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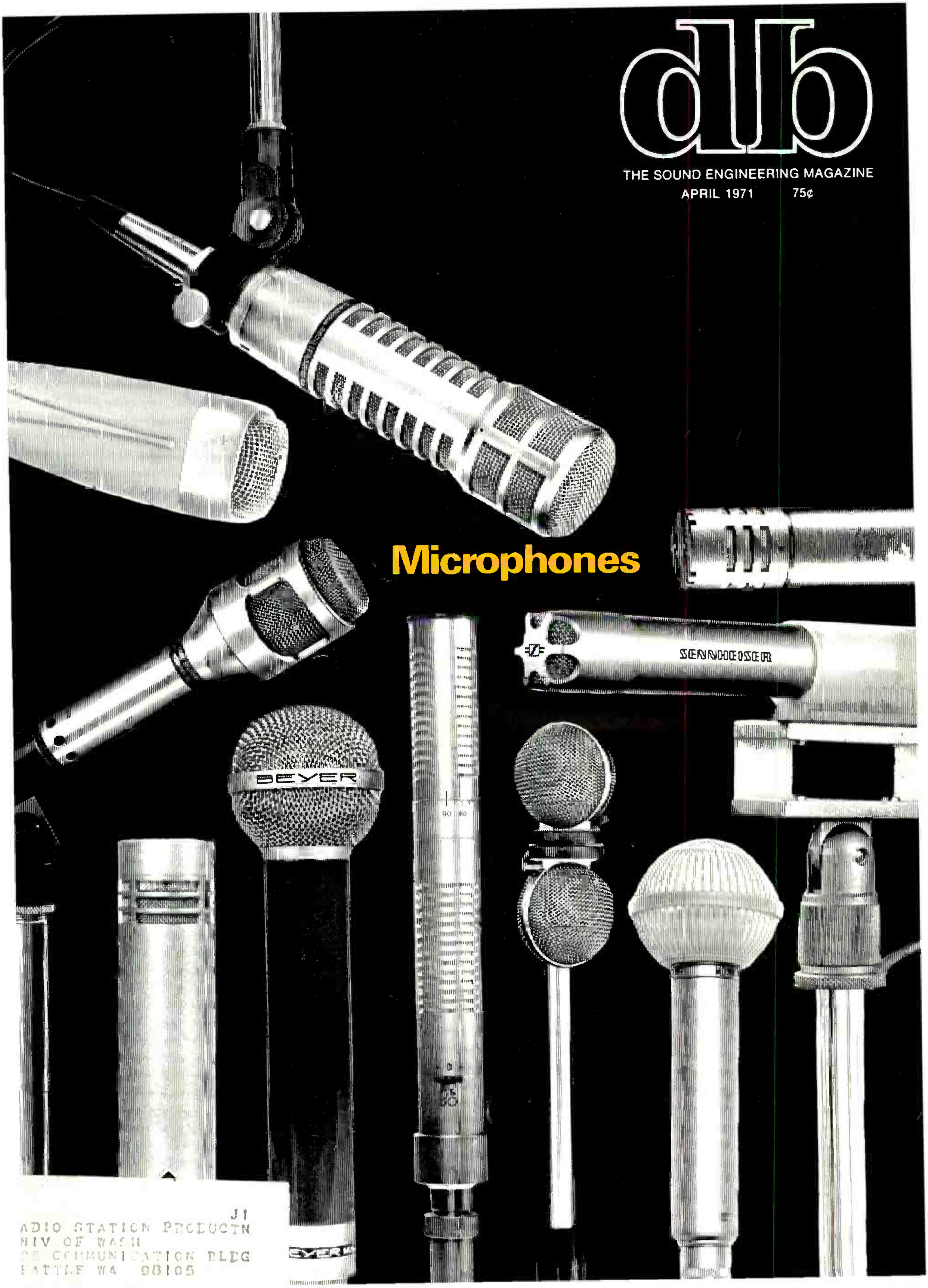
THE SOUND ENGINEERING MAGAZINE

APRIL 1971 75¢

Microphones



COMING NEXT MONTH

• Noted acoustic consultant Robert Hansen has written a down-to-earth article on the practical steps one must take in planning and actually building the studio. Every studio designer or would-be one will want to refer to it throughout his job.

Sound Insulation Requirements for Rock Studios is the title of Michael Rettinger's latest contribution. He details how it is possible to keep rock in and rumble out of the recording studio.

Part 2 of *Acoustics for Audio Men* by Melvin Sprinkle continues the basics begun in the March issue. This three-parter will prove to be a veritable textbook on the subject.

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

ABOUT THE COVER

• Our cover this month requires little in the way of explanation. It is composed of many familiar (and some unfamiliar) brands of microphone. Try your hand at identifying them. There are no prizes if you do.

advertisers index

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THE SOUND ENGINEERING MAGAZINE

APRIL 1971 VOLUME 5, NUMBER 4

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

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George Alexandrovich

THE AUDIO ENGINEER'S HANDBOOK

FLAT FREQUENCY RESPONSE—WHEN, WHY and WHY NOT

• Discussions about frequency response are as old as audio technology itself. Not so long ago scores of audio engineers and circuit designers were burning midnight oil trying to achieve better amplifier circuits, and correct frequency response of transducers and storage media. They were fighting a long battle against rolling off response at both ends of the audio spectrum with dips and peaks between. The advent of solid-state technology, supplemented by the efforts sponsored by computer and space system manufacturers, considerably changed the picture. We can purchase an amplifier today with frequency response flat from d.c. to the megahertz range. Yet, a lot remains to be done. This is not so much how flat we can make response, but how to control it in order to achieve clean, pleasant, true-to-life reproduction of a recording or performance.

Flat frequency response of the audio chain, or a part of it, is important in certain instances. These may be remixing and mixdown operations, re-recording, broadcasting, or audio distribution functions. Audio signals passing through many stages of amplification and control, have to retain their balance in order for the output signals to resemble the original information. The term *flat response* actually refers more to over-all response, than to the performance of each part of the system. You may consider an amplifier which shows 0.5 dB rolloff at 15 kHz flat; yet, if you have ten such amplifiers in a chain, the final result may be 5 dB rolloff at 15 kHz. On the other hand, if you have several amplifiers, half of which have a dip at a certain frequency, and the other half have a peak equal in amplitude but opposite in sign, then such an amplifier chain can be considered being flat. It does not mean that this is how we should construct our systems, but serves as an illustration to the following discussion.

In my audio experience over a period of more than twenty years, I have been acquainted with many recording-industry purists who believe that every step in sound recording should be identified with absolutely flat response—be it transducer, amplifier, or studio. They do not recognize any form of sound compression, limiting, equalization, or any other forms of tampering with signals. They also believe in one microphone session, and most of the time they would not record anything else but classical music. At times, the results of their efforts may be satisfactory if they happen to get a good-sounding studio and the right equipment. Most of the time their recordings are noisy and flat sounding, and not acceptable by today's standards. The trouble is that the sound you hear, even in the best hall, does not sell unless it is processed and enhanced just in the way color photography emphasizes certain colors. Let us follow the path of the audio signal from the musician to the speaker in your room.

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phone in front of every instrument, the ears of the listeners are "extended" close to each instrument. The output of each mic may be recorded on a separate tape track. In order to enhance or emphasize the sound of specific instruments, recording engineers may use an equalizer on particular channels to bring out the range of frequencies wanted to be heard from this instrument, and subdue the sounds picked up from adjacent instruments. The result is that the frequency response in this mic channel is twisted all out of shape. If this is the drum mic, it is possible to make the drum beat heard clearly while the squeaking of the foot pedal or the hissing of the air conditioning is eliminated. Before we know it, a signal is being fed into the tape recorder. The first thing that happens is that we attenuate low frequencies, boost highs, and record it that way. Once the session is over, a multi-track recording has to be remixed into two or a single channel. In playing back individual channels post-emphasis is applied—we equalize the signal by boosting the low frequencies and attenuating the highs. Then we mix the signal with other signals and re-record the mix on the new track, again applying pre-equalization. If this recording is meant for tape duplication the process is repeated again in duplication, then again in the home playback setup. One can not help wondering how after all those re-recording steps, recorded tapes and discs sound so good.

In this long list of manipulation with signals, one can count on a possible additional equalization of each channel, inclusion of artificial reverberation, compression, and limiting.

Finally, this recording is being played back in the home or in some other room. In order to compensate for the deficiencies of the speaker system and room acoustics, we introduce environmental equalization. This type of equalization can be quite severe—at times, filters boosting or filtering certain frequencies may have peaks exceeding 10 dB. After this is all done, you can hardly distinguish the obtained sound from the original copy.

What it all amounts to, is that when we refer to frequency response, we have in mind the precision with which the sound is processed. *Flat* refers to the relationship of input with respect to output. You may convert audio signals to digital form, store it in a computer memory, then read it out, and reconvert it back to analog information—and still have flat response. It is not *how* you process the sound; it is how it *compares* to the original.

Until now, we have been concerned with faithful reproduction of sound and general frequency response. But how far out in frequency do we have to go on both sides of the audio spectrum in order to achieve true fidelity? Can we hear as high as 20 kHz or as low as 20 Hz.

Lately, we all have heard much talk about different kinds of pollution. Sound is one of them. We hear speculation that loud sounds can effect our health, our minds, cause heart attacks, and so on. Well, it seems that there is little we can do in controlling the level of the hi-fi systems in the homes of the consumers.

Our technology has gone quite far unchecked. It is no secret that direct-coupled amplifiers, in combination with certain speakers, can produce high intensity sound waves in both subsonic and supersonic regions. Let us stop and think about what we have there. Think of the walls of Jericho, or new methods of detaching the retina of the eye with ultrasound. Maybe you haven't seen how ceramic magnets are cut apart with dull chisels driven at ultrasonic frequencies. Or have you ever seen the test of any mechanical structure on a vibration platform, and what happens when some parts begin to resonate? Some twenty-five years ago, I saw an experiment performed where tobacco smoke was blown into the path of ultrasonic beam—it condensed and disappeared.

Many uses of sound are not yet known to us, nor are the after effects on human organs. We know that some plants and flowers, when exposed to sounds of different frequencies, change their growth rates. Until we uncover the secrets of the world of sound, can we try to limit a generation of frequencies which seem only to be important as a sales pitch in consumer products. I think that going beyond a 20 Hz-20 kHz range is more than any one can appreciate. It only makes dogs restless.

I would like to see a built-in rolloff at these frequencies in every system. Signal harmonics in the 20 kHz region can already be transmitted over the air like radio waves. If we suspect that some sort of brain waves can influence

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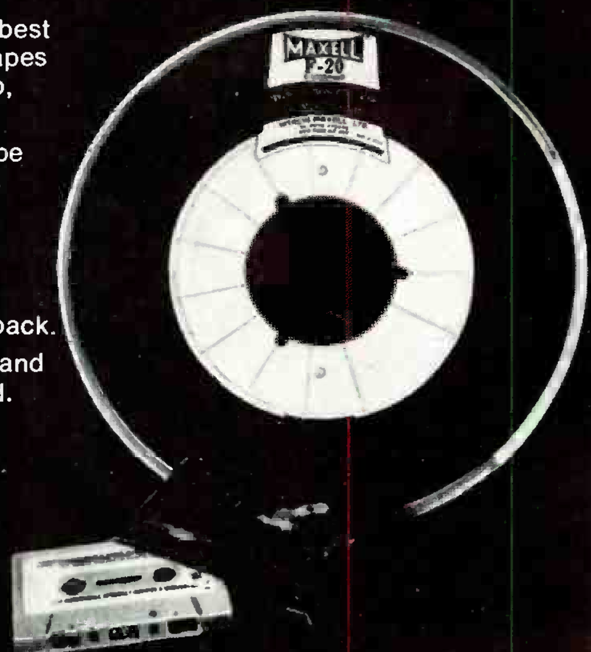

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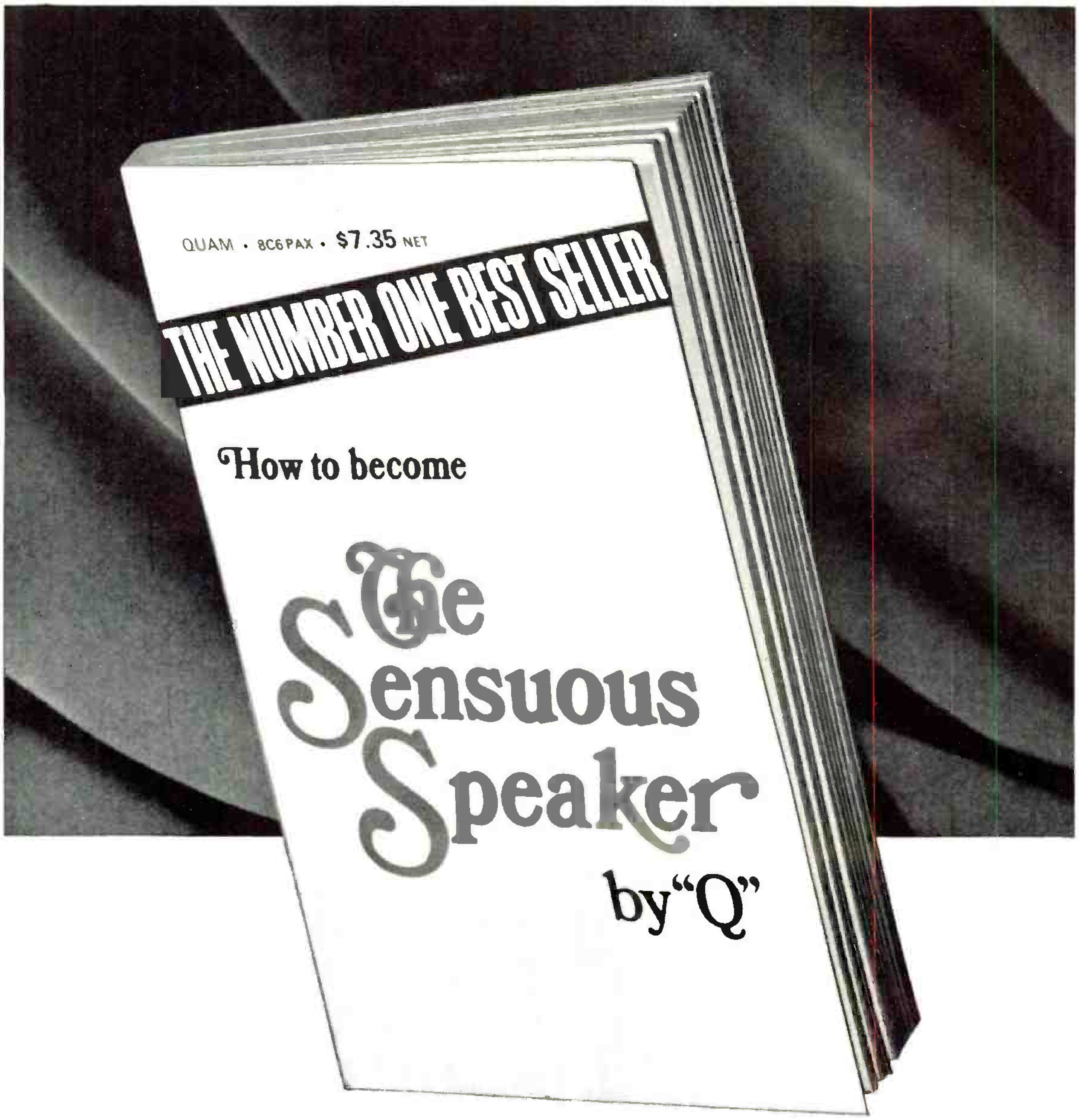
our behavior in extrasensory perception experiments, then let us be very careful with unknown signal sources many times more powerful than energy sources in the human brain. Only recently it was announced that 10¢ diodes under certain conditions can generate frequencies in gHz range.

