,** Hamburg, Germany, Congress Center. Contact: A.E.S., 60 E. 42nd St., New York, N.Y. 10017, (212) 661-2355 or Dr. Joerg Sennheiser, Sennheiser Electronic KG, Postfach 3002, Wedemark 2, Germany.

MARCH

1-5 **Hobby Electronics Fair,** Anaheim Convention Center, Anaheim, Ca. Contact: A. Kozlov, 222 W. Adams St., Chicago, Ill. 60606. (312) 263-4866.

1-3 **NYU Management Seminar, "Managerial Skills for the Developing Manager,"** New York City. Contact: Heidi E. Kaplan, Dept. 14NR, New York Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

15-17 **Smith-Mattingly Seminar, "Multi-Camera."** Smith-Mattingly Productions, 515 Kerby Hill Rd., Oxon Hill, Md. 20022. (301) 567-9265.

17-19 **Intercollegiate Broadcasting System Convention.** Biltmore Hotel, New York City. Contact: Convention Committee, c/o IBS, P.O. Box 592, Vails Gate, N.Y. 12584. (914) 565-6710.

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PATRICK S. FINNEGAN

db Broadcast Sound

Headroom Problems

• Audio has many important factors which contribute to its fidelity. One that is receiving more attention these days is called *headroom*. The term has been known for some time; perhaps the reason it received less attention in the past may be due to the fact it is essentially a design function rather than an operational one. But it can very easily become an operational problem that will militate against the audio signal's fidelity. This month we will discuss the headroom factor and some of the ways it can affect the operational views.

THE SIGNAL

To understand how headroom can become a problem in a broadcasting station, we need to take a look at the program audio signal and the problem of accurate measurements. The program audio signal that passes through the system is composed of a constantly changing variety of complex waveforms, essentially a.c. in nature. These waveforms represent the various sounds which have been picked up by microphones somewhere down the line and have been blended and mixed into what is the program presently passing through the system. Not only do these waveforms constantly change shape, but there is little repetition, the peak-to-average value is constantly changing. (These have very little similarity to the sine waves with which we test out the system.) The audio system must faithfully pass these waveforms without distortion.

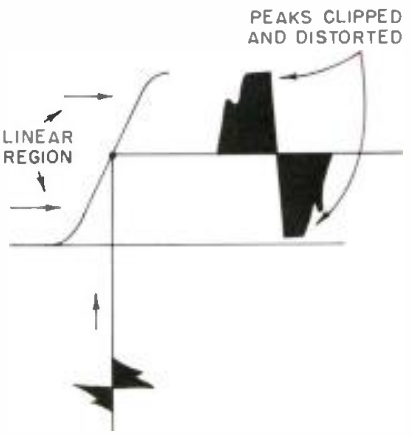
MEASUREMENT PROBLEMS

Measurement of the program audio is somewhat difficult, especially when we need a reasonable degree of accuracy in the measurement. The regular a.c. voltmeter will measure power line signals, for example, but it can't cope with audio at all because it doesn't have the necessary bandwidth. The audio voltmeter can measure audio sine waves accurately, but it can't deal with the program audio waveforms; this meter will measure program audio after a fashion, but the meter hand will vibrate badly and there will be large overshoots on signal peaks—certainly not obtaining an accurate measurement.

A number of years ago, the vu meter was developed specifically for the measurement of program audio. This meter has several forms of compensation incorporated within it that overcome the vibration and overshoot problems, but these same compensations also make the vu meter a quasi-peak indicating device. It will indicate program signal peaks, but not the true peaks. Where audio sine waves are concerned, the vu meter and the audio voltmeter will produce correct indications. The problem is with the program audio peaks.

Although a sine wave does not conform in many ways to a program signal, it is the best signal available to set up, adjust, and measure the system. Difficulties can arise when the engineer doesn't realize that the true peaks in the program signal can be

Figure 1. True program peaks must not drive any amplifier stage into the non-linear part (distortion area) of its input/output curve.



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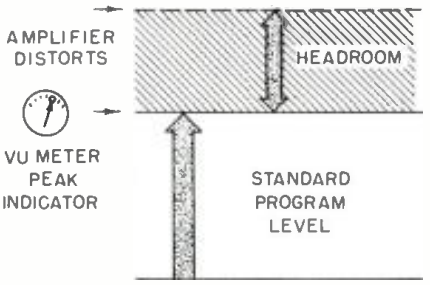

Figure 2. System headroom is the region above the signal peaks, as measured on the vu meter, and the point at which an amplifier goes into distortion.

from 8 to 12 dB higher than the peaks that are being indicated on the vu meter with program or the sine wave tones with which the system was set up. A similar problem is experienced at the modulation monitor. The modulation meter has similar characteristics to those of the vu meter; it can't indicate true modulation peaks either! That is the reason an electronic peak modulation indicator must also be used.

DESIGN PROBLELMS

Amplifiers and other audio units for broadcast work are designed to handle the generally industry-accepted standard input/output levels. These are the signal levels which will be used in the setup at the station with sine wave tone, and the level at which the program peaks will be adjusted on vu meters. If a particular unit, for example, is designed for a standard input level of +8 dB, the designer will consider this as a true peak input level of about 20 dB and will design the unit to handle that input.

The designer will have many factors to consider, but one factor is that at *each stage* the equipment must be designed to handle the program peaks easily and without distortion. Each stage then will be designed to operate at the center of the straight line portion of its input/output curve and with enough reserve so that the signal positive peaks will not drive the stage into the upper curved portion or into saturation—this would distort or clip the positive peak. He must also beconcerned that the negative peaks will not drive the stage into the lower bend of the curve nor into cut-off, as this will distort and clip the negative peaks.

SYSTEM DESIGN

Once we begin to assemble audio units into a broadcast or recording studio system, we become system designers and headroom now becomes our problem. Although the equipment designer has incorporated adequate headroom into the units themselves, erroneously connecting up and operating these units in the system can undo all the headroom provided.

We can define headroom in the system as the region between the standard signal level, as indicated by the vu meter (on either tone or program peaks) and the point where the amplifier or system goes into distortion. It is essentially based upon the signal levels that are chosen to distribute the audio throughout the system.

Since the units are designed around industry standard levels, similar levels should be chosen as the station standard. If a higher level than the industry standard is chosen, this will reduce the headroom. How much will depend upon how much headroom each of the units has in it already. On the other hand, lower than standard levels will reduce the signal-to-noise ratio of the system; how much depends upon the system's noise factor.

MEASUREMENT

It isn't too difficult to measure headroom in the system or in a particular amplifier. There is only one precaution to keep in mind; protect the system's vu meters against the higher tone levels of the test. To show how this is done, assume you have an amplifier on the bench and wish to measure its headroom. Set it up with the normal standard signal level that it gets in the system, that is, with sine wave tone. Measure the signal out of the amplifier with an audio volt-

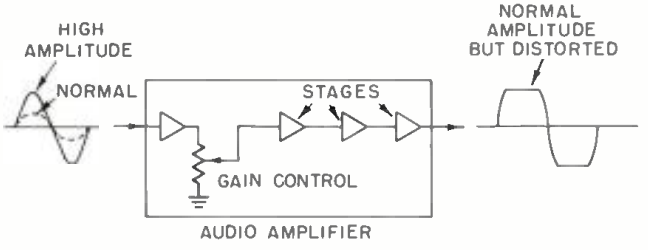

Figure 3. Be careful of audio units which have the gain control behind the first stage; the input signal can overload the first stage.

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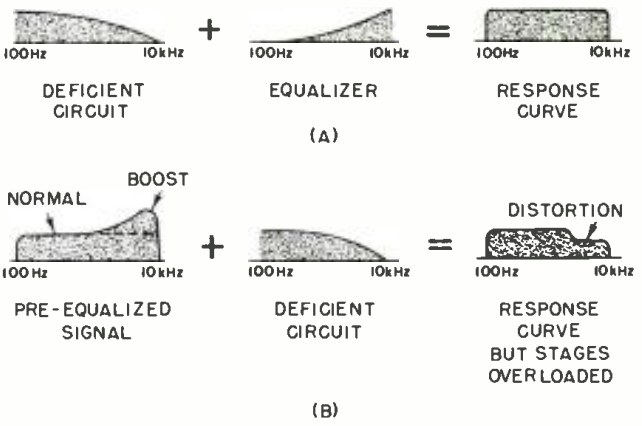


Figure 4. Pre-equalization can overload stages before the signal gets to the deficient circuit. (A) Post-equalization. (B) Pre-equalization.

meter and terminate the amplifier. Now measure the distortion level. Without making any adjustments to the amplifier, increase the signal from the generator 10 dB and again measure the distortion.

If the distortion increases, the amplifier does not have enough headroom. If there is no increase and you wish to know exactly how much headroom is available, increase the input signal again. Do this until the measured distortion begins to increase. The difference between the standard level and this high level is the headroom in dB. You can measure the system in the same manner. But go through and switch out or disconnect all the vu meters to prevent damage from the high level audio tones.

OPERATIONAL PROBLEMS

Signal levels throughout the system should be controlled by fixed pads at any point where a unit must operate with its gain control much less than half open. Although there are other operational reasons for doing this, headroom problems can also crop up. This can happen if the particular amplifier or unit has the gain control located *behind* the first stage, internally. Some units are designed this way for various reasons, so the first stage must have correct input levels from the source. If the input signal is too high, the gain control may be able to reduce the amplifier output level to normal, but the input stage headroom may be gone and the stage is already in the distortion area. It is important that the system designer know something about the particular units which are incorporated into the system. In the case just mentioned, the driving amplifier must have its gain control changed to lower the input to this amplifier—but then it may have control problems. If it can't handle that too well, a matching loss pad should be inserted between the two units.

EQUALIZERS

The use and adjustment of equalizers must be done with care or headroom can be lost in certain areas of the system. Equalizers are sometimes used to create special effects, but more commonly they are used to correct a system's deficiencies.

When special effects are desired, the normal signal level will be boosted in certain areas of the bandpass so that the resulting amplitude is that of the original signal, plus the boost. The boost at these frequencies in the bandpass can overload stages or amplifiers which follow the equalizer. The amount of distortion and its by-products may lose more in overall signal quality than is gained by the attempted special effects.

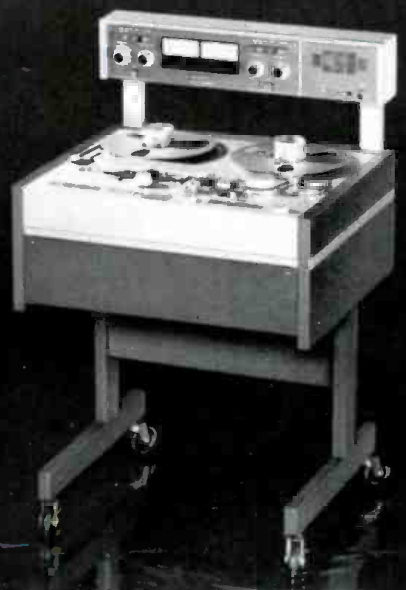
DEFICIENT BANDPASS

Circuits that have deficiencies in the bandpass will often require the use of equalizers to compensate for this. A high frequency rolloff in one circuit, for example, is complemented by the rising high frequency curve of the equalizer. The overall curve is then a flat response. The use of the equalizer in this manner will create no problems as far as headroom is concerned—as long as the equalizer is used *after* the deficient circuit. The actual signals present in the equalized area are very low before they get to the equalizer.

When the boost is made *ahead* of the deficiency, that is, there is pre-equalization of the audio signal, the signal is boosted in the same way as when done for special effects and the

Studer introduces the A80/RC

the quality defies comparison . . . the price invites it



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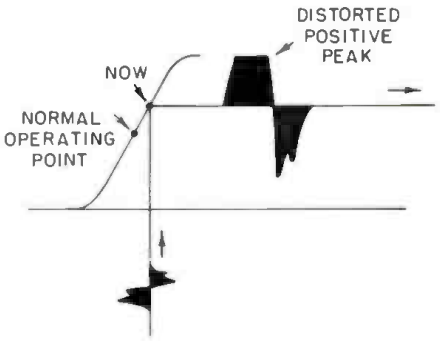

Figure 5. Defective components can shift the stage bias and its operating point up (or down) its input/output curve and produce distortion.

boosted signal can overload amplifiers that follow the boost. There are many cases where pre-equalization is done, but always keep in mind that the stages which follow must be able to pass this boosted signal without distortion.

COMPONENTS

Even though the system is correctly set up and properly adjusted for good headroom, components, transistors or power supplies in particular units may age, weaken, or become defective. These effects can change the operating position of a particular stage so that instead of being in the center of its input/output curve, it is now moved up or down the curve. This would cause the headroom to be lost on either the positive or negative peak, depending upon the direction in which the shift has taken place.

In another situation, a power supply component may alter so that the voltage to a stage has changed to a lower value. Although this changes the stage parameters, all may have changed in the same direction and the stage may still be linear—except that it cannot accept the same amount of input signal. Even the normal input signal may drive both the positive and negative peaks into clipping, and severe distortion result. This stage has lost headroom on both sides of the signal.

SUMMARY

Headroom is an important factor in high fidelity audio. When the system has a poor headroom factor, this will be manifested by various forms of higher distortion. Besides original equipment design, headroom depends upon system design and signal levels. However, when all is set up and going along well, some component in an amplifier can become defective and undo all our efforts. ■

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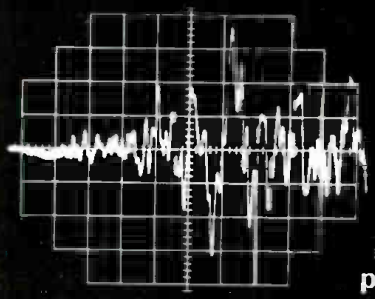
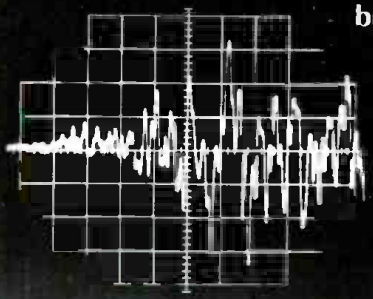


Live Piano Waveform.



Piano Waveform reproduced by SB-7000A.

It's a lot of complicated engineering, but it all adds up to something very simple. Music as it was originally played. Nothing more, nothing less. And that's a lot.

