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THE SOUND ENGINEERING MAGAZINE

July 1970 75c

EVR at Take-Off

Synchronous Recording Techniques

L.A. AES Convention — Picture Gallery

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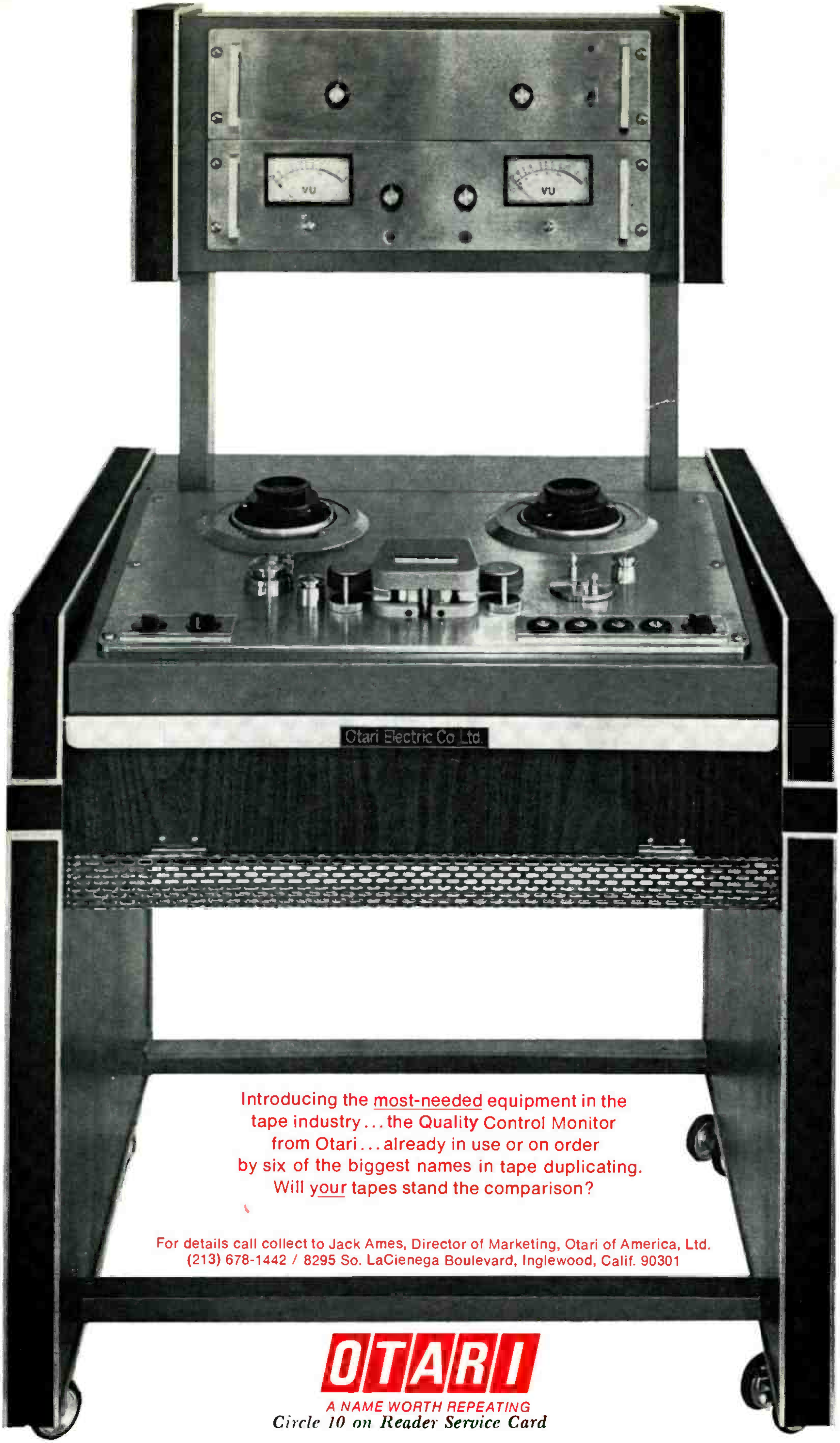

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Coming Next Month

A special report on the four-channel stereo phenomena as detailed at a recent N.Y.-section AES meeting is discussed by John Eargle. Included in his article are short summaries of the Scheiber system, Minter system, Feldman-Halstead system, and Jim Cunningham's Tetraphonic recording system. In addition, the author will give his evaluation of the systems and their likely impact on the future of the recording industry.

New studios exist at AFRTS in Washington D.C. Z. C. Jacquett has pictures and story on their construction.

Beginning with the August issue, an expanded New Products and Services section will appear.

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

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THE SOUND ENGINEERING MAGAZINE

JULY 1970 • Volume 4, Number 7

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About the Cover

• The Altec console had a different colored knob at each position, making it certainly the most colorful product to be seen at the L.A. AES Convention. A picture gallery of the products shown at AES begins on page 34.

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Letters

The Editor:

Mr. Sulzer's letter (May issue) makes an excellent detailed case for the higher-impedance cartridge and quite accurately corrects my "wrong" of understatement.

I must comment on the other "wrong", however: Mr. Sulzer says "Mr. Odom's statement. . .is in this case wrong," the case being a high-Z cartridge with Mr. Smith's (Spectra Sonic's) amplifier.

Please note that I did not suggest such a case. I said that system noise is lowest when amplifier and source are optimized, which would certainly not be so in the case Mr. Sulzer refers to. The case, then, is Mr. Sulzer's—not mine.

For clarity, the purpose of my original letter was two-fold; to point out a gross misapplication of the noise formula in Mr. Smith's presentation, and to seriously question the supposed improvement in system s/n ratio implied by him. I think Mr. Sulzer has very capably supported both purposes.

Incidentally, my reference to a s/n ratio of 80 dB was to a new preamp—not a system—and offered only to show that a more conventional (and much less costly) system can readily fulfill the criteria of "system noise below disc noise."

It appears to me and apparently to Mr. Sulzer as well, that the sole value in Mr. Smith's presentation is to accommodate longer cables between the cartridge and pre-amplifier plus the possibility of less extraneous hum-pickup in the cartridge.

Mr. Sulzer and I agree; existing preamps are good enough.

Roger K. Odom
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If spec sheets are among your favorite reading, we don't blame you for getting confused at times. Columns of figures aren't always too eloquent on their own, only in context or comparison with other specs. And statistics can be used to support anything – especially statisticians.

So it's nice to know how to read between the lines of a spec sheet. To know, for instance, that not all makers use the same measuring standards. Take overall frequency response: ours is measured at a −10dB level, the accepted broadcast standard. Yet certain other brands measure from as low as −24 dB.

Unfair to us? Yes. But more important, it's unfair to you.

Of course, there are other ways to play the numbers game. We say go ahead and compare specs till your head spins. But do it right: consider your own overall needs and objectives. Consider specs in relation to other specs on the same component. Compare that unit spec for spec, ***standard for standard,*** with competing models. Then go give a listen.

True, you can't be a computer.

But you shouldn't have to be a speculator, either.

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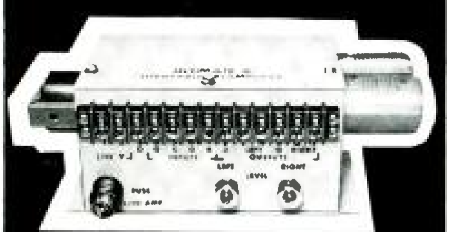

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The Audio Engineer's Handbook

GEORGE ALEXANDROVICH

●This month I will depart from my usual themes to share with you impressions carried with me after attending two spring conventions and shows; one in Chicago—the NAB and the second in Los Angeles—the AES Convention. Unfortunately only a small percentage of engineers get a chance to participate in these conventions. Most engineers, technicians, and specialists in the field of communications acquire their information through reading accounts and reports in various publications including the one appearing in this issue. Being fortunate enough to participate in *all* the major conventions and shows over the last ten years and then reading afterwards the reports of the same shows, prompted me to write a summary of my own impressions. I rarely pay attention to the lengthy description of the exhibits ,or the enumeration of the new devices—which are just another variation of the units shown last year. I look for less obvious things; unique gadgets and ideas.

Since my prime interest is in audio (the subject most conventions sidetrack—except for the AES Convention), I will attempt to highlight the happenings in this field. To characterize my attitude towards the importance of *audio* over *video* I like to remind the reader that video without sound can not survive as communication while sound can. However, video sound is often taken for granted so little improvement work is planned for the near future. I am now referring to the products at the NAB Convention. The focal point of the Convention was the picture. Most beautifully designed equipment can zoom, tilt, rotate, split, modulate the screen, superimpose, switch, and fade—in otherwords you can do almost anything you wish to a picture to get superb quality, but when you get back into your hotel room and turn on the TV set you listen to a 4-in. speaker driven by a single stage audio amplifier—and wonder about the human hearing apparatus and what it has to tolerate.

The NAB convention is not a particularly fertile ground for innovations and improvements in audio. What TV sound is all about is new and different packaging. Seldom can one see the use of slide faders which slowly force out "good old reliable" rotaries. The simple fact that rotaries require about 3-inch spacing between the faders while slide faders can be set at 1-inch intervals, dictates the use of sliders if the designer builds the console to be used by by an average size human with a hands spread of 6 feet. Philosophy of design has not changed, components and packaging has. The reason that we see some of the more complex consoles at NAB is because many radio and TV stations are in the business of studio recording of commercials, concerts, or the production of tapes, each seeking new revenues. There, the demand for better-quality sound dictated by the customer calls for much better equipment. One can see low-profile mixing boards, illuminated pushbuttons, program equalizers, and compressors. Separate echo channels and pan pots are not a rarety. However a strong demand for inexpensive equipment still comes from the independent stations working on tight budgets, while networks try to consolidate their audio production facilities so that expenditure for audio consoles can be increased and better equipment obtained.

In striking contrast to the low budget operation and marginal quality demand of NAB, is the atmosphere at the AES convention. Anyone engaged in the serious production of equipment for audio recordings (be it in the form of tape or disc), faces the dilemma of a demanding customer and keen competition. While a radio station can compete successfully with others as long as programming and sound are good (no matter what shoe-strings it runs on), in the recording field talent gets in touch with the equipment. They are so biased that unless the recording studio can do anything the other studio around the corner can do it has very little chance to get the job. Even the *brands* of equipment can make the difference; no matter how well equipment of different manufacture can perform, it can be as incorrect for the job.

Naturally, the prices for the equipment soar according to the demand for styling reliability and complexity. Stu-

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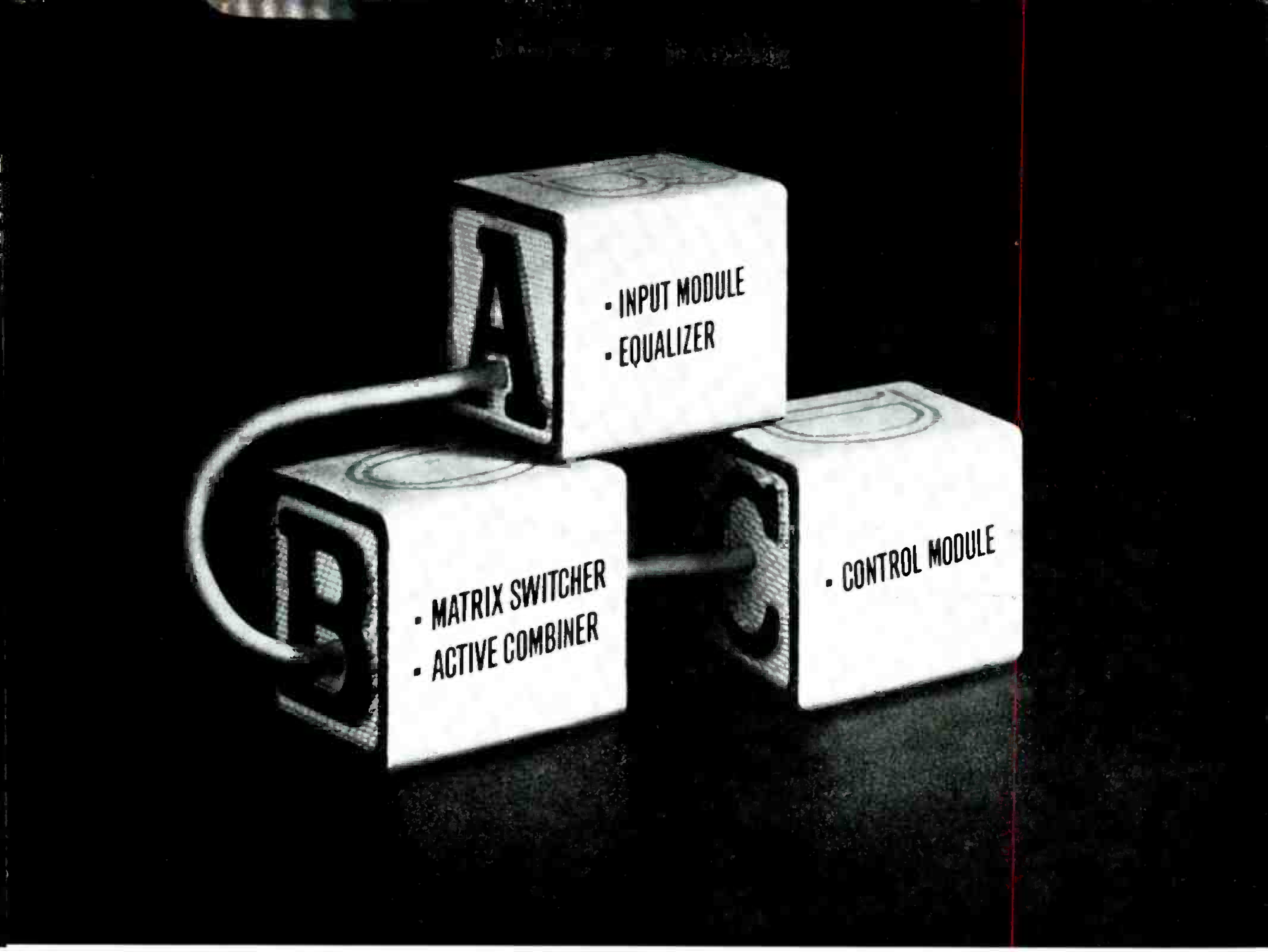

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dios think it normal to pay tens of thousands of dollars for multi-track tape machines.

I think that the broadcast industry has sidetracked audio, approaching one extreme, but the recording field is hitting the other extreme. Combine the two and you could have hi-fi transmissions from the moon in stereo, 60 dB of signal-to-noise in telephone conversations and four-channel TV sound. Wouldn't it be great to have Dolby reduce noise in TV ,radio and discs. After all we use RIAA and NAB preemphasis curves. Can't we go further?

AES PRODUCT HIGHLIGHTS

The AES show was by far the largest audio convention held on the west coast. It is interesting to note that there were at least ten major professional tape machine manufacturers exhibiting, but only two companies making turntables. After all how can they compete with 48 tracks and 6-in. wide tape as shown by the 3M people. (yes, *six-inch* wide tape). Also intriguing was Melcor's all solid-state reverberation device with 50,000 transistors (yes, *fifty thousand*) shown but not demonstrated. One could admire the high degree of sophistication reached in the design of the electro-mechanical systems such as tape duplicators running at 120 in./sec. using continuous loops with air-jet controlled storage bins. A tape deck by Magnetic Recording Systems was shown using a servo motor for the capstan drive—with the ability to select speeds instantly and control them using feedback signal from the tone wheel. Low-inertia printed-circuit pancake motors are used for the supply and take up functions.

The days of hi-fi shows were partially revived at the AES Convention when several speaker and system manufacturers set up separate demo rooms and then tried to vibrate curious conventioneers to death with 120 dB . sp.l.s.

I got an impression that at least half of the companies at the show wanted to contribute to the cause of environmental equalization, be it by coming out with a sweep generator, scope for the visual scanning of the response of the auditorium, or the filter systems.

This active participation of so many audio companies can be attributed to the fact that aside from the fact that using filters is an elegant way of coping with acoustical problems, it is also an easy task for an experienced audio design engineer to come up with a set of filters. Equipment appeared like overnight mushrooms, threatening monopoly and creating serious competition for the firms responsible for promotion of the original concept.