Many audio engineers prefer using transformers in their systems for isolation purposes, but what they really accomplish is restriction of frequency bandpass characteristics. This, in turn, helps subdue parasitic oscillations, motorboating, and cross-talk. I consider it an easy way out. A more elegant solution to this problem would be no need for d.c. isolation, but where bandwidth of the system is sharply restricted to certain limits. Actually, frequency response and bandwidth are two related terms. Sharp rolloff of the frequency response is the limit of the bandwidth.

Here is another observation in regard to flat response. Our ear, by no means, hears all frequencies with equal efficiency. The Fletcher-Munson curves tells us quite explicitly how imperfect our ear is, and how it reacts at different sound levels. We all know that recordings are processed while being monitored at excruciatingly high levels in mixing rooms. The balance of the sounds for such recordings are valid only for these levels. If you take the same recording and play it back in your living room, at moderate or low levels, your ear becomes insensitive to the extremes of the audio spectrum.

In order to get the balance obtained in the recording studio higher, you should turn your gain control to the ear-splitting levels, boost your low and high frequencies through equalization, or be content with the sound you get. Maybe today's youth are going deaf because they try to recreate the same balance as the recording engineer, heard by raising the reproduced levels well above 100 decibles.

There are instances when flat frequency response up to 100-200 kHz are needed—as during the duplication of recorded tapes at tape speeds that are 8-16 times faster than normal speed, or when cutting discs at half speed (extended low-frequency response of the end product). However, when we generate frequencies that are in turn reproduced by the speakers so that they resonate with our chest cavity and drive us slowly insane, while loosening our tooth fillings, I begin to wonder if we were not better off with good old 78's. ▪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NORMAN H. CROWHURST

THEORY AND PRACTICE

• Last month we discussed the simulation of hybrid coils without inductors (except for the dummy line, if that needs inductance as an element, or element, but no transformers needed for coupling purposes). This left us with the need for amplifiers using both inputs and outputs up in the air.

The requirement is for an output circuit that delivers signal to a line load, whether or not some signal is fed from the line toward the amplifier. The method we said we would use is that of delivering a current into a 500-ohm load, from a circuit where the voltage can float at either or both terminals.

This is illustrated at *Figure 1*. In quiescent condition, transistors Q2, Q3, Q4, and Q5 all pass precisely 12.5 milliamps. Under that condition, the 12.5 milliamps that passes through Q2 also passes through Q3, and the 12.5 milliamps that passes through Q4 also passes through Q5. This means no current flows in either direction through the 500-ohm output load.

When signal is fed in through Q1, assuming it to be momentarily positive in polarity, of 1 volt magnitude, the 3 milliamp steady current through Q1 (controlled by the fact that its emitter voltage is 3 volts above supply negative, and the emitter resistor is 1 k rises to 4 milliamps.

This increases the voltage from the base to supply positive and negative, at transistors Q2 and Q5 from 3 volts to 4 volts, raising the current from 12.5 milliamps to 16.7 milliamps. As the current in Q4 and Q3 remains at 12.5 milliamps, a current of 4.2 milliamps must pass through the 500-ohm load, yielding an output of 2.1 volts, positive at the collector of Q2, negative at the collector of Q5.

The constant current in Q3, Q4 is maintained by the use of 3-volt zener diodes and the 27 k resistor. As the steady current in Q3, Q4 is 12.5 milliamps, somewhat less than 1 milliamp will assure adequate base current for these transistors, with a sufficient amount to polarize the zener diodes to their working voltage. The voltage between these bases is twice 15-3 = 24 volts, so 27 k will serve.

To achieve a quiescent condition, the bases of Q2, Q5 must also be at precisely 3 volts from supply positive and negative respectively. Using 1 k resistors in the collector and emitter of Q1, this requires 3 milliamps as this transistor's operating current. With a 1 k emitter resistor and an assumed current gain of 60, the d.c. base input resistence will be 60 k. In parallel with the 12 k bottom resistor, this makes 10 k which must have 3 volts developed across it. The upper resistor must then develop 27 volts, requiring 9 times 10 k, for which a chosen 91 k resistor will serve.

To balance the circuit perfectly, the 240-ohm resistors must be close tolerance, and/or the 1 k resistors must be chosen so the quiescent condition exactly balances the currents in Q2 and Q3, and in Q4 and Q5.

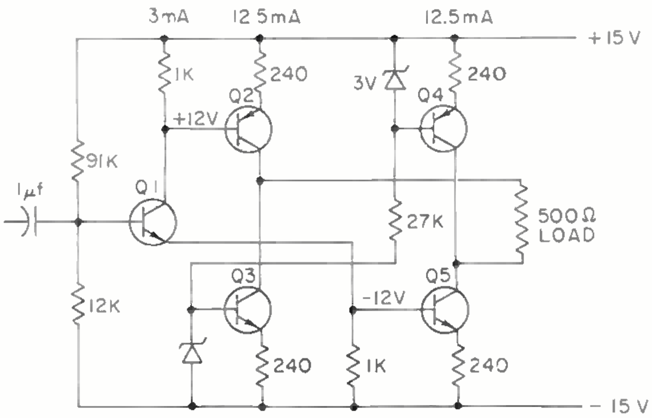


Figure 1. An output circuit that provides a "floating" signal across a 500-ohm load, just the same as a transformer can.

The input impedance is about 9 k (10 k in parallel with 91 k) so a 1 mFd input capacitor will yield a cut-off at 20 Hz.

This circuit has no voltage gain—to be precise, a little more than 2:1, as calculated above. When maximum current or zero current flows in Q2, Q5, the voltage drop across these transistors is 6 volts or zero. The drop across the 500-ohm load reaches 6 volts either way, which allows a substantial margin to allow the 500-ohm resistor (load) to float away from ground potential, and still allow adequate collector voltage to reach Q2 and Q5, as well as Q3 and Q4.

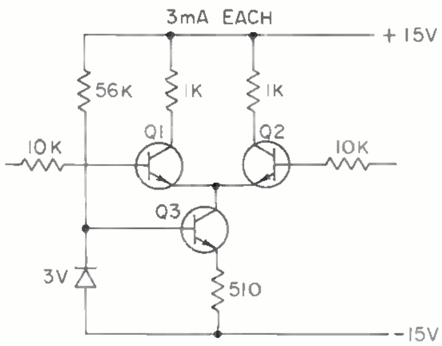
As current in all these transistors is controlled extremely tightly by the base voltage and their emitter resistors, collector voltage has virtually no effect on the signal delivered at the combined collector circuit, which is determined by the fluctuating current in the 500-ohm load.

Now to turn to the floating input, which is a little simpler to achieve, and the circuit is shown at *Figure 2*. The circuit is rendered "floating" by transistor Q3, which is held at constant current by the zener diode and the 510-ohm emitter resistor, which yields a controlled current of 6 milliamps (actually that is based on a resistor value of 500 ohms).

Collector voltage of Q3 can float, just so long as the total collector current adjusts itself to 6 milliamps. This means that, if the voltages applied to the 10 k input resistors connected to Q1 and Q2 bases are identical, their emitters will be just sufficiently negative of that voltage to bias each of them to a collector current of 3 milliamps.

If these transistors have a current gain of 60, their base current in quiescent will be about 50 microamps, requiring 0.5 volt drop in the 10 k

Figure 2. An input circuit that can accept a floating input signal, also as well as a transformer can handle it.



resistors. A signal of 1 volt balanced will drive one transistor to 6 milliamps and the other to zero.

With 1 k collector resistors, which provides a push-pull output from this input stage, if desired, each collector voltage is 3 volts below the 15-volt supply positive. Full signal produces 3 volts peak from each, or 6 volts peak-to-peak. So this input stage has a gain of 6. Further gain than the 12 provided by input and output stages can be developed by conventional intermediate stages.

Apart from the 1 volt signal, from one terminal to the other, required to produce a differential output from this input stage, the pair of input terminals can float from almost 10 volts negative of ground to some 9 volts positive of ground, while still giving all the transistors an operable collector voltage.

As this common voltage drives Q1, Q2 emitters and bases positive or negative, the bases maintain the same quiescent current, which means the 0.5 volt *drop* in the 10 k resistors remains unchanged, whatever the *actual* voltage is. When the input terminals get to −12 volts, the collector voltage across Q3 vanishes, while pushing it to +9 volts, this voltage rises to 21 volts.

The voltage at the collectors of Q1, Q2, relative to their emitters and bases, also varies. At quiescent, each collector is 3 volts negative from supply plus, or +12 volts. Maximum output swing is ±3 volts from this, or from +9 volts to +15 volts.

To achieve balance in the output, Q1 and Q2 should be matched, otherwise equal base current, produced by equal voltage drop in the two 10 k resistors, will not produce equal collector currents. If the intermediate amplifier is only single-ended, which can be just as good as a balanced amplifier, and the input shown for *Figure 1* is single-ended, one of the 1 k collector resistors may be omitted, and the output taken from the other. In this event, precise matching of Q1 and Q2 is not so vital to balance.

On the other hand, the output circuit could be rendered balanced by coupling push-pull signals directly to the bases of Q2, Q5. Then it would be necessary to control the quiescent voltage of both sides so base-to-supply voltage of these transistors matched that of transistors Q4 and Q3.

While some form of direct coupling is not impossible, especially as the d.c.

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value of 3 volts is common throughout the circuit, it is not too feasible, because the quiescent condition should be set up and maintained quite precisely, for both input and output stages, as well as any in between. This is easier to achieve by using a.c. coupling with separate values to control quiescent at input and output.

The constant-current circuits set up by the transistors with zener diodes exhibit a quite high collector resistance at that constant current. The zener voltage will not change more than a small fraction of a volt, and the emitter voltage of the transistor to which the zener controls the base voltage will follow it, again within a small fraction of a volt.

Thus the emitter resistor controls the emitter current very closely indeed. The only possible cause of collector current change is due to change of current gain with collector voltage, which is small with most transistors. And anyway, this change is compensated for by the fact that the zener will change its current so the base current adapts.

Put more directly, this change can only change collector current by the amount of change in the base current, because the emitter current is held constant. Thus, if current gain is 60, the collector current change must be well within 1/60th of its value, almost certainly well within 1/100th.

Thus the floating effect provided by each of these circuits is extremely good. A really high-quality transformer may do better at mid-frequency, if the tappings are accurate to a small fraction of 1 per cent (which this type of transformer commonly provides). But at frequency extremes, where winding capacitances and magnetizing currents of a transformer invalidate its precision somewhat, the transistorized version can actually improve on the older transformer-ized version.

As an old-time transformer-designer, who loved the challenge of this kind of design, this is a little bit of a blow to my ego—but at the same time, a bit of a relief, too. ■

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John M. Woram

THE SYNC TRACK

• Since this April issue of **db** is featuring various aspects of the microphone, it is more than appropriate to discuss microphones in this column.

By an odd coincidence, it was just two years ago this month that a feature story by the well-known R. D. Worther was to have been published, revealing certain innovations in surveillance equipment, including an ultra-miniature microphone and transmitter concealed within—of all things—a common 6 penny nail. I say, "was to have been published", for as readers will recall, the page plates were confiscated at the last minute by the authorities, and Mr. Worther was never seen again.

At that time, there was considerable speculation as to Mr. Worther's fate. One Federal bureau claimed his body had been found by pro-western kulaks near an obscure railway junction on the Peking branch of the Trans-Siberian Express. More recently, some American tourists vacationing in the Tirenean Alps have reported being approached by a person reportedly resembling Mr. Worther. Unfortunately, the man was spirited away by the local police, and again we are plunged in mystery.

And so, although we continue to speculate on the whereabouts of the enigmatic Mr. Worther, we have been more fortunate in recovering the missing page plates. Some time ago, they turned up in a locker at a small mid-western bus depot. Although we cannot divulge how they were discovered—nor have we in fact seen more than a copy of them—our informant's credentials are impeccable, and he has told us enough to convince the editors of his absolute reliability.

Since this is a technical journal, and political reportage is really beyond our domain, we shall confine the rest of this column to the relevant aspects of this most unusual case; specifically, a description of the surveillance microphone.

The development of the ultra-miniature microphone was not without a large share of problems. It hardly need be mentioned that a microphone concealed within a 6 penny nail would have to be wireless. Obviously enough, any wire connected to a nail would be cause for a certain amount of suspicion by even the most naive. After a bit of experimentation, a unique d.c. carrier system was perfected. Once the "nail" was hammered into the appropriate wall, the transmitter would be powered by a unique application of nature's laws of molecular dispersion. By chemical reaction, the nail would derive the requisite power from the lime content in the plaster wall. Unfortunately, the chemical reaction eventually discolors the plaster surrounding the nail, thereby revealing its presence, so for longer range applications, a wall that has been covered by wallpaper or panelling must be chosen.

Obviously, there is no particular advantage to an omnidirectional polar pattern, since the microphone is to be hammered into the wall. Generally, a cardioid pattern is most suitable, since proximity effects need not be considered important. But the nature of surveillance work usually means that a good portion of the program being monitored will be in some foreign tongue. Since the untrained ear often has difficulty differentiating between several alien speakers, it is often a good idea to employ two nails for a stereo pickup. That way, the voices can at least be localized, which should help in minimizing confusion. It should of course be remembered that the distance from either nail to the speaker(s) should be about one quarter the distance between the two nails, to prevent phase shift distortion.

Considerable time and money was spent developing a mic diaphragm that was rugged enough to be hammered into a wall, yet sensitive enough to provide wide range pickup characteristics.

Shortly after the first batch of microphones was completed, a near disaster almost cancelled the entire project. The nail-mics were sent to a reliable agent in the newly emergent nation of Kallabriya, where a neutral nation was constructing an embassy in the capitol city of Wredjiyo. Unfortunately, the surveillance nails were mixed with the regular construction supplies, and the entire supply was hammered into the embassy walls. To compound the error, the receiver was concealed in an ice-cream vendor's cart in the street outside the embassy. The vendor was of course another trusted agent, and the hearing aid he wore was in reality a speaker connected to the concealed receiver.