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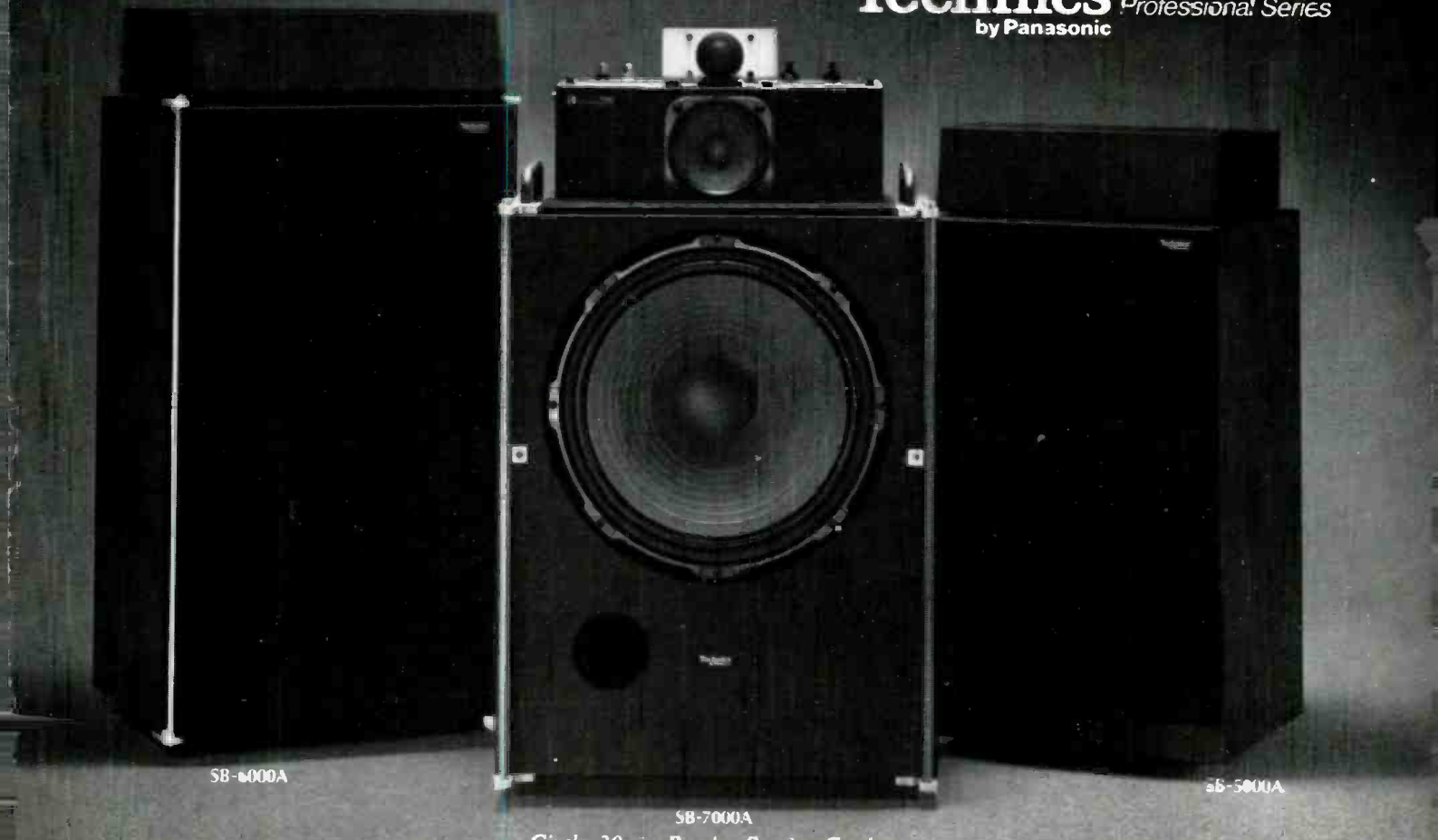

SB-6000A

SB-7000A

SB-5000A

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NORMAN S CROWHURST

db Theory & Practice

Faithful Reproduction

● This is a perennial topic. Only the details change. Back in the days when radio and the phonograph were battling over which of them would take over the home entertainment market —there being no television or tape in the picture—the main thing seemed to be *frequency response;* how much of the audible frequency range could the system reproduce?

If all the frequencies present in the original sound were also present in proper proportion in the reproduced sound, that would be faithful reproduction, wouldn't it? It seemed logical. What else is there to sound, beside acoustic vibrations of different frequencies? Today, such a question may seem naive. In those days, it would have seemed redundant, or rhetorical.

But after the advent of talking pictures, the motion picture industry ran head on into something called *intermodulation distortion.* This showed that true reproduction is not merely a question of making sure that all the frequencies are present in the correct proportions, but also of making sure that frequencies foreign to the original performance do not creep in. We became conscious of distortion and noise.

Reproduction was still what we then called *monaural.* This term was used because we were aware of binaural reproduction; as early as a Paris exposition in the nineteenth century, binaural reproduction, or at least transmission, had been demonstrated, with a realism that those who heard it would never forget, we have been told. So in contrast to that experiment so far in advance of its time, what we commonly heard was called monaural—not that we listened with only one ear, which is what the word "monaural" literally means, but that we had only one channel of sound. The early binaural experiment provided the basic realism that was to be repeated later with stereo. Stereophonic, to give it its full name, literally means "solid sound," or sound with depth and perspective.

To be strictly correct, binaural relates to how we *listen* to stereophonic sound. The earliest efforts at stereophonic sound for general public enjoyment were presented by the movies. Disney's *Fantasia* put loudspeakers all around the theater, to heighten the illusion that could be conveyed to the audience. But in the strict sense of the word, it was stereophonic sound.

Actually, nothing in the word "stereophonic" says anything about two channels. So I'm not quite sure why, when extra channels were added to make what has now been called *quadriphonic*, this mode of making a distinction was chosen. The erroneous implication many seem to derive from it is that stereo means "two-channel."

But this didn't start to be a discussion of semantics, although it is sometimes difficult to get far without digressing into what words mean. During the transition from mono to stereo, with however many channels, and however those channels are used, another idealized theory has been promoted, either explicitly or implicitly.

This is the notion that "perfect" reproduction duplicates exactly the sound field around the listener's head that he would have experienced during the original performance. Of course, this is a far cry from the corresponding notion of half a century ago, that what we needed was the complete frequency spectrum, no more, no less.

HOW WE HEAR

So again we ask, is that the true ideal? The answer to this is important, if we are to put 4-channel sound—whatever we call it—into perspective against what has gone before. Sometimes it is instructive to think about how we hear and perceive more everyday things than reproduced sound.

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field—where do you want it recreated? In which kind of room? As soon as you ask that, you realize that the original sound field was itself in a room, or auditorium, that had its own characteristics. Do you want to believe you are actually in that auditorium?

That was one thing the original binaural listening experiments were very successful in achieving. But unfortunately, that kind of realism can be achieved only with headphones or the equivalent so that the sound for each ear is very precisely conveyed to, and limited to, that ear.

And if you think that success is to be achieved by this method, so let us get the most comfortable headphones we can find, that method is not perfect, even supposing the headphones are. You see, it assumes that you will hold your head absolutely still!

Of course, in your everyday listening experience, you do not hold your head as in a vice. You move it, for various purposes. And you are accustomed to the fact that the sound you hear changes when you move your head because your ears happen to be attached to your head. The sound changes, but your impression of it is interpreted as coming from objects that do not move along with your head but are stationary in their relative positions, or are moving independently.

When you are wearing headphones, the sound piped into your ears by the binaural system is picked up by binaural microphones that simulate the position of a listener who does sit absolutely still. While you move your head with the headphones on, the dummy listener with the mics in his head does not move his head through some servo-mechanism connected to your head movement so you get the correct illusion. His head just sits there.

So moving your head, while listening binaurally, creates an unnatural illusion as if the whole sound field moves with your head, instead of your head moving within the sound field, in its normal fashion. Whether they realize it or not, that is why most people reject binaural listening in favor of stereo, which produces, perhaps not such a faithful replica, but one whose credibility is not destroyed by moving your head.

So what does stereo, and now quadriphonic, really have to do? What are we aiming for, if not for that hypothetical perfect recreation of an original sound field?

In case you are still thinking that is what we really want, let me ask you, have you ever tried listening in an anechoic room—one of those test rooms used by manufacturers of loudspeakers, microphones, as well as by universities? They are, as far as possible, completely free of any sound reflection. The walls, floor and ceiling are all virtually perfectly absorbent.

IS PERFECTION DESIRABLE?

If you installed a perfect quadriphonic system in such a room, you would have absolute control of the sound surrounding the listener. You could recreate any sound field you wanted to perfectly, or very close to it. For the average home, this would be a very costly way to go, but it is something the man who has everything might want to tackle.

Can you imagine what it would be like? Provided all you do is listen—and maybe that is what you want to do—it is conceivable that the illusion conveyed to the listening faculty in your brain would exactly duplicate that of the original performance. But I think even then, you would have to be a rather special kind of listener. Does anyone listen to a whole performance quite that passively?

Because this means you must be a total receiver for the whole time. You must not react, because the listening system will not respond in any way to reaction. You must act just like a silent mouse. Is that your normal conduct? I rather feel that only a corpse can be quite that "dead."

You are conscious of your acoustic surroundings, not only because of sounds totally external to yourself, but partly because you yourself emanate various body noises, such as breathing or various movements. These are not obtrusive, but they are present. In a quiet room these sounds become obvious conveying to you the acoustic environment you are in even when there are no other sounds. The anechoic room would virtually destroy this reaction, as you have undoubtedly found when you have been in one.

So what is your system to do, or to be expected to do? Briefly, the object is to give you a convincing impression of what you want to hear in the room in which your system reproduces it. The answer is not nearly so simple as it once appeared, and as people from time to time still try to make it appear. But, with intelligent application it is possible to put together a system that suits the room in which we want to listen. ■

Nearly every concert tour by a "super group" in recent years has had its origin at Showco. We design and build the huge, high-level sound systems, intricate lighting and special effects systems, and provide the stage designs for over 1000 concerts a year. At the conclusion of the tour, the tapes that we produce have resulted in best-selling "live" albums.

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The Pyramid speaker incorporates a unique fully symmetrical folded bass horn which in turn allows the mid and hi frequency drivers to be optimally mounted for wide dispersion. The overall result is a single full range, high level extremely efficient cabinet ideally suited to discotheques.

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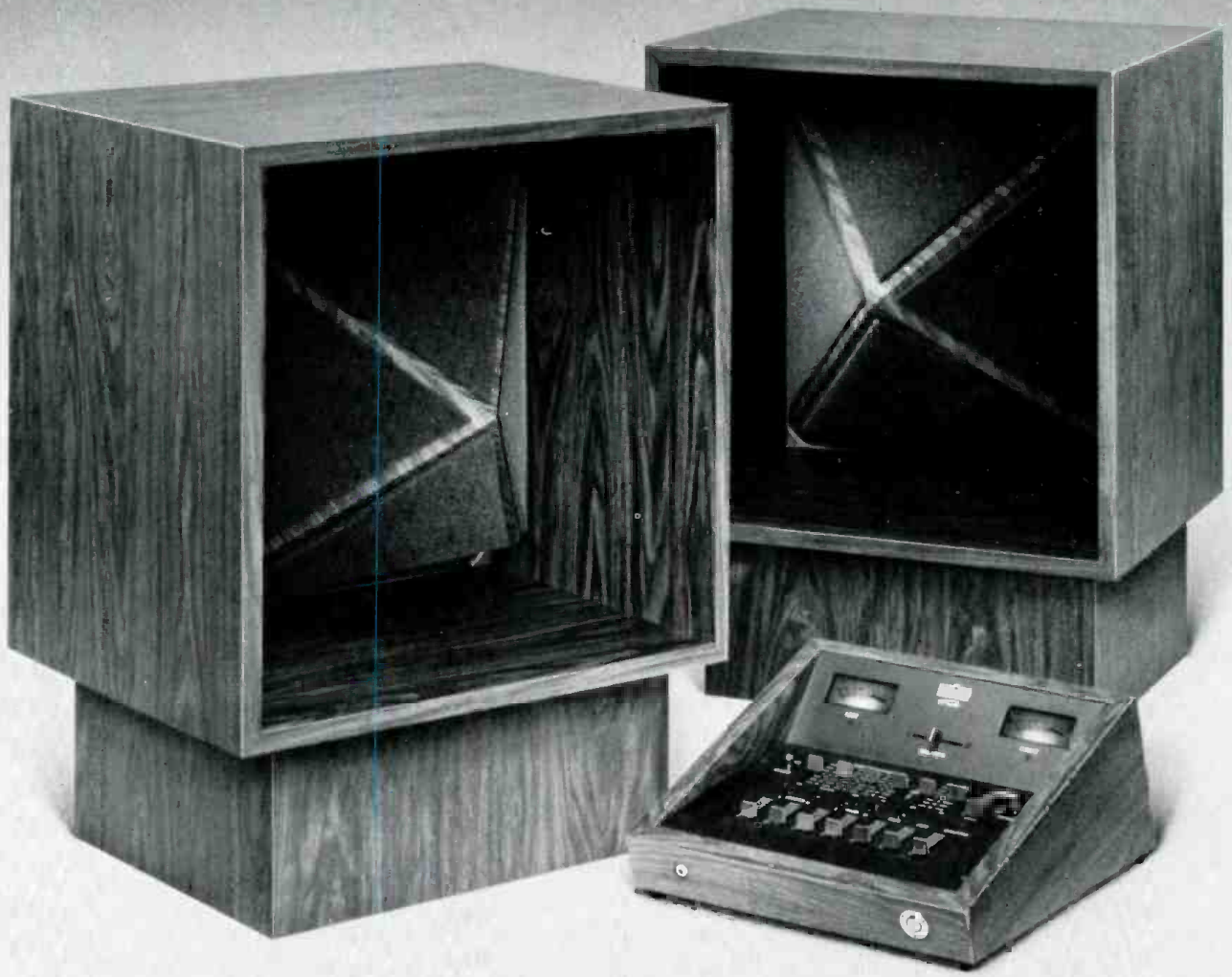

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theory and practice (cont.)

For example, how conscious are we of our acoustic environment, most of the time?

Let us draw on an experience that most of us have had at one time or another. Perhaps we have suffered a temporary hearing impairment due to an accumulation of wax or a blocked Eustachian tube. Most of us have had a very short-term variation of this experience with altitude or air pressure change. Normally, swallowing remedies this.

But if you have had your hearing impaired progressively for a somewhat longer period and then suddenly the full sensitivity is restored, you experience some of the confusion of sound that during most of our lives is fairly well resolved. Most of the time, our binaural faculty, coupled with other analytical processing of the "information" our ears pick up, enables us to concentrate on certain sounds while virtually rejecting others to a simply amazing degree.

We do it so effectively that we do not even realize this is happening. And that is what can make it deceptive. Have you ever taken a small tape recorder with you to a meeting to record the proceedings and then, when you replayed the tape, found that some comments from other parts of the room, that you heard perfectly from where you sat—and the tape recorder was right beside you—are unintelligible on the recording?

It is not just that the recorder was not sensitive enough to pick the voices up. More, it is that other sounds drowned out the voice you were trying to hear. The failure may even be caused by the impossible reverberation of the voice to which you were trying to listen. Why does the recorder make that impossibly confusing, when in person you certainly did not have that difficulty with it?

It comes down to the processing that your hearing faculty, which is an interpretive computer in your brain, applies to the enormous variety of sounds communicated to it by your two ears. This is going on in your brain all the time, and most of the time you don't even know it.

AMBIENCE

Coming closer to the problems of sound reproduction, perhaps your home has two kinds of rooms. At least, you must have experienced both kinds, as extremes, with some in between. There is the "dead" room, that contains more absorbent than reflective surfaces. It has heavy draperies, fully carpeted floor, plenty of well-stuffed furniture, and an absorbent ceiling.

You may notice a pleasant "cosiness" as you walk in. You quickly come to accept the acoustic environment provided by that room and its furnishings. At the other extreme is the typical recreation room: composition tile floor, wood paneled walls, plaster ceiling, and little padding on any of the furniture. Such a room has a "brightness" about it, acoustically.