The AES show can be also characterized as all solid-state show. Not a tube

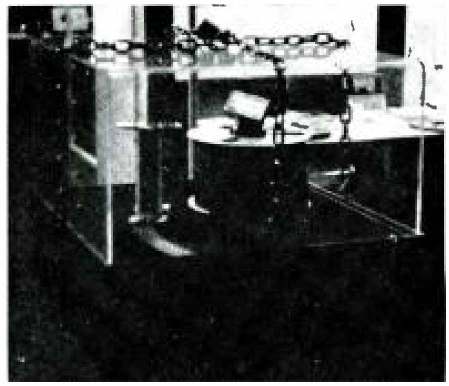

Figure 1. 3M is still keeping it under lock and key, but here is the very first illustration of 48 tracks on six-inch wide tape. A head and tape, but no machine. Maybe next year?

could be seen (except for a crt) in the equipment. Conversion of the industry to solid-state devices can be considered an accomplished fact. Although electronic packaging using i.c. micro component devices has started penetrating the circuit design of professional gear, the majority of manufacturers have expressed their disappointment in attempts to use i.c.'s for their equipment. Discrete components are still preferred. It is my feeling that since many manufacturers use plug-in transistors (apparently some may fail and have to be replaced) they believe that the i.c. being an outgrowth of a single semiconductor chip have a bigger chance to fail because they pack so many more components in much smaller space. (By the way, flying back home from conventions in the newest aircraft my friend and I witnessed failure of the audio systems on two separate flights. Discrete components so far are hard to surpass in consistency, reliability, and cost. The Opamp Company exhibit did attempt to change the image of i.c.'s. I sincerely hope they will be able to divert the attenation of transistor manufacturers to assign some research time to audio problems.)

Despite the few *new* things at the show (most were really new packaging of old circuits), it looked like a race for more channels, controls and knobs—only to remix everything back to stereo or mono. There were no laser-beam recorders, nor preamps which could not be overloaded. Except for the solid-state reverb, one could almost guess what to expect at the show. Nevertheless, it was great fun to see and learn by looking at the equipment—and learn we do every day even if it is by looking at the familiar equipment, old or new.

One irreplaceable advantage conventions offer is the program of technical sessions where exchange of ideas and experiences combines efforts of many isolated from individuals into a stream of new ideas and findings from which stem new trends in technology and science. ■

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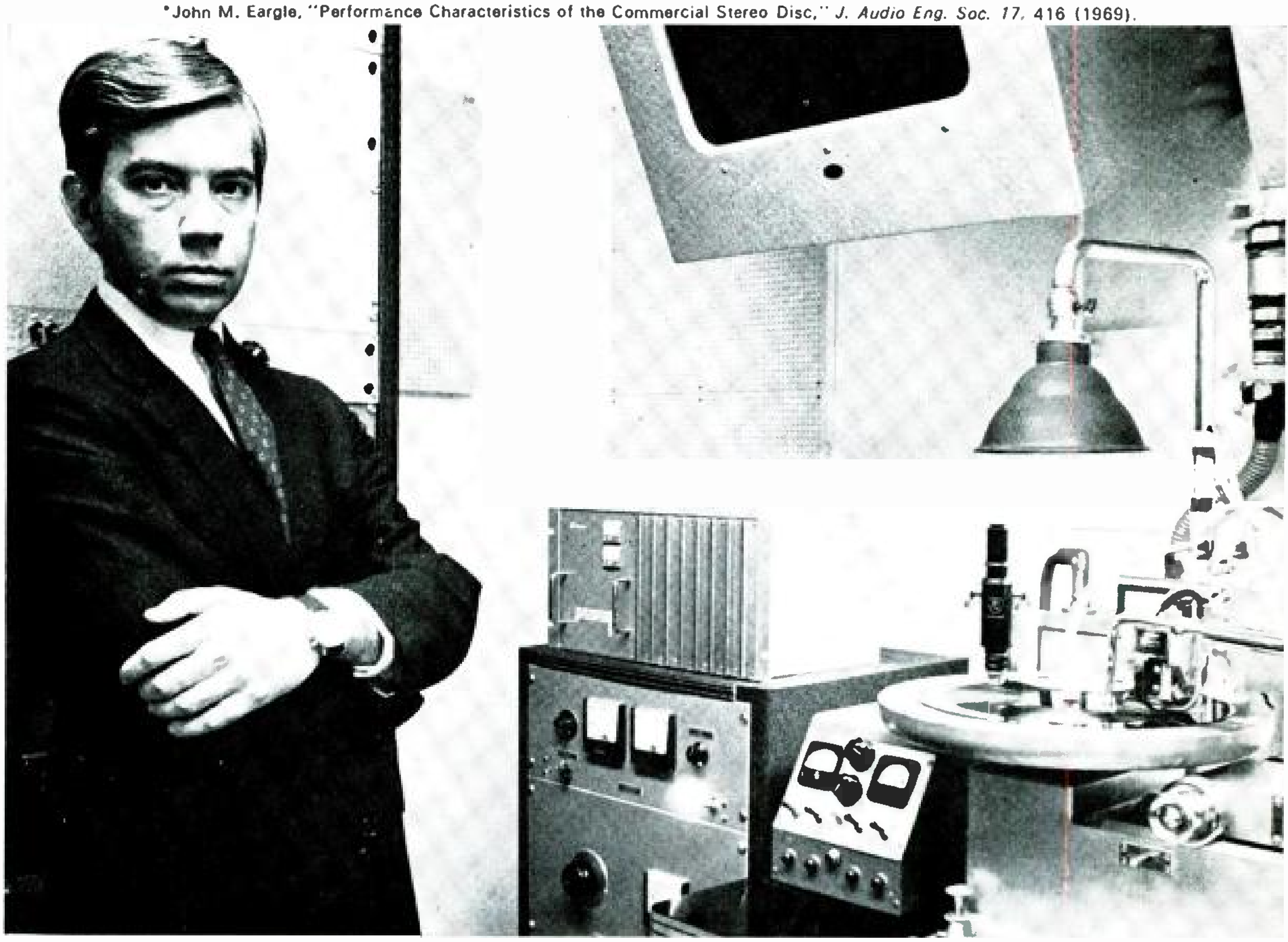
*John M. Eargle, "Performance Characteristics of the Commercial Stereo Disc," *J. Audio Eng. Soc. 17*, 416 (1969).



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The Feedback Loop

ARNOLD SCHWARTZ

●Last month I discussed how bandwidth (the range of frequencies over which the signal is transmitted without significant loss) in disc recording is limited by frequency response. If disc recording were an all-electronic system, frequency response would be the only limiting factor. In an all-electronic system the response of all the devices in the signal transmission path combine to give an over-all response, and thereby define the system bandwidth. In the disc-recording system the signal is converted from electrical to mechanical energy, and is then transferred to a storage device, the disc. It is this transfer, cutter head-to-storage on a disc, and then back again from disc-to-phono cartridge, that introduces another aspect to disc recording not present in the all-electronic system. Because the disc is an information storage device there are other considerations besides that of frequency response that limit bandwidth. This is an important concept; frequency response alone does not define the bandwidth of the disc-recording system.

WAVELENGTH

Basic to all discussions of energy transfer to-and-from the disc is the concept of wavelength. Because information is transferred to the disc for storage, and is then mechanically scanned by the phono-cartridge stylus, the disc-recording system performance is dependent upon wavelength; a phenomenon not normally present in an all-electronic audio system.

Let us review the concept of wavelength. We have in FIGURE 1 a diagram of a vibrating recording stylus cutting a modulated groove. The direction of vibration of the stylus, driven by the recording head, and the motion of the disc due to the rotation of the recording lathe are shown. As the disc moves linearly past the stylus, a modulated groove will be cut into the lacquer. The *wavelength* is the distance, in the direction of linear record travel, covered by one complete cycle of the modulation. Wavelength depends upon two quantities; 1) the frequency of vibration of the recording stylus, and 2) the linear velocity of the recording disc. *Linear velocity* is defined as the velocity of the recording blank, at the point of contact with the recording stylus, in the direction perpendicular to the record radius. *Linear velocity* should not be confused with *modulation velocity* (usually referred to as *velocity*). This latter quantity refers to the motion of the recording stylus, while the linear velocity that we are talking about refers to the motion of the recording disc. Linear velocity depends on the rotational velocity and disc diameter.

Two cases can be described to help visualize the concept of wavelength. At a given diameter the linear velocity is constant, and if the frequency of vibration of the recording is increased, wavelength will decrease. On the other hand, if the frequency of vibration is held constant, and the linear velocity is decreased (by decreasing the recording diameter), the wavelength will also decrease. Wavelengths on actual recordings vary from 0.0005 inch to more than 0.4 inch, and can be calculated by the formula:

$$\lambda = \frac{0.052DN}{f}$$

λ = wavelength in inches
D = recorded diameter in inches
N = rotational velocity in rpm
f = frequency in kHz

We now have a quantity, wavelength, which exists because we have cut a mechanical replica of the electrical signal. The process of transferring this mechanical energy, to and from the

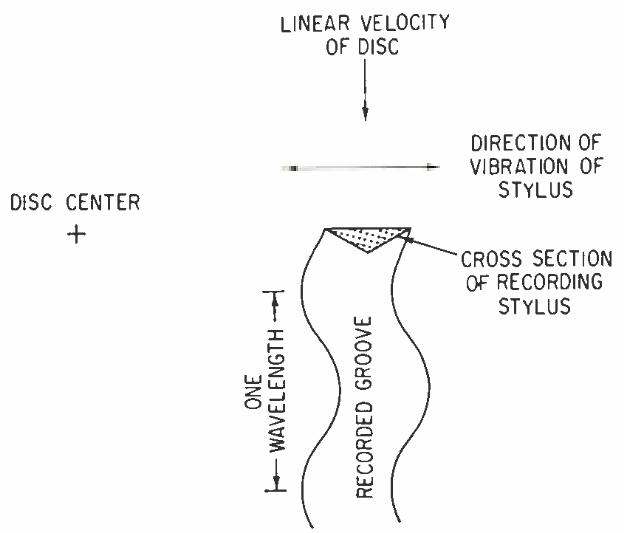

Figure 1. A diagraming of wavelength.

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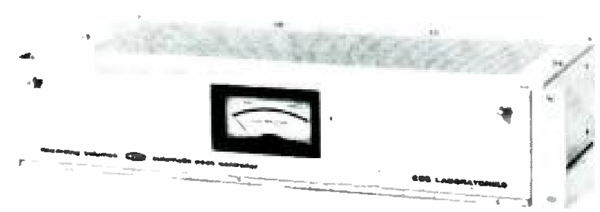

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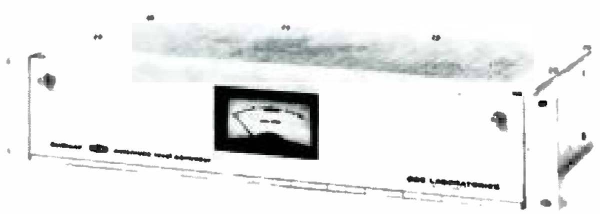

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The 600 is also equipped with a separate DC output for graphic logging over the full 60 dB range or to drive a second meter for remote monitoring.

While not intended as a replacement for the standard Volume Indicator, the 600's meter ballistics are such that its readings are compatible with VU indications. It's a practical program monitor as well as a valuable measuring tool.

It is also available in a standard 19-inch mounting rack from which it can be easily removed for portable use. Price: $505. Rack mounted: $550.

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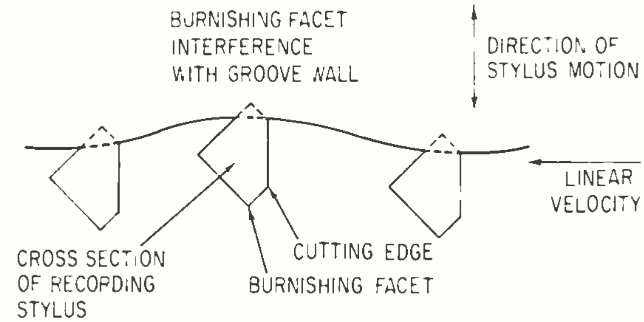

Figure 2. This is what happens during long wavelength cutting.

Figure 3. This is what happens during short wavelength cutting.

disc, is wavelength sensitive. That is, the system output varies with wavelength, and this output variation imposes a restriction on the disc-recording system bandwidth.

If the linear velocity were constant, as it is in magnetic recording, then each wavelength could be related to a specific frequency, and wavelength effects could be dealt with as a frequency-response phenomena. As it is, the linear velocity of the disc varies by almost 2.5 to 1, and wavelength effects must be dealt with independently of frequency response. The failure to distinguish between these two related (but basically independent) quantities is the cause of much confusion and fuzzy thinking. I have come across the published results of time-consuming research in the disc-recording field that turned out to be hopelessly confused, and therefore useless, because of the failure to separate and isolate these two effects.

A detailed cross-sectional view of a recording stylus cutting a groove is shown in FIGURE 2. Cutting actually consists of two almost simultaneously processes. The first is the cutting and removal of the material from the groove. The second is the interference action of the burnishing facet with the groove wall which smoothes the roughness left by the cutting process. This polishing action of the burnishing facets is an essential feature of the recording stylus, but which can cause problems as we shall now see.

In FIGURE 2 the stylus is shown cutting a long wavelength. The burnishing facet is virtually in phase with the cutting edge, and the amount of interference with the groove wall is constant along the entire wave. The resulting modulation will be a faithful replica of the recording stylus motion. In FIGURE 3 the stylus is cutting a short wavelength. Here the burnishing facet lags the cutting edge by a significant proportion of a wavelength. This lag causes the motion of the burnishing facet to be opposite to the slope of the modulation, and tends to wipe out that modulation. Since the short wavelength depicted here occurs at inner diameters and high frequencies, the recording bandwidth will be restricted accordingly. For example, let us assume a recording system with a flat frequency response from 30 to 15,000 Hz. At long wavelengths (outer diameters) little or no wavelength losses are encountered; the system remains flat to 15,000 Hz. At short wavelengths (inner diameters) the modulation tends to be erased by the burnishing facet as shown in FIGURE 3; there will be a substantial loss of recorded level at 15,000 Hz.

The correct solution to recording wavelength loss is the proper design of the recording stylus. Elimination of the burnishing facets, while eliminating wavelength cutting losses, would result in an unacceptable increase in noise. We are apparently faced with a set of equally undesirable results; cutting losses and low noise, or no cutting losses and high noise level. The problem has been resolved by using a 0.00016-inch burnishing facet, set at the correct angle, in combination with an extremely fine cutting edge. The resulting signal-to-noise ratio is about 70 dB, and cutting losses are less than 1.0 dB at the shortest wavelengths encountered. Efforts to counteract cutting losses at short wavelengths by increasing the drive to the cutter head, that is radius equalization, can only be considered a second-best solution, and tend to increase distortion and cause cutter overload. ■

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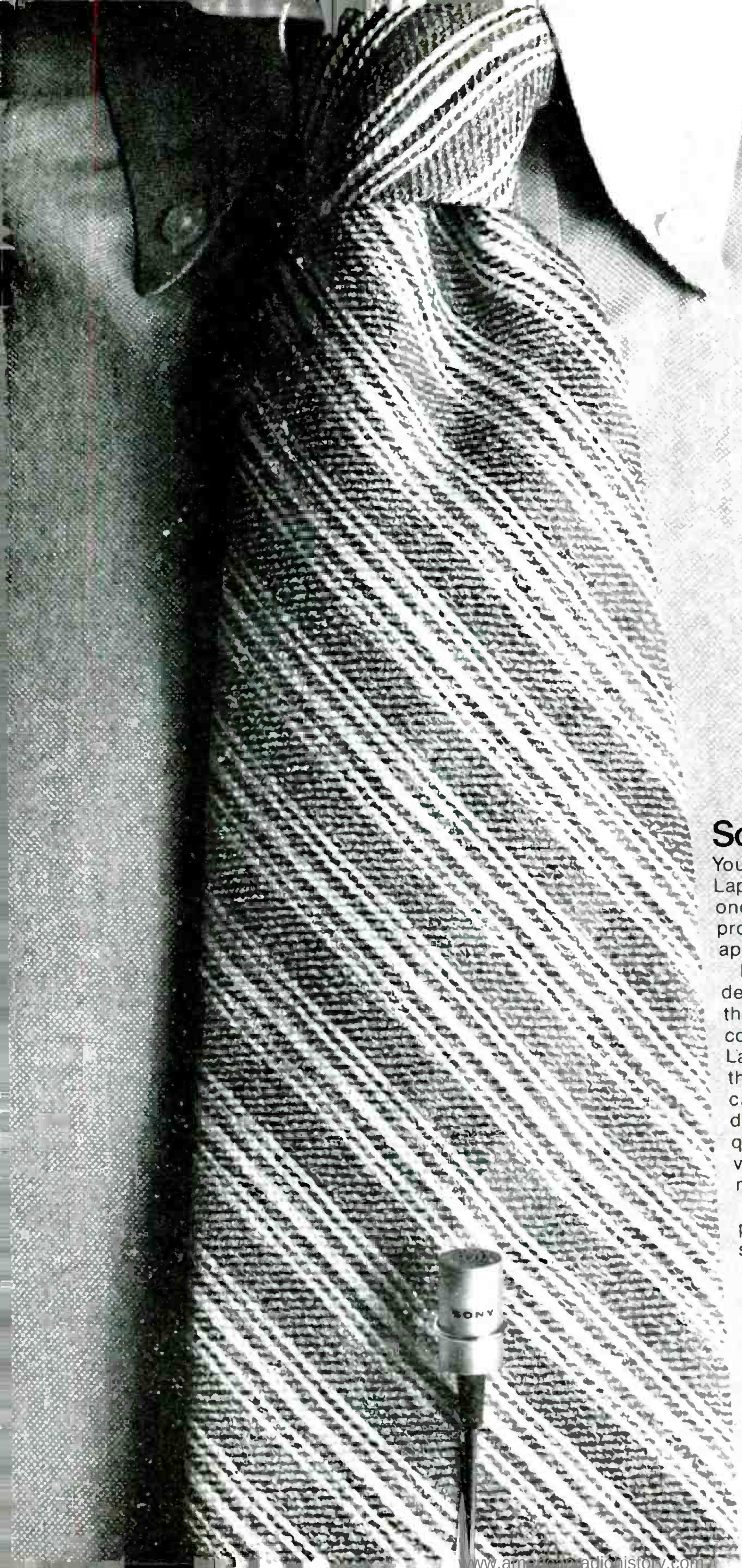

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The Sync Track

JOHN M. WORAM

COMMUNICATION, EDUCATION, & N.A.R.A.S.