When the poor man switched on the receiver, the massive surge current representing hundreds of nails connected, as it were, in parallel, launched the cart swiftly down the street until it collided with the limousine of the just-arrived Russian ambassador. The agent was thrown clear of the cart and landed almost in the lap of the diplomat. Since the ambassador had spent considerable time in Washington as a minor official, he saw nothing unusual in this peculiar demonstration, and in fact ordered ice cream cones for all the members of his entourage. No doubt the well-known Russian weakness for ice cream played an important part in preventing what otherwise might have become an unpleasant international incident.

Recent reports from sources within the embassy reveal that the walls are now beginning to deteriorate due to the massive chemical reaction from so many nails, and that embassy officials are beginning to suspect something is amiss.

On a more positive note, the issuance of the next batch of nails was more carefully administered, and the devices have since been judiciously hammered into key walls throughout the world.

Our fears that the unique device might fall into the wrong hands were quickly dispelled. We had wondered what would happen if some nails were secreted in the Capitol's various caucus rooms and the information leaked to the enemy. Our informant correctly reminded us that it has been some years since anything worth repeating has been heard on Capitol Hill, and although some nails had indeed been

NEW PRO-4AA

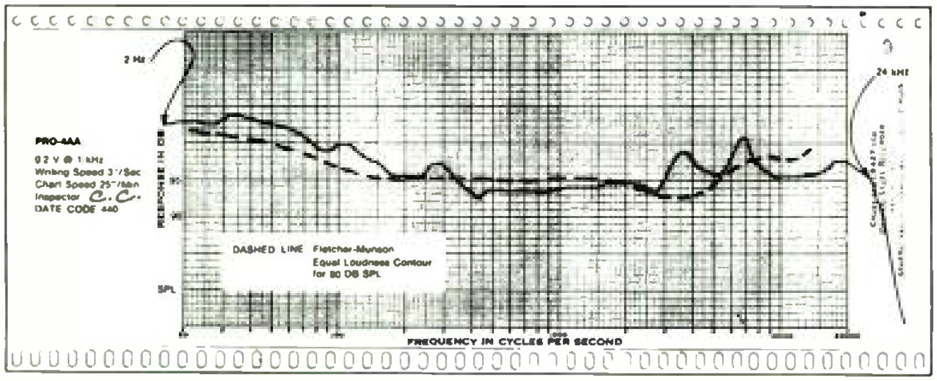
The good sound you monitor is the Sound of KOSS

Better than speakers

Here is a new, rugged, wide-range dynamic headset with good sensitivity that delivers precision monitoring far beyond that obtained by speakers. You exclude outside noise; you eliminate disturbing room reflections. Freedom from distortion and flatness of response are exceeded only by the famous Koss electrostatic units. You'll find that the "Sound of Koss" is the *good* sound.

Price $60.00

TYPICAL RESPONSE CURVE OF PRO-4AA



WHAT THE SPECS DON'T TELL YOU—

EXTENDED BASS RESPONSE TO 2 CYCLES/SECOND—The compliance of the diaphragm is large, the seal is good against the ear and the physical design permits very long excursions to give you lo-lo bass at full level—and the PRO-4AA does it with liquid-filled cushions for perfect seal and superlative comfort, whether you wear glasses or not. This bass range response *exceeds by 4 octaves* that needed to insure good low-end monitoring.

TAILORED CURVE SHAPE FOR FATIGUE-FREE LISTENING — Characteristically the PRO-4AA runs ± 3 dB except below 150 Hz and for a rise at 6.5 kHz. As long as we must have *some* variation, we put the belly of the curve in the mid-frequencies to follow closely the Fletcher-Munson equal loudness contour for 90 db SPL at 1 kHz. This keeps fatigue low in long, intense sessions because you don't reach for the extremes of the range as you tire and your ears become less sensitive. Last, but not least, the music sounds *good*.

HIGHER HIGHS THAN YOU CAN USE—The 24 kHz point on the chart is about where the "2" is in the figure 1521—the PRO-4AA needs longer chart paper than this standard charting equipment provides. Even though you can't hear these frequencies, the capability promotes good transient response in the range you *do* hear.

WHY DOES KOSS RAISE THE BOTTOM?—The wide-range coupler used for Koss measurements effects a perfect seal to promote high bass level almost to dc. An air leak to the sealed cavity lowers the bass response level. Koss feels that modern side-burns and luxuriant hair are good for a full 1-second leak or 4 dB less. This makes the PRO-4AA the flattest dynamic headset we know how to design at this time!

See and hear the PRO-4AA at your dealer today or write the factory for a 16-page catalog on "How to Choose Stereophones."

ELECTRICAL SPECIFICATIONS
Frequency Response Range, Typical: 10-20,000 Hz ■ **Efficiency:** Medium ■ **Total Harmonic Distortion:** Negligible at 95 dB SPL. ■ **Source Impedance:** Designed to work direct from 4-16 ohm amplifier outputs. When used with headphone jacks where series resistors are employed, response should not be measurably affected, but slightly higher volume settings will be required. ■ **Power Handling Capability:** Maximum continuous program material should not exceed 5 volts as read by an ac VTVM (Ballantine meter 310B or equal) with average indicating circuitry and rms calibrated scale; provides for transient peaks 14 dB beyond the continuous level of 5 volts.

PHYSICAL SPECIFICATIONS
Cushions: Fluid-filled for high ambient noise isolation averaging 40 dB throughout the audible range. ■ **Headband:** Extendable, stainless steel with self-adjusting, pivoting yokes; conforms to any head size. ■ **Boom Mount for Microphone:** Knurled, anodized, aluminum knob on left cup with threaded shaft and 2 compressible rubber washers; accepts all standard booms. ■ **Headset Cable:** Flexible, 4 conductor coiled cord, 3 feet coiled, 10 feet extended. ■ **Plug:** Standard tip, ring and sleeve phone plug. ■ **Element:** One inch voice coil virtually "blow-out proof"; takes surges up to 20 times rated maximum power levels. Has 4 square inches of radiating area from 2 mil thick mylar diaphragm. ■ **Weight of Headset Only:** 19 ounces.

KOSS Stereophones

Koss Electronics, Inc., 4129 N. Port Washington Rd., Milwaukee, Wis. 53212 • Koss Electronics S.r.l. Via Valtoria 21 20127, Milan, Italy

Circle 17 on Reader Service Card

discovered during the remodelling of a Congressional cloak room, they had become corroded over from lack of use. ■

41st A.E.S. Convention

Although the 40th A.E.S. convention is just now coming, it is not too early to begin making plans to attend the 41st convention, to be held in New York City this fall.

The following twelve technical sessions have been scheduled, and persons interested in submitting papers should contact the appropriate session chairmen as soon as possible.

Technical Session	Session Chairman
Transducers	James Novak Jensen Mfg. Co. 5655 West 73rd St. Chicago, Ill. 60638
Electronic Music	David Friend Tonus, Inc. 45 Kenneth Street Newton Highlands, Mass 02161
Design of Audio Transmission Systems	John Woram RCA Records 1133 Ave. of the Americas New York, N. Y. 10036
Disc Recording and Reproduction	Lawrence Shaper Empire Scientific Corp. 1055 Stewart Avenue Garden City, N. Y. 11530
Broadcasting	Leonard Feldman Engineering Consultant 97 Oxford Blvd. Great Neck, N. Y. 11023
Magnetic Recording and Reproduction	Marvin Camras IIT Research Institute 10 West 35th Street Chicago, Ill. 60616
Sound Reinforcement and Architectural Acoustics	Peter Tappan Bolt, Beranek and Newman 1740 Ogden Avenue Downders Grove, Ill. 60515
Medical Electronics	Philip Kantrowitz 2435 Frisby Avenue New York, N. Y. 10461
Digital Techniques in Audio	Ronald Schafer Bell Telephone Laboratories Murray Hill, N. J. 07974
Audio Instrumentation and Measurements	Emil Torick CBS Laboratories 227 High Ridge Road Stamford, Conn. 06905
Amplifiers and Signal Processing Devices	Saul Walker Automated Processes, Inc. 35 Central Drive Farmingdale, N. Y. 11735
Acoustical Noise Control	William Siekman Riverbank Acoustical Labs P. O. Box 189 Geneva, Ill. 60134

Martin Dickstein

SOUND WITH IMAGES

• These pages started reporting in depth on the latest development in home entertainment when the article on the CBS *EVR* invention was printed in the September, 1968, issue.

Then, in the December, 1969, issue, I followed up with a description of the RCA unit called *SelectaVision*. In April, 1970, I continued with a discussion of the Sony entrance into the home entertainment field with its *Videoplayer*, and in October, 1970, I described the demonstration by CBS at the AMA show in New York of the EVR. The December, 1970, and January, 1971, issues of db provided full discussions of the newest entrant, the *Video Disc* by Teldec. In December I also provided a chart comparing some of the estimated projected consumer costs and some of the markets in which the different systems would probably find their first applications. (Incidentally, I plan to update the chart as more information becomes available and the units themselves are readied for market introduction.)

For about the past year and a half, there have been meetings in almost every field of endeavor—in which audio-visual equipment plays any part at all—to discuss the meaning, impact, uses and applications, the best time to jump in, and to what extent (if at all), initial expenditures, and the future of the latest and apparently greatest method of reaching the public.

One such recent meeting was held toward the end of last year by the National Visual Communications Association, New York. The organization was founded in 1952 "to provide industry executives and professional visual communicators with an opportunity for an exchange of ideas and a source of information on techniques and new developments." The Association is a non-profit professional and scientific organization with a membership open to all persons actively engaged in visual communications whether in sales, service, manufacturing, or in the use and application of the equipment.

At this conference, the 17th annual Days of Visuals, there was a small display of equipment and software for audio-visual application and also talk and discussion sessions. Speakers at the various meetings included Mr. Leslie H. Waddington, President of NVCA, on the subject "Media 70's—What Next?", Mr. Malcolm E. Shaw, President of Educational Systems and Designs, Inc., Westport, Conn., on "Television in Management and Sales Training." At one session, Eastman Kodak representatives discussed the subject "Concepts in Communication."

One entire afternoon of the two-day convention was devoted to a discussion of several different devices being developed in the video cassette field. A talk was scheduled on the EVR by a representative of Motorola, the manufacturer of the player unit for the CBS cartridge; the Sony Videoplayer; the Ampex *Instavision*; and the AVCO *Cartrivision* system. Unfortunately, the representative of Sony could not attend, but the other

(Continued on page 23)

NEW PRODUCTS AND SERVICES

REVERB UNIT

• The O/P Reverberation is designed for use in those professional recording studios whose people wish a substantial improvement in the sound quality obtainable from a spring. Flutter is reduced in the conventional way—by using multiple springs, while noise is kept below audibility by means of correct design of the pickup amplifier. A floating threshold peak limiter is included. This reduces objectionable noises in the form of popping springs on transients. Console and rack mount, with or without power supply is available.
Mfr: Parasound, Inc.
Circle 58 on Reader Service Card

CASSETTE DUPLICATORS

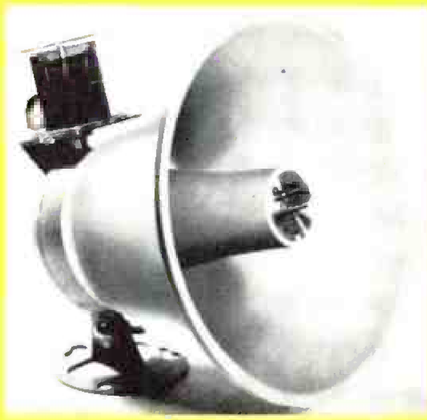
• New models have been added to this existing line. As the model DC1542/30 they duplicate two-track cassettes while as the model DC1544/30 4-track capability is provided. The master unit will accept 3¾ or 7½ in./sec tapes. Three large hysteresis synchronous motors are used for the capstan drives and an additional five torque motors used for the takeup function. Heavy balanced brass flywheels driven by flat belts are used in the cassette mechanism to cut flutter to less than 0.2 per cent. The time needed to duplicate four copies is one eighth the time required to normally play one cassette. Additional slave units can be used to a capacity of 20 copies at a time.
Mfr: C.E.E.
Price: $2825 (two track)
$3450 (four track)
Circle 56 on Reader Service Card

TELEPHONE TRANSMITTER/RECEIVER

• Here is a quick, easy, and inexpensive way to transmit or receive recorded information over the telephone with high quality. The PC-48 telephone transmit/receive coupler provides unmatched convenience for transmission of recorded material from *any* tape recorder through any standard telephone. Simply plug the jack into the output of the recorder and slip the loop over a telephone earpiece. Recorded material is heard at the other end without distortion and may easily be monitored and edited. The PC-48 also doubles as a high resolution telephone pickup by merely plugging the jack into the tape recorder input.
Mfr: Trinetics, Inc.
Price: $9.95
Circle 68 on Reader Service Card

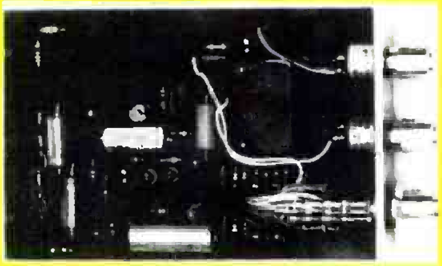
PAGING PROJECTORS

• The first of a series of newly designed, low-cost, paging projectors, the 12-watt PA12 has been introduced. It features computer-calculated horn flare, a design factor that provides excellent response characteristics and dispersion. A newly-designed diaphragm and voice-coil assembly, plus a powerful Alnico V magnet structure make these units highly efficient, requiring less amplifier power for a desired sound pressure level output than other speakers. Excellent speech articulation and intelligibility and a voice-coil impedance of 8 ohms are offered. The round horn provides a nominal 130-degree dispersion angle. It may be oriented in any desired position in a vertical plane by loosening a single wingnut on the mounting base. The housing is high-pressure injection molded, has high resistance to impact, and is extremely sturdy. Its molded-in Mesa tan colored finish will not fade, chip, or peel. Frequency response of the PA12 is 325 to 14,000 Hz. For use in line-voltage installations, the company offers the TR12 transformer in 70.7 or 25-watt versions for the PA12 speaker. This transformer mounts on a special bracket at the rear of the PA12 horn and has solderless push-clips for selecting wattage taps. The cover for the TR12 is made of special non-yellowing clear formed acetate allowing easy inspection of connections. The transformer has been vacuum varnished for full protection from the weather, moisture, and fungus.



Mfr: Electro-Voice Inc.
Price: PA12–$27.00
TR12–$10.00
Circle 73 on Reader Service Card

TEST OSCILLATOR CARD



• Model 692-OSC test oscillator card has been designed to complement the INTEGRA II 692 card series. It packaged on a card 3½ inches wide by 5½ inches long and can be used in conjunction with the 692 cards, or can be inserted in a special card holder for complete shielding from adjacent equipment as well as for mounting into a 5¼ inch rack mounting frame. The unit covers a complete audio range in one continuous sweep from 20 Hz to 15 kHz, or in five selected frequencies from 20 Hz to 15 kHz. A unique feature is that frequency can be remotely controlled by simple modification. Specifications are: Output level + 10 dBm; distortion 0.2 per cent maximum; output uniformity within 1 dB; output impedance 3 ohms; mic feed output impedance 200 ohms. Power requirements 24 V at 100 mA with remote control, 10 mA without remote control.