You may notice that in the "dead" room you engage in conversation more comfortably, while in the "live" room you feel the need to get closer to someone else who is talking to you to avoid having to listen so carefully. You accept the nature of these rooms, and proceed to forget about it.

Then perhaps, one day, you are moving. The carpet is taken up and the furniture removed from that nice dead room and it sounds completely different. You would never have believed the difference the furnishings could make. The point is, those differences are always there, whether you realize them, or are continuously aware of them, or not.

Now back to that ideal of recreating a duplicate of the original sound

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Nakamichi Research (USA) Inc., 220 Westbury Ave., Carle Place, N Y 11514 Tel (516) 333-5440 Pres E Nakamichi, Mktg Dir Ted T Nakamichi, Dealer Relations Dir Ken Ohba
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JOHN M. WORAM

db The Sync Track

• With this issue of **db**, we celebrate 100 years of recorded sound. Although our editor was no doubt on hand for most of this time, I myself am a relative newcomer on the scene, and can only speak about the past twenty years or so. But who wants to hear about that, anyway?

However, as we start out on the second hundred years, it does seem appropriate to mumble something or other about where we are today, and possibly, where we are going. Actually, our next two issues will cover some of this ground, since they highlight quad sound and education in audio.

We shall hear very much more on both subjects during the next few years, and who knows, they may even become part of the history of the second hundred years. Meanwhile, what about today?

Last month's *Sync Track* commented on the state-of-the-art, and I suppose this is more or less a continuation of the same theme. Since last month, the state-of-the-art has taken a few giant steps forward. For one thing, the Audio Engineering Society held its 58th convention, at which attendees got to see some new laser beam sound systems, and hear a few conventional digital recordings.

Conventional? Well, perhaps not just yet, but Dr. Thomas Stockham was on hand with his Soundstream digital tape recorder, upon which he had just completed a digital recording at Boston's Symphony Hall. There, he was the guest of Bert Whyte, who simultaneously made a direct-to-disc recording of the Boston Pops for the Crystal Clear label.

And now, I'll shift gears for a paragraph or two and go back to the recent *Sync Track* columns (June and October) about broadcast audio. Hopefully, this digression will prove to be related to where we are today.

PROCESSING

The October column—with a letter from an f.m. station chief engineer—prompted a few more letters. Mr. W. Jimerson, a recording engineer with the Plough Broadcasting Company agrees that *". . . listeners are not fools. They know when a station sounds good. They may not know the reasons for a particular sound, but they do know when they hear good, clean sound . . . What the good chief engineer should understand is that audio processing introduces distortion, and distortion induces listener fatigue. Granted, initially a listener may tune to a particular station because of its loudness. This situation, however, is short lived if heavy audio processing has greatly reduced the dynamic range and fidelity . . . No matter how great the programming content, it isn't worth a damn if it isn't transmitted properly. This means from stem to stern or, as the case may be, from the dj's turntable to the listener's receiver."*

Joel Tall, of Editall splicing block fame writes, *"It is my belief that the standard of broadcasting should be up to the state of the art. Anything that introduces distortion of any kind should be outlawed. We have the capability to broadcast fairly clean sound. Why produce sound barely good enough for the 4 in. speaker mentioned in that letter? Why aim for lowest quality? I have heard that excuse for poor quality sound many, many times, especially when I protested many years ago, the network line limit of 5 kHz, plus much phase distortion. One network executive responded, 'Why produce 100 Hz to 15 kHz for midget radios that can't get more than 5 kHz tops?'."*

Mr. Tall feels that the broadcaster who distorts the air waves is in pretty much the same league as other polluters of the environment. Fortunately for those who care, we can still turn off the lousy broadcaster, even if we can't seem to do much about cleaning up the rest of our mess.

I don't know whether these letters represent the majority viewpoint or

John Woram's The Recording Studio Handbook

FOR RECORDING ENGINEERS, TECHNICIANS AND AUDIOPHILES

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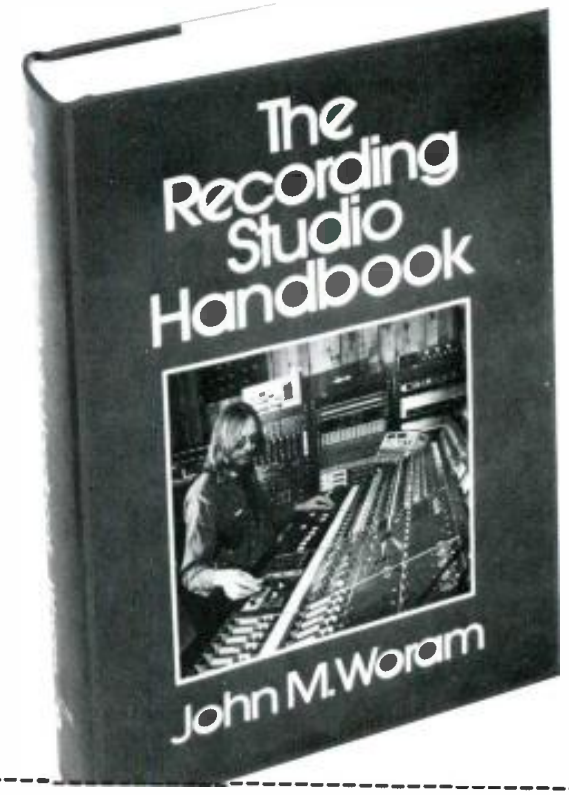
- Tape and Tape Recorder Fundamentals
- Magnetic Recording Tape
- The Tape Recorder
- Tape Recorder Alignment
- Noise and Noise Reduction Principles
- Studio Noise Reduction Systems
- The Modern Recording Studio Console
- The Recording Session
- The Mixdown Session



In addition, there is a 36-page glossary, a bibliography and five other valuable appendices.

John Woram is the former Eastern vice president of the Audio Engineering Society, and was a recording engineer at RCA and Chief Engineer at Vanguard Recording Society. He is now president of Woram Audio Associates.

This hard cover text has been selected by several universities for their audio training programs. With 496 pages and hundreds of illustrations, photographs and drawings, it is an absolutely indispensable tool for anyone interested in the current state of the recording art.

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not, but I'm glad to see that I'm not entirely alone in my opinions.

To tie all these loose ends together, on the one hand we see some impressive advances for tomorrow's technology, while on the other, we find those who continue to abuse even today's hardware. However, let's put this state of affairs in perspective and realize that the entire broadcast industry cannot be regarded as the villians, with the recording folks cast as the good guys.

PERSISTENT MONO

As it happens, I've recently gotten involved with the broadcast industry as part of my consulting duties. (Well, you didn't think I was living on my *Sync Track* income, did you?) Sure enough, they're just like the rest of us; some care about what they are doing—others are just punching a time clock.

One broadcast chief engineer notes that although his "beautiful music" format station is stereo, the overwhelming majority of his audience is still listening in mono. And this despite the fact that mono lp record albums are almost an extinct art form.

Why so much reliance on mono? Well, when was the last time you saw a stereo clock radio? How many drivers have stereo car radios? And what about all those hand-held transistor radios? When you add up all of these, it's no doubt true that the mono listener is still a potent force, especially if you're trying to sell ad time for your station.

So, how important is better sound, either in the recording studio or at the broadcast station? Obviously, some stations are making a very healthy living polluting the air with distortion. Their listeners faithfully tune in to hear the latest chart busters, and accept the sound quality because they've never heard anything better. Therefore, they don't know what they're missing. To them, the home phonograph or tape recorder is "something else," and they don't make comparisons. If that sounds far-fetched to the audio freak, how many of you have ever complained about the high fidelity characteristics of the telephone system? Probably few, if any. The telephone is simply a tool for exchanging messages. It just never occurs to anyone how much better the quality might be. But just imagine a phone system that sounds as good as a decent radio. Then, think about a radio that sounds as good as your own favorite records. And while we're off in fantasy land, think about quiet pressings, too.

Actually, none of this needs to remain in the realm of make-believe. Telephones, radio broadcasts and pressings could all sound a lot better if their makers could be convinced there was a market for quality. Well, the extraordinary growth of direct-to-disc recording projects shows that perhaps there is a market for good sound. Digital technology—as well as the latest advances in analogue recording—demonstrate that the next few years could well witness more improvements than we have previously heard over the first hundred.

But, is there a *need* for something better than today's sound? Some people think so—others don't. Here and there, innovative industry leaders continue working for better broadcast and recorded sound. Others are more than content to supply their followers with more distortion, more compression, more noise—all in the name of loudness, and to hell with quality.

To wrap this all up, what would *you* like to do over the next hundred years? You might try leading the followers, or for a refreshing change of pace, try following the leaders. It's up to you. (No, I'm not a leader—I'm just watching.) ■

MARTIN DICKSTEIN

db Sound With Images

• Since this corner usually operates on the premise that what you see and hear is what you get here, this last column of the year would cover two things. First, a look back to join in the celebration of the 50th year of sound in the movies, and second a look at some ways to help you in the coming year, whether you work on presentations for others or make some yourself.

Although this is the year the government and industry have recognized as the 50th year of sound joining motion pictures (a stamp has been printed commemorating this event), this column actually was closer to the truth when, seven years ago, we published an item on how movies began. The truth of the matter is that sound on film actually came about almost 10 years before 1927—in 1919 to be more exact. Three years later, this development was presented and written about.

Credit for this discovery and development was given to the inventor by the federal government in a patent issued in 1924—April 8 to be precise. The patent reads in part: *Be it known that I, Lee De Forest, a citizen of the United States, residing in the City of New York, County and State of New York, have made a certain new and useful Invention in the Art of Recording Sound, of which the following is a specification.*

This invention relates generically to the art of recording sound and more specifically where such record is obtained photographically for use in connection with photographic sound records such as films or the like, and is especially adaptable for use in connection with the art of motion picture photography.

The object of the invention is to provide means which are simple, economical and efficient for photographing sound record on films.

This is the same Lee De Forest who invented the electron tube back in 1907 (or *valve*, as it was called, because it could control the flow of electrons and result in a controllable output). He also then developed an amplifier by connecting in tandem three of these devices. This in turn led to the development of long telephone communications because now there was a way of setting up a system of repeaters as needed. This also led to the "radio" (television without pictures), television, hi-fi, public address systems, radar, computers, etc., etc., etc. (Perhaps we should call this the 70th year of sound amplification.)

Just another note or two on the development of sound on film De Forest also developed the narrow slit for recording sound on film, the first double system using separate film for image and sound and then combining them on the first composite film (one of the problems here was development of picture film and sound tracks in the same process), the first variable density sound recording (variable area did not come until the early 30's), and enough other devices of all kinds in the electrical and associated fields to gain him over 100 patents by 1915, and more than 300 by 1949.

FIRST TALKING PICTURE

So, if you want to win a beer at the New Year's party you're going to attend, bet on the first year of sound motion pictures. It wasn't 1927, and the first real talking movie wasn't "The Jazz Singer," which only made use of De Forest's sound amplifying equipment from a separate mechanical means to feed the house sound at proper times during the playing of an actually sound-less motion picture. Actually, De Forest had developed demo sound movies, but the identity of the first talking picture is hazy.

IMPROVING A/V

Now that we've looked back and destroyed a few illusions, the rest of this corner will be devoted to improving your a/v in the coming year. I was recently invited to write a paper for presentation to a group of executives on the application of audio visuals (especially slides) to presentations. As a result of this information, perhaps these people will now know a bit more about ways that slides can be used. They will be making more use of some of the innovations now available to relieve the boredom that is almost inherent in a single image slide format.

The following 37 ways suggested to that group to liven up their presentations may be of use to you.

ONE PROJECTOR

Use a horizontal format and metal or plastic mounts

All slides can be made horizontal even if material may look vertical.

Verticals may not always fit on the screen. Horizontal slides will fit better. The sturdier metal or plastic mount will protect slides, keep better focus, and greatly decrease the possibility of jamming.

Use large lettering

Jumbo type, if possible, is better than the capitals on a regular typewriter. Legibility will be greatly improved. Use capitals for single words or short phrases, but caps with lower case letters for longer copy.

Use fewer words, more numerals

Fewer words and digits stand out, and are more memorable than long paragraphs. Long paragraphs should be used sparingly. Read all copy—then talk.

Use symbols and logos where possible, and montages

Symbolism and relevant visuals can be more memorable and effective than words. Logos can be used for client names, symbols for their obvious meanings, or newly designed visuals for enhanced interest.

Use pictures whenever possible

Pictures, of products, locations or people, can illustrate better, be more memorable, and relieve the tedium of continuous slides with words.

Use drawings or cartoons when applicable

When appropriate, cartoons and drawings can add a bit of lightness to an otherwise complex or serious subject, and make a fact or figure stand out more effectively.

Use charts and bar graphs rather than numbers

Columns of numerals are difficult to see; charts or bar graphs will prove more readable, and much more memorable.

Use light lettering on a dark background

Slides are most legible with light letters on a dark color. Dark letters on a light background are legible, but the bright area tends to be blinding.

Use different dark colored backgrounds

To add variety, or to indicate separate sections, different dark backgrounds can be used.

Use different colored letters

With different colors on the same slide, the more relevant words or numerals can be made to stand out most effectively. Different sections of a flow chart can also be indicated most clearly.

Use white letters on black background

For greatest contrast of key words or short phrases, and for greater impact visually, use white on black.

Use colored letters on black background

Variety and enhanced visual interest, as well as greater memorability, can be achieved by using different colored letters and numerals on a black background. Large size letters and numbers can be most effective.

Show ads on a black background

Whether black and white or in color, all ads should be photographed on a black background. They also should be shot to fill the full height of a horizontal format slide for legibility and effectiveness. Ads shot this way will seem to look vertical and will be uniform so they can be used in any presentation, regardless of background color used.

Use key word or visual in a corner

In a series of related slides, using the key word or visual in a corner of the slides will create continuity and keep the subject being discussed before the audience, as in case histories, for example.

Segment slides

This is done in t.v. as a "split screen" effect. Half the slide is used for copy, for example, and the other half for related copy, or a picture, or is left blank. This can be done either left and right, or top and bottom. Successive slides can use different halves to create movement during a sequence. It can be done in quarters, also. Use different quadrants for a feeling of mobility during a sequence.

Use different shapes

The use of a variety of geometric figures can differentiate between topics, sections, or subjects in a presentation.

Use different colored shapes

Changing the colors of the shapes can provide an innumerable variety of combinations to differentiate between parts of a presentation. These can be used in the corner of slides for sequence identification.

Use multi-shapes on the same slide

Greater interest can be achieved by using a variety of shapes and colors on a single slide.

Go to black

Slides should not be left on the screen after they have been discussed. Use of simple slides and blank dividers permits quicker movement of the presentation.

TWO PROJECTORS (ONE IMAGE)

Use dissolves

This effect requires two projectors and a dissolve unit but can be operated with a single remote control. The dissolve effect eliminates the black space between successive slides, and creates a smoother flow. Set up and moving of slides is not as simple as with a single projector.

Combine segments with a dissolve

Used with charts, or graphs, or segmentation, this effect creates the illusion of motion.

Use supers

This effect requires two projectors and an individual remote control for each. Putting both slides, properly designed, on the screen simultaneously, will create a "super" effect as seen on t.v. Use this arrangement also for side-by-side half slides, moving each side separately.