● A few weeks ago, NARAS—the National Academy of Recording Arts and Sciences—held a most interesting meeting at A & R's 7th avenue studios in New York City. The panelists and audience discussed the roles of recording engineer, producer, and arranger, and how to get the best that each has to offer.

Panelist Mike Berniker suggested that NARAS establish a workshop so that the various contributors to the recording scene could get together regularly for mutual good. Another suggestion was "a glossary for engineers" so that producers could understand their terminology.

If one had to summarize the meeting in a few words, the NARAS press release came very close; ". . . .the need for greatest communication between the three important contributors to all recordings."

COMMUNICATION

In an industry where the artist doesn't make it *unless* he communicates with his public, one might hardly think it necessary to talk about communication within the studio. Surely, effective communications here are a foregone conclusion.

Unfortunately, no. Many recording sessions run into difficulties because somewhere along the way, engineer and producer—or arranger—have not communicated. Have you ever set up for a big instrumental session and just as you plug in the last microphone, someone walks in and says, "Where do you want the choir to stand?" Or, later on—after you've just used up the last of 16 tracks, a voice in the control room says, "Great, now we'll add a few guitar parts and we'll be finished."

When little incidents like this come up, it's time to start thinking about more effective communications. At the NARAS meeting, it was generally felt that most engineers would be more than willing to spend an hour before the session talking with the producer and arranger about the work to be done. This of course is an ideal situation, but there are some complications. If it's going to be an involved recording, the pre-session meeting should be scheduled some time in advance of the actual recording. This can be a problem, since presumably the principals are all busy with other comittments, and a mutually convenient time and place are often all but impossible to find.

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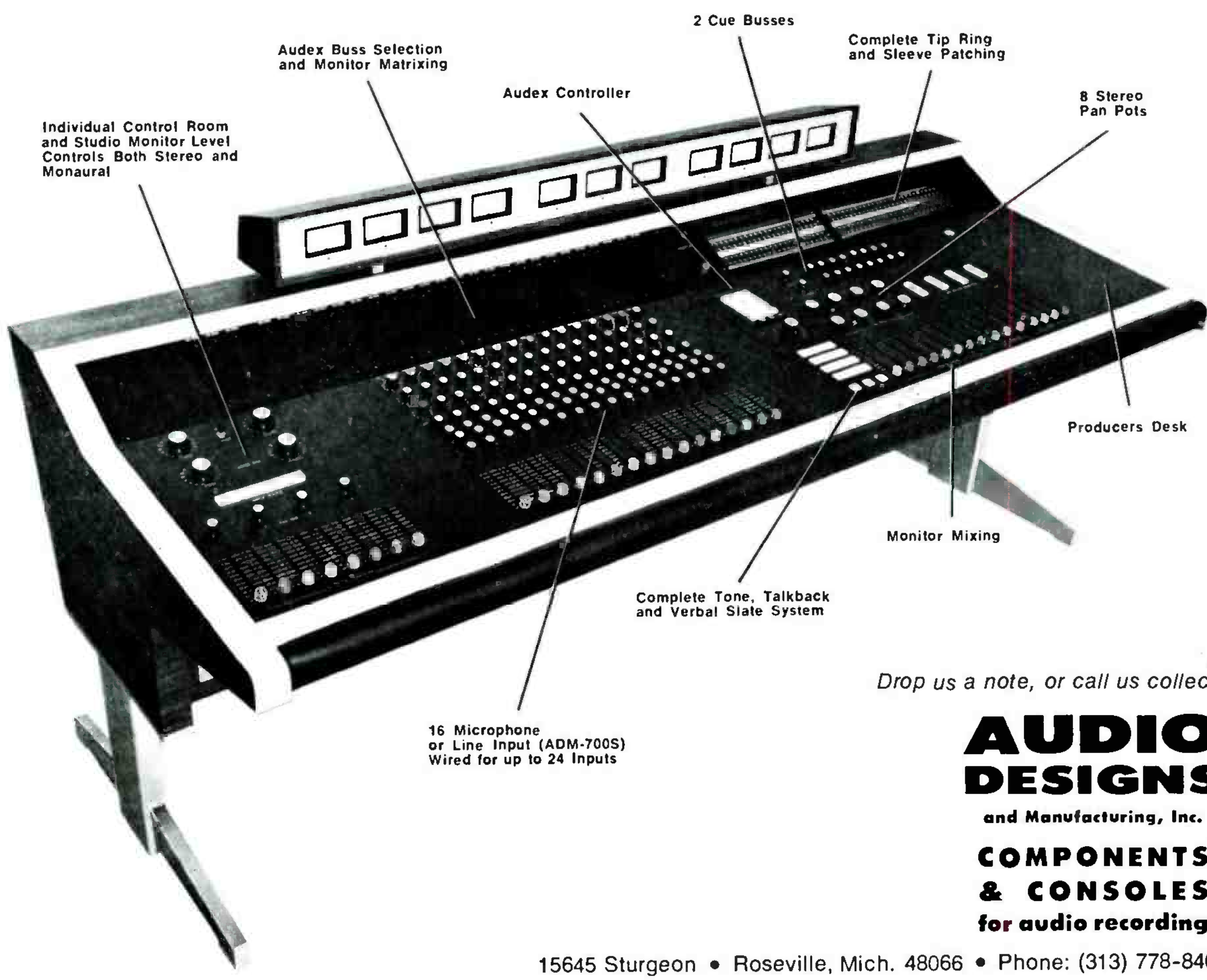

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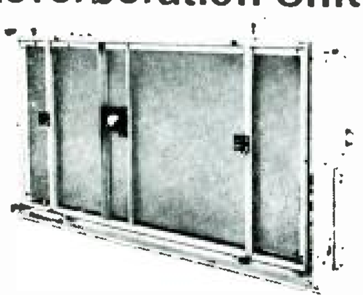

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An obvious solution is to actually book a pre-session session. But, this adds to the cost of the recording, so it's up to the bill-payer to decide if its worth it. More often than not, the bill-payer is not an engineer, now will he have an engineering background. Therefore, regularly - scheduled pre - session meetings will probably not become standard operating procedure, unless the engineering staff can demonstrate that they are well worth it.

Which brings up the question: Are they? Although most everyone at NARAS agreed some pre-session communication was required, time did not permit extending the discussion to include this point.

EDUCATION

Under the best conditions, engineers, producers, and arrangers may learn from each others' experience. One arranger pointed out that—via engineering—he was able to achieve instrumental relationships that would otherwise be impossible. For example, an acoustic guitar could be heard above a brass section. This is certainly no problem, but it does demand careful treatment if a musically-credible performance is sought. When the listener hears an acoustic guitar above the brass, chances are the arrangement will suffer artistically, even though the engineering may be first-rate. All of which means that as one learns from colleagues, this knowledge must not be applied haphazardly. The more you learn, the more there is to learn—which is certainly not a phenomenon unique to recording.

As the engineer develops new techniques, the arranger or producer must learn how to apply them correctly. Likewise, the engineer may learn much from a knowledgeable arranger. The engineer functions as a translator, converting music into electronics, that later may be re-converted back into music. The more he learns of music, the better equipped he becomes for his work.

Credit goes to NARAS for beginning this three-way discussion. Hopefully, there will be more meetings like this in the future—perhaps even a regular series in the fall. An upcoming issue of db will feature the subject of communication between engineers, producers and arrangers. Perhaps we can re-convene a panel of experts on the subject of education. Any readers interested in pitching in with their comments are invited to do so.

While I'm on this communication thing, this is a good time to say once again that letters about anything mentioned in this column are always welcome. If there's anything you'd like to see discussed, please let me know. And hurry, because in two more months, I will have written everything I know. ■

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Theory and Practice

NORMAN H. CROWHURST

●As we get older, time seems to pass faster. Recently someone questioned something I wrote about choice of loudspeakers. With some surprise, I found it was printed in 1959. Reaching for a copy of *The American Record Guide* of October that year, I re-read my article—and it brought back memories.

Shortly before that, *Consumer Reports* had published a piece on loudspeakers in which they check-rated a certain bookshelf type as a best buy, with the further impression that nothing else was much good for anything. Understandably, other manufacturers were up in arms. But what could they do, singly or collectively? Any public complaint would do no good: the oracle had spoken!

CU had yielded to, if not deliberately encouraged, the misconception that one particular model loudspeaker was universally best. Before that, I had written a number of articles that appeared in various publications, stressing that different types excel in different environments, and suggesting that a customer should be helped to select a speaker system to suit his room.

CU's article had suggested that writers like me pandered to manufacturers of inferior units that did not happen to merit, in their opinion, the check-rating reserved exclusively for that certain brand of bookshelf speaker. This just was not true. So I wrote an article, by invitation, published in *The American Record Guide*, to refute their position in detail.

Since then loudspeaker design has shown considerable progress, particularly in the development of better bookshelf speakers. This was an inevitable outcome of CU's presentation. With their following, millions would believe their "unbiased" news that bookshelf were best. And every manufacturer naturally would like a little of that gravy.

So if he did not already have a book-

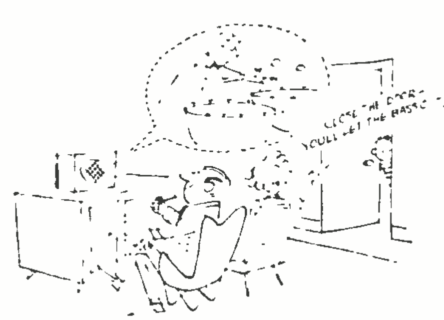

Figure 1. An explanation of small-speaker bass, after Crowhurst, oversimplified, Hi-Fi Made Easy, **1959.**

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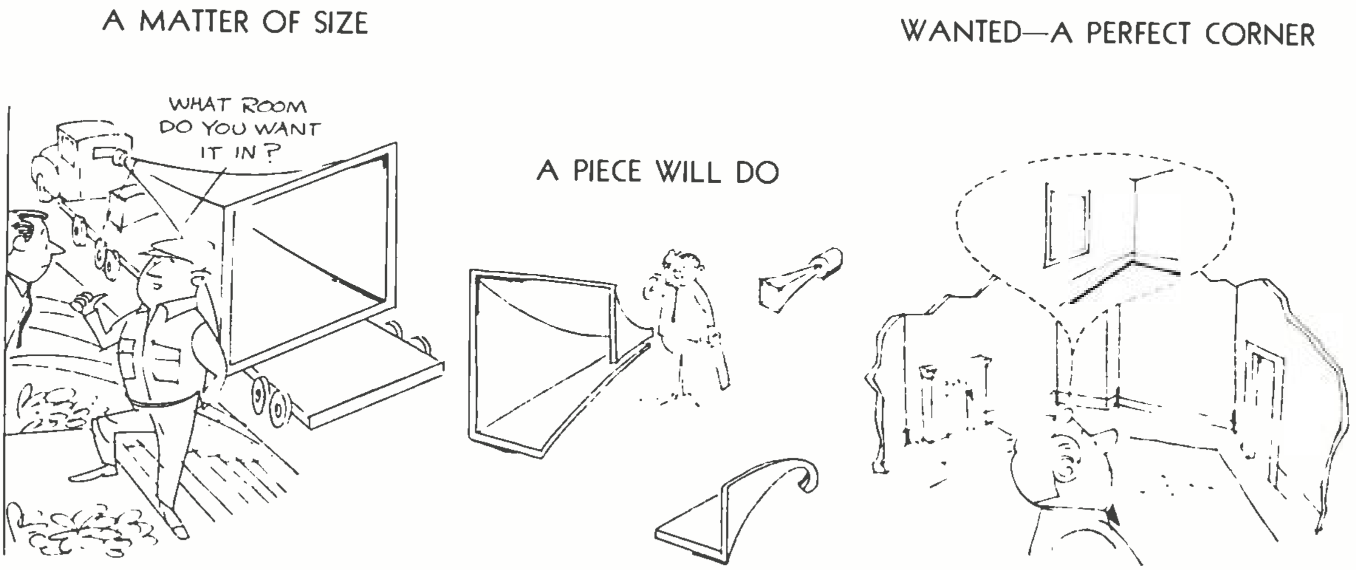

Figure 2. On explanation of horn-speaker problems, using the same source as Figure 1.

shelf speaker in his line, he had better make one. Those with a commitment to quality tried to make sure it was worthy of their label, when they were through. Some pretty wonderful things happened in loudspeaker design, it is true, but the basic facts did not change.

If you are looking for what CU implied is possible—a unit that has the magic of introducing perfection in reproduction into any environment where you put it—forget it! The first thing to learn is that reproduction is, even at best, an illusion. The story of high-fidelity reproduction has been the story of producing better and better illusions.

You cannot actually put Carnegie Hall in your living room. You can only introduce an illusion of listening in Carnegie Hall into your living room. The real question is how to get the best illusion. And the answer to it depends largely on the individual listening room.

The first thing to realize is that you are audibly aware of your surroundings, before ever the speakers start to reproduce. The room may have brilliance, due to hard surfaces; deadness, due to soft, plushy surfaces; a big resonance due to symmetry of its dimensions; and so forth. Whether you consciously evaluate this or not, it is there, in your subconscious—part of everything you hear in that room.

Now you turn on the loudspeakers to listen to some program. If the system is skillfully designed, it may change the illusion of the room you are in, as well as conveying a program to you. But it cannot eradicate the room, nor should it, altogether. For that would be unnatural.

The sound to which we listen is a complex thing, indeed: a multiplicity of frequencies, ever changing, propagated in the space in which we listen. And a lot of sheer bunk is talked about it. We hear, for example, about "low-frequency transients"—meaning, presumably, the way a 40 Hz tone can start suddenly. If it ever does that, the start tones contain a lot of components much higher than 40 Hz, and it is upon these that the transient illusion depends, not on the 40 Hz itself.

People's questions about loudspeakers as reproducers tend to divide into two groups: concerning the low- and the high-frequency components.

For the low frequencies, we have the choice of: high-mass, high-compliance units mounted in small infinite baffles, commonly called bookshelf speakers; bass-reflex baffles or enclosures, some of them going part way to the high-mass high-compliance approach; conventional sized infinite-baffle enclosures, using conventional, high - efficiency design loudspeaker units; and long folded horns, again fed by relatively high-efficiency units.

All except the horns are intended to fill the room with low-frequency sound pressure. The horn type intends to propagate a low-frequency sound wave. Right there is a fundamental difference in approach. The first group of types, to which most loudspeakers sold today belong, rely on feeding into an essentially closed room, while horns should feed into complete absence of enclosure: the room should have no walls to throw back the sound waves it generates.

Obviously, neither ideal is completely realized. In a book of mine (now out of print), I satirized one of these situations with a little cartoon (FIGURE 1). And the horn ideal is one compromise after another (FIGURE 2). First it should be big, but then you'd have nowhere to put it. So it can be sectioned and folded, but that poses more problems. Then it needs putting in a perfect corner, which does not seem to exist in most houses.

And a horn in a small room is a long way from ideal, because of the reflections from walls that are not very far away from the speaker, in terms of low-frequency wavelengths. But in a large room, and correctly placed, a horn may well be the best form of loudspeaker.

Each of the other types reverses the internal balance of things. In the horn, the front is loaded by the acoustic impedance of the horn, which eventually feeds the sound wave into the room. The horn is the major load on the diaphragm's movement (FIGURE 3). So incorrect termination due to room reflections can reflect all the way back to the amplifier.