Mfr: Fairchild Sound Equipment Corp.

Circle 70 on Reader Service Card

TAPE CLEANER

• Although marketed as a video tape cleaner, 2-inch audio tape can probably also benefit from the Magnetek 1 video tape cleaner system. It has been designed to acomodate 1 and 2-inch tapes and to remove physical errors (dirt, oxide particles, etc.) from the tape surface. Simple to operate, only a minimum of operator skill is required. In the cleaning process the oxide surface of the tape passes over precision-ground tungsten carbide blades which remove loose or embedded oxide particles, backing materials, or other foreign matter. Embedded particles are sliced to avoid depressions or pitholes. Particles are then wiped similtaneously from both surfaces of the tape by continuously moving silicon-impregnated tissue synchronized with the tape movement.

Mfr: Advanced Transducer Systems, Ltd.

Circle 57 on Reader Service Card

PULSE GENERATOR ADAPTER

• This unique device is a low-cost laboratory pulse generator which claims not to sacrifice quality or reliability. It is designed to be driven from any oscillator, such as a sine-square wave generator, and may be operated at any frequency from 1 Hz to 10 MHz dependent only on the driver. The output of the pulse generator adapter offers variable amplitude; 0 to 12 volts; variable pulse width, 5 millisecond to 100 nanoseconds; and variable frequency. The rise time of the output pulses are up to 20 nanoseconds. Output impedence is 50 ohms and is compatible with TTL, making it the ideal instrument for logic development.

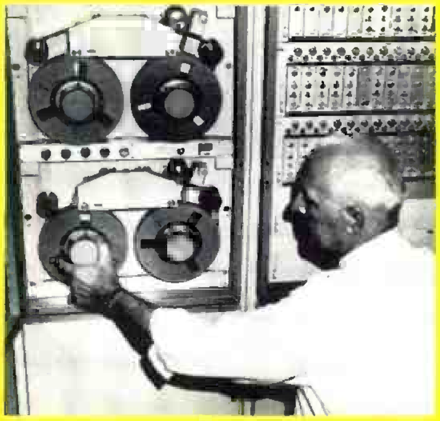
Mfr: Blulyne Electronics Corp.

Price: $59.95

Circle 72 on Reader Service Card

MULTI-CHANNEL RECORDER

• Simultaneous recordings of as many as 31 different incoming and outgoint messages is possible with this new recorder. A single reel of one-inch tape provides a full 12-hour recording of all 31 channels. When playback is necessary, an electronic timing device shows, to the second, the time the message was originally recorded. The Paterson, N. J. Police Dept. is now using this equipment for continuous communications recording. All radio instructions and information between headquarters and field forces, as well as telephone calls to headquarters are recorded. Some phone lines are not recorded—all recorded phone calls hear

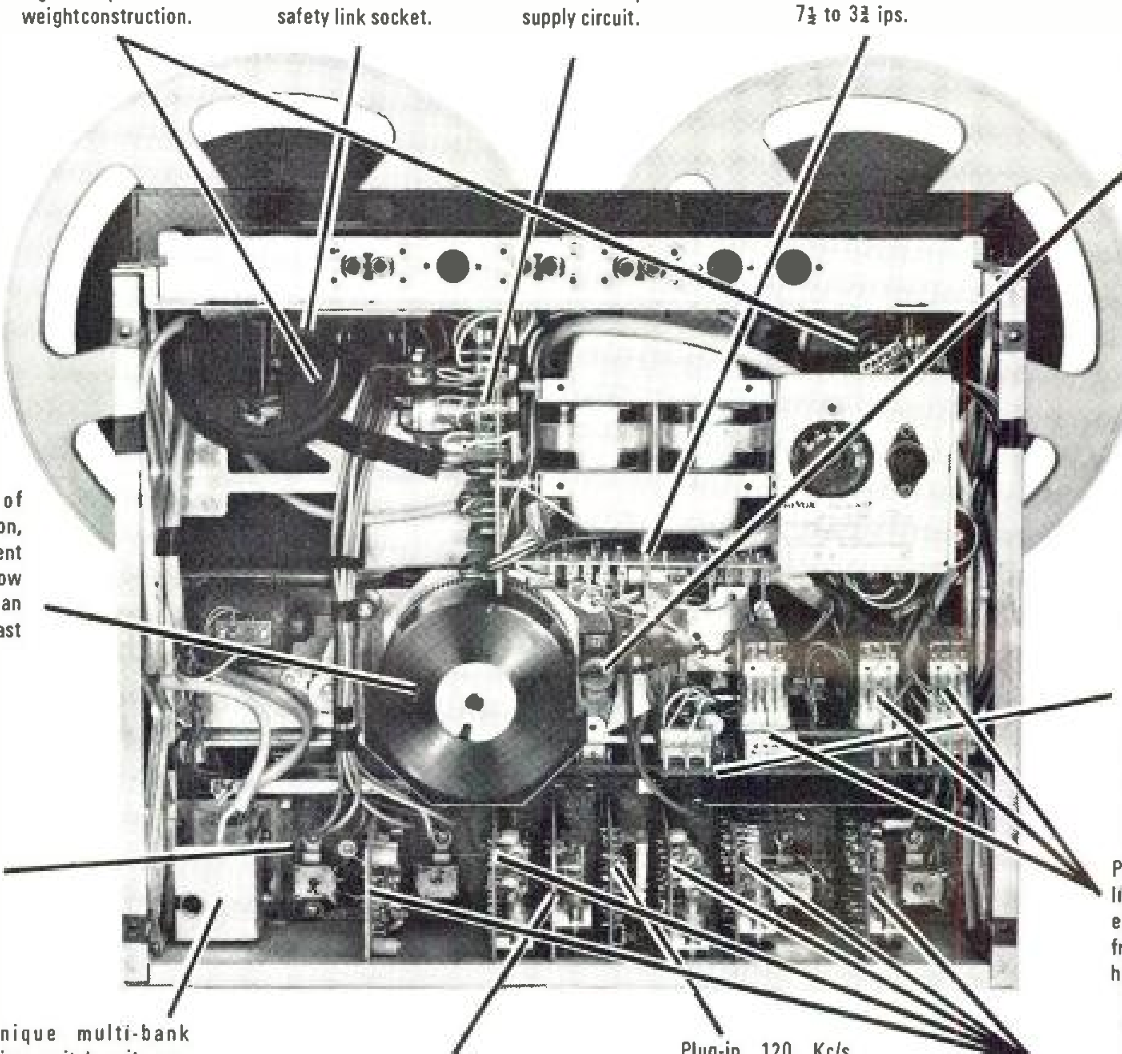


the customary "beep". The system is only 72-inches high in two racks. While one tape deck records for twelve hours, the second and third are on automatic standby or may be used for playback or rewinding. In the event of failure, a stand-by deck would take over. Recording is at 15/16 ips, yet quality is extremely clear. Response is claimed +3 dB from 300 to 3000 Hz. It is anticipated that radio stations, airports, courts, railways, and electric power stations will find use for equipment of this type.

Mfr: Philips Broadcast Equip. Corp.

Circle 61 on Reader Service Card

For technical sound recording everything points to Revox



New from the Willi Studer Factory comes the revolutionary Model 77 incorporating design developments based on experience gained in the broadcast field with the 37 and 62 Series Studer machines. The 77 is a studio quality machine compactly presented and offering features unique in this price class including total indifference to fluctuations in mains supply periodicity. With a wow and flutter level below broadcast standard requirements plus a linear response from 20-20,000 Hz at 7½ ips. (±2 db) and an ultra low noise level, this new Revox will fulfill virtually every scientific and industrial requirement in the sonic band.

Write or telephone for further information to :—

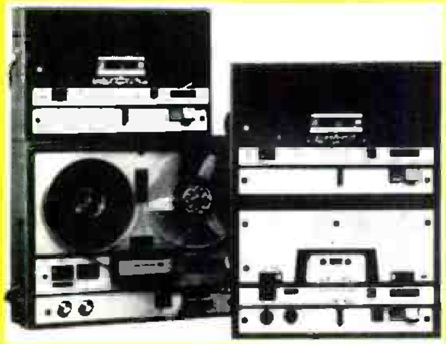
REVOX delivers what all the rest only promise.

Revox Corporation, 155 Michael Dr., Syosset, N. Y. 11791
1721 N. Highland Ave., Hollywood, Calif. 90028
In Canada: Tri-Tel Associates, Ltd., Toronto, Canada

Circle 13 on Reader Service Card

CASSETTE TAPE DUPLICATING SYSTEM

• A unique concept in cassette duplicating systems, incorporating the heavy-duty, high performance mechanism of the Wollensak audio-visual cassette recorder, has been developed. The modular system permits placement and operation in a variety of work layouts or space arrangements. Because the system is designed on a modular, plug-in basis, the user can start small—with a single master and copier—and add units as his needs develop. Either of the two master units—reel-to-reel (model 6040 AV) and cassette (model 2750 AV)—can drive up to 10 cassette copiers or slaves (model 2760 AV). Two unique and patented features provide automatic high-speed rewind of copies and automatic sensing of stalled cassettes. The latter feature assures that the system makes only perfect copies. Duplicating speed is four times program speed. Both master and copier units are available in either two or four-track formats. The reel-to-reel master will accept master tapes at three speeds—7 1/2, 3 3/4 and 1 7/8 in./sec.



Mfr: 3M Co.
Price: $499.95 (master unit); $299.95 (copiers)
Circle 77 on Reader Service Card

BROADCAST AUDIO AMPLIFIERS

• A new solid-state, 50-watt plug-in audio amplifier with high gain and low distortion is available for use as a monitoring amplifier by broadcast and recording studios. It is capable of driving 4-, 8- and 16-ohm speakers or a 70-volt line for sound distribution and reinforcement systems. The amplifier, type BA-48A, produces 50 watts continuous, with or without optional output transformer, with total harmonic distortion of less than 0.5 per cent from 20 to 20,000 Hz. The BA-48A is designed for plug-in installation in the BR-22 mounting shelf which accommodates two amplifiers. Accessories include remote gain control module, input, bridging, and output transformers.
Mfr: RCA
Circle 69 on Reader Service Card

PENCIL-SIZED TESTER

• A pocket-sized instrument which indicates direction of flux lines and measures relative strength of any permanent magnet or magnetic field has been introduced. Said to be the only testing device of its type, the MagTester utilizes high-strength magnetic materials designed to resist demagnetization or polarity reversal. A magnetic wheel mounted at one end of the MagTester, with a north/south axis across its face, will align itself parallel to the flux lines of a magnetic field, thus indicating polarity. Testing the relative strength of a magnet is based on the principle of repulsion. By holding one end of the unit against the similar pole of the magnet being tested, an internal rod magnet is repelled upward within a clear plastic tube. The relative strength of the magnet under test is indicated by the length of travel of the rod magnet. A numbered scale provides a handy measure for comparison purpose.
Mfr: Sel-Rex Corp.
Price: $19.95
Circle 67 on Reader Service Card

REVERB SYSTEM

• The RV-10 is a new and patented variable delay reverb system that uses a fresh approach to generate mechanical reverberation. A 55 ms transducer delay resembles the artificial delay times used on other devices for modern recording studio techniques. Front panel adjustment of decay time and low frequency filtering permit this system to match other reverb systems and also to create new effects not available in other devices. An almost total immunity to mechanical shock or outside acoustical pickup is claimed, making this unit feasible for control room installations. Input sensitivity is +4 dBm. However, levels down to −20 dBm can be accommodated by internal strapping.
Mfr: Quad-Eight Electronics
Price: under $800
Circle 80 on Reader Service Card

(From page 17)

gentlemen provided interesting talks and literature of their respective systems, rough costs of the units and software, future developments, markets and applications.

Ampex, in describing the system of Instavision, indicated that the medium of half-inch magnetic tape, which permitted re-use by the consumer as many times as desired for home recording either from a camera or the t.v. set, is the most versatile. Their tape is contained in a cartridge from which the tape is threaded automatically when played on an Instavision unit. However, as the record/playback specifications conform with the Type 1 standard, the tape can be played on a machine other than the Instavision unit that also conforms to the same standards with use of an accessory hub insert.

Among the other features stressed by Ampex are the provision for two independent audio channels for stereo or language studies, slow speed or stop motion for study of single frames in industry or medical applications, simplicity of use for public use at home parties, etc. Still another feature is the auto-search provision which permits the unit to sense the signal put automatically on the tape when a recording is completed. Thus, the next time, the end of the preceding recording can be found easily; this results in a cueing or indexing system for different sections of recordings. Total recording time at standard speed is 30 minutes, or 60 minutes in the extended play mode.

This system, which according to the literature has been "designed for use in education, business, industry, medicine, sports and government applications," including the camera, also provided for simple electronic editing of program material from the camera—avoiding picture roll or tear. Sync signals are furnished by the recorder for the camera. The camera has a small electronic viewfinder which permits instant playback of the taped material. The recorder also has "digital" indication and automatic head cleaning (by just pressing a button on the machine).

Cartrivision, the name given to the system placed in the running for the money by AVCO, includes a color t.v. set in a cabinet with the video tape player mounted within the cabinet . . . sort of a video hi-fi unit. With a special adapter, the playback unit can also be played through any other t.v. set as well.

The medium of this system is also half-inch magnetic tape. AVCO will also provide, at extra cost, a camera for use by the consumer for home recording. This blank tape will be marketed in a yellow box for easy identification. One additional feature is an automatic timer which will permit recording from the t.v. set even though the buyer is not at home at the time as the desired program goes on the air. The recording will also turn itself off when finished. The cartridge will run in sizes from one-half hour to two hrs., and is of the reel-to-reel type with one reel above the other.

The reason for the special color of the box is that AVCO will also sell recorded tapes (movies, courses, and classes in various fields, sports events, etc.) in black boxes. Another color, red, will be used for boxes containing reels with material which will be available only for rental, and handled probably by a local outlet or library.

The only unit presently already on the market is the CBS EVR system. This system offers a playback-only capability. The unit is being made by Motorola for feeding color or black-and-white pictures to the home t.v. set. Thus, only recorded material will be available on the market in this system. However, provision has been made to connect a t.v. camera to the playback unit to feed live pickups to the t.v. set without recording.

The medium is a very thin plastic film fed through the machine like magnetic tape (without sprockets). The cartridge is completely sealed to prevent dirt or finger marks from getting on the film. The film is sealed until the cartridge is placed on the machine at which time small "fingers" push the end of the film out of the cartridge into a threading system which, in turn, automatically feeds to a take-up reel.

Total running time of the cartridge is fifty minutes of b/w or twenty-five minutes of color material. Since both visual tracks of the film have to be used simultaneously for color reproduction (b/w image in one track and color information in the other) the playback time is shorter but both audio tracks can now be used for stereo sound. With a b/w film, both tracks of visual information are used independently for full playback time but only one channel of audio is available with each track. Synchronization is achieved and maintained by a visual marker at each frame. This can not be seen on the screen. It is used by the machine to adjust for constant speed.