Use a "pop" or "flash" effect

This also requires individual controls for each of two projectors and permits flashing a bright light on the screen during a slide change for a different optical effect.

TWO PROJECTORS (TWO IMAGES)

Use two screens

Two projectors, each with its own control, are required. The images can be separate on both screens, or one image can be spread across the double width. The slides can be moved independently or simultaneously. Either side can be used for film, with the other side black or with a slide, or the film can be shown in the center.

THREE PROJECTORS

Use three projectors with two images

This combination allows two projectors with a dissolve to be used on one screen while the other projector is used independently on a second screen. Two controls are needed to effect a dissolve on one screen and regular slide movement on the other.

Use three projectors with three images

Three individual controls are used and projectors can be moved in any combination. A triple-width screen is needed although this is usually not readily available everywhere.

Use motion slides

This effect requires special art work, and a device to fit in front of the projector lens. Portions of the treated slide will appear to move on the screen. This can be used on flow charts or diagrams, for example, to indicate a process in motion. Normal slides are unaffected.

Use a T-scope

This device placed in front of the projector lens, permits a slide to be flashed quickly on the screen, or to be kept on for any predetermined time period. It is useful, also, for repeated showing of the same slide during a presentation.

Use special slides

Special slides can be made by using paint on the slide glass, by scratching on black film, by cutting out any desired shape in silhouette, and in many other ways.

Use slides with center cut-outs

By cutting out the center of a black slide in any desired shape, an opening is formed in which a film can be shown. The cut out center can also be done with a regular slide leaving the slide around the opening and having the film showing in the center.

Blend slides with film

A smooth transition between slides and films can be achieved by making a slide of the first frame and the last. The film can be started over the slide preceding film, the slide can be removed for a blank, and the slide following the film can be put on the screen over the last frame of the film. This eliminates the black pause at the start and end of films and creates a smooth blend.

Combine effects, techniques, and multi-screens

Any slide or effect usable on one screen can be shown in multi-image presentations for greater impact and interest, and improved results.

Use a tape sound track and automatic slide control

Recording a commentary on tape permits the use of cue signals on the same tape to control slides or effects in synchronization with the script.

Use a programmer for complex special effects

Multi-function programmers can be used to control a complex presentation with several projectors, images, and devices all synchronized with a sound track on tape. Effects including "pop ons," flashing or blinking slides, different speed dissolves, and so on, are possible.

Use odd-shaped screens.

It is possible, in special setups, to have images shown on any shape screen, either in front or rear projection. This also allows the placement of these screens anywhere in the viewing area.

Use the projector as a spotlight

When the presentation is made in a totally dark room, either by desire or necessity, another projector can be used as a spotlight for the presenter. By cutting a tiny hole in a black slide, the light can be aimed at the speaker and the projector advanced or reversed when the illumination is required.

REHEARSE . . . the most important point of all

The presenter should rehearse, in the presentation room, if possible, under actual conditions to perfect the movement of the slides and the effects, and to be sure the slides are arranged as they should be. Slides and effects to be controlled manually should be operated by the presenter whenever possible for a smoother presentation. Slides and effects should be used for emphasis, not to overpower or distract, and to communicate clearly—and entertainingly. ■

db New Products & Services

INTERCOM POWER STATION

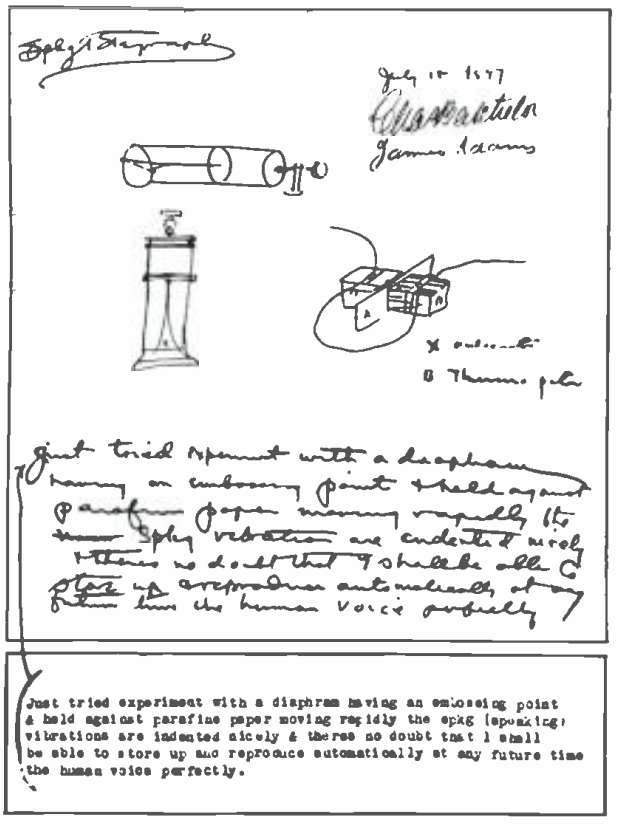
● Up to forty stations using this manufacturer's intercom system can he accommodated by the PS-3000 power station. The modular unit may be installed away from the intercom area; also, a program input is provided to allow external program material to he fed into the intercom system. System interconnect outputs are harrier terminal strips located on the rear panel. The program input is an XL-type 3-pin connector also located on the rear panel for an unhalanced line in. All other controls are on the front panel. Indicators show excess power or threatened short circuit conditions.
Mfr: Clear-Com.
Circle 51 on Reader Service Card

SPEECH CONTROLLER

● Recorded speech can be played back up to 2.5 times faster or 40 per cent slower than the original recording speed without distortion on the Model A6 speech controller cassette playback machine. Slide controls regulate playback speed and volume. The units accepts standard cassette tapes and plays back tapes recorded on standard tape recorders.
Mfr: Variable Speech Control Co.
Price: $295.
Circle 52 on Reader Service Card

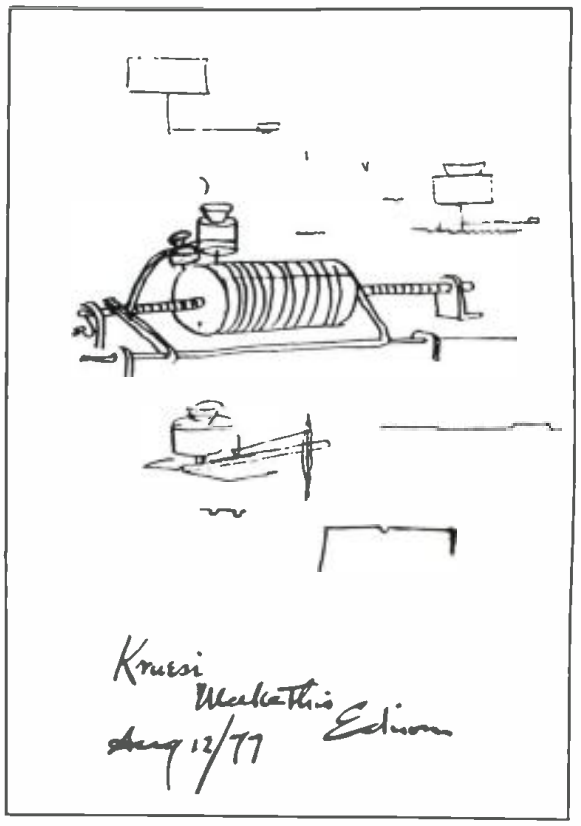
The Edison Phonograph Drawings

Note that Edison's later addition of the line "Kruesi Make This," Edison, whose spelling was notorious, spelled his assistant's name wrong. It was spelled Kreusi!



Just tried experiment with a diaphram having an embossing point held against parafine paper moving rapidly the spkg (speaking) vibrations are indented nicely & there no doubt that I shall be able to store up and reproduce automatically at any future time the human voice perfectly.

The Conception



Kruesi Make this Edison
Aug 12/77

The Model

New Literature

VIDEO CONSOLES

Wood grain consoles for video equipment, as well as other steel storage and retrieval a/v furniture are described in a color brochure. Mfr: H. Wilson Corp., 555 W. Taft Dr., S. Holland, Ill. 60473.

PROGRAMMABLE CALCULATORS

Keystroke programmable advanced scientific calculators with 98 fully merged program steps, continuous memory, full editing and storage functions, 30 data registers, and a built-in thermal printer are described in a 6-page brochure. Mfr: Hewlett-Packard Company, 1507 Page Mill Rd., Palo Alto, Ca. 94304.

BARGAINS

32 pages list a miscellany of discount and closeout mail-order bargains in electronic equipment. Mfr: Etco, c/o Marvin Birnbom, 464 McGill St., Montreal, Que. H2Y 2H2, Canada.

MINI SPEAKERS

A group of linear phasing speakers is covered in this literature. Mfr: Custom Craft, 819 S. Kraemer Blvd., Placentia, Ca. 92670.

AIR HANDLING SILENCER

The Slimshield Quiet-Vent silencer/louver hushes your air-conditioning and heating systems. Mfr: Industrial Acoustics Co., 1160 Commerce Ave., Bronx, N.Y. 10462.

DARLINGTONS

This data sheet describes a series of very high voltage monolithic Darlingtons with power ratings to 125 watts. Mfr: International Rectifier, 233 Kansas St., El Segundo, Ca. 90245.

STEREO

Semi-pro and pro stereo receivers and other products are covered in this booklet. Mfr: Nikko Audio, 16270 Raymer St., Van Nuys, Ca. 91406.

ENGLISH LABELLING

Confusion over regulations for/against labelling in English of products destined for foreign markets is clarified in this compendium of current laws. Mfr: ITA International Inc., 4530 Madison, Kansas City, Mo. 64111. (Legal Translation Dept.)

CASSETTE/CARTRIDGE COMPONENTS

A color folder features components for audio, digital, and video cassettes and cartridges. Mfr: Dixon Industries Corp., Bristol, R.I. 02809.

BREADBOARD/TEST EQUIPMENT

A loose-leaf punched catalog details breadboard equipment and accessories, plus a metric conversion chart. Mfr: Continental Specialties Corp., 44 Kendall St., New Haven, Ct. 06509.

CONSUMER ELECTRONICS

Radio Shack's fat (165 pg.) 1978 catalog is full of audio and hobby goodies. Mfr: Radio Shack, 205 N.W. 7th St., Ft. Worth, Texas 76101.

OSCILLOSCOPES/MULTIMETERS

Test equipment is featured in this catalog. Mfr: Leader Instruments Corp., 151 Dupont St., Plainview, N.Y. 11803.

TOROIDS

Ferrite toroids used in wide band, pulse and power transformers and inductors, along with technical data and equations are contained in an 18-page booklet. Mfr: Terronics, Inc., 60 N. Lincoln Rd., East Rochester, N.Y. 14445. ■

HAZEL KRANTZ

Eldridge R. Johnson, Builder of Talking Machines

The founder of the Victor Talking Machine Company put Emile Berliner's device into every respectable home.

ALONG WITH the first ripples of the tide of technology in the United States came the little machine shops, sired by the harness making and agricultural implement repair workshops. It was a while before the manufacturers of early machines got the bright idea of making replaceable parts. If a machine broke down, the owner would take it down to his little neighborhood fix-it shop and have a replacement made for the ailing part.

Inevitably, inventive dreamers also came to the machine shops to have their theories translated into nuts-and-bolts reality. This kind of business was hardly lucrative to the mechanic. Most inventors started out poor and ended up destitute, with the machine shop's bill leading all the rest. There had to be another incentive beside immediate profit. This was not only the natural curiosity of the born tinkerer about making something work, but a gambling fever too. The world seemed wide open for new and marvellous inventions. Each small-town mechanic had a dream of participating in the development—and subsequent untold riches—of *the* great invention, the better mousetrap.

One of these little model-making shops was called Scull & Johnson in Philadelphia, Pa. operated by a young

An 1898 Gramophone built by Johnson.

Hazel Krantz, **db** *copy editor, is a freelance writer. She has published five books for young people and a number of articles.*

The Victor-Victrola

man named Eldridge Reeves Johnson. The company had been founded in 1886 by Captain Andrew Scull as an outlet for the talents of his son John, a mechanical engineer. Unfortunately, the son died at an early age and the father was left with the business in which he took a desultory interest. His employee, Eldridge Johnson, bought out Captain Scull's interest in 1894, a sensible move prompted by the reality that the business did not earn enough to support two owners.

To be technical, it didn't support one owner. But in spite of hardship and financial travail, Johnson was of that breed that seemed indigenous to American soil, the man who wanted to be his own boss. Born in Wilmington, Delaware in 1867, he had drifted around the country, earning a good living as a skilled mechanic. He settled in Philadelphia and accepted the opportunity of becoming sole proprietor of the struggling machine shop with a sense of moving into a life design.

As he said later, "Being the proprietor and manager of a repair machine shop was well calculated to either break a man's spirit or fit him for better opportunities." Johnson viewed his early struggles as just part of the mosaic of his career.

We often have an image of these pioneers of the machine age as pragmatic fellows who channeled their values into pure mechanistic lines—technology was to provide the halcyon of human existence (they used words like "halcyon"). But Johnson's nature radiated in many directions, mingling curiosity with an almost mystical visionary attitude. He was not only concerned with putting the right gears together to make wheels turn. He dreamed of the future implications of the device. When he was confronted with an early "talking machine" it was not merely a strange toy to him; in his imagination he translated it into the significant medium of education it has become. Nor was he concerned only with technology. In later years, he invested in things like the original manuscript of "Alice in Wonderland," endowed churches and a community center, placed a statue of Peter Pan in front of the Public Library of Camden, New Jersey, and became close friends with artists such as Caruso.

A PARTIALLY EDUCATED PARROT

During the early days when he was trying to combine his machine repair business with a manufacturing sideline producing a book-binding machine he had developed, someone brought Johnson one of the new "talking machines" for alterations.

As Johnson described it, "The little instrument was badly designed. It sounded much like a partially-educated parrot with a sore throat and a cold in the head, but the little wheezy instrument caught my attention and held it fast and hard. I became interested in it as I had never been interested before in anything. It was exactly what I was looking for. It was a great opportunity and it came to me as it can never come to any other man in the talking machine business again. Other opportunities may come to other people, but that was the great opportunity and I

If you're in the vicinity of Dover, Delaware, an interesting side trip is a visit to the Delaware State Museum, at Meeting House Square, 316 S. Governors Ave. An entire building, the Eldridge Reeves Johnson Memorial Building, is devoted to memorabilia of Johnson's career, ranging from the earliest talking machines of the outside horn type to Orthophonic models and the rare Aux-e-to-phone. Also included are thousands of Victor records. The items are displayed in a reproduced Victrola dealer's store. The building is open to the general public Tuesdays through Saturdays from 11:30 a.m. to 4:30 p.m. and on Sundays from 2:00 p.m. to 4:30 p.m. It is closed on Mondays and legal holidays, but open to researchers by appointment any day except Monday. For information on tours and group visits, telephone (302) 678-4280.

Closeup of the drive system used in the 1898 Gramophone.

An early Victor ad for a Gramophone. Note the price!

was ready for it—thanks to a chain of favorable circumstances, one link of which, if missing, would have changed this account totally."