In all the box-type speakers, the box itself provides the major control on diaphragm movement; the sound wave radiated into the room has relatively little effect on diaphragm movement (FIGURE 4). So the sound wave produced in the room depends on the size of the room compared to the size of the box that controls diaphragm movement. This is why box and bookshelf speakers are better in smaller rooms.

Before we leave the low frequencies, we should discuss distortion. As high-fidelity enthusiasts, we should be committed to find the system with the lowest distortion, right? Maybe. This is a problem that has plagued loudspeaker manufacturers for a long while.

Find a unit that reproduces frequencies below 40 Hz with very low distortion, and one that has more conventional amounts, and use a pure-tone source to compare them. If you appreciate what low distortion at these frequencies means, you will like the fact that, from the low-distortion unit, you

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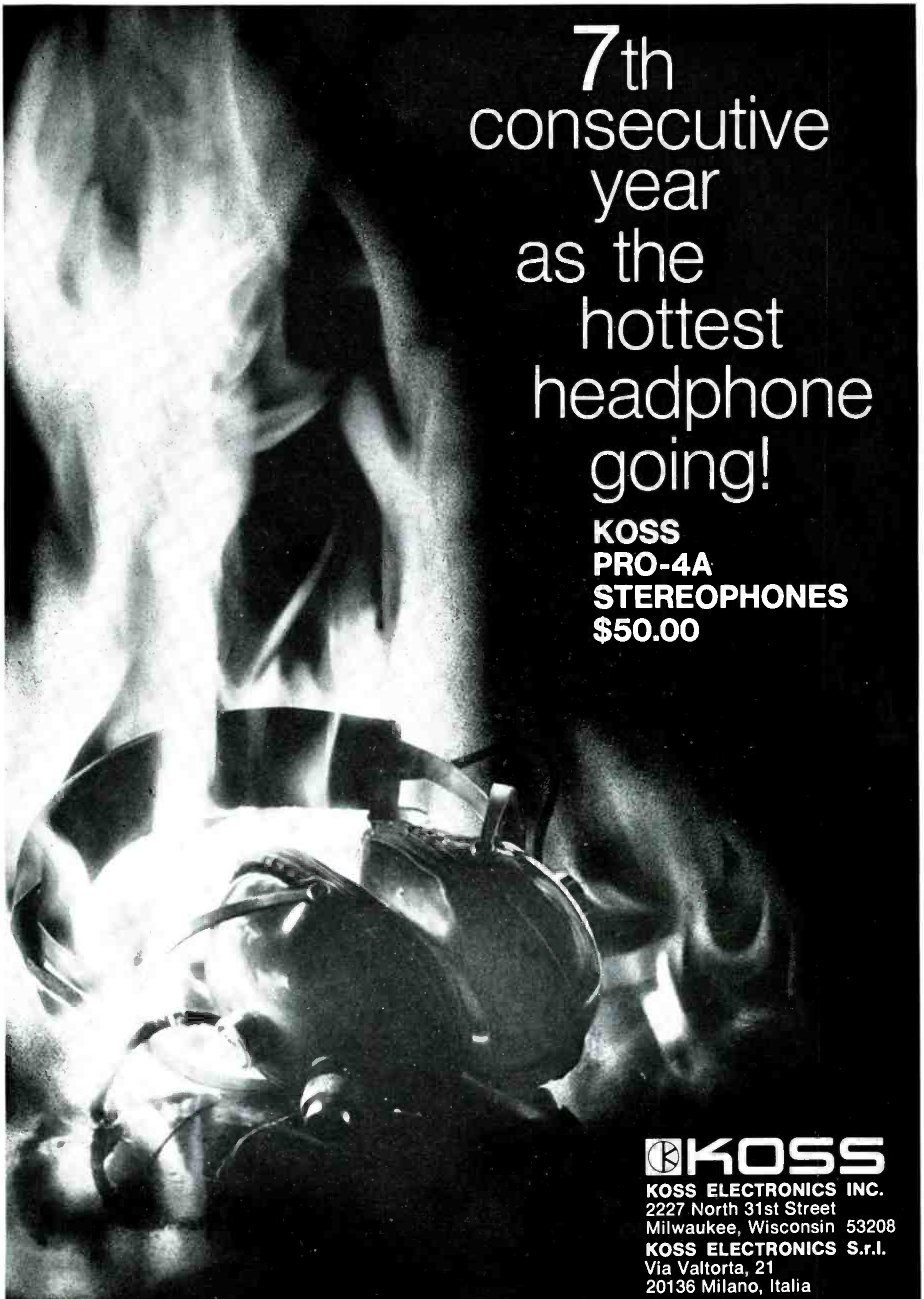

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hear very little, and tend to feel the frequencies more than you hear them.

But most people are listening to determine which gives the most audible bass. And the one with more distortion undoubtedly does that! So most buyers will pick the one with more distortion, really (although they do not know this) because it has most distortion!

Another factor to be considered is intermodulation distortion, which introduces Doppler effect. The loudspeaker may be perfect at reproducing all the frequencies it handles, one at a time. None of them is distorted, let us say. But it can still produce quite serious Doppler distortion, which results in intermodulation.

This is because when it reproduces a lower and a higher frequency at the same time, the diaphragm is going back and forth at the low frequency while it is also reproducing the higher frequency. When it is moving forward at the lower frequency, the high frequency is raised in pitch, as is a car horn, when the car is approaching you. When the diaphragm

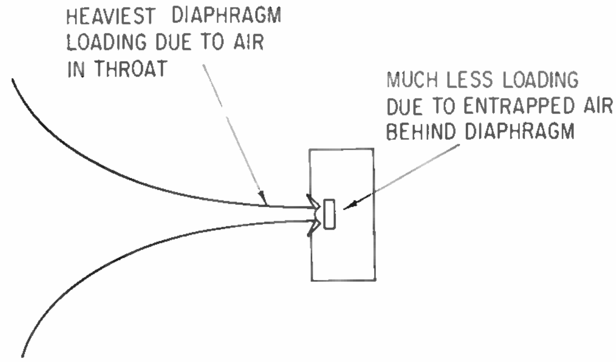

Figure 3. Why loading on the diaphragm of a horn speaker is more efficient, and more susceptible to incorrect termination of the acoustic wave.

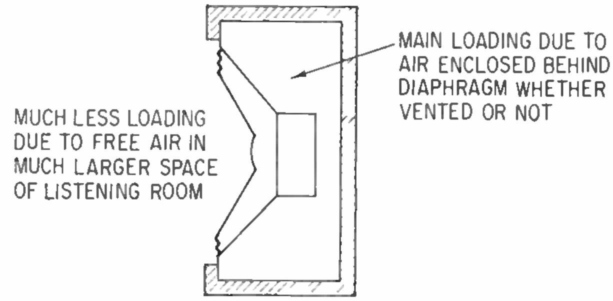

Figure 4. Any box-type speaker is little affected by the room in which it plays, but it tends to be more efficient in smaller rooms.

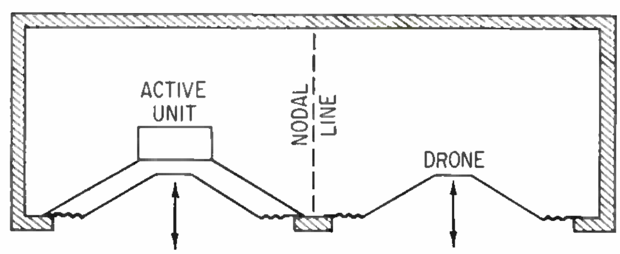

Figure 5. A reflex speaker that uses a drone cone instead of a port helps to understand the principle and relative advantage of the method.

is moving backward at the lower frequency, the high frequency is similarly dropped in pitch.

Bookcase speakers, with their large diaphragm movement at low frequencies, are particularly susceptible to this form of distortion, however well they are made for linearity at individual frequencies.

The only way to avoid this is to reproduce different frequencies from enough separate diaphragms, or else to be sure that movement, even at low frequencies, is kept small. Using separate diaphragms means electrical or electronic cross overs are needed, to see that each diaphragm gets the correct range of frequencies which ideally, for this purpose, should not exceed an octave.

This approach introduces as many problems as it solves, because the electrical crossovers produce excessive phase shifts between successive octave bands. The alternative is to keep the diaphragm movement small. This can be achieved in one of two ways, to achieve appreciable energy radiation: either work the diaphragm into higher acoustic air pressure, as does the horn; or use a larger diaphragm area.

The latter can be achieved, either by using a very big diaphragm for the bass frequencies—a super woofer—or by using many more smaller speakers, connected so their diaphragms move in phase, and thus move the total air to form a big wave without individual diaphragms having to move so far.

Before leaving the question of handling the low frequencies, I must say something about bass reflex, because many ask about them. One can theorize in a number of ways, but something that can be visualized in a practical way is always more meaningful. Assume you make two identical holes in the box, put an active speaker in one, and a drone cone, with no voice coil or magnet, in the other (Figure 5).

Throughout the upper range of frequencies, the drone does virtually nothing. At the lowest frequency the loudspeaker reproduces before it starts a rapid cut-off, both diaphragms move about equally and in phase. The active cone drives the air to produce a pressure resonance in the box. The drone is likewise driven by the air pressure in the box.

So you could approximately cut the thing in half and view it as a loudspeaker with two driven cones, radiating very nearly equally, at this frequency. Thus bass radiation at this frequency is achieved for about half the diaphragm movement needed without the reflex action. ■

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Sound with Images

MARTIN DICKSTEIN

IMAGE BRIGHTNESS II

● Before continuing with methods to calculate projector output requirements or estimate the required image brightness for film and slides, it might be best to set the record straight on some details that were given in the previous discussion of image brightness.

The recommended value for screen luminance for both 35-mm and 16-mm film, when projected in a viewing room (small audience), is 16fL, plus or minus 2. The recommended value for screen luminance in an indoor theater (showing 35-mm films) is 16fL, plus 4, minus 6. The SMPTE also suggests that brightness should not be in excess of 18fL in the showing of 16-mm films. This is to avoid the apparent flutter in the image when the illumination is too high. Also, the SMPTE recommends that in the presentation of slides, the luminance should exceed 5 foot-lamberts. In indoor theaters, for 35-mm film, recommended brightness should be between 5.5 and 20fL within specified angles of viewing.

When a footlambert meter is not available, a rough estimate of the stray light falling on the screen can be made by judging the readability of a newspaper. If a large headline (about 1-in. lettering) can just be barely made out when placed in front of the screen, the illumination can be judged to be about 0.1 fL. If a newspaper column is barely readable when placed in front of the screen, the stray light can be estimated at about 1 fL. If the newspaper column is quite legible when held up in front of the screen, the light falling on the screen can be "guestimated" to be about 10 fL.

This, then, provides a rough idea of the stray light falling on the screen with the room darkened to normal projection conditions with the projector turned on but with the lens capped to prevent the light from hitting the screen directly. Multiplying this value by the brightness ratio required by the type of slide material to be presented will give an idea of the minimum screen brightness needed for proper legibility of the projected material. (Slide material, to recap briefly the suggested categories, where high detail of color or black-and-white values must be seen is given a brightness ratio of 100 or more. When good-quality diagrams are shown, a ratio of 25 might be acceptable, and when typewritten material or simple bar charts or graphs are projected the proper ratio could be considered to be 5.)

It must be emphasized that the method of estimation of stray screen illumination is only a very rough guide and should not be used as a hard-and-fast criterion for setting up a projection system. It must be remembered that the value estimated for image brightness is a minimum value only, and as there is no top limit to the brightness of slide images (except for the possible washout of the image depending on the slide itself), it might be well to include a multiplying factor in the calculations when judging the required image brightness. Also, remember the suggested minimum values that are recommended.

After a value for a 35-mm slide image brightness has been calculated (based on stray light and material to be projected), it now becomes necessary to decide on the various factors of the projection system which will provide this requirement. If all elements of the total system were ideal, or assumed to be so, the required output, in lumens, of the projector could be found simply by multiplying the required luminance (stray light × material factor) by the area of the image on the screen. This figure indicates what the projector must put out if it is to provide the size of image desired with the necessary brightness. The basis for each of the variable factors involved in this calculation will be discussed subsequently. However, note at this point that the screen is assumed to be an ideal matte with a reflection factor of 1 (incident light is reflected without loss or increase).

A similar figure for output requirement can be achieved by multiplying the incident light (in footcandles) by the brightness ratio for the material to be projected and by the area of the desired image. (With most projectors, the lumen output is available from the manufacturer based on the lamp and lens being used or furnished as standard equipment.) A more rigorous calculation is achieved, and a more accurate result, when the screen is divided into 9 equal areas—3 horizontal, 3 vertical—across the full projected image. The incident light is then measured in footcandles at the center of each area. The total incident light is calculated by adding up all the readings. This is in turn multiplied by the area of the image and the product is divided by 9. (Area is in square feet.) This final figure is the output in lumens required of the projector.

It must be remembered that above calculations are based on the fact that all elements of the system have been assumed to be ideal. As this is not really true, it becomes necessary to include some or all of the variables into the calculations for projector output requirement, if a more accurate value is desired.

Beginning with the assumption that the format of the projected slide is the most common 35-mm double frame variety, we can start with the size of the image. Image size is determined by the throw distance and the focal length of the lens being used. Sometimes it is possible to decrease the projection distance and thus reduce the size of the image to the point where the brightness is acceptable. Sometimes, because of the size of the room and the number of persons in the audience, this is not possible. The image size can still be reduced by using a longer focal length lens. (However, changing the lens also sometimes changes the speed of the lens, another variable to be considered.)

If the distance of the farthest row of seats demands a large width of projected image, and the size of the image can not be reduced sufficiently to result in an increased brightness, perhaps the screen material can be changed. Depending on the viewing angles of the audience, it might be possible to use a screen with a reflective factor greater than 1, resulting in a gain in the brightness of the reflected image. For example, screens that are lenticular, metallic or beaded have much higher reflective factors than matte; the latest screen on the market has a reflective factor of 12 as compared to 1.00 of ideal matte.

Although the above discussed front projection, primarily, it is also true that there are different types of rear-projection material available with a variety of transmission factors so that a material could be chosen which had a relatively high gain in passing the image light. However, care must be taken as the angle of light dispersion also changes and the material chosen only for its gain may restrict the seating area of the audience to an unacceptable extent.

Another variable which can be controlled is the lamp used in the projector. There are different lamps which have different wattage ratings with dif-

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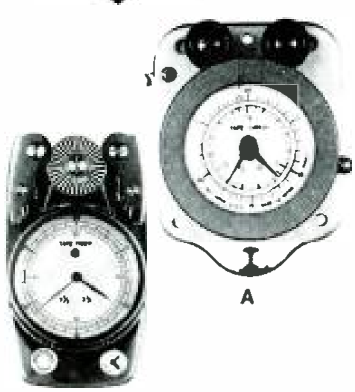

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ferent life ratings and under different source voltages. Any tests made of the output of a projector should be made with a new lamp as many lamps darken and fall off in output with age. An important consideration in some installations might be the brightness of the lamp rather than the rated life expectancy, depending on the material to be shown and the anticipated usage of the equipment—and the cost of replacement of lamps.

Two more variables which may be controlled, depending on the installation, are whether the image is projected through glass and whether the image is thrown onto the screen with or without the use of a mirror. If the slide is glass-mounted, a small amount of light is lost in passing through the glass sides of the mounting. Also, if the projector is located in a projection room and not in the conference room, it is possible that a port has been allowed for projection, and this port hole may or may not be sealed with a piece of glass. If there is glass dividing one room from the other, another bit of light is lost. The glass should be of the water-white variety which allows projection with a minimum loss of light. A mirror also causes a certain amount of light loss and although the amount is small, it should be included in calculations for greater accuracy.

To illustrate quickly the variations possible in the factors presented in slide projection, let's look at the items mentioned:

Screen: Ideal matte factor is 1.00, metallic lenticular is rated at 2.00 and beaded at 2.80. Ordinary matte material is rated at 0.85 (loss of 15 per cent).

Rear-projection material: Average is 2.25, highly diffusing is 0.75, and highly directional is rated at 4.00.

Lamps: If a DEK is rated at 1.00 at 120 volts, it is rated at 0.75 at 110 volts. A DEL (also 500 watts) is rated at 1.2 at 120 volts and 0.9 at 110 volts, but the life is lower of the DEL than is the expectancy of the DEK.

Lens: Considering a 5-in. f/3.5 as 1.00, a 3-in. f/3.5 is rated at 0.75 while a 7-in. f/3.5 is rated at 1.07. The zoom lens is 0.89.