CBS has already contracted with many industrial firms to provide them with EVR cartridges containing the customer's original material converted to the CBS medium. Films and other previously-recorded material will also be made available for purchase by CBS. They are contracting for famous motion-pictures, sports events and other programs of interest for purchase through local outlets or record stores.

At present, this unit has a running head start in the video-cassette race since the equipment is already available while the other manufacturers are still getting theirs ready for marketing. One further step CBS has taken, in addition to transferring the customer's own material to EVR, is to provide full services of its special projects group to assist in designing the entire program for EVR recording from scratch even if the client does not have any previously-recorded material at all. The service extends from consultation through story boards, scripts, production, shooting, and the final step of recording and delivery of EVR cartridges.

Although Sony was not represented at the meeting, it is only fair to mention that their system uses a reel-to-reel cassette with magnetic tape. When we described the system shortly after it was presented, about a year ago, we concluded with the question "Can commercials be far behind?" Here it is just one year later and the answer is upon us.

Last month, another meeting was held to discuss the impact of the video cassette business. This t.v. seminar was held by the American Association of Advertising Agencies. The speakers were Mr. Morton Dubin, president of Video Tape Producers Association; Mr. Paul Caravatt, Jr., senior v.p. of Interpublic, a group of Ad Agencies; Mr. George Tompkins, general executive, Electrographic Corp.; Mr. Harland Kleiman, v.p. Video Cassette Division of Teletronics International, Inc.; and Mr. Paul Klein, president of Computer Television, Inc. The chairman and moderator for the meeting was Mr. Phillip L. Tomalin, senior v.p. of Ogilvy & Mather Inc., Advertising Agency and vice chairman of the 4A Broadcast Administration Committee.

Among the suggestions of how the cassette (or cartridge or disc) might be distributed for the public was the local library (for loan as presently with books and records), rental (also from the local library or book or record stores as with present best sellers), or by purchase from local stores or supermarkets as presently with records or books, or in give-away programs tied in with specific products through food chains, specialty stores, and chain stores.

Mr. Caravatt, with simple mathematics, showed how the software market could go as high as 11 billion dollars in the next decade or so. He mentioned some of the programming opportunities for classrooms, libraries, sales, and medical training. old or specially produced motion pictures and Broadway shows, travelogues, cartoons, highway-safety messages, political programs, special programs for the handicapped, home economics for the housewife, etc. He described the new medium as "Telechoice", an all-inclusive word for the diverse systems with which the public would have almost unlimited choice of what to watch on their t.v. set.

Mr. Tomkins explained how video cassettes would be borrowed from local libraries and would be a perfect means for advertisers and their agencies to produce special how-to programs for hobbyists and enthusiasts in every conceivable field, with inclusion of the manufacturer's products as part of the program. Where else will the advertiser have the opportunity to reach the precise customer he wants to buy the products specially made for that person?

Mr. Klein said that there is no question but that the advertiser and the agencies would play a very important part in the future of the video cassetts production and development business, but it was his contention that the way to go was not necessarily with the customer buying the cartridges. He felt that by having a computerized central location for cartridges (or cassettes or discs), the customer could dial for any information or program material he wished by referring to a listing (to which he would subscribe) with a special code. The home set would be tied to the central system with a cable (as is now being done in areas with c.a.t.v. installations). This way, the home viewer could have program material available for every channel on the set, not just the few that cable and air broadcast. Charges for the service could be through the customer by subscription, charges on the phone system or special dialing system for getting the special material desired and could extend to advertisers who furnished material for cable transmission.

According to the experts who are taking this new business very seriously, it will be up to the sponsors and advertisers and their agencies to produce more and better program material with which to attract the viewing public, including, of course, commercials. First, the public will have to decide which type of system to buy (or maybe one of each, as at present, with a record player and tape machine) and then have a multitude of choices for viewing material. The agencies will have to decide how best to reach the public with so much choice at his disposal. Decisions! ■

A Forum on Microphones

What about stereo micing a piano?

Here is what happens when you place several recording engineers in a room, give them a topic to discuss, and turn on the tape recorders.

SOME weeks ago, db held the first in an anticipated series of informal meetings, bringing together engineers from several recording studios to discuss topics of mutual interest. On this occasion, the subject was microphones.

Bob Schulein, manager, Electroacoustical Systems at Shure Bros. Inc., flew in to meet with the group and add the manufacturer's point of view.

Beyond calling the evening, *A Forum on Microphones*, no particular format was prescribed, and the meeting quickly became a lively bull session, with everyone contributing his own viewpoint—arguing at times, agreeing at others. It must have been a successful evening, for the original typed transcript of what was said ran to over 125 pages, from which we have distilled what follows.

Schulein: Being a design engineer, I'm concerned with building a better microphone. I have an advantage in that I can make accurate and repeatable laboratory measurements. However, I don't have any first hand knowledge of how you people are using microphones, or what you are looking for. You know what you like to hear, and you know when you're getting it. But you may not know *why* one mic works better than another—you just trust your ears, because if you don't like what you're hearing, all the charts and specs in the world aren't going to get you to change your mind.

Woram: I think most recording engineers, unless they're particularly interested in specifications, couldn't tell you much about the published data on their favorite mics. However, they certainly could tell you in subjective terms which mic they prefer for any particular application.

Schulein: To you, a microphone is just another link in the complete chain. In a given situation, you know that along with all the other variables—equalization, limiting, your console, tape recorder, producers taste and so on—a certain mic will do what you want it to. Back in my realm, the microphone is the most important thing in the world. I could tell you the differences between the mic you prefer and any other one, and if we can determine what the right measurements are, we may be able to predict which mic is the best for any application.

Bradley: With an exception for that all important variable—personal taste. I doubt if many of us would agree on any choice of microphone for a particular instrument.

Baxter: Right! John and I are always arguing over microphones. He really likes the Shure SM 76 on acoustic guitar. Most of the time, I don't.

Katz: My favorite acoustic guitar mic is a Neumann 87 with the bass roll-off switched in. The guitar can be a very subtle instrument. And a twelve-string especially has the tendency to have a run away low end. I'll put the 87 approximately over the hole and use a limiter to tighten it up a bit.

Figure 1. The group gathered around an omni to record the conversations that are here transcribed. The location is Studio A at RCA in New York City.

FORUM PARTICIPANTS

Steve Katz	Sound Exchange
John Bradley	Ultrasonic Recording Studios
Mike Colchamiro	Ultrasonic Recording Studios
Dick Baxter	RCA Record Division
John Woram	RCA Record Division
Larry Zide	db Magazine
Bob Bach	db Magazine

It would be interesting to find out what mics you fellows are now using, and then measure these mics in some way that would relate to how you're using them.

Baxter: Have you ever tried the omni pattern on the 87, and moved in even closer?

Katz: I don't think I could get in any closer. Six inches is about as close as you can get.

Woram: That's one of the reasons I prefer the SM 76. Since it's very small, you can get in as close as you like, and still not be in the musician's way. And since it's an omni, you don't have any proximity effect.

Schulein: You know, when I first got involved with the recording industry, I thought there might be a very simple way to work things: Just get a basically smooth microphone, and an equalizer on each mixer. After all, the biggest difference between microphones is their frequency response. If you could equalize them, I think you'd find many mics are quite similar, particularly omnis.

Colchamiro: That might be okay with omnis, but with cardioids, there are a lot of other considerations-proximity, off-axis response, working angle, and so on. All of these things play an important part in selecting your favorite mic for a particular instrument.

Schulein: What do you think about a so-called basic mic with a few variables? Say, a presence peak which you could switch in or out, and maybe a high end roll-off. And a three-position switch at the low end for a boost or a cut. And you had all this in either a uni or an omni.

Baxter: Do you need all that equalization at the mic? There's so much equalization done at the board now.

Schulein: Well then, a basic mic, and you could use your own equalizers.

Baxter: Then we get back to, what is a basic mic?

Colchamiro: A basic mic is one that accurately picks up what the performer is doing. Maybe *accurate* isn't the right word. It's just the mic that sounds best with maybe some equalization under the conditions at the moment.

Woram: I'm not much on equalizing everything. If I can't get what I want with a very slight amount of equalization, I'd rather go out and put up another mic. Listening to some tracks, you can almost say, "oh, it's plus 8 at 100 hertz." You can almost hear the equalizer.

Katz: Equalizing an instrument is such a delicate thing. You've got fundamental, overtones, and harmonics to consider. You can really upset this critical balance, and that's where the beauty of music is.

Woram: If you equalize a mic by adding plus 8 at 100, you're affecting the low end, and the further the instrument goes from playing its lowest notes, the further it is from the equalization. If you can try a different mic instead of putting in all that comp, I'd think you'd get the quality you're looking for over the entire range of the instrument.

Fifteen feet away, and at variable height, the condenser microphone was set up 53 inches above the floor . . .

Schulein: Either way, you're equalizing. You're either adding externally, or choosing a different mic with probably a different response of its own.

Bradley: Except that the internal differences between two mics are usually more varied over the entire range than anything you could do with a console equalizer, unless you had a very good graphic.

Schulein: It would be interesting to find out what mics you fellows are now using, and then measure these mics in some way that would relate to how you're using them. Then, we might pick a reference mic and I'd give you some specific equalization settings to get it to approach the performance of the other mics.

Katz: I'd like to know what everyone uses on vocals.

Woram: I usually try an Electro-Voice 635a first.

Bradley: One of the best vocals I ever got was with a Shure 546. That's the kind of mic I usually use just for a reference vocal but at the time, our old studio was ripped apart, the console was half gone, and I was short of mics anyway. The singer happened to know how to work a mic, and it was really beautiful.

Katz: I've used 87's, the Sony C37, and for a full, round, rich sound, there's nothing like the 47.

Baxter: Sometimes, I've used the Sony C-22, and if I remember right, I think that John used an old RCA 44 a few years ago for Glenys, the female vocalist with *Four Jacks and a Jill*.

Woram: I remember that very well. We went through every microphone in the place before rediscovering the 44, which turned out to be just right. However, I don't think I've used it since. Steve mentioned the Neumann 47, which was a really fine microphone. It's too bad they're not still being manufactured.

Katz: It's a terrific mic for celli and trombones.

Baxter: We also used to use it a lot for low strings and brass, but I think most of us have switched to other mics as the 47's wore out and couldn't be repaired or replaced.

Zide: Bob, you talked about measuring the various microphones a little while ago. Maybe you could say something about how you go about evaluating a mic. Since you don't do as much actual recording as the others here, how do you compare one mic with another?

Schulein: Our main source of information is the anechoic chamber. Of course, this is not a realistic environment, but it is highly controlled and constant. We know we can repeat our experiments later and come up with the same results again. So, we can subject two microphones to the identical test and then compare our results. The performance of a mic in the anechoic chamber won't tell you whether you'll like the mic in the studio, but if you do like the mic in the studio, the chamber may be able to give us a clue as to why. Also, we can make accurate measurements of off-axis response and proximity effects, and these measurements are of value as is.

I'd like to know what everyone uses on vocals.

. . . you talked about measuring the various microphones . . . . Maybe you could say something about how you go about evaluating a mic.

PROXIMITY EFFECT, AND POPPING

Katz: What do you do on your SM 53 to minimize proximity effect.

Schulein: Well, it's a little involved–there's an AES paper on the design of this mic which I'll send you.[1] Basically, it's a two-entry uniphase system, and the low frequency entry is quite far from the diaphragm, which helps minimize any proximity effects. There are times when you can use the proximity effect to advantage. Let's say you want to minimize the pick up of unwanted low frequencies from off axis sources. So, you move in close with your cardioid until you have too much bass as a result of proximity. Then you roll it off until you're back to normal. In doing so, you cut down all the unwanted low frequency noise from the surrounding area.

Another point to keep in mind when using two-entry mics: if you're using a wind filter on the front, don't forget to put some kind of filter over the rear entry ports also. The microphone works on pressure differences, and if you reduce the pressure, or wind, at one end and not at the other, it may very well sound worse than with no filter at all.

Zide: I guess we all know what a pop filter does, but I'm not so sure I know how it does it.

Schulein: Well, think about what a pop is, from a physical standpoint. It's really not so much acoustical, because when I say a word like *Peter*, you don't hear the pop that you might get if I were speaking into a microphone. So, obviously the pop signal is somewhat different from the acoustic signal. The pop is literally a puff of air being forced from mouth to mic, whereas the rest of the signal is a vibration of air molecules travelling at approximately 1000 feet per second. The pop signal is moving much faster, and the pop filter materials' resistance is non-linear. For low-velocity signals, it's quite low, but as soon as the velocity goes up, it starts to get higher. In essence, you have a selective filter that minimizes the high-velocity part of the pop signal.

Colchamiro: Is there much of a sub-sonic component in the pop? I should think there would be.

Schulein: When we were running spectrum analyses, we were going strong at 20 Hz. And if you go down to 10 Hz or so, there would be a detectable output. So, some of it is sub-sonic and could therefore cause excessive overloading. You could get into a low frequency saturation problem on your tape.

Woram: Of course, one way to minimize the pop problem is to go to an omni microphone. Or, if you're working with a cardioid, working it slightly off axis.

Schulein: Sometimes having your performer sing over the top of the mic will cut down on popping *p*'s but may get you in trouble with *t*. The *p* signal comes out pretty straight, but a *t* signal is dropped down.

Another thing we've found is that three inches seems to be a very critical distance for mic popping. Oddly enough, as you get in closer on many mics there is apt to be less trouble. I know why it gets better at *more* than three inches, but I'm not sure why the sudden improvement at *less* than three inches.

DRUM MICING

Schulein: When you fellows are micing drums, do you find yourself using a lot of mics–more so than you did in the pre-multi-track days?

Baxter: For me, it depends on how many tracks are available for the drums. If I can put the drums on two tracks, I'll use extra mics and try for some stereo effect, depending on what the drummer is doing.

Woram: I've been averaging about five mics, if I can go onto two tracks.

Zide: How do you assign them?

Woram: I usually put two EV RE-55's (which are omni's) over the drum set and about two feet apart. I'm probably violating every rule in the book, but it just seems to work out very well for me. Then I put an RE 15 close to the top of the floor tom, and a condenser mic near the snare, and then a 546 in the bass drum. The RE 15 and one of the RE 55's goes to one track and the condenser and the other RE 55 to the other, with the 546 split to both tracks. I was using a Sony C-22 for the snare, but now I'm trying the Neumann 86.