It was with this attitude of being precisely in the right place that Johnson later formed his partnership with Emile Berliner. Johnson recounts the story of his own role in bringing Berliner's device to reality. "Mr. Berliner had given the world the greatest basic improvements in the talking machine since the day of Mr. Edison's original discovery, and I happened to be the man who happened to be there at the right time to give this great discovery the needed improvements and refinements, and to manufacture it in such forms and designs as to become most popular with the buying public. My years of hard experience in model making and repair work had well qualified me to cope with intricate designs and processes. I immediately undertook a course of experimenting with talking machines and made discovery after discovery until a talking machine of the disc Gramaphone type, capable not only of reproducing sound in its own mechanical fashion and in a tone of its own but of reproducing the tone true to the original sound, stood in my laboratory."

VICTOR TALKING MACHINE COMPANY

Johnson founded the Victor Talking Machine Company in 1901, manufacturing machines inspired by Emile Berliner's original design. During the period 1898 to 1915, patents awarded to Eldridge Johnson for talking machines, recording devices, cabinets, and improvements on the devices came to about 60, plus ten more issued in conjunction with other developers. The Victor machines, offering the marvel of speech and music actually reproduced in recognizable form, became the status symbols of their day; no respectable home would be without one. Johnson had truly latched onto the one-in-a-million lucky strike dreamed of by every freelance machinist and his impecunious inventor clients. There was luck, and incidentally, the will to work toward a goal, envisioning a concept and then laboring to bring it into tangible form.

Johnson had a sense of people moving together to create something. One of his favorite quotations was, "No man can be happy who is not in touch with Humanity." This included the people who worked for him. It may sound paternalistic, but there was a clarity of focalization when the head of the Victor Talking Machine Company said to his employees "We seek to improve everything we do every day."

Some of the improvements on the talking machine brought litigation in their wake. A dispute over patent rights with the Berliner Company cost the Victor Talking Machine Company over a million dollars for the right to a patent which expired within a few months after it had been acquired. Eldridge Johnson took the litigation in stride. It was his contention that "It is a bad plan to fight a patent unless you are perfectly sure that you are right."

Always on the side of agreement rather than wasteful recrimination, Johnson arranged to merge his own interests with that of the Berliner litigants so the two could utilize their combined power. By 1927, the Victor Talking Machine Company had branches in Yokahama (JVC) Great Britain, Europe, Canada, Chile, Argentina, Brazil, as well as the United States. In 1929, the RCA Company obtained the U.S. rights to the name and the trade mark.

HIS MASTER'S VOICE

Eldridge Johnson had thoughts of great achievement in technology, even a sense of pride at becoming a tycoon of industry. But it's doubtful, although he was interested in scientific marketing, that he ever dreamed he would become one of the heroes of the advertising business, celebrated in the folk annals recounted by professors in college marketing courses. Yet it was Eldridge Johnson who immortalized a trademark that rivals Mickey Mouse in worldwide familiarity, "His Master's Voice."

Eldridge Johnson's desk much as it appeared during his lifetime. It is on display at the Delaware State Museum.

The painting which forms the basis for the trade mark, done by Francis Barraud, is of a not really throughbred bull terrier, Nipper, listening to an old Edison phonograph. Celebrated as the most copied painting in the world, it has a poignant history.

Nipper originally belonged to Francis Barraud's brother, E. M. Barraud, a painter of theatrical scenery. In fact, E. M. Barraud's skill was so great, he was often summoned for curtain calls along with the casts of the productions for which he had designed the scenery. Always, standing by his side, was his dog Nipper.

E. M. Barraud died at the age of 39, leaving the dog, who thereupon adopted Francis Barraud, a photographer turned painter. Francis Barraud owned one of the early phonographs. One day it seemed as if the dog was listening with special intensity to a recording. Barraud listened carefully; the voice on the recording did indeed resemble that of his dead brother. He quickly sketched the scene and the painting followed. Eldridge Johnson happened to see the painting. He suggested it to his partner, Emile Berliner, as a natural trademark for their fledgling company. He was right.

MANUFACTURING TALKING MACHINES

In 1913, Eldridge Johnson described the intricacies involved in the manufacture of the phonograph. "The manufacture of the Victor and Victrola calls for skill and workmanship far beyond that of watch manufacturing and violin making. Watches are constructed to measure time at intermittent intervals, but a talking machine record must revolve evenly, true to pitch, and maintain the same percentage of accuracy through each degree of its revolutions. It must measure out billions of vibrations so small that the eye can detect but few of them so accurately as to make the true tone of the original. The construction of the parts that record and reproduce the sound to a satisfactory volume without destroying its beauty is most difficult and complicated, and calls for an organization of experts with a greater variety of skill than any other business."

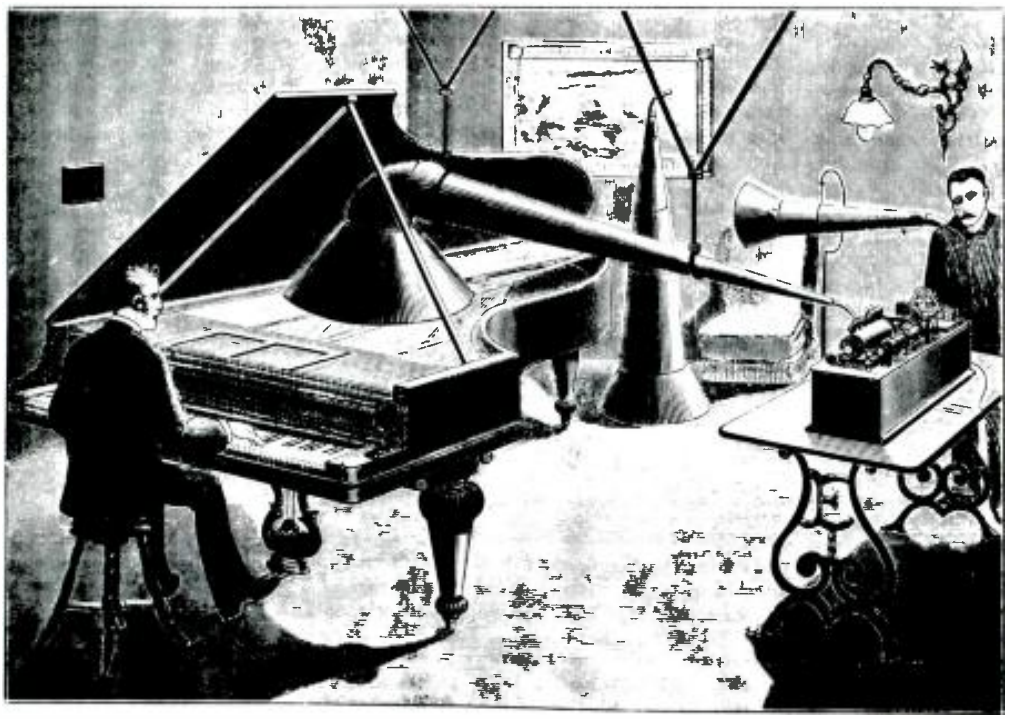
At that time, Eldridge Johnson predicted that it would take another twenty-five years to perfect the talking machine. He would probably be astounded, sixty-five years later, to hear the cacophony of experts uttering cries of "Eureka" at quad, or direct-to-disc, or the newest magnetic computerized tape, all guaranteed at last to truly reproduce for posterity that which the human ear has no trouble in handling.

But then again, perhaps Johnson, who died in 1945, would not be so astonished after all. With his sense of his own position in the scheme of things he might agree that even his most ardent dreams of technological excellence must, rightly, always fall short of perfection.

REFERENCES

Material for this article came from a pamphlet compiled by Mrs. Eldridge Reeves Johnson in 1951. Our thanks also for their assistance to the people at the Delaware State Museum in Dover and to Mr. Shortell of RCA. ■

Edison's Parisian Triumph



Apparatus for registering piano music by the phonograph.

EDISON, the illustrious American inventor who recently came to Paris in order to visit our great universal exposition, belongs, through his discoveries, to the privileged class of the benefactors of humanity. The respect that he has found among us is justified, and to it we add our humble tribute by summarizing in this place the extraordinary history of the great physicist, whose debut was so modest, and whose labors, already so important, have obtained applause throughout the world.

Edison was born in Milan, a little village in Ohio on the 11th of February, 1847. He is, therefore, not yet forty-three years of age.

He received from his mother an elementary education which he himself completed by assiduous toil, passing whole nights in reading such scientific works as fell into his hands. At the age of twelve, while simply a train boy on the Canada and Central Michigan Trunk Railway, he started a newspaper, or rather a journal of reference, which was printed on the train, while running from station to station, with a press and type bought at second hand and placed in a corner of the baggage car. This was the young American's first invention, for *The Grand Trunk Herald*, of which he was the sole owner, publisher, editor, compositor, printer, and vendor, was the first journal ever printed upon a railway train. In his printed sheet, the young publisher furnished all the practical information that he could procure from station to station, such as regarded the carriages that ran to places in the vicinity of the stations, amount of fare, hotels to be recommended, and likewise news of all sorts caught on the fly and printed while the train was in motion. There was here an essentially original idea, and one that was absolutely remarkable when we consider that it was conceived and put into execution by a child twelve years old.

Edison was not satisfied to be a journalist and reporter. He made use of his leisure time in the study of mechanics, electricity, and chemistry, and always in the corner of the baggage car that was reserved for him. But one

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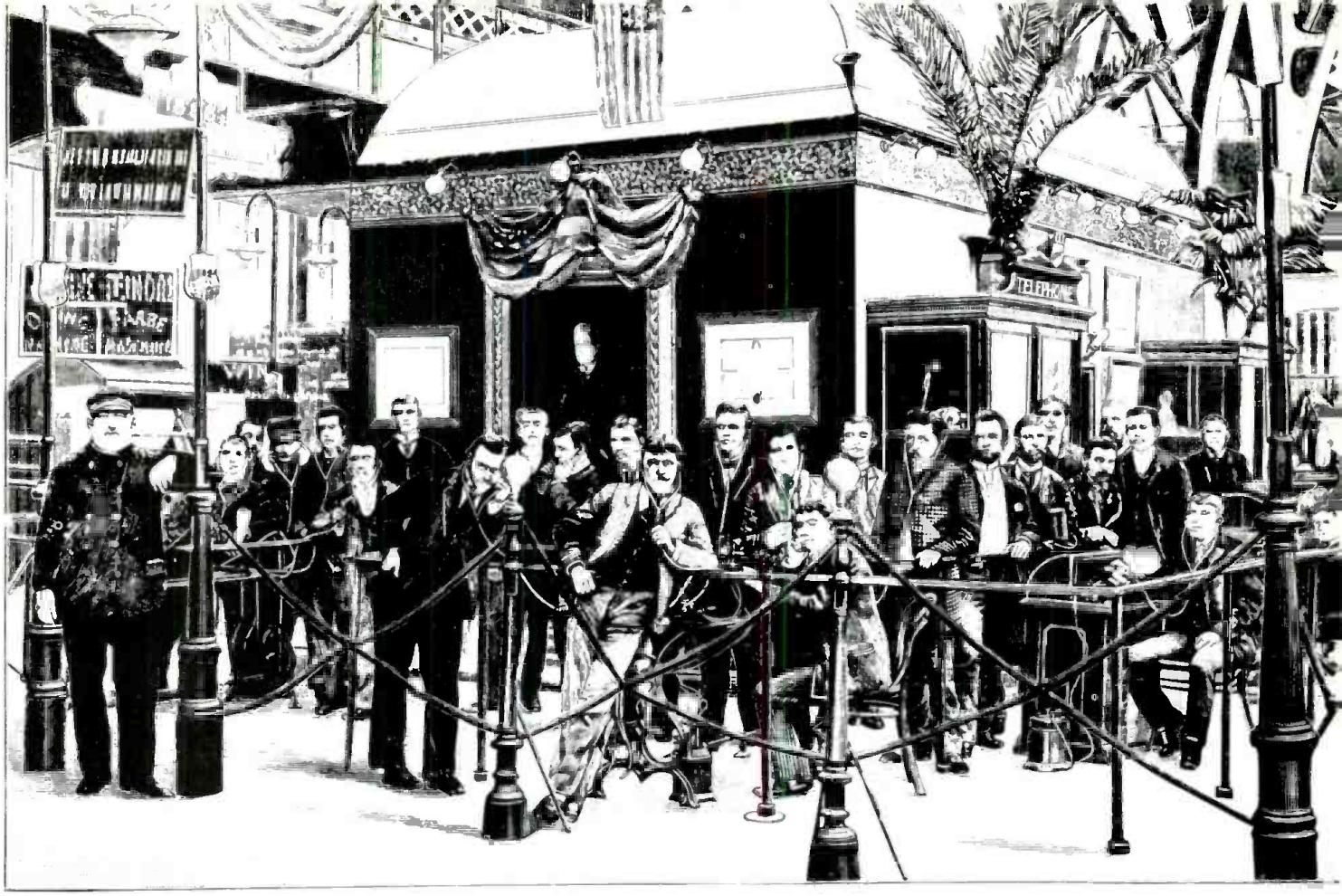
It may appear, both in the timing of the subject matter and the ornate verbosity of style, that **db** *has been caught in a time warp. In reality, we swiped this article from the October 12, 1889 issue of* Scientific American, *happily in the public domain.* Scientific American, *incidentally, had lifted the piece from a French publication,* La Nature.



Edison's assistants posed listening to his phonograph at the Paris exposition.

day, an unfortunate experiment set fire to the car, and the conductor of the train, being angry, put the little printer off the train along with his press, his books, his products, and his chemical apparatus, that had gradually found their way into the baggage car and converted it into a genuine laboratory.

The experience gained by Edison in his multiple functions upon the train permitted him then to become a telegraph operator at Port Huron, Mich. and to more thoroughly study telegraphy, which his inventions have caused to make so remarkable a progress. His first invention, duplex telegraphy, dates back to 1864, and quadruplex telegraphy, the use of which is now so general, was conceived, if not realized, at about the same date.

In 1868 Edison went to Boston, and it was then that he began to be appreciated at his just values. Here it was that he opened the first shop to work up his inventions, which as yet remained more especially in the domain of telegraphy. Shortly afterward he entered the service of the Gold and Stock Exchange and of the Western Union Telegraph Company, which bought his inventions from him and thus started his fortune. A factory for 300 workmen was built at Newark, N.J. for the manufacture of stock and market telegraphs, but the management of this left Edison too little time to occupy himself with his inventions, and he soon relinquished it for the thereafter historic Menlo Park laboratory, whence have proceeded most of the inventions that have rendered his name so justly celebrated.

ORANGE, N.J. LAB

Later on, the Menlo Park laboratory being found inadequate, Edison abandoned it in order to found a special establishment at Orange, where his shops for construction and experiment, greatly enlarged, now form a true industrial city. Edison has touched every branch of the applications of electricity with success. His telegraphic inventions, which began his fortune, are in widespread use in America.

Although it is not just to attribute, as is too often done, the merit of the invention of the telephone to Edison, to the detriment of the true inventor, Graham Bell, it cannot be denied that Edison has introduced important improvements into this invention. The first carbon transmitter employed in practice was that of Edison, for which, everywhere since, there has been substituted transmitters based upon the Hughes microphone; but the electrophone, a loud-speaking telephonic apparatus, is a first-class invention, the original idea of which belongs to Edison.