For a glass-mounted slide, the light loss is about 15 per cent of an unmounted slide and by shining through two surfaces of projection window, about 10 per cent light is lost. Reflection from a mirror causes another loss of about 10 per cent over direct projection. Thus, the factors to be used in the calculations for glass-mounted slides, port windows, and a mirror are 0.85, 0.9 and another 0.9.

In 16-mm projection, similar factors determine the brightness of the image—with one difference. The screen material (front or rear), the lamp (its power rating, operating voltage and life expectancy), whether there is projection window glass or not, whether a mirror is used, and the area of the screen image, are all still factors (perhaps, to a slightly different extent than with slides, but nevertheless very important). In the film projector, because of its mechanism and the method of operation, there is a shutter. Some projectors have two-bladed shutters while others have three blades. Since the three-bladed unit interrupts the light more often (three times per revolution as compared to two times in the two-bladed units) there is a 30 per cent loss of light. It should be remembered that in 16-mm projection there is no image brightness value (as there is in slide projection) dependent on the material to be projected. There is, however, a recommended image brightness which is the guide for establishing the system elements.

To indicate quickly and briefly the relative values of the controllable factors in a 16-mm system, a 2 in. f/1.6 is rated 1.00 while a 4-in. f/2.5 is rated at 0.52. The 1000-watt lamp operating at 120 volts is rated at 1.00 while a 750-watt lamp at the same voltage is rated at 0.75 and a 1200-watt lamp at 115 volts is rated at 1.00. Values of screen material, window glass and mirrors have the same relative standings as with slide projection. ■

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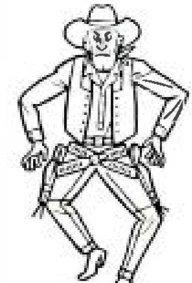

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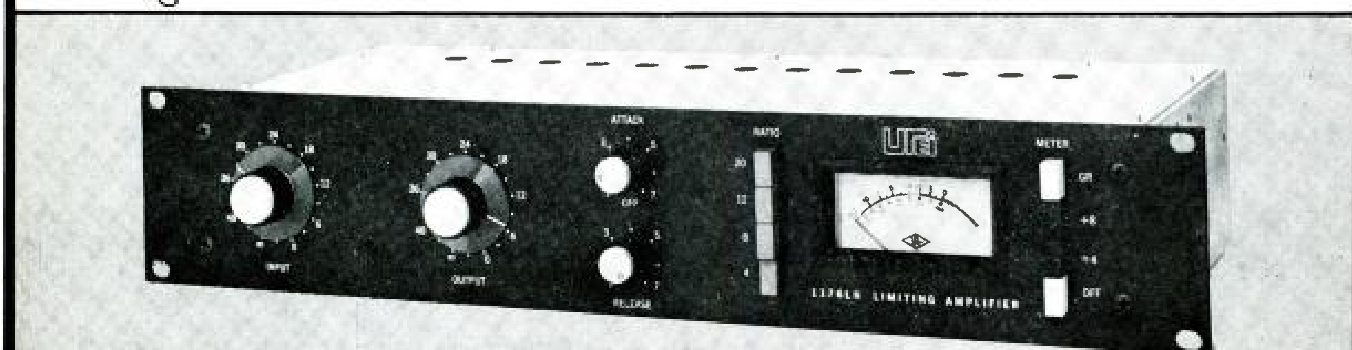

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Synchronous Recording Techniques

SIDNEY L. SILVER

The many methods of recording synchronized sound with motion picture are detailed. Sound on film-tape, conventional audio tape, and cassettes, as well as transfer systems are discussed.

In motion picture production, the synchronization of audio and visual information is commonly achieved by recording the sound track separately on a sprocket-driven magnetic-film recorder, using the same film gaguge (16mm or 35mm) as the picture stock. Assuming that the motion-picture camera and the magnetic-film recorder are driven by synchronous motors from the same a.-c. source (either 120-V single-phase or 220-V three-phase), the drive motors will hold precisely the same speed relationship once they have attained synchronous speed.

An alternate method of synchronizing sound for motion pictures is to employ a quarter-inch magnetic-tape machine, in which a synchronizing pulse, or control signal, is recorded on the tape along with the program material. This sync signal can be considered as a series of invisible sprocket holes which provide a positive index for the subsequent control of tape movement during reproduction. For line-current operation, the sync pulse can easily be derived from the same power source through a step-down transformer. The magnetic tape is then synchronously transferred, or resolved, to sprocketed magnetic film so that the normal editing and other production processes can be carried out, and the sound track finally printed as a standard optical track on the picture film.

The use of ¼-in. tape as a synchronous recording medium offers a particular advantage in location recording, because of the reduction in the size and weight of the sound equipment required, as well as the recording material itself. At the present time, there are a number of compact, lightweight, fully transistorized tape machines available for location recording, whose performance quality is comparable to their studio counterparts. Since these recorders are battery-operated, they must incorporate some method of stabilizing the voltage source, not only to maintain the precise adjustments of the bias and recording currents, but also to maintain the d.-c. motor at a constant speed. The tape machine must also be equipped with a built-in facility for handling and retaining synchronization between picture and sound.

Sidney L. Silver is with the United Nations Telecommunications Center at U.N. Headquarters in New York City.

SYNC-PULSE SYSTEMS

Several techniques for synchronizing the sound track from ¼ in. tape recorders with motion-picture cameras have been developed, each of which accomplishes the same end result in a different way. In these systems, the objective is to magnetically record a synchronizing pulse on the same tape as the program sound in such a manner as to avoid cross-talk interference between the sync pulse and audio signal. For practical reasons, a 60-Hz sync pulse, or pilot tone, is used in the U.S. because this conforms with the standard power-line frequency. In those parts of the world where 50 Hz is the standard line frequency, a 50-Hz sync signal would be employed. The simplest approach is to use a dual-track tape machine in which the program material is recorded on one half of the tape width and the sync pulse on the other half. This technique, however, does not fulfillprofessional requirements, since the tape cannot be reproduced on full-track equipment. Moreover, dividing the audio tape area in

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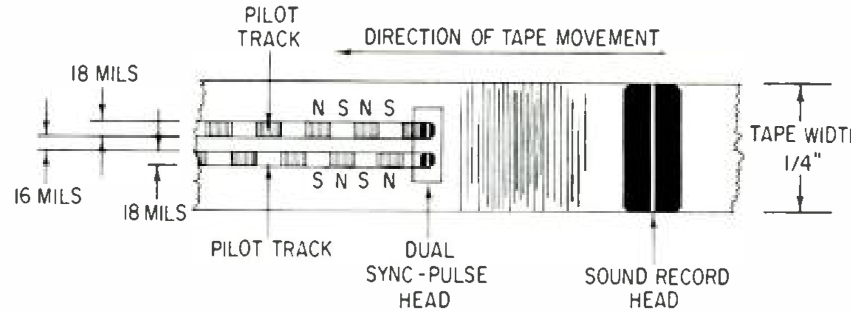

Figure 1. The Neopilot system uses a push-pull sync-pulse head.

half reduces the signal-to-noise ratio by 6 dB.

Another method of synchronization is the Fairchild system, in which a 14-kHz carrier signal, modulated by the 60-Hz line frequency, is magnetically recorded with the same record head used for the program sound. In this arrangement, the modulated carrier-signal level is about 30 dB below program level, so that it does not interfere with the sound material. In reproduction, the 14-kHz carrier is demodulated and the 60-Hz signal is used for synchronization. For maximum stability of the carrier frequency, it is preferable to record at 15 in./sec., but under optimum operating conditions, a tape speed of 7½ in./sec. is acceptable. Unfortunately, the high-frequency carrier signals are subject to dropouts (due to poor tape-to-head contact) which are caused by any accumulation of foreign material on the tape surface.

In general, most synchronous recording systems employ an auxiliary record/reproduce head, or sync-pulse head (usually positioned between the program record and playback heads), which records an independent pilot track in a narrow portion of the tape width. Biasing for the sync-pulse head is provided by the local bias oscillator of the tape machine, which effectively maintains a pure 60 Hz pilot tone. Without a biasing arrangement, harmonic frequencies of the sync signal would be generated which could be picked up by the program heads, resulting in cross-talk interference.

In one scheme, known as the *Pilot-Tone* system, the 60-Hz sync signal is recorded in the center portion of the tape width, with the sync-pulse head gap oriented exactly perpendicular to the program record head slit. This results in a transverse recording in which the magnetizing force is at an angle of 90 degrees to the direction of tape movement. In contrast, the program record head uses longitudinal recording where the magnetization is parallel to the direction of tape travel. A disadvantage of this system is that the sync-pulse head utilizes a rather wide gap (about 20 mils), which prevents a good bias action, and hence reduces the signal-to-noise ratio of the sound track. In the *Rangertone* system, the sync pulse is also recorded in the center of the tape, but the head gap is rotated about 87 degrees out of azimuth from the program record head slit. This angular position produces a reasonably wide pilot track, but the sync-pulse head adjustment is extremely critical and hum pickup on the sound track is a difficult problem.

Another method of synchronization is the *Perfectone* system, which employs longitudinal recording of the sync pulse and the audio signal. Here the sync signal is recorded in push-pull by a dual sync-pulse head, with the pilot tracks occupying the outer edges of the magnetic tape. Since both tracks are 180 degrees out of phase with respect to each other, a cancellation effect occurs when the tracks are reproduced by by the program playback head, thereby reducing cross-talk to a minimum. A variation of this technique is the *Echelon* system, in which the sync signal is recorded in-phase on the outer edges of the tape, but the pole pieces of the dual head are somewhat displaced from each other. The cancellation effect is achieved by staggering the sync-pulse head gaps at a distance of one half the wavelength of the 60 Hz sync signal. A limitation of this system, as well as the Perfectone scheme, is that any crimping or weaving at the edges of the tape would tend to make the sync-pulse area critical, and hence the synchronization process would be unreliable.

At the present state of the art, the most widely used technique for synchronous ¼-in. tape recording is the *Neopilot* system. In this system, the dual sync-pulse head is designed with an extremely narrow gap so that bias power dissipation is considerably low. Referring to the illustration in Figure 1, the tape movement is from right to left with the oxide ocating toward the viewer. As the magnetic tape moves in contact with the program record head, a full-track audio signal is recorded longitudinally on the tape. The tape then passes over the sync-pulse head (which is actually two heads in push-pull) so that the high frequency bias across each head

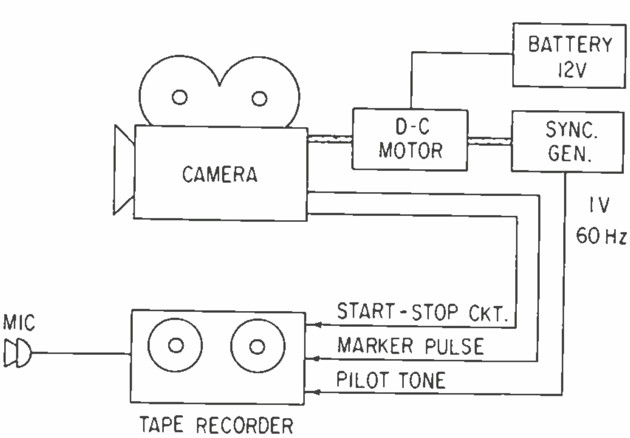

Figure 2. This synchronous recording system uses interconnecting cable between the camera and tape machine.

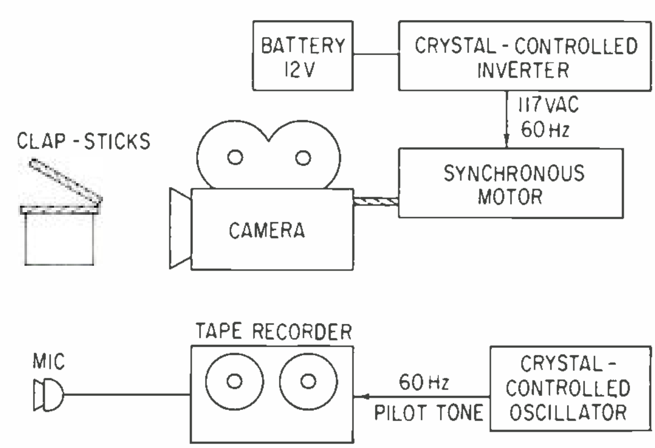

Figure 3. A crystal-drive synchronous system eliminates the need for interconnecting cable such as shown in Figure 2.

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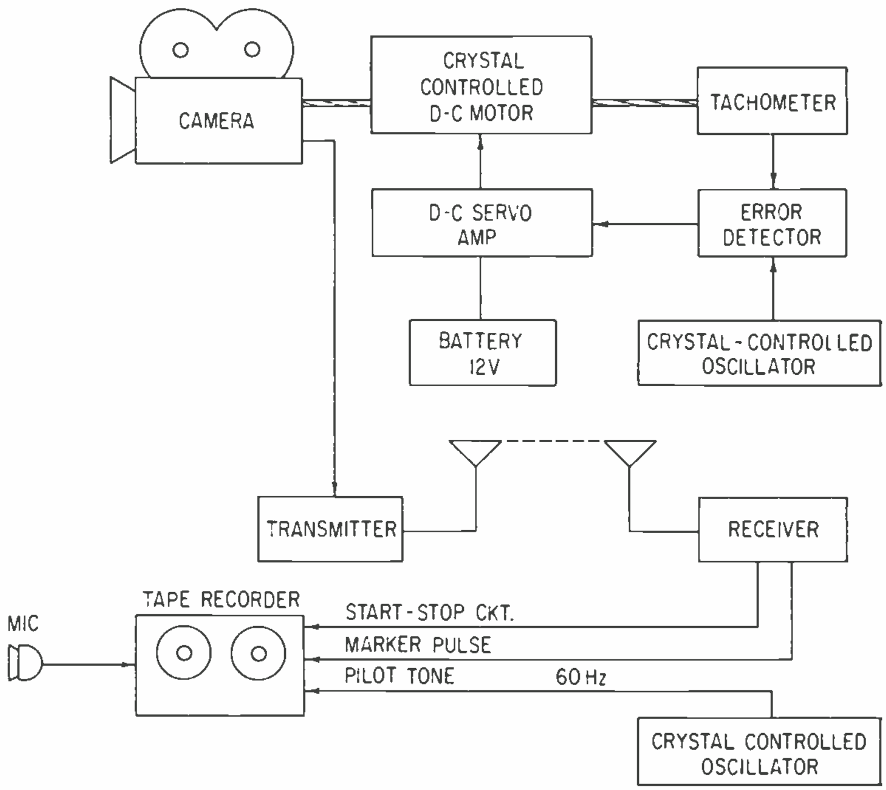

Figure 4. A radio-control system for synchronous recording.

erases the audio signal in the respective areas, and records a 60-Hz push-pull signal. This signal is in the form of two narrow tracks recorded in the center portion of the tape, the width of each track being about 18 mils, with a 16-mil separation between them. Each track is recorded in opposite phase, so that where a hill of pulse waveform is recorded on one track, a valley is impressed on the corresponding portion of the other track. In relation to the program playback head which reproduces the full tape width, the two pilot tracks effectively cancel each other out, so that the sync signal is not audible on the program channel. This condition is based on the assumption that the applied record currents in the sync-pulse heads are properly balanced with regard to phase and amplitude. In practice, the symmetry of magnetic flux in both tracks is controlled by a balance pot arrangement which reduces cross-talk interference to negligible proportions.

The Neopilot system has the capability of providing a greater signal-to-noise ratio than any other synchronizing method. Owing to its dominance in the field of ¼-in. synchronous tape recording, it may possible become the accepted international standard. Although the system is incorporated as a built-in facility in a number of tape machines designed for synchronous recording; e.g., Nagra, Tandberg, and Uher; the Neopilot head assembly itself is available as an accessory component which can readily be adapted to other high-quality professional tape machines.

INTERCONNECTING CABLE SYSTEM

In location recording, there are many situations where a stable-frequency a.-c. source is not available for the capstan drive of the magnetic tape transport and the drive motor of the motion picture camera. In such cases, it is feasible to use battery-operated d.-c. equipment employing some form of regulating device in the drive systems of both the camera and tape recorder, in order to establish proper speed control. FIGURE 2 shows a simplified block diagram of a synchronizing system where close accuracy in speed regulation is achieved by driving the camera with a governor-controlled d-c. motor, powered by an external 12-V battery. Here a small rotating generator (mounted at one end of the motor shaft) provides the necessary pilot tone, whose frequency is synchronous to the frame, or shutter, frequency of the camera. Since the camera is driven at 24 frames per second, and the generator is designed to produce 2½ cycles of sync signal for each frame of film movement, the sync pulse generated is the required 60 Hz. The sync signal (about 1 V of amplitude) is fed by a wire pair to the sync-pulse head circuit of the tape recorder; the recorder being driven by a servo-controlled d.-c. motor, powered by an internal battery. Another line provides a means of automatically starting and stopping the tape machine in conjunction with camera operation. The third line in the interconnecting cable enable marker pulses to be generated under the control of an electronic time-delay circuit contained within the camera.