Katz: For me, the greatest snare drum mic is the 83. It's very small so I can get in really close, and since it's omni I

A GLOSSARY OF MICROPHONES MENTIONED

Model Number	Manufacturer	Transducer type	Polar Pattern	List Price
RE 15	Electro-Voice	Dynamic	Cardioid	$ 159
RE 55	Electro-Voice	Dynamic	Omnidirectional	$ 132
635a	Electro-Voice	Dynamic	Omnidirectional	$ 52.80
666	Electro-Voice	Dynamic	Cardioid	discontinued
SM 53	Shure Bros.	Dynamic	Cardioid	$ 153
SM 60=	Shure Bros.	Synamic	Omnidirectional	$ 49.20
SM 76	Shure Bros.	Dynamic	Omnidirectional	$ 111
546	Shure Bros.	Dynamic	Cardioid	$ 142
U47	Neumann	Condenser	switchable	
			Cardioid/Omni	discontinued
KM 83	Neumann	Condenser	Omnidirectional	$ 225
KM 86	Neumann	Condenser	both switchable	
			Cardioid/	$ 327
KM 87	Neumann	Condenser	figure-8	
			omnidirectional	$ 342
44 BX	RCA	Ribbon	figure-8	discontinued

still get the attack and the snare ring. Sometimes people get into problems, trying one mic *over* and one *under* the snare. You place the 83 properly and you'll pick up the whole drum.

Woram: I agree with you about the 83. From time to time, I've borrowed one, and I've never been able to beat the sound I've gotten with it.

Colchamiro: We've gotten very good results with the 546 on snare.

Baxter: What about on bass drum? That's where I use the 546.

Colchamiro: Now, I'm using the 666, but I've gone through quite an assortment in the past few years.

Katz: Most of the time I use the 666. But if I were doing something like a jazz trio, I think I'd probably go for an 87.

Schulein: I think the main difference here is response. You all end up with more or less the same response, but get it in different ways—from different mics or with different equalization.

Bradley: Dick said he liked the 546 for bass drum. Isn't he just using the proximity effect as a tool here?

Schulein: Probably. You can get a bigger low end than you would with an omni.

Baxter: I find I have good control over the low end by moving the mic in or out until I get the right balance.

PIANO PICKUPS

Katz: What about stereo micing a piano? Would you put the mics in close and at right angles to each other?

Schulein: I'd probably want to do a little experimenting. Just like the drums, the piano source is spread out. It's not like a point source that you're picking up from two different places.

Bradley: If you get in too close, there's a hole in the middle of the piano. There's got to be a good amount of leakage or it will sound false.

Schulein: It's very easy to get into trouble if you double mic a piano and put the mics on separate tracks. It sounds fine in stereo. but there can be a lot of phase cancellations when you combine later to mono. If you are going to use two mics onto separate tracks, I think Steve's idea of putting them at right angles would be the safest bet.

Woram: Lately, I've gotten away from double micing the piano. I've got one of your SM 60's and it sounds much better than anything else I've ever come across. I use it really in close. Later on if I want a more open sound, I'll use a stereo reverberation room—not a plate, but a natural room—and feed the two microphones in the room to extreme left and right, with the direct piano output in the center.

THE CONDENSER SOUND

Schulein: This is something I've been interested in for a long time. I've made comparisons between condensers and dynamics, and the responses were practically the same. Yet, to the ear there was a subtle difference. The point is, if the lab says there's no difference, and the ear says there is, then we've got to find other lab testing methods that will reveal just what these differences are.

Katz: I've read that a typical dynamic rise time might be in the neighborhood of 40 microseconds. For a condenser, it's more like 15 microseconds. That's not much of a difference, but still, 15 is better than 40, and subjectively a condenser gives me the sharp attack—especially the 83 on the drums—that I like.

Schulein: Another thing you may like about the condenser is the slight high-frequency peak that some of them have. This could contribute to the sensation of sharpness of attack.

Zide: Before we break up for the evening, I'd like to propose that some of the mixing engineers here send Bob Schulein their favorite microphone for some specific instrument. He could run some controlled tests and compile data on each of the microphones. Maybe once enough tests were made, we could see some correlation between test results and personal preferences. And then, if any conclusions can be made, we'll include them in a later issue of **db**. ■

[1] Development of a Versatile Professional Unidirectional Microphone, Robert B. Schulein, Journal of the A.E.S.. February 1970, p. 44-50.

ROGER ANDERSON and

ROBERT SCHULEIN

A Distant Micing Technique

Here is a study of a microphone placement technique which some engineers have already discovered but not fully utilized.

DURING an investigation of distant microphone pickup techniques, we were comparing two tape tracks recorded from the same source, one recorded at a near distance of one foot and the other at a far distance of fifteen feet. Compared to the near recording, the distant recording had a hollow quality, somewhat like short-wave reception when the signal is fading.

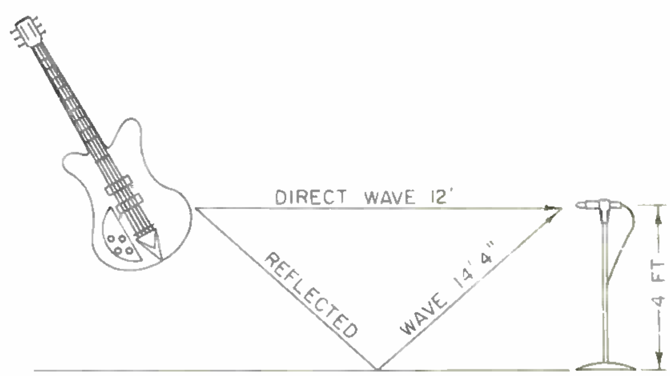
Another experiment pinpointed the cause of this effect. Here the distant microphone was moved vertically from a six-foot altitude down to the floor, keeping the source distance constant at twelve feet. Now the hollow effect varied in pitch, becoming higher until it vanished as the microphone approached the floor closely. With the microphone barely off the floor, excellent results were produced. The only difference between the near and far recordings was the greater reverberation and lower level in the far recording, as expected.

The explanation of this effect may be seen in *Figure 1*. Here a sound source (performer or musical instrument) is located four feet above the floor. The microphone is located twelve feet away on a floor stand, also four feet high. This arrangement might be used with a chorus or orchestra to maintain balance between performers and capture some natural reverberation; or in a singing/dancing routine where the stage area must remain clear.

The direct sound travels twelve feet; however a considerable amount of sound is reflected from the floor and up to the microphone again. This reflected sound travels a total of 14.4 feet, which is 2.4 feet farther than

With the microphone barely off the floor, excellent results were obtained.

Figure 1. The explanation of the quality change effect caused by moving the microphone vertically.



Roger Anderson is chief development engineer and Robert Schulein is a senior development engineer, both at Shure Brothers, Inc.

A unidirectional microphone used on the floor will retain most of its polar discrimination.

the direct sound. At a frequency of 233 Hz (wavelength 4.8 feet) the reflected sound will be 180 degrees out of phase with the direct sound, producing the phase cancellation effects associated with misaligned tape recorders or multiple microphones. This cancellation will also take place at all odd multiples of 233 Hz; *i.e.*, 699, 1165, 1631, 2097, etc. Actually, the cancellation is not complete because the reflected sound pressure is less than the direct sound pressure due to its longer travel and imperfect reflection. This is still sufficient to produce 15 dB dips in the response!

An objective experiment to document the effect was performed in an anechoic chamber. The results are shown in *Figure 2*. A one-inch condenser microphone and loudspeaker were set up four feet above the non-reflective mesh floor, separated by a distance of twelve feet. The resulting sound field experienced by the microphone is shown as curve (A). Next, a 4 x 12-foot sheet of plywood was placed on the mesh floor, between the microphone and source. Curve (B) is the result. The interference effects are quite noticeable. Curve (C) shows the result of a computer simulation of the setup, assuming 100 per cent reflection from the floor. The similarity of curves (B) and (C) show that the effect is real and predictable. The differences are due to the restricted size of the "floor" employed, and the absorption of the wood at higher frequencies.

The microphone was then lowered until it was barely clearing the floor. Curve (D) is the result, showing that the irregularities have disappeared and the level has nearly doubled. The high frequency roll-off occurs because the center of the microphone is still above the floor level.

An easy way of visualizing and explaining the situation is shown in *Figure 3*. Here, the floor has been removed and a mirror-image "virtual" source introduced which emits sound waves identical to the original source. A microphone located at A will receive the two sound waves somewhat out of step because the path lengths are not the same; consequently, interference effects will be produced. The only locations which are free of these effects lie along the perpendicular bisector of the line joining the two sources. Any point on this line will be equally distant from the two sources, and the two sounds will be exactly in phase. This line corresponds to the floor line in the real situation. Of course we cannot semi-sink the microphone into the floor, but using 1/16 or 1/8 inch clearance will insure that the lowest frequency cancellation is above 10 kHz.

To demonstrate the effect of a real, not anechoic, environment, a sound source was set up 53 inches above the floor on the stage of a high-school auditorium. Fifteen feet away, and at variable height, the condenser microphone was used to record the broadband noise fed into the loudspeaker. One-third octave analysis was later performed

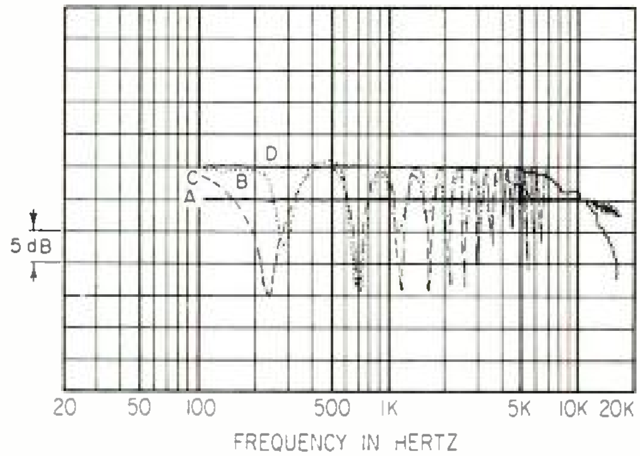


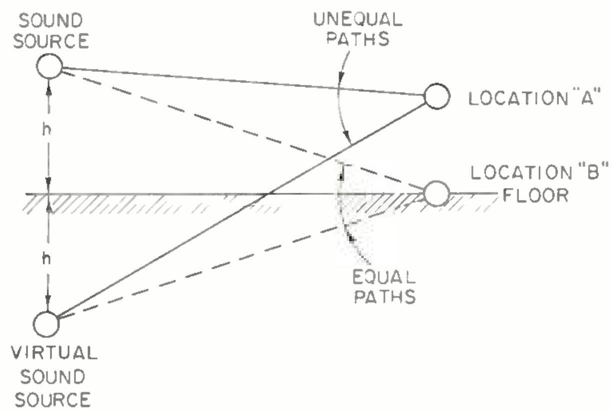
Figure 2. Anechoic chamber tests. At (A) we see the original sound field without a floor. (B) shows a 4- x 12-foot floor added. (C) is a computor simulation of (B). (D) is the microphone at floor level.

to yield the families of curves in *Figure 4*. The one-inch curve is similar to the response of the source measured in an anechoic chamber, and is the basis of comparison to the other curves. The two-inch curve shows a serious loss around 6 kHz. At twelve-inch spacing, the "hole" has moved down to 1 kHz, and some near relatives have appeared at 3 and 5 kHz. At the usual height of 53 inches, a serious dip occurs at 230 Hz, and even at 144 inches on an overhead boom some loss may be noticeable. The strong smoothing and averaging effect of 1/3-octave analysis makes the nulls less drastic than the sine-wave measurements, but they still are quite apparent.

Tests performed with unidirectional microphones have shown the same type of response-perturbation which the omnidirectionals exhibit. A unidirectional microphone used on the floor will retain most of its polar discrimination. Of course, when the microphone is close to the source, the intensity of the reflected sound is too small to have much effect, even though the path length is vastly different. In addition, the polar pattern of directional microphones will afford useful discrimination against floor reflections. If the floor is carpeted, the effects of reflection will also be reduced.

To effectively use this new position, the microphone must be very close to the floor and in a parallel orientation. The use of a desk stand places the microphone too high, or at an unfortunate angle to the floor. Overhanging the microphone head on the edge of a foam block is

Figure 3. A visualization of the effects described.



To effectively use this new position, the microphone must be very close to the floor and in a parallel orientation.

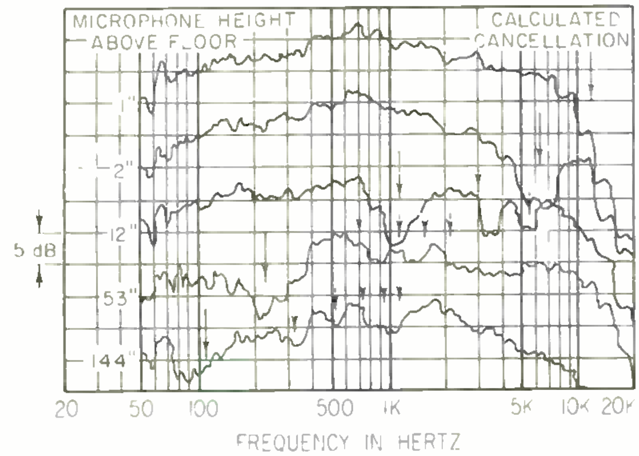


Figure 4. On-location tests. The curves have been displaced on this graph for clarity.

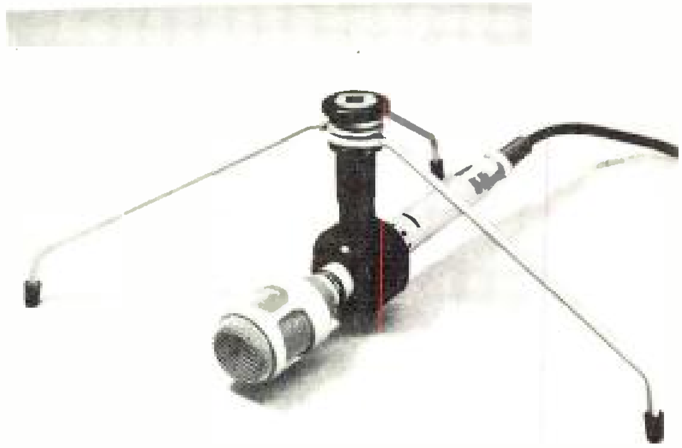


Figure 5. The mic stand that has been devised to take full advantage of the conditions described. It is commercially available from Shure.

acoustically usable, but mechanically unstable.

A practical solution to the problem is shown in *Figure 5.* This new stand has been designed to support the microphone properly and securely. In addition, it affords excellent shock isolation from floor vibrations. It is available in two models, the S53P and S55P, to fit 0.790 or one-inch diameter microphones respectively, and folds flat for storage.

Once the possibilities of reflections are recognized, other applications come to mind. For instance, a recording made at a desk from one or two feet away with the usual desk microphone stand will show the same type of interference effects noticed at greater distances. Similarly, when recording in auditoriums, putting microphones next to the side walls may be desirable. Many other examples will be apparent if the principle is kept in mind.

Our experiments have led to this general rule: *When the microphone-to-source distance becomes greater than one or two times the distance from the source to the reflecting surface, it is desirable to place the microphone next to the reflector.*

As a bonus, the sound level will be 6-dB higher than if the reflecting surface was not present. ▪

JOHN EARGLE

How Capacitor Mics Produce Cardioid Patterns

IN the studio, capacitor microphones are almost always used in their cardioid or (directional) pick-up pattern, but few engineers understand how this is accomplished. The purpose of this article is to show how this is done—with a minimum of mathematics and an abundance of graphics. But first we must touch upon a couple of basics. Just what *is* a cardioid pattern, and just how does the basic capacitor element function as an electro-acoustical transducer?