The general principle, too, of the incandescent lamp burning carbon in a vacuum long antedates the labors of Edison, but it was the great inventor who, through his numerous researches, rendered the incandescent lamp practical, and truly produced, in lighting, that revolution which we have witnessed for some years back.

THE PHONOGRAPH

The most remarkable, the most incontestable, and the least contested of Edison's inventions is, without doubt, the phonograph. We have many times referred to the improvements introduced into the original invention but it seems to us of interest to return to it again and point out some of the modifications adopted for the faithful reproduction of speech, or of pieces of music, which, reproduced by the improved phonograph that we recently described, astonish and delight the numerous visitors who daily crowd around the apparatus in the machinery gallery or in the American section of industrial arts. All those who have heard the phonograph of 1878, and who

Registration of a cornet solo.

compare it in mind with the one of 1889, will certainly be struck with the progress made during this first period of ten years, and will agree with us that, although the fine promises made at first might have seemed premature and stamped with exaggeration, none of them can today be considered as impossible to realize materially. Edison is still young enough to keep all his promises, even those that his as enthusiastic as sincere admirers have often hastily made in his name, *Gloire, comme noblesse, oblige.*

AN IMMENSE EAR TRUMPET

When one has heard the new phonograph speak at the exposition, he is astonished at the distinctness exhibited in the reproduction of piano and wind instrument music. It has seemed to us of interest to indicate the means employed for registering the airs obtained by the aid of these musical instruments. FIGURE 1 shows the immense ear trumpet which leads the sounds of a grand piano to the wax cylinder of the phonograph. The apparatus, as here represented, is the one that is operating in the room set apart for Mr. Edison at the exposition. For the registration of the airs obtained by means of a brass instrument, a cornet of smaller size suffices, as may be seen in FIGURE 2.

The phonographic experiments at the exposition are having great success, and the crowd does not cease to show how much it appreciates the interest thereof. FIGURE 3 represents the aspect of these remarkable experiments executed in the machinery palace. We reproduce a photograph which shows numerous auditors listening, through the intermedium of double speaking tubes, to the speech or music registered and reproduced by this wonderful apparatus; but these auditors merit on the part of our readers a special examination, for they consist of the various co-laborers and young engineers of the great American savant. One of Mr. Edison's representatives, Mr. Hammer, has been kind enough to communicate to us a copy of this photograph, which may be considered as a historic piece from a scientific point of view. All the young American scientists are grouped in the attitude of the public when it is listening to the phonographs, and they have taken care to place themselves in the presence of the picture which reproduces the features of their master, Edison.

The illustrious American inventor long ago gained everyone's admiration by his discoveries, and we may add that when one has the honor of seeing him close by, it is soon recognized that he knows how to enhance his merit by those rare qualities—simplicity and modesty. ■

OLIVER BERLINER

The Bark Heard 'Round the World

Technical breakthroughs, and legal battles, spawned the recording industry.

IN OUR ZEAL to commemorate 100 years of commercial sound recording, we tend to forget that this same year marks the 100th birthday of an equally important invention, the microphone—the first and, in my opinion, the greatest invention of my grandfather, Emile Berliner.

We also fail to recognize that the disc record, its forerunner the cylinder dictation machine, and the microphone all owe their origin respectively to three inimitable Frenchmen. My grandfather's microphone, the principle of which is still in use in every one of the world's telephones, utilizes the loose contact principle discovered by Count du Moncel. But the Count failed to render practical that which he had demonstrated in theory.

In 1876, after the Emperor of Brazil made possible worldwide publicity for Alexander Graham Bell's telephone which he had seen at America's centennial exposition in Philadelphia, many inventors and would-be inventors set out to create a practical telephone; Dr. Bell's marvellous device was not only sound-powered, but also used the earpiece for talking. Twenty-five year old German immigrant Emile Berliner, a dry-goods clerk and one-time student of electricity at New York's Cooper Union, tried working on such a telephone. Discouraged, he went out one day to visit his friend Alvan Richards, chief operator of the Washington Fire Office. Richards tried to amuse his dejected friend by letting him try his hand at a spare telegraph key.

Richards immediately pointed out that young Emile was not pressing hard enough upon the key. "What difference does that make, as long as I make contact?" asked my grandfather. Richards explained that in long distance telegraphy where resistance in the lines is high, you must make a forceful contact at the key in order to get adequate reception. Richards was quick to point out that this was the reason why women could not be used as telegraph operators. He noted that more current passed through a forceful contact than through a light one in these cases.

THE TOY DRUM

Emile Berliner rushed home, knowing that this was the secret of a telephone transmitter. He embedded a sewing needle in the center of the "head" of a child's toy drum. Standing the drum on its side, he dangled a polished ball on a wire from the edge of the drum so that it lightly rested against the tip of the needle. Now, by speaking to the drum and causing the head to vibrate with the sound waves, the ball bounced ever so lightly against the point of the needle, thereby making contact in sympathy with the sound waves.

The rest is history—for this microphone principle, which passed the limits of scientific credibility at the time, was acquired soon after by the fledgling Bell Telephone Company to overcome the drawbacks in the basic telephone. Curiously, the then-powerful Western Union Telegraph Company had acquired the rights to a microphone invented by the already famous Thomas Edison. Although Western Union was eager to get into the exciting new field of telephony and envisioned itself as the ideal organization to do so, its lawyers examined the Berliner microphone

Oliver Berliner, grandson of Emile Berliner, is the author of numerous articles on music, audio and video. West Coast editor of Broadcast Management/Engineering Magazine, *and author of the textbook,* Color TV Studio Design & Operation. *He is president of Ultra Audio Pixtec. This article, which was reprinted from the July/August 1977 issue of the* Journal of the Audio Engineering Society, *originated as an address delivered at the May, 1977 A.E.S. Convention in Los Angeles.*

and its patent and advised their client that the Bell system would prevail, setting the stage for Bell to become the world's largest corporation.

EDISON'S PHONOGRAPH

The Berliner patent application was not filed until April 14, 1877. Recovering from his defeat, Edison set out to conquer new fields. Before the end of that year he was to rock the world with a device which he called the *phonograph*. Yet in 1857, twenty years before, the French physicist Leon Scott de Martinville had invented a device for recording sound waves on a rotating cylinder covered with lampblack, called the *phonautograph*. Scott's machine, which was manufactured in small quantity and which traced sound patterns laterally, could be used for recording only, whereas Edison's device would allow for reproduction of the recording. Edison used tin foil, which was rendered useless after one or two playings, and failed to heed Scott's tacit warning that a laterally moving stylus should be used. Consequently, Edison's vertically cut recordings were forever cursed by the scientific fact that disproportionate amounts of sound pressure were needed to record the louder passages. Edison never accepted this basic law of physics.

So great was the publicity attached to Edison and anything that he did that a paper by Charles Cros filed with the French Academy of Sciences, received there on April 30, 1877 and revealed to the world in December of that year, was ignored because of the announcement that very month of the advent of Edison's phonograph. Thus few people were aware, least of all Mr. Edison, that the poet, Charles Cros, had envisioned a method of recording using a flat disc, as contrasted to Scott's cylinder, but with the laterally vibrating stylus. Interestingly, Cros envisioned the disc's surface being coated with lampblack, thus (for the first time) continuing the impossibility of reproduction of the recording.

ACID-DEEPENED GROOVES

Exactly ten years later, Emile Berliner, who had sold his microphone to Bell for $50,000, sought a better way of recording than that of the popular cylinders. Cros' obscure theory held the secret, but the problem of how to reproduce the recording remained. Eventually my grandfather developed a process in which an acid ate away the portion of the disc where the stylus had traced, using the lampblack to resist the acid elsewhere in what we call the "land" area of a disc. Again using the principle of variable pressure against a diaphragm, Emile Berliner developed a pickup arm and stylus that would track the acid-deepened groove and reproduce the sound waves captured therein. The lateral cut groove, as envisioned by Scott and Cros, overcame the inherent flaw in Edison's hill-and-dale system. But it remained for Emile to create a method for mass producing discs from this single master. He developed a stamper, which was a mirror-image of the master, and from this large quantitaties of discs made of rubber were pressed, which could be sold to the consumer. Later, because rubber often created grooves of uneven depth, shellac was used as the "biscuit" and this continued until the advent of plastic discs many decades later.

It was not until some dozen years after, in 1898, that my grandfather formed Deutsche Grammophon and the British Gramophone Company, and in 1899 the latter firm acquired the painting that—again thanks to Emile Berliner—was to ultimately become the symbol not just of a few record manufacturers but of the giant record business itself. *His Master's Voice*, from a painting by still another Frenchman, Francis Barraud, was registered by Emile Berliner in the United States Patent Office on July 10, 1900.

In 1902 the great Italian tenor, Enrico Caruso, sounded the death knell of the cylinder when he vowed that he would make only disc records which could be recorded just once, yet could be produced in enough volume to meet the public demand for his works. All other name artists followed suit. Soon after, the phonograph was relegated for use as an office dictation device, and in home entertainment the gramophone was king. It is amazing to note that many years later the great Scotsman, Sir Harry Lauder, a leading artist for The Gramophone Company, informed the Company at contract renewal time that in the future he would record not for a fixed fee, but for royalties, and further insisted that he be paid royalties on all previously sold records. Had he been alive, Nipper, the dog in the painting, would have no doubt barked with rage. But His Master's Voice, already the name by which British Gramophone had become commonly known, bowed to Sir Harry's demands, thus setting the pace for the present custom of paying royalties. Truly, the record industry has never been the same since this bark heard 'round the world.

Many have wondered what became of the Berliner Gramophone Company. It had been established in Philadelphia to record artists, press their discs and manufacture gramophones—Trademark Model gramophones, of course. Emile Berliner's U.S. Gramophone Co. of Washington, D.C. owned the Berliner patents and engaged in research on improving disc recording and manufacture. Emile Berliner and his associates were so unskilled in marketing that they entrusted nationwide distribution of their products to Frank Seaman, who then founded New York City's National Gramophone Co. as their distributor. The Columbia Graphophone Co., long a competitor of Edison's in the cylinder business, was making cylinders of wax and playing them with a floating stylus system, both of which were invented by Charles Tainter and Chichester Bell. (Chichester was a cousin of Alexander Bell and was working at the Volta Laboratory—now Bell Labs —which had been established with the $10,000 prize that Alexander had received from France for his telephone.) Columbia was eager to enter the disc business and its lawyer, Philip Mauro, frantically sought a way to break the Emile Berliner disc patent. In a brilliant maneuver, Mauro sued not Berliner but Seaman, and claimed that the Berliner pickup system infringed on the Bell-Tainter patent that Columbia owned. Seaman, who could not distribute his store of merchandise, not only surreptitiously formed another firm to compete with himself, but then declared that "Mauro was right" and that the Berliner patent did indeed infringe on Columbia's.

LEGAL MANEUVERS

Even more incredibly, the Court enjoined Emile Berliner from manufacturing his own products, based solely upon Seaman's "admission of guilt." Across the Delaware River from Philadelphia lay the Camden, New Jersey machine shop of Eldridge Johnson, where the springworks that powered the gramophones had all been made. While business was good, Johnson had been building complete gramophones to supplement the output of the Philadelphia Berliner Gramophone Co. Johnson was enjoined along with Emile Berliner, but Johnson brilliantly persuaded the Court to lift the injunction against himself, paving the way for his disposal of a huge quantity of unsold merchandise which the Berliner company had been unable to pay for. He did this by forming a firm called The Consolidated Talking Machine Co., because he did not wish to use Emile Berliner's coined word, gramophone. One month later, in April of 1901, the injunction imposed upon Berliner as a consequence of Seaman's irrelevant declaration was lifted and Emile emerged victorious. Seaman's National Gramophone Co. was destroyed along

with his other secret operation for the manufacture of Zonophones, as well as Columbia's dreams of plunging into the disc record business, which was once again controlled solely by Emile Berliner.

TO THE VICTORS

But my grandfather was financially ruined while Johnson was enjoying unprecedented prosperity. They joined forces. Consolidated was abandoned and on October 10, 1901, the Victor Talking Machine Co., named to recognize the victory of Emile Berliner, was formed. For contributing his patents, know-how, and trademark, my grandfather and his associates received 40 per cent of the Victor stock.

However, we were not yet to see the last of Philip Mauro. Reeling from the blow of the Berliner court victory, Columbia desperately sought another way of crashing into the disc business. This was neatly handed to them by young Joe Jones who, four years before, had worked for a brief period in the Washington laboratory of Emile Berliner. My grandfather had experimented with wax disc masters instead of metal, for they were indeed superior, but he believed that to use them would violate a Bell-Tainter wax cylinder patent, not realizing there was no patent as yet. Four years later the patent was issued and Jones rushed to Columbia with the information that Berliner was using wax. Columbia threatened to sue Victor, which under Johnson had begun using wax masters, believing that they were not patentable. Rather than engage in costly litigation, Victor and Columbia agreed to allow each other to use their respective patents. This resulted in opening the record business to any firm desiring to enter it. Nipper, no doubt, by this time would have been too discouraged to even whimper.

As a footnote, it should be added that the input transformer widely used in professional audio was also invented by Emile Berliner as a means of amplifying weak telephone signals. Francis Blake, third of telephony's "Three B's," developed a microphone using the Berliner loose-contact principle combined with the Edison carbon button. In manufacture, the Blake improvement proved to be unreliable and Blake was unable to correct this—so Emile Berliner did.

In his later life, my grandfather devoted his energies to humanitarian endeavors, not the last of which was bringing pure-milk laws to Washington, D.C. In the first half of the 1920's my grandfather and his son Henry, who later created the famous Aircoupe, a small spinproof airplane, pioneered in autogyro design. The results of their effort, a French plane modified for vertical flight, is on display in the Smithsonian Institution's Air Museum. And although Valdemar Poulson gets credit for the introduction of magnetic recording in 1889, Emile Berliner's 1882 device that proved wire recordings' feasibility—five years before the advent of the disc record—is also in the Smithsonian.

Born in Hanover, Germany, May 20, 1851, Emile Berliner died in Montreal on August 3, 1929 while visiting me and his son Edgar, my father, who had the unique distinction of being President of all three successive Canadian companies: Berliner Gramophone, Victor Talking Machine Company, and RCA Victor. My father retired one year after I was born; he could not stand watching the new owners' attempt to replace records with radio. Fortunately, they never succeeded. ■

HAROLD LINDSAY

Magnetic Recording Part I

A tantalizing proposition—reproduce a machine with no information regarding its electronics.

THE YEAR 1977 marks one hundred years since the invention of the first demonstrable sound recording devices, and thirty years since an event that profoundly influenced the development and acceptance of magnetic sound recording—the first radio show to be aired in the United States from a magnetic recording of acceptable professional quality. This event was to revolutionize broadcasting transcription practice.

Early in the evening of May 16, 1946 my wife Margery and I drove the 35 miles north from Redwood City, California to San Francisco to attend an Institute of Radio Engineers (now known as I.E.E.E.) meeting to be held in Studio A of the NBC/ABC complex. Little did we realize as we set out that this event would serve to change the whole course of our lives and many others as well.