In operating the system, the sequence of events is as follows: when the camera is started, the start-stop circuit in the tape recorder is energized by the camera battery voltage and, simultaneously, the 60Hz pilot tone is conveyed to the sync-pulse input of the tape machine and magnetically recorded. After a short time delay, which allows both the camera and tape recorder to come up to normal speed, a fogging lamp in the camera fully exposes a few frames of film. At the same time, a d.-c. control voltage derived from the camera battery actuates a bloop oscillator in the tape machine, which enables a brief audible marker tone (of the order of 1 kHz) to be recorded on the program track. The fogging lamp then automatically extinguished, the marker pulse is simultaneously switched out, and the system is now ready to accept program material. In this system, the fogging lamp and marker oscillator establish an identical time-point relationship on the picture film and magnetic tape at the beginning of each take. By identifying a particular visual mark on the film with a corresponding audible start mark on the tape, picture and sound can be subsequently matched.

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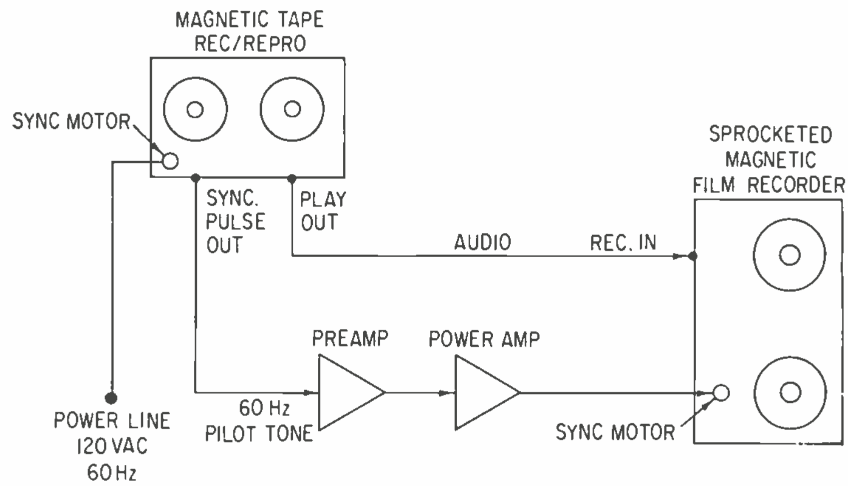

Figure 5. This direct-drive system is used for synchronously transferring magnetic tape to sprocketed magnetic film.

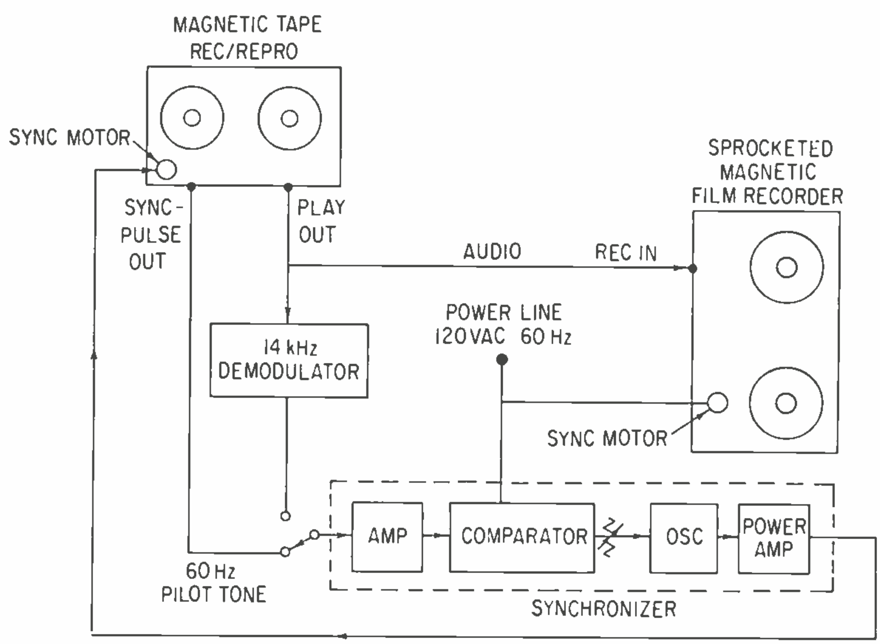

Figure 6. This is a closed-loop servo system for synchronous transfer.

CRYSTAL-DRIVE SYSTEM

To obtain greater freedom of movement between the cameraman and sound recordist, it would be desirable to eliminate the "umbilical cord" linking the camera and tape machine. This may be accomplished by utilizing two separate frequency sources of great accuracy; one frequency source for driving the camera, and the other for synchronizing the tape recorder. Using this method, several cameras and tape recorders can easily be incorporated into the system, each unit carrying its own independent precision frequency source.

In the wireless system shown in Figure 3, the synchronous camera motor is driven by a miniature solid-state inverter operating from the camera battery and generating 117 V a.-c. at 60 Hz. For maximum precision, the frequency-determing element of the inverter is a highly stable crystal-controlled oscillator, which is counted down by a chain of frequency dividers to produce the required drive frequency. A precisely matched crystal-controlled oscillator, operating from the internal battery of the tape machine, delivers the 60 Hz pilot tone to the sync-pulse head circuit of the recorder. Typically, the inverter and sync-pulse generator have an accuracy of 20 parts per million over a temperature range of minus 20 deg. C to plus 50 deg. C.

In some systems, a precision tuning-fork standard is employed as the stable frequency source. Here a higher frequency fork resonating at, say, 960 Hz, is divided down to the necessary 60 Hz; the reduced size of the fork rendering it less susceptible to disturbance by environmental conditions. Since they are heavier and require more power, tunning-fork units are not very common in this application.

Obviously, the removal of the interconnecting cable eliminates the facility for automatic start-stop operation, and also the means for initiating start mark control. As a solution, the start mark can be established in the traditional manner by the use of clap-sticks attached to a slate, in which the take number, scene number, and any other information essential to the subsequent editing process is conveyed to the system. Initially, the cameraman and recordist are given a verbal or visual cue to start rolling. After the camera and tape machine have reached their normal speed, the clap-sticks are brought together in front of the camera, and the transient sound picked up by the microphone is recorded on the program track.

RADIO-CONTROL SYSTEM

The wireless system offers a particular advantage in situations where a high degree of mobility is required, such as in the modern technique known as cinema verite. Obviously, an electronic means of marking would be called for, since the use of clap-sticks is inconvenient and, in most cases, a distracting influence. This condition can be met by utilizing a sophisticated radio-control system which has the capability

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of transmitting the necessary control signals for start marking and for starting and stopping the tape machine.

FIGURE 4 shows a miniature radio-control system which employs citizens band equipment operating in the 27 mHz range. According to FCC specifications, no license is required if the d.-c. power input to the final stage of the transmitter is not in excess of 100 mW. The receiver, operating from the tape machine battery, picks up the information, and processes and selects the appropriate control signals for the marker tone and the start-stop operation. Using this system, the cameraman and recordist can freely maneuver anywhere within the range of the transmitter. If other cameras and tape recorders are involved, coding devices can be incorporated in the radio system for identification purposes.

Some systems are designed to transmit the 60 Hz sync signal by radio, but this procedure is unreliable, since any obstruction between the transmitting and receiving antennas would result in a loss of syncronization. In FIGURE 4, the sync signal for the tape recorder is provided by a precision-controlled source. The camera, however, is driven by a crystal-controlled d.-c. motor which operates in a servo-control system to regulate the speed of the motor. Here a tachometer, coupled to the drive motor, generates an a.-c. voltage whose frequency is compared with a crystal-controlled reference frequency. Any error, or difference between the two frequencies, produces a resultant d.-c. signal which is amplified and used to correct the motor speed. In effect, the gain of the d.-c. control amplifier driving the camera motor, is made to increase or decrease, according to whether the motor speed is too slow or too fast.

SYNCHRONOUS TRANSFER SYSTEMS

In the process of transferring, or resolving, ¼-in. synchronous tape to sprocketed magnetic film, corrections are automatically made for variations in the speed of the tape machine, elongation and contraction of the tape (due to mechanical strain, temperature changes, humidity variations), and any other factors that may have affected the linear speed during the original recording. The objective is to maintain absolute synchronization, so that in reproduction, the sound track re-recorded on the sprocketed magnetic film will match the camera picture, frame by frame.

FIGURE 5 shows a block diagram of the direct-drive resolving system, in which the tape reproducer drives at a constant speed and the sprocketed magnetic film recorder is synchronously controlled. Here the reproduced 60-Hz sync pulse is amplified by a preamp and a 75-W amplifier, in order to provide sufficient power to drive the synchronous motor in the film recorder. In practice, the power amplifier includes a wave-shaping device so that the motor excitation is approximately 120 V of a well-formed sine wave. The transfer drive motor will thus increase and decrease its speed in accordance with the taped sync signal. In the direct-drive system, small, fast deviations between the tape sync pulse and the power-line frequency may produce audible low-frequency flutter (wow), unless some form of delay timing is incorporated in the film recorder to provide a means of damping the changes in motor speed.

Another method for synchronously transferring magnetic tape is the closed-loop servo system. In contrast to the direct-drive system, the drive motor of the sprocketed film recorder is now driven by the power-line source, and the speed of the synchronous tape machine motor is controlled by a synchronizer, or resolver. The reproduced sync signal is electrically compared with the line frequency and an error-correcting signal is delivered to the reproducer motor, thereby correcting the speed and retaining frame-by-frame synchronization. In the servo system of FIGURE 6, the synchronizer is designed to accept 14 kHz carrier signals modulated by 60 Hz, as well as the 60 Hz pilot tone originally taped along with the program track. Here the sync signal is fed through an amplifier to a comparator, which compares the 60 Hz sync pulse (plus or minus any deviations that may exist) to the 60 Hz line frequency. The comparator drives a potentiometer which controls the frequency of an oscillator, whose output frequency is sufficiently amplified to drive the tape transport motor. Assuming that the reproduced tape is running slower than it should, the sync signal will actually be less than 60 Hz. This will cause the comparator to turn the pot in such a direction as to increase the oscillator frequency so that the motor speed, and hence the tape speed, is made to conform with the 60 Hz line frequency. At this point, the comparator will come to rest, thereby maintaining constant tape speed until the sync signal should try to deviate again from the line frequency.

In the transferring process, the battery-driven tape machine used in the original recording can also be used to reproduce the pilot tone. Here the principal component of the resolver is a phase discriminator which compares the frequency of the taped sync pulse with a suitable reference frequency. Any phase difference is converted into a d.-c. control signal which is used to correct the speed of the d.-c. motor in the tape machine.

RECENT DEVELOPMENTS

In recent years, a number of battery-operated sprocket-driven magnetic film recorders have been developed which are rugged, compact, and sufficiently light in weight to be carried by shoulder strap. These unique machines are available for 16-mm and 35-mm operation, and since the transfer process is eliminated, they provide direct editing and projection capabilities. Synchronism with the motion picture camera is achieved by the use of a 60-Hz sync pulse derived from the camera generator, which is amplified and used to control the speed of a synchronous motor gear-coupled to the sprocket drive of the film recorder.

Several years ago, a ¼-in. magnetic tape with 16 mm film perforations on one edge, was developed for use with special sprocketed tape recorders. Unfortunately, tape stretch produced in the area of the sprocket holes created alignment problems (due to sprocket modulation), thus making this system impractical. More development work is needed to produce a tape transport capable of eliminating this stretching action, especially during starting and stopping operations, before this technique can be re-introduced.

The latest development in the synchronization of sound with motion pictures is the cassette recording system which provides all the features found in reel-to-reel tape recorders. In this method, a standard cassette with a 150 mil tape width is employed, in which a 56 mil program track is recorded on one edge of the tape width and a 56 mil sync track on the other. In order to maintain a signal-to-noise ratio and frequency response that is comparable to professional open-reel tape recorders, the tape speed is 3¾ rather than the standard 1⅞ used in other types of cassette recorders.

Acknowledgement

The author wishes to express his appreciation to Gerard J. Doherty and Christopher Lankester, of United Nations Telecommunications, for their helpful suggestions and discussions. ■

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EVR at Take-Off

EDWARD TATNALL CANBY

Electronic Video Recording is about to spring forth full grown—almost surely before this year is out. The author offers the implications that this medium in its final form will mean.

"NO WONDER there has been a slight delay," I wrote at the end of an article on EVR, Electronic Video Recording, published two long years ago in the September issue of **db**. At that time the much-heralded new TV recording system from CBS, pioneered by Dr. Peter Goldmark of lp record fame, still seemed hopelessly tied up in back-stage maneuverings though it had been formally announced more than a year earlier. The new system had impressive potential—but it had yet to be launched.

There was a slight further delay. As of the spring of 1970, almost three years after announcement, the mammoth international EVR system, ever growing larger, was still grounded. In the U. S. not a cartridge was available on the market, nor a player to convert its miniature film into TV images.

But outward appearances are deceptive. A large-scale, world-wide recording system. based on a new process cutting across conventional lines, takes a long time to put into productive order; almost everything must be designed from scratch. EVR's delays are in part a matter of semantics. When is a delay a delay? Mostly when the public relations department is over-eager. CBS has contradicted its own pronouncements on more than one occasion, if we must quibble over details. The 1967 announcement stated, probably rashly, that "EVR programming and color and black and white equipment will be demonstrated next spring, and cartridges and players will be available in the spring of 1969." Somebody probably wishes he could eat those words right now, but they are not overly important. CBS now claims to be "a year ahead" of original scheduling in its color capability. The Motorola black-and-white EVR teleplayer demonstrated to the press more than a year ago never got into production—but it was superceded this March, 1970, by a color player (monochrome compatible) at the same announced price. That indicates some sort of speed-up in schedule even if Motorola is technically delayed in its production. Color *capability*, at least, has come along fast.

The "poop" now is that take-off is, at last, not far away. Motorola's color teleplayers were pre-production models last March. The company's is geared, they say, for a capacity of 100,000 a year as of this September when the machine is scheduled for release. The necessary processing will be provided by the same date—hopefully—via the new CBS facilities in Rockleigh, New Jersey. This first teleplayer is primarily a ruggedized version aimed at educational, scientific and industrial areas, but anyone—they say—can have one for $795, come September.

Impressive quantities of software, the actual material to be cartridged for playback are lined up via a host of EVR affiliations. The sources in this country range from the New York Times all the way to Darryl F. Zanuck's 20th Century-Fox continuing library of films, which will be available for EVR recordings when they are five years old. Educational and scientific sources are proliferating too. Instructional material in everything from grade-school learning to medical technology are meat for the EVR grinder. Or will be when things get started.

EVR AROUND THE WORLD

In these last three years, too, a world-wide network of EVR companies, affiliates, and licencees has grown up, a consortium of major operatives in many countries, including our own, to provide the basic EVR series—the software, the cartridges and teleplayers, and the EVR processing. The central entity is not CBS itself but a British-based super-company called the EVR Partnership made up of CBS in America, Imperial Chemical Industries in England and CIBA in Switzerland. In each country or area, subsidiaries or affiliates provide the local EVR potential. Thus in Britain the EVR teleplayer (a "50-field" model adapted to British television and the British 50-Hz current) is manufactured by the Rank Bush Murphy division of the Rank Organization. In Germany, Bosch will produce it. In France it will be Thompson, C.S.F. Motorola has the exclusive for the American area ("60-field", and 60-Hz a.c.) through 1971. Distribution facilities have similarly been elaborated on an impressive scale. But most outsiders will be even more interested in the world-wide network of source-material affiliates; for what good is a TV cartridge without a catalogue of playable material?

CBS and the EVR Partnership have rightly foreseen that this is a crucial element for EVR's success. And so arrangements have been largely made before—not after—official launching of the system.

Edward Tatnall Canby is a well-known writer on audio and musical subjects who has appeared before in the pages of db.

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Catalogue material, available without problems and quickly, covering every possible interest and usefulness in every foreseeable area, is the *sine qua non*, the without-which-no, of every brand-new communications system. We need merely remember the immense amount of music that CBS, back in 1948, painfully transcribed from 78 and 16-inch transcription sources for the new lp record, to understand that *content* played a big part in the success of that format. To this day, the lp-disc has not lost that first-off headstart. Obviously, EVR in the vast TV field of playable consumer recordings, intends to begin operations with exactly the same advantage. One cause for delay? Very possibly, and a good one.

Pages would not suffice to list all of the EVR affiliations so far announced in this software department. A few items will give the shape of the EVR picture.