Figure 1 shows a capacitor microphone in its simplest form. The capacitor, made up of a fixed back plate and a moveable diaphragm, is in series with a battery and a resistor. The battery charges the capacitor through the resistance, and the steady-state condition which is readied after charging is given by the equation

$$Q = CE$$

Where Q is the charge on the capacitor in coulombs, C is the capacitance in farads, and E is the voltage of the battery.

When placed in a sound field, the diaphragm moves and the capacitance varies. This in turn tends to vary Q, but the high value of R effectively prevents the charge from leaving the capacitor. Thus there is a change in the voltage across C which is given by

$$\Delta E \cong \Delta C$$

We have made a few simplifications here, but the explanation shows essentially what happens.

A cardioid or heart-shaped, pattern is the sum of two simpler ones. *Figure 2* shows how a figure-8, (or cosine) pattern combines with a constant, or omnidirectional, pattern to yield the familiar cardioid. It's a pure and simple geometrical construction shown in polar form, where O represents the angle of incidence to the microphone. Obviously, if we can make a set of capacitor elements exhibit *both* figure-8 and omnidirectional response at the same time, then by linear combination the output will be a cardioid. We are just about to show how this is done, but first we must relate the familiar elements of electrical circuits with their mechanical analogs (*Table 1*).

John Eargle is chief engineer of Mercury Sound Production

TABLE 1

Electrical Quantity	Mechanical Quantity
Voltage (E)	(Impedance Analogy) Force (F)
Current (1)	Velocity (V)
Resistance:	Damping (dash pot)
Capacitance:	Compliance:
Inductance:	Mass:

A simple example of an electro-mechanical impedance analogy is shown in *Figure 3*. Here, the series resonant electrical circuit is likened to a weight bobbing up and down on a spring (the dash pot represents the normal viscosity of air acting on the spring and weight tending to damp out their oscillation). Note that at resonance a low force results in a high velocity in the mechanical circuit, while a low voltage results in a high current in the electrical circuit. Stated differently, both systems exhibit low impedance at resonance.

Both systems have the same resonance curve, as shown in *Figure 4*, for a constant applied force or voltage. Note that this curve has *three* regions of interest. Below resonance the response falls off at 6 dB-per-octave. Above

Figure 1. How a capacitor mic converts sound pressure to an electrical signal. The capacitor is charge by a voltage source through a resistor: Q (charge) = CE. Sound pressure varies C which tends to vary Q. However, the high value of R prevents the charge from leaving the capacitor. Thus there is a change in voltage on C which is ΔE = Q/ΔC. This voltage then appears as a signal across R.

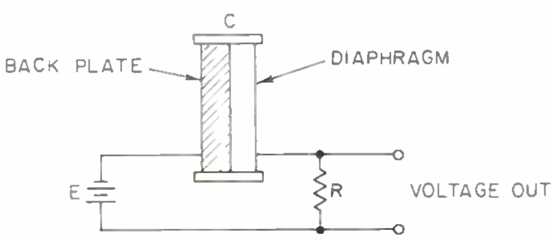


Figure 2. The construction of a cardioid from its two components. Thus, if we can make a mic element behave as an omni and a Figure-8 simultaneously, its output will have the directional characteristics of a cardioid.

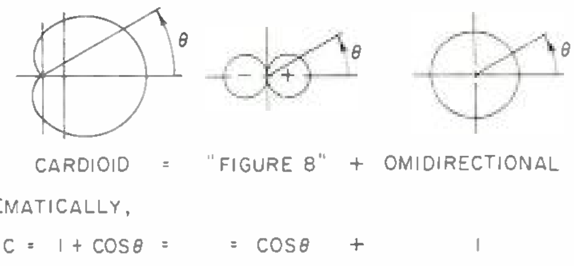
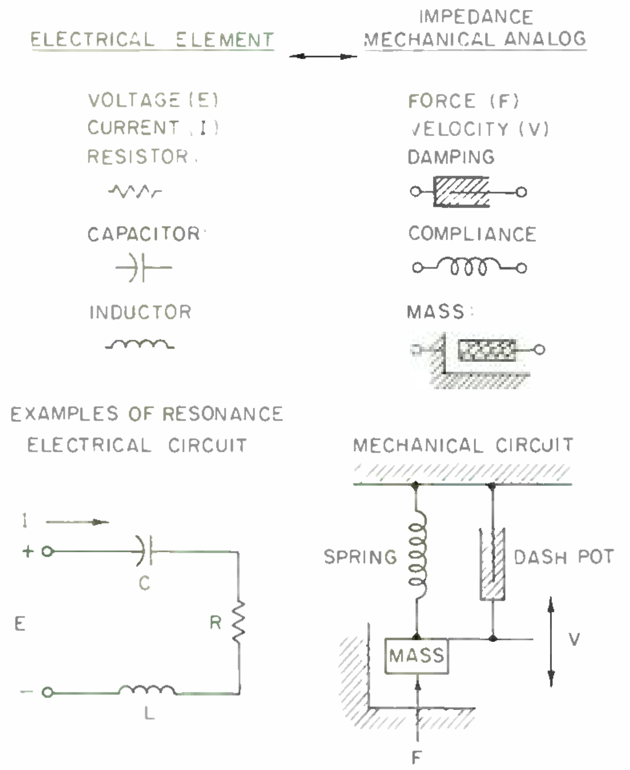


Figure 3. Examples of analagous electrical and mechanical circuits.

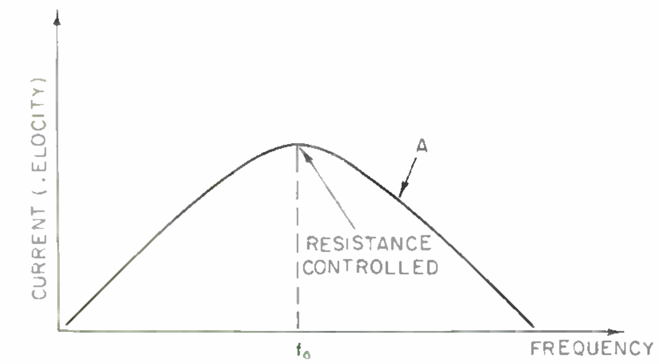


resonance the same thing occurs, while in the region of resonance, depending on how much damping there is, the response is fairly flat. There is another description of this; above resonance the systems are said to be *mass* or *inductance* controlled. That is, the reactance of these elements is far greater than that of the other elements. Below resonance the systems are said to be *compliance* or *capacitance* controlled. In the region of resonance (where the reactances largely cancel) the systems are said to be *resistance* controlled if there is enough damping or resistance present in the systems to flatten out the curve.

We are now ready to take a look at the compound diaphragm system which makes us a modern capacitor microphone (see *Figure 5*). Note the following characteristics of this arrangement:

1. There are two diaphragms on either side of the back plate.
2. The back plate is *perforated* by many fine holes.
3. There are additional holes on each side of the back plate (which do not go all the way through) which provide extra viscous damping for the diaphragms.

Figure 4. A resonance curve for constant voltage or force input for the circuits of Figure 3. The arrow at A points to the fact that above resonance, the system is mass or inductance controlled. However, below resonance the system is compliance or capacitor controlled. Both curves roll off at 6-dB per octave.



4. The two diaphragms and the back plate constitute *three* electrodes.

In the standard omnidirectional back-up, the three electrodes are powered as shown in *Figure 6(A)*. Here, the back plate is at ground potential, while both diaphragms are biased positively. Under this condition the microphone responds only to pressure variations as shown in *Figure 6(B)*, and this yields omnidirectional response. Furthermore, the system is operating well below resonance and there is a 6-dB/octave rise in diaphragm velocity with frequency as shown in *Figure 6(C)*. If the *velocity* of the

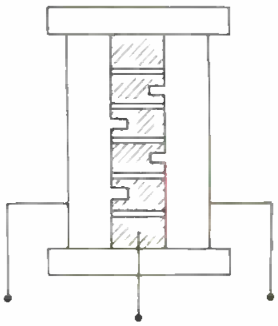
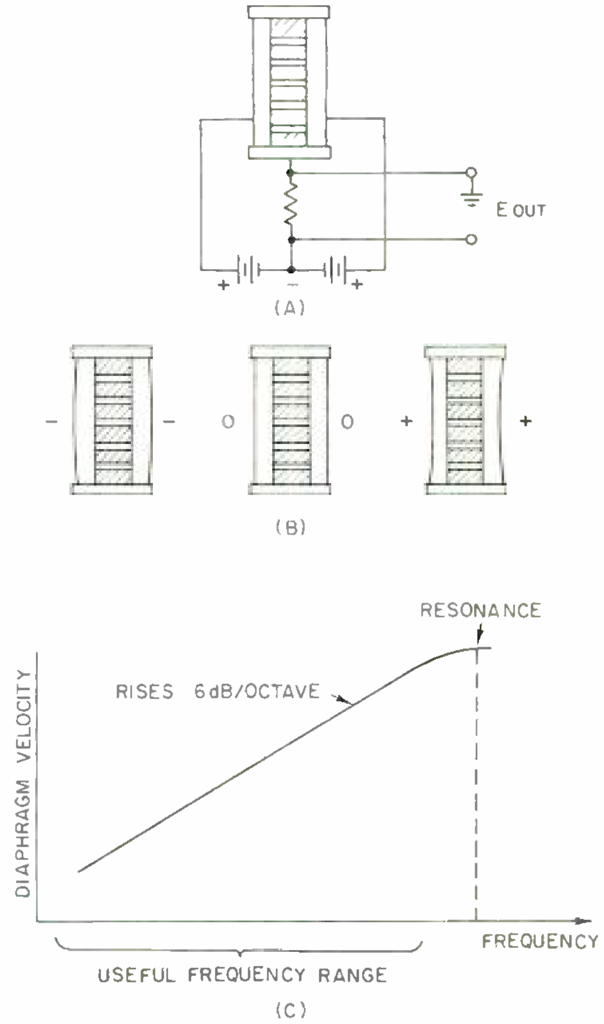


Figure 5. A standard capacitor mic (a U-67) looks like this. Notice that there are two diaphragms, one on each side; the back plate is perforated by many fine holes; there are additional holes provided in the back plate for purposes of damping; and the back plate and two diaphragms constitute three electrodes.

Figure 6. Here is the compound capacitor mic in its electrical connection for omnidirectional response. At (A) the electrical connection; at (B) this electrical connection is sensitive only to these motions of the diaphragms; at (C) diaphragms are compliance controlled.



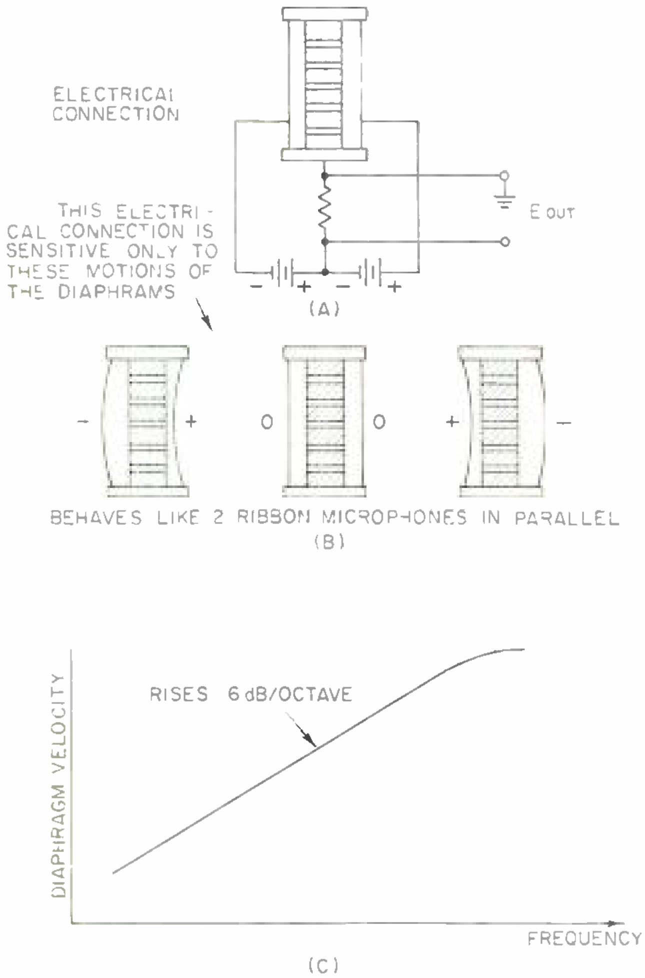


Figure 7. The same mic as in Figure 6 only connected in standard figure-8. At (A) electrical connection; at (B) this electrical connection is sensitive only to these motions of the diaphragms; at (C) diaphragms are resistance controlled in this mode, however, pressure difference between the two sides of the capsule rises with frequency.

diaphragm rises with frequency at 6-dB/octave, then the *amplitude* of the diaphragm displacement is constant with frequency. This is an elementary fact of calculus, and further explanation is beyond the scope of this article. What is important is to observe that the flat amplitude response in this mode of operation results in a flat electrical output over the operating range.

By a simple change in the polarity of one of the voltage sources in the compound capacitor array, we get a figure-8 response out of the array. As shown in *Figure 7(A),(B)*, this array produces an output voltage *only* when the two diaphragams are moving in parallel. This motion resembles the action of a ribbon microphone; at right angles to the capacitor array, the two motions *cancel* electrically, while pressure variations perpendicular to the diaphragms produce a maximum voltage output. In this connection, the array is acting as a pressure gradient microphone; that is, it responds to the *difference* between the instantaneous pressures existing on each side of the capacitor array. Because of the finite acoustical path length between the two sides of the array, there will *always* be a pressure gradient or difference between the two sides, and this pressure difference is a direct function of frequency as shown in Figure 7(C). Because of the many fine holes in the back plate there is a high degree of damping on the motion of the diaphragms in this pressure gradient mode. The mechanical circuit is operating in its *resistance controlled* mode, and it is this, in combination with the frequency

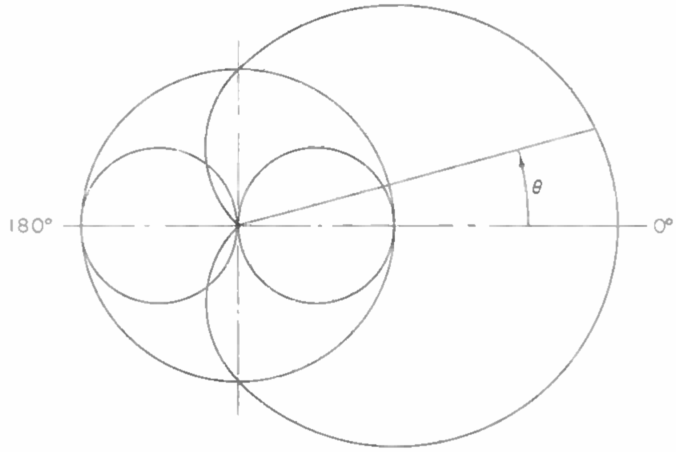
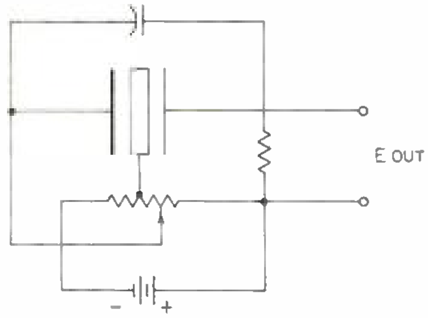


Figure 8. A summation of the two patterns of Figures 6 and 7.