The speaker of the evening was John T. (Jack) Mullin and his subject the "Magnetophon." This was to be the first public presentation in the United States of this remarkable recording device, which had been first demonstrated in August 1935 at the Radio Exhibition in Berlin, Germany. The device, developed by Germany's A.E.G., in conjunction with I.G. Farben, used tape consisting of carbonyl iron powder coated on cellulose acetate. In January, 1938 the German Reichs-Rundfunk-Gesellschaft had adopted the Magnetophon and magnetic tape as the future standard for radio broadcast recording in Germany.

Further refinements in machines as well as tape continued throughout the war and somewhat beyond its end. In all, three different types of tape were produced along with at least six different models of the Magnetophon.

It is nothing short of astonishing that while researchers here were still struggling with steel tape and wire recorders, our wartime enemies were fully a decade ahead of us—and we didn't even know it. People engaged in the audio professions in this country were not even aware of the advancements that had taken place overseas until after the war's end. Only then did military intelligence and communications personnel take an interest in this "new" technology and recognize its potential.

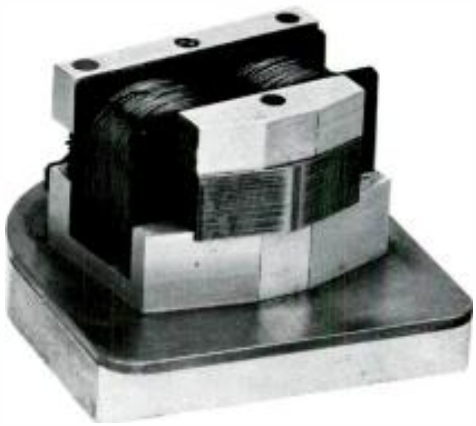
By that time, Germany's industrial capacity was in a state of near collapse. At least two of the "Magnetophone Union" factories had been bombed out, and production of recorders and tape was at a virtual standstill. One of the last operating factories to produce type "L" tape used in the machines was confiscated and shut down by Russian occupation forces.

Therefore, the machines on which Jack Mullin demonstrated the use of magnetic tape were exceedingly rare, representative of what had become an extinct species. And the tape on which they depended was rarer still; there was no possible way of getting more. The fact that Jack Mullins later shared some of his precious tape with the people from Ampex will always be remembered with gratitude.

MULLIN'S DEMONSTRATION

The studio in San Francisco was packed to the foyer. We could sense the feelings of anticipation and excitement

Harold W. Lindsay, a distinguished audio pioneer and internationally recognized authority on magnetic recording, helped lead Ampex Corporation to success and growth and is currently special consultant to that company's magnetic tape division.



Original prototype Ampex playback head (enlarged 3.5X). This is the actual head that was proportioned to allow mounting in Mullin's Magnetophon head housing for proof of performance.

as the crowd viewed the puzzling array of sound equipment crowding the stage. Jack Mullin opened his presentation with a slide-illustrated technical description of the Magnetophon. Then came the demonstration.

Previously recorded musical numbers were played back while, intermittently, live music from a small jazz combo in an adjacent studio was switched with an A/B switch back and forth from live to tape. No one, but no one, in that audience of critical ears was able to detect a difference between live and tape. This brought forth a standing ovation from the spellbound listeners. Equally amazing was the demonstration of the fascinating capabilities of tape editing, including a one-minute stretch of program containing twelve splices, none of which was detected by the listeners.

A deluge of questions followed the formal presentation, and Jack fielded the queries in fine academic fashion. Adjournment brought a crush and jam of the technically inclined to the lecture platform for a close look at the fantastic Magnetophon.

Margery and I waited until the crush had thinned out before inspecting the equipment. Quite overcome with excitement, I burst out to Jack, "I've got the feeling this development is going to change the lives of millions of people. That's what I'd like to do someday—work with magnetic recording."

Jack smiled as he shook my hand. "I hope you do. If I can be of any help, look me up." As we parted, little did I realize that this offer, so lightly made, would be taken up in earnest only six months later.

My first contact with the Ampex Company came in September, 1946 while I was working in the engineering department of the Dalmo Victor Company in San Carlos, on the San Francisco Peninsula. Forrest Smith, general manager of Ampex, frequently visited Dalmo Victor in connection with the precision permanent magnet motors and generators Ampex had been supplying to Dalmo for assembly in the APS-6 airborne radar for Sperry Gyroscope and the U.S. Navy.

Mr. Smith and I became quite friendly. Then one day he surprised me with a message from his employer, Alexander M. Poniatoff, asking to meet with me at my earliest convenience for a technical discussion. The meeting arranged for the following week became another turning point in my life. Mr. Poniatoff explained that with the end of their war-time contracts in view, he and the people at Ampex were anxious to find a post-war product to help them stay in business They were considering studio-type turntables, but felt they should have some consulting expertise to assist in the final decision. Mr. Poniatoff proposed that I serve in a part time consulting capacity to Ampex in this matter of new product selection. I accepted, and a series of meetings ensued.

AMPEX CONTACTS MULLINS

After many weeks of discussion and review I finally conjured up enough nerve to suggest to Mr. Poniatoff that he consider looking into the German Magnetophon with the idea that the design be upgraded where possible and adapted to suit radio broadcast practice in the United States. His response was immediate and favorable, which was typical of Mr. Poniatoff when presented with a new and intriguing idea. I described the May 16th I.R.E. meeting to him and when I related Jack Mullin's parting comment, Mr. Poniatoff was fast to interrupt: "Let's phone him!"

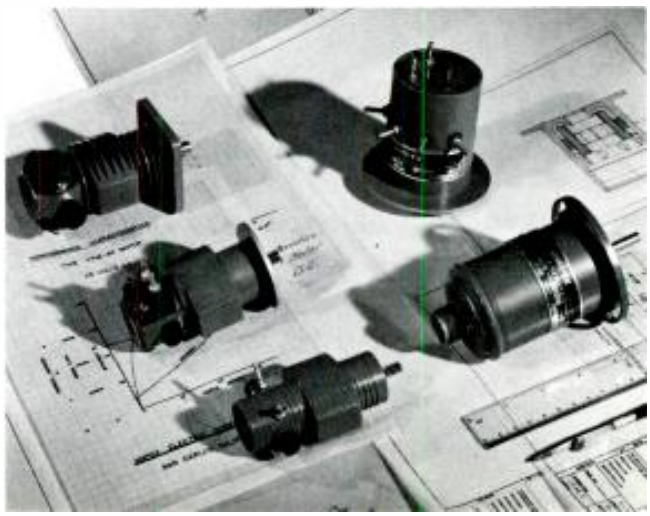
Jack was cordial but apologetic. He was all packed and ready to depart for Los Angeles to attend the annual convention of the Society of Motion Picture Engineers (SMPE—there was no "T" for television then). He suggested that Mr. Poniatoff try to make plans to come down to this affair where he could meet Jack and see the equipment demonstrated. After hasty arrangements, Mr. Poniatoff was on his way.

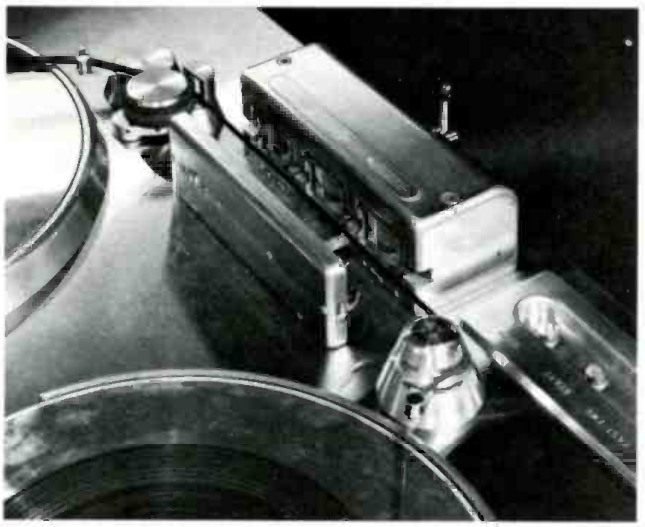
He returned with a display of enthusiasm for the tape recorder, which unmistakably meant Ampex was about to enter a new field. His first comment, directed to me, was, "I want you to become a full-time member of Ampex and assume responsibility for the development of our first magnetic recorder." How could I refuse? My wish had become a reality.

THE DEVELOPMENT PROJECT

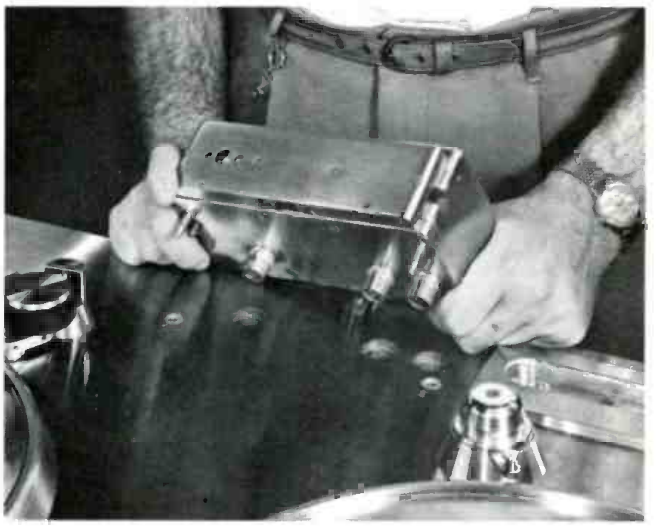
On the 10th of December, 1946, not quite eight months after that memorable I.R.E. meeting we were on our way toward the development of a magnetic tape recorder. None of us in our wildest dreams could have visualized the full

Ampex's first products. Precision permanent magnet motors (left) and generators (1944-1946).





Partial view of top-plate showing cast Meehanite head housing with gate forcibly extended beyond its regular open position permitting view of magnetic heads. Note alloy inner shield cans. Far left head is play-back with laminated shield can. Also shows straight-line threading path of tape.



View illustrating plug-in feature of magnetic head assembly. Slotted cap screw at left of head gate covers hole for editing pencil insertion over playback gap.

impact of what lay ahead, but I remember saying to Mr. Poniatoff, "If we succeed, one day people will be beating on our door to get these products."

At the outset of the development project, the immediate challenge was where to start and how to divide the work load. In fact, the division of labor was quite simple. There was Myron Stolaroff, the electrical engineer who had done much of the design work on the radar motors and generator, and myself. That was the entire engineering team at my disposal as project leader!

A good suggestion as to the best starting place came from Jack Mullin, whom we had phoned for advice. Based on his experience with the Magnetophons he had found there was no question that the most critical part of the entire recorder rested in the design and construction of the magnetic heads, especially the play-back head. With this in mind, he urged us to attempt a play-back head design and to construct a model for performance tests. Success with this should give encouragement to continue the whole project; but should we fail we would be better off dropping the idea of ever producing a magnetic recorder!

In proposing these early head tests, Jack of course realized that we would be in no position to perform them without the availability of an already operable recorder, so he kindly extended an invitation to test our head design, when ready, on one of his two Magnetophons. By designing our play-back head so that at least its mounting requirements would be adaptable to the Magnetophon's head housing, we would be able to make performance tests using the German erase and record heads.

THE MOMENT OF TRUTH

In the spring of 1947, after several months involving construction of lamination dies, a hydrogen annealing furnace, core stacking and lapping fixtures, and many tedious hours of stamping, stacking, hand lapping and winding, we were at the point of final assembly and static testing. We believed we had gone as far as we could without tape—we were ready for that long sought, but now almost frightening moment of truth, the final test. I phoned Jack and set a date. The following evening found an excited but nervous Ampex group on its way to the W. A. Palmer Studios in San Francisco, where Jack Mullin and Bill Palmer had been using the Magnetophons for over a year in their commercial film production.

The first tests were to be subjective listening tests using the best master taped material in the Palmer studio. We listened critically to this as it was played back with the normal Magnetophone head, using their best monitoring equipment. After replacing the German reproduce head with the Ampex prototype and rewinding the test material, we were ready.

I have always remembered that next moment, just before pressing the start button, as one of the most anxious

Author Lindsay checking out Model 200 (January 1948).

times in my entire life—so much hung in the balance: a dismal failure or the beginning of an exciting future.

The tape whipped up to speed; we were stunned, entranced, suspended in an eternity of mere seconds. Then cheers and hand shakes and clapping—the sounds of a wild celebration. Our ears had just told us what measurements later confirmed—we had outperformed the Magnetophon head. We were destined not to failure, but to fame.

We followed the playback head with a successful record head and finally one for erase. These head successes and Alexander Poniatoff's unbending courage and confidence served to carry us through the very difficult months ahead, months when finances would dwindle to the near vanishing point, plus loss of credit, inability to get supplies when needed, weeks without pay checks and experimental and developmental reverses. Nevertheless, in the face of all these obstacles we continued, stubbornly unwilling to give up.

During these rough months Jack Mullin was helpful in many ways and on many occasions, allowing us to examine the mechanical portions of the Magnetophon, but never the electronics. This puzzling situation was later explained when we were told of his previous commitment and contract with Col. Richard Ranger who was also hoping to produce a domestic version of the German recorder. Jack had made certain improvements in the electronic circuitry which were to be exclusively used in the Rangertone equipment.

While unable because of these commitments to show us any of the electronic assembly beyond the front panel, Jack did, however, help us in many ways. His moral support, encouragement when going was rough, loan of a number of reels of German "L" type tape when he had precious little on hand, design suggestions, and last but certainly not least, his promotional efforts in Hollywood on behalf of our forthcoming product were vital to us.

THE TAPE CRISIS

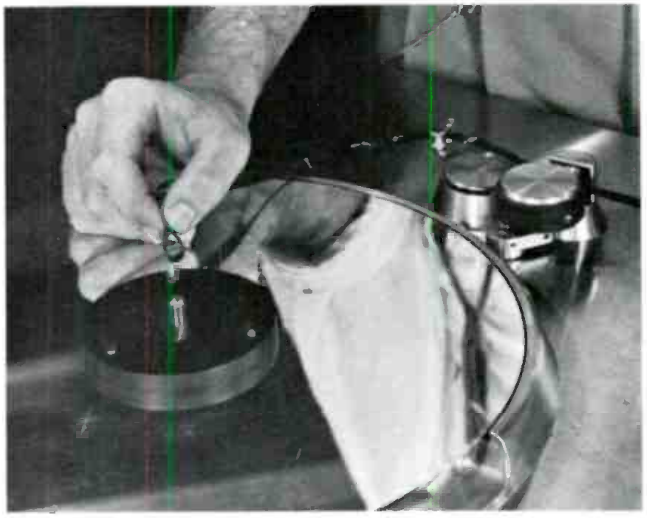
As development of the prototype model of the Ampex 200 reached the tape pulling stage, we began to get very uneasy feelings. Up to now, Jack Mullins had been sharing his slender stock of type "L" tape with us. But the sources of the tape were no longer in existence. If we didn't develop a tape to go in our machine, we'd be all ready for production with no place to go.

But fate was moving along with us. One day a gentleman came into our office, introducing himself as a representative of Audio Devices, an eastern manufacturer of disc recording blanks. They'd heard through the grapevine about our project and wondered whether we would cooperate with them in using our new machine to test some new tape they were developing. Needless to say, we were more than happy to oblige.

It seems almost incredible, but a few weeks after the Audio Devices arrangement had been made, we again had an unannounced visitor. This man seemed to be in a great rush, somewhat nervous. In a hurried manner, he explained that his firm in the middle west believed that there was a great future for magnetic recording. They'd embarked on an intensive project to develop an acceptable tape product. However, like Audio Devices, they were stymied because they didn't have suitable recording equipment on which to test their tape. They also wanted to use our new equipment.