On the Swiss scene, for example (and do not underestimate little Switzerland!) a new corporation has been set up for the purpose, combining CIBA, the giant Geigy firm, and the Lausanne-based Editions Recontre, a publisher widely known in the book business and its modern relatives. This combine, called CADIA, will "create EVR materials in medical, agro-chemical, scientific, encyclopedic and purely cultural topics."

In France, the famous Librairie Hachette (*Librairie* in French means publisher) is signed up. Other arrangements have been concluded in Italy and Austria. In Germany a film and TV-producing company called Videothek Programm GmbH, specializing in learning programs in the audiovisual area, has added EVR to its other production outlets.

Of more direct concern to us, numerous U.S. companies are already involved in the EVR pre-launch operation. Equitable Life, for example, has announced training and communications programs to be processed on EVR. Also New England Mutual. Publishers include—needless to say—the CBS-owned W. B. Saunders Company. All told, there were already some thirty commitments to EVR by early 1969 and we may assume that most of them are still holding on, with new names appearing all the time. CBS has no intention, clearly, of falling between stools when the great moment comes. Manufacture, processing, distribution *and source material*, will abound, if the EVR people can manage it, right from the beginning.

Promises, promises! Of course. The whole affair is a gamble just as any other large-scale commercial venture. I am merely quoting CBS informational material here—no guarantees. But the fact is that we are on the verge of entering a new age, that of *manipulable* television, TV under the viewer's direct personal control. It is startlingly different in action from TV as we know it now, and will lead to a new television industry, brand new habits for the TV viewer, new educational methods of immense significance for the teacher, for the corporation, for libraries, filing systems, public service.

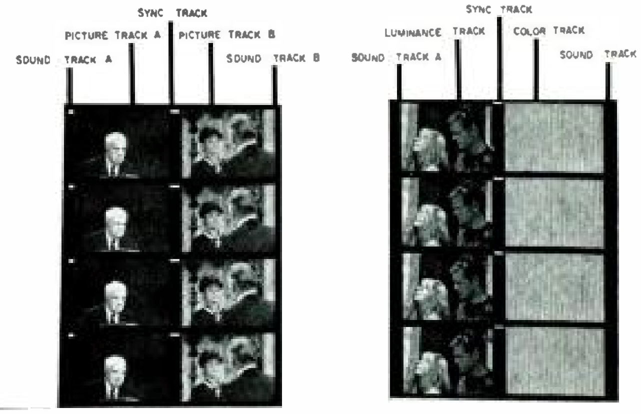

Figure 1. The EVR film. On the left a monochromatic film will hold two side-by-side pictures, each with its own sound track. On the right, color EVR contains a black-and-white luminance track (the fundamental image) and a separate chrominance track (containing the color information). A faint picture image is sometimes visible in the chrominance track. Note on both films that the sync track has a window per frame. This is not a perforation, but a printed clear bar

SOME ESSENTIALS OF OPERAT ON

EVR, yet unborn, has generated a fantastic quantity of press and other informational material, a pile of which is before me. But in all this time the fundamental technicalities of the EVR process have been kept under wraps, probably with good reason. This spring, at last, CBS issued an 18-page document with 32 additional pages of diagrams, photos and charts in which, finally, the technical gist of the entire system, and especially of the ingenious color coding process by which a black-and-white pair of micro-images on a tiny film convert to a standard television color signal of professional quality, is spelled out in technical detail. The document followed Dr. Goldmark's first complete exposition of the EVR technology at Stuttgart, Germany, this last spring. (Other presentations are now being made before various technical bodies.)

Though largely technical, the paper reinforces the sense

Figure 2. The EVR player and cartridge. The player is being manufactured by Motorola in an exclusive arrangement with CBS.

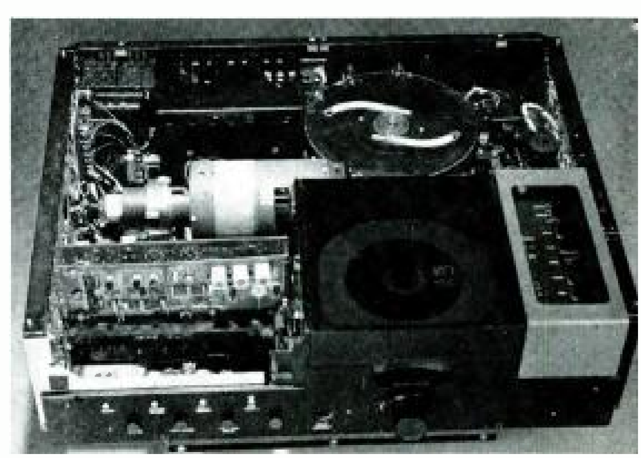

Figure 3. Inside the Motorola EVR player. Note the reel behind the cartridge that serves to take up the film during play. After play film is rewound to the cartridge.

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that EVR, unlaunched, is still a fascinating and workable medium. One reads at last just how it is done—though space precludes more than a few spicy details here. One proceeds from the basic premise, electron beam recording of the EVR film master *in vacuo* (the beam's spot is 2.5 microns in diameter, tracing four master tracks on one 40 mm electron-sensitive film in a vacuum "no higher than 10-6. torr via a double pumping system) to the final simple rf connection at any home TV receiver or professional monitor.

There is the high-speed photographic multihead wet gate printer, a British development, which operates at up to 200 feet a minute (approximately 40 in./sec.) to generate 16 25-minute color programs each time the master film loop goes through the machine—100 times normal playing speed, a color print every 18 seconds. (Tape duplicators, how about that?)

There is the teleplayer itself, in which the published EVR film is scanned without starts and stops via a double system of optics and a 3-inch special crt the film running smoothly at 6 in./sec. (U.S.). The film is scanned much as we commuters used to board a moving trolley car in the old days; you ran at the same speed as the car, then hopped onto the step. The EVR scanning moves with the film, snaps back for the next frame, the whole synchronized via optical clear windows at the centerline between the two rows of frames. No stop and go, and thus a much-reduced wear factor as compared with normal moving picture film of any sort. (Note, too, that the magnetic audio tracks do not have to be mechanically isolated for playback.)

The cartridge itself, seven inches by one half, is round, with a hole much like a 45 r.p.m. record. It is sealed and unreels automatically onto a take-up reel inside the teleplayer. The film is 8.75mm. wide, sprocketless, 90,000 frames on each of the two parallel tracks (more when thinner film is available), each single frame only 0.13 by 0.1 inches, moving at 60 frames per second (U.S.) at a continuous speed of 6 in./sec. (All these parameters are slightly different in Europe.) The player's scanning and optical-electronic operations are put down in great detail in the CBS paper. Suffice it to say that for color the luminance or monochrome values are on one track, the chrominance or color values on the other. The chrominance recording (in black and white) is spatial: one can sometimes see a faint ghost of the picture in the forest of close-packed vertical lines that make up the color coding (see Figure 1). Luminance and chrominance are combined, with the help of a pilot signal, into the standard rf that is fed to the TV receiver. For black-and-white programs, both the parallel channels are used, two discrete programs in parallel.

EMPHASIS POINTS

Note that EVR mastering will accept most types of existing primary material, moving *or* still, via 35 or 16 mm, color slides, film strips, videotape and so on—always providing that multiple printing of identical copies is the aim.

All material for EVR publication must be processed at CBS-operated centers (or equivalents in other countries), somewhat like Kodachrome in its early days. (CBS is making much of the fact that EVR material is thus protected from unauthorized duplication—pirating.) Whether the exclusivity will last is an iffy question and depends, I'd guess, on demand, though legal aspects might be involved. CBS (like Kodak) can always license out its processing.

Note again that the EVR type of consumer TV recording is *not* a replacement for the generally bulkier and more expensive (picture-for-picture) videotape. Videotape, whether in commerce or education, is primarily a means of *direct* recording and erasure, like audio tape. Duplication, even with the ingenuity of a Sony, is not its natural *forte*.

A school, for instance, can produce its own recorded TV shows via videotape equipment—many do. But to make use of EVR the single tape must be submitted to CBS for processing and duplication at a minimum of 50 copies. The parallel with the lp disc *versus* the audio tape machine is close. A disc is an audio *publication*. An EVR cartridge is published TV.

Note that EVR has been ingeniously tied to each of the various world television systems where it will be sold, to provide an optimum signal for the particular parameters involved. The curious repetition of the numbers five and six in the European and American specs has to do with this

Color EVR Player Performance Specifications

VIDEO:	Line Rate: 15,750 Hz. Field Rate: 60 Hz. RF Signal Output: 50 MV into 75 ohm line. Double sideband modified NTSC signal. Video S/N: 35 db peak white to RMS noise on the reproduced picture. Video Output: 1.5 V pp across 75 ohm unbalanced line. Black Negative, 525 line standard. Video Frequency Response: No limitation below 4 MHz. Gamma Correction: Gamma corrected for linear response on receiver.
AUDIO:	Audio Output: 1 V RMS, 600 Ohm unbalanced. Frequency Response: Normal band pass response ±3 db. Signal to noise: 45 Db. Flutter: 0.2% rms on an unweighted flutter meter.
POWER REQUIREMENTS:	Power Source: 105-135V, 60 Hz, A.C. ONLY. Power Cord: 3 conductor power cord provided with player. Power Consumption: 100 Watts.
DIMENSIONS:	21½" wide 19½" deep 8½" high 50 lbs. shipping weight
MODEL NO.:	CR 100 G

Above, the specifications given by Motorola for the EVR player they are manufacturing.

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adaptation. 5 in./sec. playing speed in Europe, 6 here; a 50 field picture in Europe, 60-field here, fifty, or sixty frames per second in the playback. This stems from the locking-in of the system to the prevailing 50-Hz current in Europe and our own 60-Hz equivalent. The 5:6 ratio is evidently basic to the two versions. Thus European and American EVR are not compatible—but neither are the TV sets. (That's one limitation: no European imports to be offered exotically alongside our plebian American product!) Foreign material, of course, can be offered here in the American EVR cartridges, and *vice versa*.

AN IMPORTANT ADDENDUM

The fine-grain silver-halide EVR cartridge film may be replaced by a less expensive diazo film, now under final testing. It is also simpler to process: exposure by ultraviolet light and development in an atmosphere of ammonia. This, perhaps, is in answer to the RCA plastic wrap threat.

At the core of the EVR system is the extraordinary miniaturization of the photo-scan process, a development paralleling the miniaturization of solid-state electronics. EVR master film will take a detail resolution of no less than 800 line-pairs *per millimeter*, with a crystal size of less than a tenth of a micron. The tiny final EVR print can be blown up, similarly, with incredible sharpness of detail. The entire EVR system, thus, is able to provide better television resolution than exists in any present TV broadcast system and probably as good as anything likely to appear in a closed-circuit configuration where EVR might be of use. It is a question whether any species of consumer magnetic videotape recording can match the EVR color specs, though, it must be said that videotape has its own different areas of usefulness, already well established.

EVR PRICES?

Obviously fluent, depending on future volume. Preliminary price schedules are out, graded according to quantity. At one end of the scale, the complete production costs (mastering and printing) for 50 color cartridges, the minimum, are now set at $36.50 for each 25 minute program, $9 for a five-minute "spot". The price for 2000 of the longer programs drops to $18.50. The cost for 2000 50-minute monochrome programs, (two programs in one cartridge,) is $23.10. If this sounds confusing as here quoted, I am merely reading off the CBS price lists. Prices quoted are *per cartridge*, including all processing. Not cheap—yet. Give them time.

AUDIO IN EVR?

Not much to say. Sound engineers are going to have to admit, ruefully, that in the coming era of TV recordings audio is but the handmaiden of the picture. EVR's audio is perfectly respectable, otherwise unremarkable. What else? At least EVR has gone magnetic, via two edge stripes, assuring a signal that will not likely be less good than its source. Stereo, too, when and if, for color EVR; or two alternative channels for instruction or entertainment in either of two languages, to choice. Actually, the pair of channels is intended for the monochrome EVR programs that will dominate the medium outside of America for the initial period. A bit of wisely designed switching takes care of the rest.

Now, with bated breath, let us await the launching. Or should I say the take-off? ■

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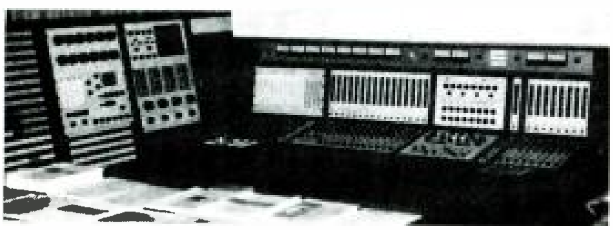
Picture Gallery— L.A. AES Convention

On this and the following three pages are to be found the new and almost new products our peripatetic camera found at the grandest AES Convention yet. Los Angeles' Hilton Hotel was host to exhibitors, givers of papers, and guests, in this 38th Convention to be held.

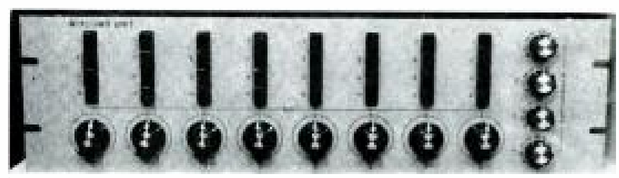
The space we have available in this issue does not permit us to show all the exhibitors. Watch future New Products and Services pages for interesting equipment that didn't make it into this roundup.

Each product is keyed with a reader service number. Simply circle the appropriate number(s) of your interest on the reader service card at the rear of this issue and you will receive further information directly from the manufacturer.

Consoles



This big console from **Electrodyne** is folded around a corner. Circle 65 on Reader Service Card.



This 8-channel mixing module goes into **Gately's** modular systems. Circle 50 on Reader Service Card.

Quad-Eight has 16 in and 8 out in its new console. Circle 51 on Reader Service Card.

Spectra-Sonics showed a new console with 20 input channels. Circle 46 on Reader Service Card.

The **Fairchild** FPC-50 has 16 inputs and 8 outputs you can carry Circle 66 on Reader Service Card.

The Altec console that appears on our cover. Light-panel volume indicators are used. Circle 99 on Reader Service Card.

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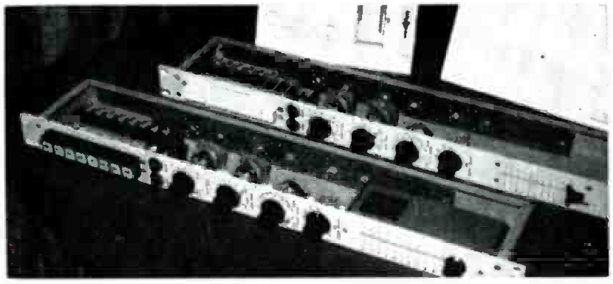
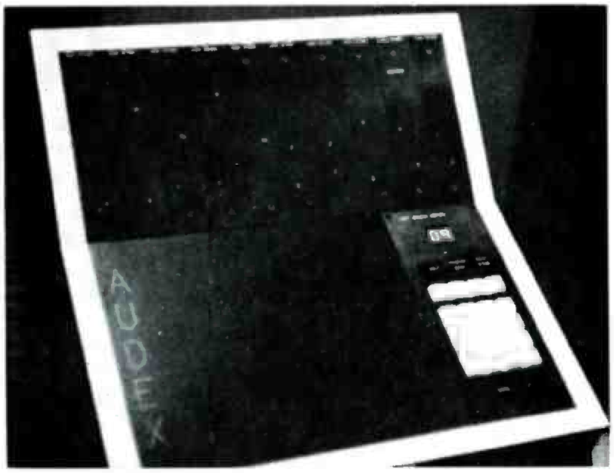
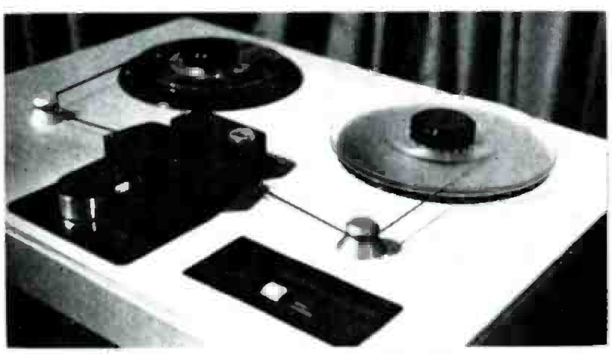


Opamp uses its special circuitry in a mic input module kit. Circle 64 on Reader Service Card.



The **Audio Designs** Audex control system in a separate package. Circle 72 on Reader Service Card.