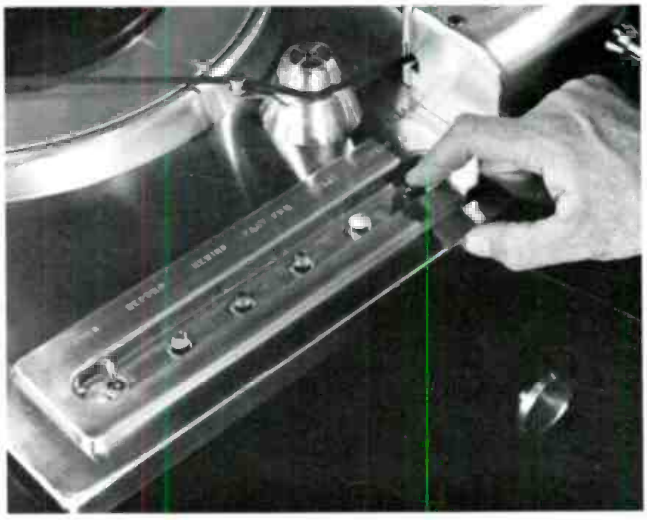
Without identifying the other company, we told him about our previous arrangement.

He was not shaken. "Why not help us both? The results can easily be kept confidential. Furthermore, if you have

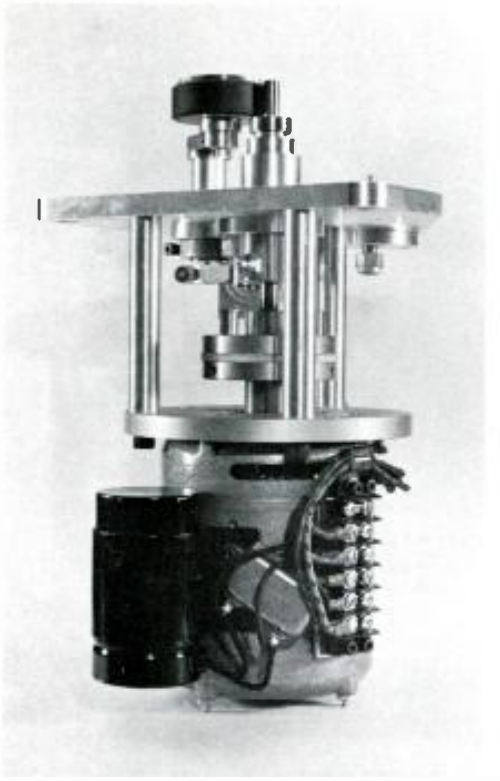


Threading the 14"-diameter open-faced "reel." Reel held 5400 ft. 0.002" thick tape. Torque/threading pin mounting circle dimensions have carried over to present day N.A.B. Standard Hubs as inside (hub bore) driving slots.

Recessed push-button control center. Buttons of Lucite were illuminated, recessed to reduce chances of mis-cueing.



Front view with cabinet doors opened. Note modular electronic assembly on vibration-isolated base. Removable modules are (left to right) power supply, control logic assembly, record module, and playback module.



Capstan drive sub-assembly removed from top-plate.

two tape sources, this will double your chances of arriving at the marketplace in time with tape."

This aspect of the proposal was too tempting; we couldn't turn it down. As he rushed to leave I called after him, "Pardon me sir, may we have the name and address of your company for our records?"

He replied, "I come from Minneapolis, and my company makes pressure sensitive tape products labeled 3M."

MODEL 200 STEAMROLLERS

As mid-summer 1947 arrived, the Model 200 project was accelerating. Six- and seven-day work weeks, as well as many around-the-clock sessions were stepping up progress, but not without their toll on the participants. By this time (July) trials of Mr. Mullin's reworked Magnetophons were also accelerating at ABC/NBC's Radio Center in Hollywood. We had heard of the misfortune Col. Ranger suffered when the "Rangertone" failed in its comparative demonstration with the Magnetophon (held in the NBC recording department).

However, Jack Mullin's successful demonstrations for NBC and ABC as well as for the Bing Crosby/Philco radio show people had served to stir up great interest in the potential use of professional quality magnetic tape recording equipment for broadcast applications.

The next step would be an actual trial on the air, and the Crosby people were in a position to benefit handsomely from its successful use. They were willing to go ahead but had two principal concerns. With the failure of the Rangertone unit, who would supply the needed equipment for back-up should the German machine wear out, and where would be the source of new magnetic tape when the German "L" tape was eventually consumed by splicing operations?

Jack Mullin called us long distance and explained that since the Rangertone fell by the wayside the Crosby and Philco people were anxious for Ampex to succeed. It seemed we were being put on the spot to quickly produce an acceptable unit, but it was also a fantastic opportunity for recognition and the establishment of credibility. There was an ominous mandate: we must not fail.

The Crosby people visited us at Ampex and, satisfied with what they saw in a partially completed machine, encouraged us to notify them when it was finished and to bring it to Hollywood to Crosby's "listening room" at ABC/NBC Radio Center for demonstration.

THE CROSBY CONNECTION

After conferring with Jack Mullin, the Crosby/ABC people decided to go ahead with the Magnetophon taping of the Philco show. That decision was based on Mullin's assurance that he felt Ampex would produce an acceptable recorder within a reasonable period. The decision called for initially recording on tape, editing, and performing a single-generation dub to a Scully cut disc from which the program would be broadcast. It was hoped that when the additional recorders were available, the operation might be ultimately expanded to the use of tape playback directly to the network.

In August Jack Mullin set up his two Magnetophons in a small studio in the NBC building and started recording and editing an average of one show a week.

In the meantime, there was rapid progress on tape development. Audio Devices and 3M were moving along on somewhat parallel paths. Both concerns were supplying test samples at frequent intervals to Ampex for evalution. 3M also supplied samples to Jack Mullin with the assurance that they were most anxious to cooperate in any way possible to help make the application of magnetic tape practical. Both firms arrived at the marketplace with acceptable tapes in time for use on the first Ampex machines.

Toward the end of August, our prototype Model 200 had reached the stage of final testing. We phoned Jack and a date was set for early in September for the Crosby demonstration. During the course of final testing and adjustment, a decision was made for a slight alteration in the record and bias circuits. To our dismay we experienced severe degradation of signal quality in the record mode. We feverishly worked night and day in an effort to restore the original circuits and performance, but to no avail. Our date at Radio Center was less than a week away and it appeared that we would have to cancel out. We needed more time to rectify our error.

In desperation we phoned Jack Mullin and explained our situation. His first question was. "Will it play back?" On being assured that the playback performance was excellent he implored us not to cancel the appointment. This was one of those rare opportunities which might never come again.

TAPE SPEED

It was now that a decision made some eight months previously was to pay off. In our early discussions with Jack with respect to transport design direction, the question of tape speed was considered. It was thought that in the interest of interchangeability of recorded tapes between the Magnetophons, with their 76.2 cm/sec tape velocity, and the Model 200, that we should adopt the same speed. A simple conversion from the metric provided an answer of 30.0 inches per second. This speed was adopted in our design and it has continued as a reference base for tape speeds throughout the industry's expansion.

This simple decision made it possible to demonstrate our prototype on a playback-only basis in Hollywood, using excerpts from the Crosby show tapes as source material. The Ampex 200 was set up in Crosby's listening room at Radio Center, and to our surprise the event turned out

MAGNETIC RECORDING: HIGHLIGHT SUMMARY

1898 The Danish physicist Valdemar Poulsen introduced the "Telegraphone," first of the early magnetic recording and reproducing devices of practical design. Danish Patent No. 1260, British Patent No. 8961.

1900 U.S. Patent 661,619 issued to V. Poulsen covering the "Telegraphone."

1907 U.S. Patent 873,033 issued to V. Poulsen and P.O. Pedersen covering the principle of d.c. bias.

1912 Dr. Lee De Forest's invention of the vacuum tube.

1918 Leonard F. Fuller was issued a patent covering the use of high frequency current for erasure of magnetic recordings.

1920 Dr. Kurt Stille of Germany recognized the real value of magnetic recording as applied to a variety of uses.

1921 U.S. Patent application by W. L. Carlson and Glen W. Carpenter for the use of d.c. bias on a wire telegraphone. This was finally issued as Patent No. 1,640,881 in 1927.

1927 J. A. O'Neill granted U.S. Patent No. 1,653,467 covering powdered recording media. December 20, 1927.

1928 Dr. Fritz Pfleumer, German Patent No. 500,900, January 31, 1928, British Patent No. 333,154, August 5, 1930, covering application of magnetic powders to paper or plastic backing media. Seeking technical help for the development of his idea he approached the German electrical company Allgemeine Elektrizitats Gesellschaft (A.E.G.) of Berlin. A.E.G. in turn interested I.E. Farbenindustrie Aktiengellschaft of Ludwigshaven in the project. Concurrently with the tape development at I.G. Farbenindustrie the A.E.G. carried on a project resulting in a product to be known as the "Magnetophon."

1931 Ludwig Blattner, a German, exploited Dr. Kurt Stille's ideas and introduced the steel tape "Blattnerphone" to the British Broadcasting Co. where it was used for radio transcription purposes.

1935 The A.E.G. developed the Magnetophon using tape consisting of carbonyl iron powder coated on cellulose acetate. It was publicly demonstrated in August 1935 at the Radio Exhibition in Berlin. The eight models displayed were sold during the show.

1938 In January, German Reich-Rundfunk-Gasellschaft adopted the Magnetophon and magnetic tape as the future standard for radio broadcast recording in Germany.
His "Telegraphic Patent Syndikat" obtained rights to various magnetic recording patents. along with some of its own, and issued licenses for commercial exploration.

1938 Dr. Hans-Joachim von Braunmuhl re-discovered a.c. bias and patented it.

1946 May 16, 1946, Institute of Radio Engineers (now I.E.E.E.) San Francisco Chapter local meeting featuring John T. (Jack) Mullin as speaker of the evening. Subject: "The German Magnetophon Magnetic Tape Recorder."

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German Patent	*	Braunmuhl/Weber	
*(Published in U.S., U.S. Property Custodian Ser. No. 413,380) 1934			
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U.S. Patent	3,761,311	Perrington et. al.	1973

to be much more demanding than we had been led to believe in the planning discussion. Early in the day playbacks were made for the Crosby principals and crew, and while they were in progress a waiting line began to form outside. It was composed of engineers and technical people from all over the area—from the networks, disc recording studios, and the motion picture industry, as well as others. The word had gotten around and they were not about to miss what they were inadvertently helping to shape into an informal first showing of an exciting new product. The demonstration room was small, with room enough for only 12-15 guests per playing, and the demos went on all day!

As the last of the admiring visitors left, we of the Ampex crew were left in a state of amazement. We had fully anticipated that among that continuous stream of tech-

Our first advertisement.

nical experts, at least one engineer would have said, "The playback is beautiful, but how about a demonstration of recording!"

A few days after our return to Redwood City, some representatives of Crosby Enterprises called on us. Their comment, "We assume that you know you have taken Hollywood by storm," served to open the subject they had in mind: "Now, what are your plans for marketing it?"

MARKETING

In a somewhat naive manner, we had to admit that we had been so preoccupied with development that there had been no discussion of such plans; as a matter of fact, I think most of us believed that the marketing might in some mysterious way take care of itself.

This seemed to be just the sort of answer they were expecting. They had a proposal: would we be interested in their representing us in the eleven western states as our distributors?

After a short discussion we agreed and signed the contract they had brought along. And then another document appeared from a hidden pocket—a signed order for twenty recorders! These (and ultimately four others) were to be for the American Broadcasting Co. Some were to be installed at each of three locations—New York, Chicago, and Hollywood, and all were to be ready in their respective installations by April 25, 1948.

A few days passed before we re ered from the euphoria induced by this event and were able to start in earnest on the task of planning for our first production run of Model 200s, which of course included parts and material ordering. It was at this point that we became abruptly aware of a serious shortcoming.

Ampex was almost completely devoid of working capital! There were not sufficient funds to purchase the materials and parts necessary to go into production, and the local banks were not ready to make loans for such a wild enterprise.

But good fortune was with us again. Quite unexpectedly an envelope with a Hollywood postmark brought us a check for $50,000—with no strings attached or collateral requirements. The signature it carried: Bing Crosby. ■

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FACTORY DIRECT PRICES: Microphone cables, snakes and accessories. Write or phone for Free Catalog and prices. **Concertaudio Labs, Mt. Hope, N.Y. 10963. (914) 386-4330.**

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STUDIO GOING 24-track. Audiotronics console Model 501 "Son of 36 Grand," 20 x 16, consisting of two cues and stereo monitor, 4 echo sends, quad output bus & quad panning; 16 bus metering with quad and stereo metering; many extras, including remotes, $20,000. 3M79 16-track w/8-track stack, VSO and 30 ft. remote, $20,000. Heads recently relapped; all modules meet new specs; like new condition; selling individually or package, both pieces. Contact: **Spectrum, (213) 392-2663.**

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Signetics Op Amps: Fast Performers Ready For Fast Delivery.

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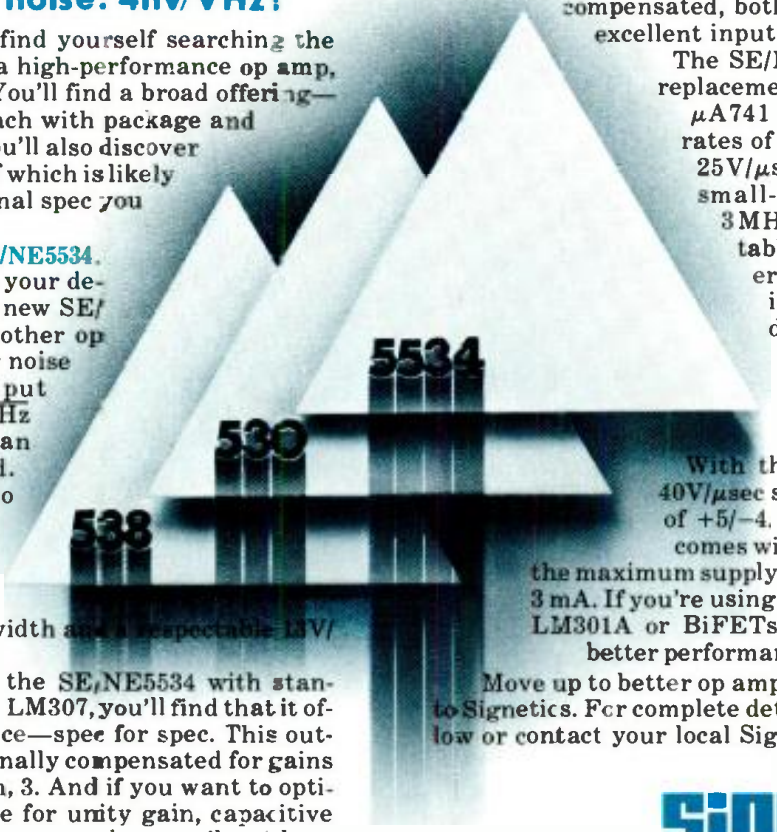

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Db-12

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