Tape

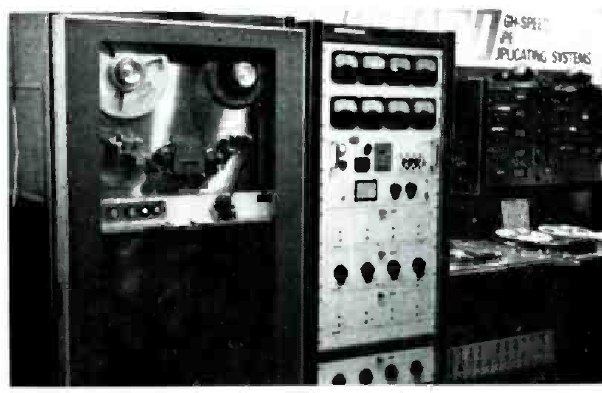


The **3M** loop drive system is applied in this cassette duplicator slave. Circle 55 on Reader Service Card.

Teac offers the A 7030, stereo in a compact studio console. Circle 63 on Reader Service Card.

MRS, with electronic speed control on its machines, now has a cassette duplicator slave. Circle 59 on Reader Service Card.

Langevin has 15 inputs on this new console. Circle 60 on Reader Service Card.



Otari of Japan showed a complete line of tape duplicating equipment. Circle 71 on Reader Service Card.

The **GRT** 500 counts dropouts and evaluates audio tape. Circle 62 on Reader Service Card.

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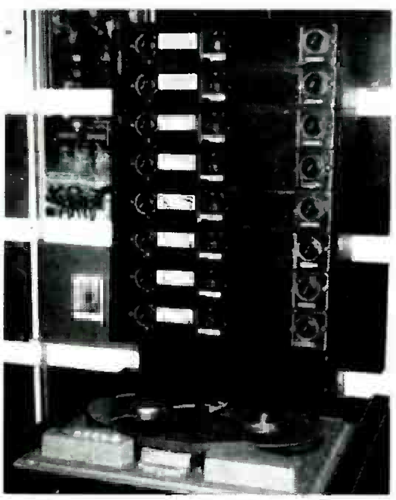
The **Norelco** PRO-51, newest professional recorder in their line. Circle 74 on Reader Service Card.

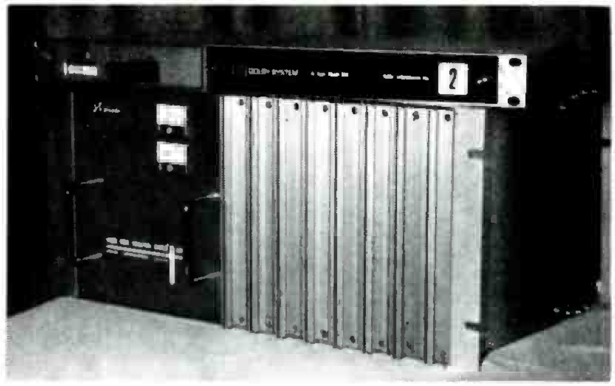
Sony-Superscope's servo-controlled TC-850 stereo tape recorder. Circle 57 on Reader Service Card.



This is the vanguard model of a new generation of **Ampex** studio tape recorders. Circle 45 on Reader Service Card.

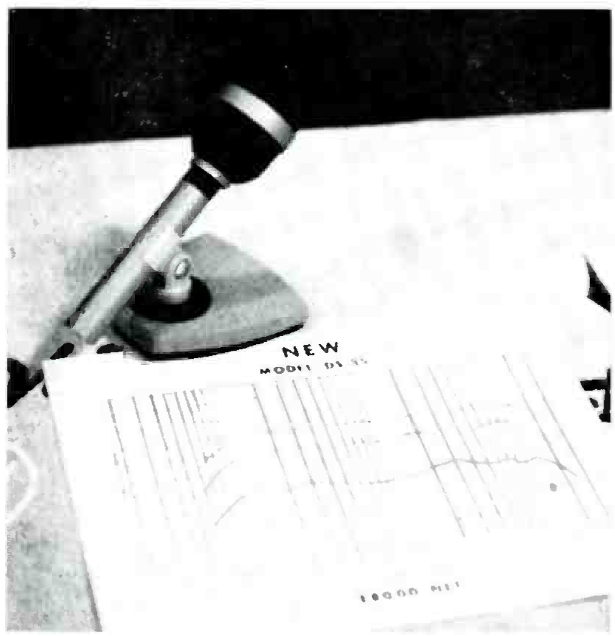
Other Equipment

Control peaks adjustably with **UREI's** 2-channel leveling amplifier. Circle 52 on Reader Service Card.



Dolby's new model 360. A thin mono stretcher over the thicker two-channel A301. Circle 43 on Reader Service Card.

This is an all-electronic reverb—first from **Melcor.** Circle 47 on Reader Service Card.



Response curves were shown of the **Electro-Voice** DS-35 dynamic. Circle 73 on Reader Service Card.

Two turntables and a small console make up the **QRK**-5 system Circle 68 on Reader Service Card.

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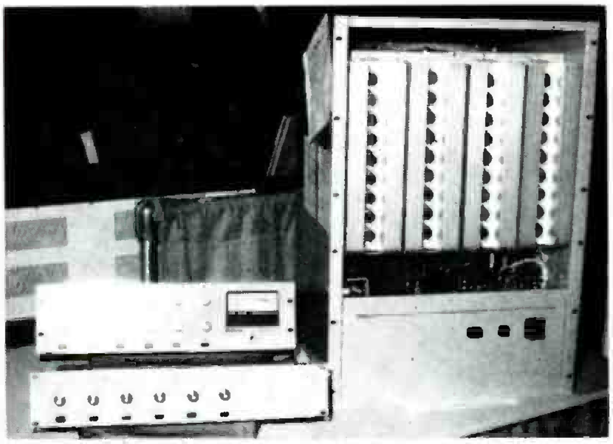
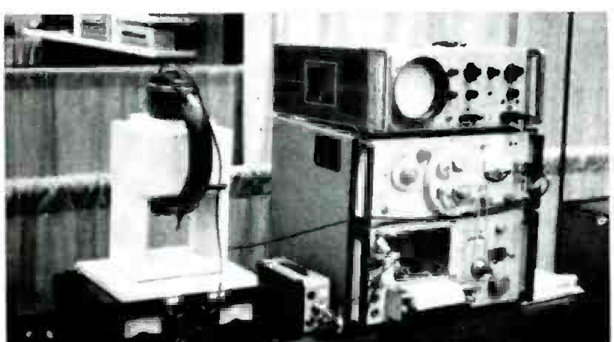


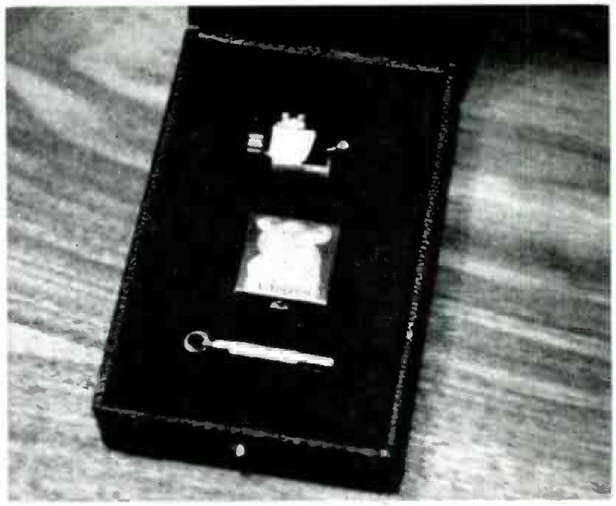
DuKane Medallion systems—high power for sound reinforcement. Circle 40 on Reader Service Card.

Rek-O-Kut variable-speed CVS-12 is again in production. Circle 77 on Reader Service Card.

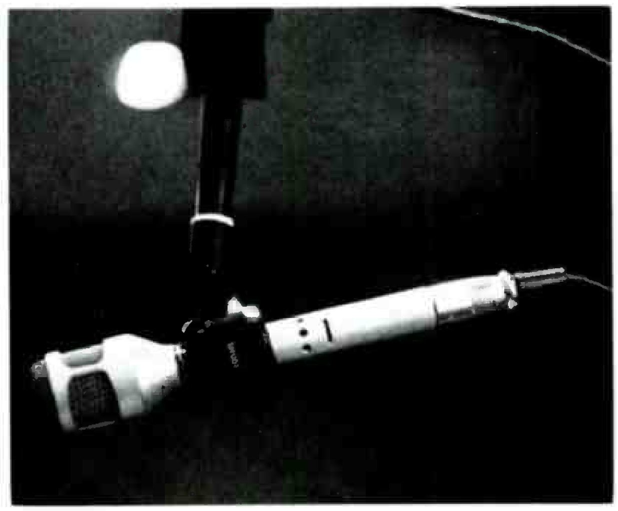
Gotham Audio is distributing this new British-made tape cartridge program effects generator. Circle 44 on Reader Service Card.



A checking setup such as this evaluates **Koss** ESP electrostatic earphones. Circle 67 on Reader Service Card.



Stanton 681 series cartridges include a little mounting screwdriver. Circle 54 on Reader Service Card.



Shure's new SM-53 dynamic mic for the professional. Circle 53 on Reader Service Card.

The show's biggest speaker dwarfs **JBL's** not-so-short Craig Stevenson. Circle 79 on Reader Service Card. ■

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People, Places, Happenings

● Readers interested in work being done in the field of compressed speech may be interested in the **CRCR Newsletter.** This is the news bulletin of the **Center for Rate Controlled Recordings** which details various research projects and investigations in this exciting field. The bulletins are available at no charge from the Center at the **University of Louisville, Louisville, Kentucky 40208.**

● The third **Conference on Magnetic Recording** as sponsored by the **Hungarian Optical, Acoustical, and Filmtechnical Society** will be held September 8-12 in Budapest, Hungary. The Conference will cover the theoretical and practical problems of magnetic recording on moving magnetic media (of all kinds). The preferred language of the Conference is English, but papers in Russian, German, and Hungarian will also be given. Abstracts of the papers will be published in all these languages. Registration fees for non members of HOAFS are $20 ($10 for members). Contract the HOAFS in **Budapest, V., Szabadsag ter 17. Hungary** for details.

● **General Radio,** in cooperation with **Bolt Beranek and Newman** will conduct a three-day seminar on practical techniques of product-noise reduction. The seminar will be held in Chicago on August 3-5 and will be lead by **William Ihde** of **S V Engineering,** acoustical consultant to General Radio, and **George Kamperman,** manager BBN-Chicago. Tuition for the entire three days is $200; registrants will be responsible for meals, lodging, and travel arrangements. General Radio will make motel reservations for those who desire this. For additional information contact **Tom Fricke, General Radio Company, 9440 West Foster Ave., Chicago, Illinois, (312)992-0800.**

● **Sparta Electronic Corporation** of Sacramento, California has acquired the **Bauer Broadcast Products Division** of **Granger Associates.** According to Sparta president **William J. Overhauser** the Bauer operation is in the process of moving to the recently expanded Sparta facility in Sacramento. This gives the audio operation of Sparta full entry into the transmitter market via the ten-year old Bauer company.

● The addition of a 13,000 square-foot facility has doubled the warehouse capacity of **Elpa Marketing Industries** of New Hyde Park, N. Y. In making the announcement, **E. L. Childs** Elpa's president stated "the growing demand for Elpa-endorsed products has necessitated this additional facility as part of our over-all growth program." Elpa markets Thorens and PE record playing equipment, Ferrograph tape equipment, Ortofon cartridges and tonearms, Watts record-care products, and Editall splicing blocks.

● The **Institute of High Fidelity** has elected **Walter Goodman** as president of the trade organization. He is president of **Harman-Kardon, Inc.** With more than 20 years of experience in the audio industry, he also brings more than ten years of trade association to his new position.

● What is billed as the world's most powerful and intelligible sound system is being unveiled this month at the **Ontario Motor Speedway,** 40 miles east of Los Angeles, California. More than four hundred Altec-Lansing multicellular horn speaker systems and eighty-four special Altec power amplifiers were employed to generate an audio output of more than 30,000 watts. (By comparison, all of Cape Kennedy has 20,000 watts.) Other staggering figures include the fact that more than 600 *miles* of audio and communications cable were used. The speaker lines operate at 210 volts to reduce line transmission losses in the system. Ontario will be auto racing's most elaborate facility with seating for 140,000, a 2.5 mile oval track, a 3.2 mile road race circuit and a quarter-mile drag strip—all on a 700-acre site.

● Formation of a new company, **Otari of America, Ltd.,** was announced recently by **Jack A. Sain,** president. The company has been established to market and service Otari high-speed professional tape duplicating systems. Offices have been established at 8295 S. La Cienega Blvd., Inglewood, California. The manufacturing company, **Otari Electric of Japan** produces virtually every link in the tape duplicating chain, from their own ferrite heads to complete mastering equipment, slaves, q-c monitors, tape winders, and automatic cartridge run-in machines. The new American company is a joint venture with Otari Electric and U. S. investors.

Ampex—Cov. III, Circle 11 on Reader Service Card

GRT—Cov. IV, Circle 12 on Reader Service Card

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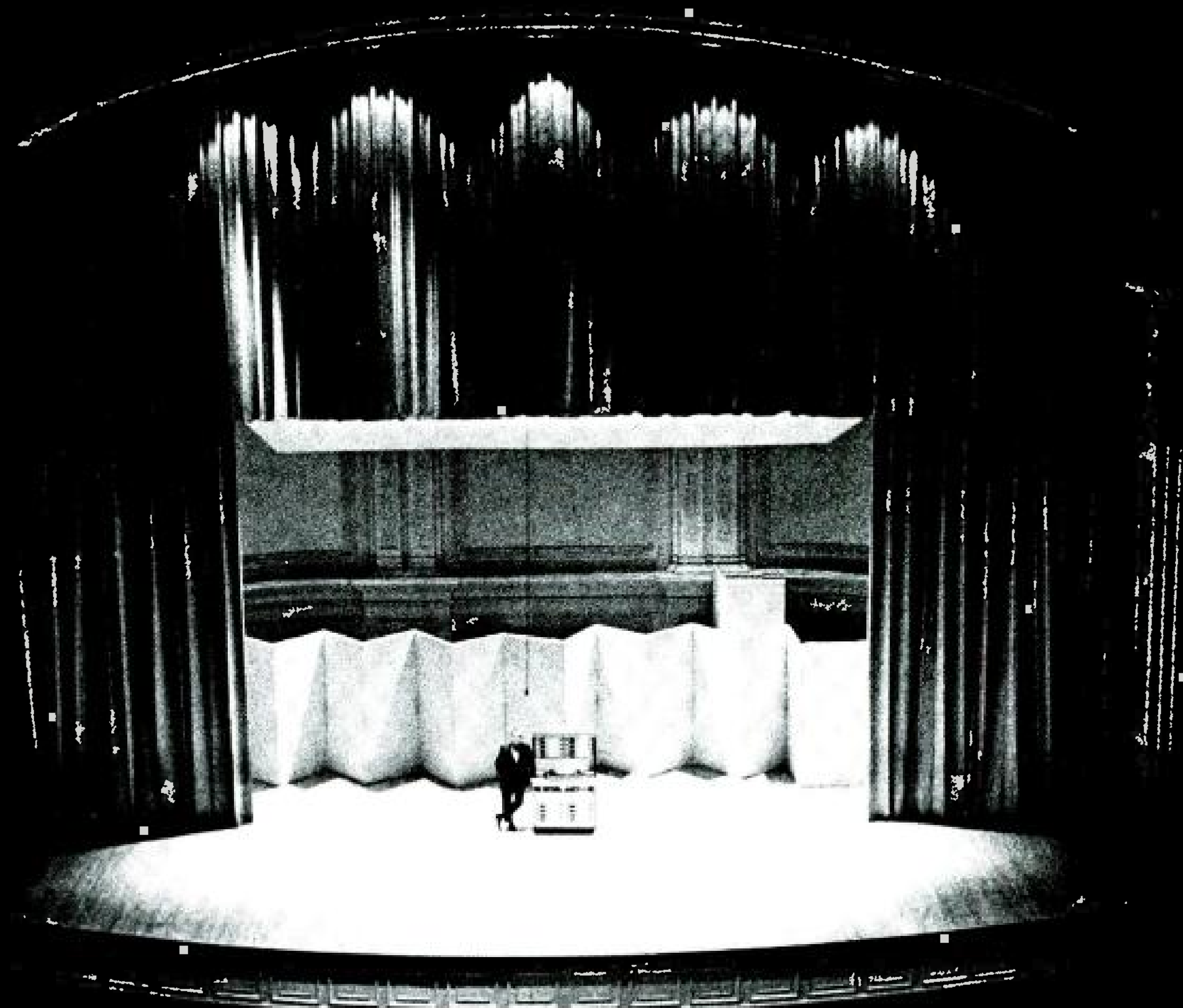

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