Figure 9. A schematic of the variable-pattern Neumann M-49 microphone.



dependent pressure gradient, which results in a response which rises 6-dB/octave with frequency.

We have described two distinct motions of the compound capacitor array, one producing omnidirectional response and the other producing figure-8 response. Both of the motions are linear, and they can be added geometrically as shown in *Figure 8*. Since these two motions coexist in the compound capacitor array, we can combine them in any degree by simply providing a center-tapped potentiometer in the biasing network, as shown in *Figure 9*. This is a schematic diagram of the variable-pattern Neumann M-49. When the swinger of the potentiometer is at the positive end of the voltage source, the response is omnidirectional. When the swinger is at the center tap the response is cardioid, and when it is at the negative end the response is figure-8. There is a gradual transition from one pattern to another as the swinger moves from positive to negative.

I have described the fundamental workings of the compound capacitor array in modern capacitor microphones. Actual design work however goes far beyond these fundamentals. The effects of diffraction, material choice, and dimensions would all play a large part in determining the sound of a microphone. Their choice would in fact determine how well the principles I have outlined would work. ■

REFERENCE:

New High-Grade Condenser Microphones F.W.O. Bauch, Journal of the AES July 1953 Volume 1, Number 3.

40th AES Convention and Exhibition

SCHEDULE OF EVENTS

LOS ANGELES HILTON HOTEL

Monday, April 26, 5:00-7:00 P.M.—Welcoming Cocktail Party

REGISTRATION

Monday,	April 26—1:00 to 5:00 P.M. EXHIBITORS ONLY
Tuesday,	April 27—8:00 A.M. to 8:00 P.M.
Wednesday,	April 28—8:30 A.M. to 8:30 P.M.
Thursday,	April 29—9:00 A.M. to 5:00 P.M.
Friday,	April 30—9:00 A.M. to 5:00 P.M.

For Recording Studio Workshop
Registration will be at the door.

EXHIBIT HOURS

Tuesday and Wednesday,
April 27 and 28— 1:00 P.M. to 9:00 P.M.
Thursday and Friday,
April 29 and 30—11:00 A.M. to 5:00 P.M.
PACIFIC, WILSHIRE, GARDEN AND SIERRA ROOMS

DEMONSTRATION ROOMS

Mission, Cleveland, Washington, Detroit, Boston, Buffalo
St. Louis, Foy, New York, Dallas, Hartford

TECHNICAL SESSIONS

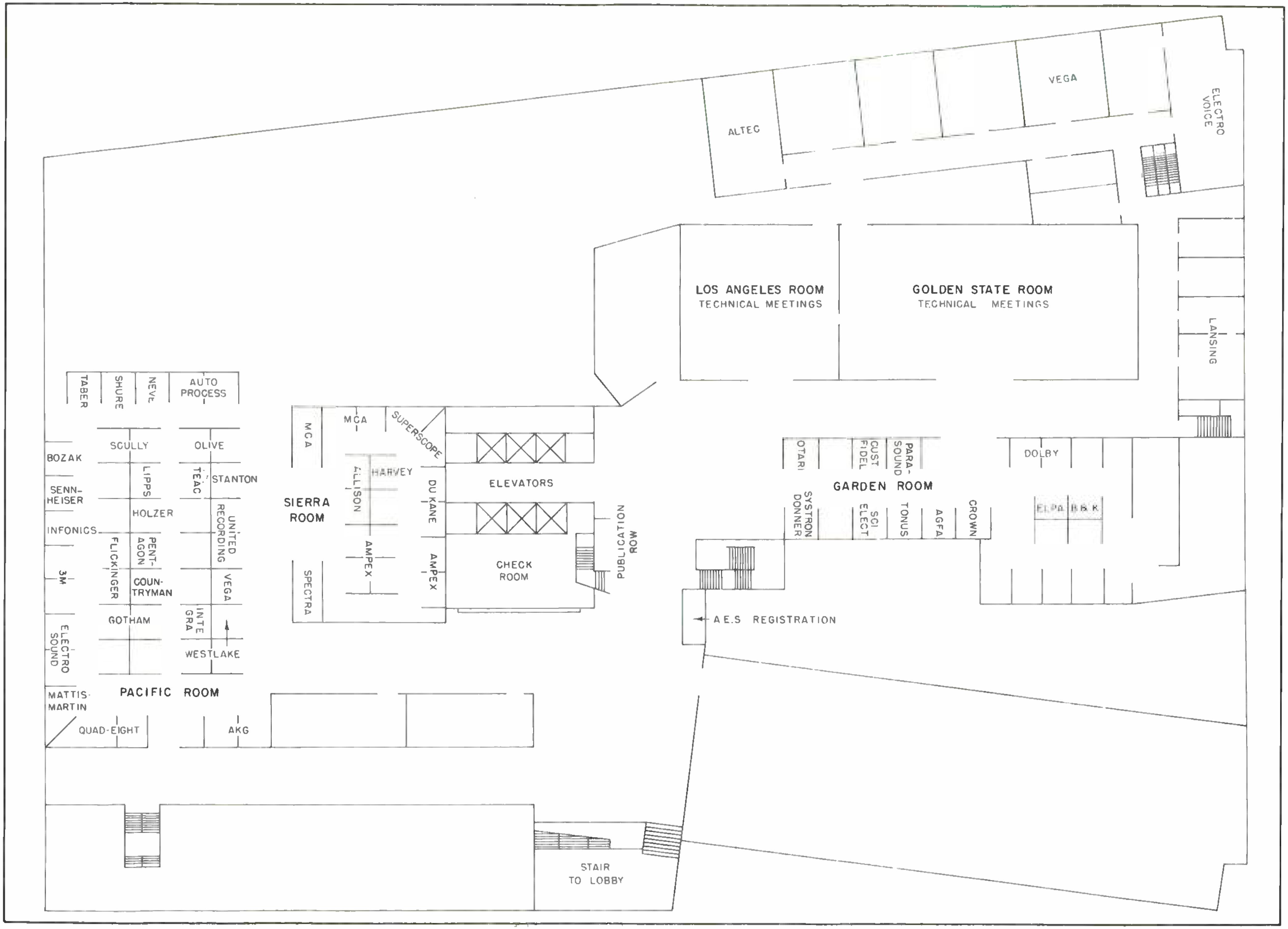
Tuesday,	April 27—9:30 A.M.	A & B
	2:00 P.M.	C
	7:30 P.M.	D
Wednesday,	April 28—9:30 A.M.	E
	2:00 P.M.	F & G
No Sessions Wednesday evening		
Thursday,	April 29—9:30 A.M.	H
	2:00 P.M.	J & K
Social Hour	—7:00 P.M.	Los Angeles Room
Awards Banquet	—8:00 P.M.	Golden State Room
Friday,	April 30—9:30 A.M.	L
	2:00 P.M.	M
	7:30 P.M.	N

Note: Session N—Recording Studio Workshop
No Registration Fee

LADIES ACTIVITIES

A program of activities is being planned. Ladies may join the hostess and her committee at 9:00 A.M. each day for coffee and sweet rolls before commencing the day's activities. Suite number will be posted.

Ladies Committee: Mrs. William Brandt
Mrs. Hugh S. Allen, Jr.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LANSING
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TECHNICAL MEETINGS
GOLDEN STATE ROOM
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GARDEN ROOM
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B & K
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UNITED RECORDING
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3M
COUN-TRYMAN
VEGA
GOTHAM
INTE GRA
ELECTRO SOUND
WESTLAKE
MATTIS-MARTIN
QUAD-EIGHT
AKG
STAIR TO LOBBY

SESSION A

Tuesday, April 27, 1971, 9:30 A.M.
Golden State Room

MAGNETIC RECORDING AND REPRODUCTION

Chairman: KEITH JOHNSON,
MCA Technology,
North Hollywood, California

A High Energy Cassette Tape With Compatible Magnetic Properties—D. A. Eilers and E. W. Reed, 3M Company, Magnetic Products Division, St. Paul, Minnesota

A Servo Controlled Recorder For Studio Applications—Harold T. Schneider, Philips Broadcast Equipment Corp., Montvale, New Jersey

Chromium Dioxide Audio Tape—Klaus E. Naumann, Memorex Corporation, Santa Clara, California

The Fringing Response Of Magnetic Reproducers At Long Wavelengths—J. G. McKnight, Ampex Corporation, Redwood City, California

Musicassette Quadrasonic: Tape Record Compatibility—E. R. Hanson, North American Philips Corp., New York, New York

SESSION B

Tuesday, April 27, 1971, 9:30 A.M.
Los Angeles Room

AUDIO MEASUREMENTS AND NOISE CONTROL

Chairman: CHARLES HORTON,
Altec, Anaheim, California

The Application of Impulse Measurement Techniques To The Detection of Linear Distortion—Alfred Schaumberger, Georg Neumann GmbH Electroacustic, W. Berlin, Germany (translated and presented by Stephen F. Temmer.

30 Band 1/3 Octave Spectrum Analyzer—Daniel N. Flickinger, Daniel N. Flickinger & Associates, Inc., Hudson, Ohio

A 1/3 Octave Real Time Analyzer Using Calibrated Meter Readout—Victor M. Hall and J. Earl Chapman, Communications Company, Inc., San Diego, California

Instant RT60—Victor M. Hall and J. Earl Chapman, Communications Company, Inc., San Diego, California

Airport Noise Management—John K. Hilliard, Ramberg & Lowrey, Architects (Acoustics and Noise Control Division), Santa Ana, California

Application of Acoustically Terminated Tube for The Measurement of Horn-Loudspeaker-Driver Characteristics and Comparison of Distortion Measurement Methods—Bart N. Locanthi, Ludwig W. Sepmeyer, Independent Consultants, Los Angeles, California

SESSION C

Tuesday, April 27, 1971, 2:00 P.M.
Golden State Room

DISC RECORDING AND REPRODUCTION

Chairman: STEVEN A. GUY
Location Recording Service,
Burbank, California

A New Dynamic Feedback Stereo Cutter-Head With Associated Solid State Driving System—Howard S. Holzer, Holzer Audio Engineering Company, Los Angeles, California

Further Improvements In Performance of the Westrex 3D-II Stereodisk System—Frank E. Pontius, Westrex, Beverly Hills, California, and John P. Jarvis, Consulting Engineer, Northridge, California

Groove Echo In Lacquer Masters—Daniel W. Gravereaux and Benjamin B. Bauer, CBS Laboratories, Stamford, Connecticut

Development of Skew-Sampling Compensator for Tracing Error—Shigetaka Washizawa, Tomofumi Nakatani and Takeo Shiga, Nippon Columbia Co., Ltd., Kawasaki, Kanagawa, Japan

Analysis of Crosstalk in Stereo Discs—Bernhard W. Jakobs, Shure Brothers, Inc., Evanston, Illinois

The Education and Tribulations of a Precursory Disc Recording Engineer—Robert Callen, Glen Glenn Sound Company, Los Angeles, California

A Console Approach to Quad-Sound Disc Mastering—Michael S. Levey, The Custom Fidelity Company, Inc., Hollywood, California

SESSION D

Tuesday, April 27, 1971, 7:30 P.M.
Golden State Room

STUDIO RECORDING TECHNIQUES TODAY

Chairman: HUGH P. STARK,
Elektra Records, Los Angeles, California

On The Processing of Two and Three-Channel Program Material for Four-Channel Playbacks—John Eargle, Mercury Record Productions, Inc., New York, New York

Studio Recording Techniques of a Small Recording Studio—Philip Kaye, ABC Dunhill Records, Los Angeles, California

Dual-Triphonic Matrix Stereo System—Takeo Shiga, Michio Okamoto, Nippon Columbia Co., Ltd. and Duane H. Cooper, University of Illinois, Urbana, Illinois

Two Ears, One Mind, and the Stereo System—David Thuesen, Poppi Recording Studios, Hollywood, California

Design Considerations for a New Studio Complex—John Mosely, Command Studios, London, England

A Stereo-Quadraphonic System—B. B. Bauer, Daniel Gravereaux and Arthur J. Gust, CBS Laboratories, Inc., Stamford, Connecticut

On The Acoustics of Multi-Track Recording Studios—Michael Rettinger, Consultant in Acoustics, Encino, California

SESSION E

Wednesday, April 28, 1971, 9:30 A.M.
Golden State Room

TRANSDUCERS

Chairman: AUSTIN J. BROUNS,
Advanced Technology Center, Inc.,
Dallas, Texas

A High Quality All Horn-Type Transducer—Raymond Newman, Electro-Voice, Inc., Buchanan, Michigan

Improved Measurement of Loudspeaker Parameters—J. Robert Ashley and M. D. Swan, University of Colorado, Colorado Springs, Colorado

A Mobility Analysis of the Closed Box and Reflex Loudspeaker Enclosures—Wayne M. Schott, Zenith Radio Corporation, Chicago, Illinois

Transducers and Industrial Espionage—Leo Jones, Saber Laboratories, Inc., San Francisco, California

Gradient Loudspeaker for Low Frequencies—W. L. Hayes, Altec, Anaheim, California

SESSION F

Wednesday, April 28, 1971, 2:00 P.M.
Golden State Room

SOUND REINFORCEMENT AND ARCHITECTURAL ACOUSTICS

Chairman: CHARLES A. STANDIFORD,
Altec, Anaheim, California

The World's Most Powerful Sound System—Robert E. Reim, Hannon Engineering, Inc., Los Angeles, California

Blossom Music Center—Daniel N. Flickinger, Daniel N. Flickinger and Associates, Hudson, Ohio

The Alteration of the Reverberation Times in a Small Theater and a Concert Hall Using Loudspeaker Equipment—Ernst-Joachim Voelker, Radio and TV Hessischer Rundfunk, Frankfurt, Germany

A Complex Sound System Equalization—G. R. Thurmond, McCandless Consultants, Inc., Austin, Texas

Sound Reinforcement Systems for the Modern High School and College Gymnasium Complex—Albert A. Huff, Hannon Engineering, Inc., Los Angeles, California

Acoustical Design of Poppi Studios—Ronald L. McKay, Bolt, Beranek and Newman, Inc., Canoga Park, California

SESSION G

Wednesday, April 28, 1971, 2:00 P.M.
Los Angeles Room

AUDIO IN AM, FM AND TV BROADCASTING

Chairman: DONALD C. McCROSKEY,
American Broadcasting Co.,
Hollywood, California

The Dorren Compatible Four-Channel FM Broadcast System—James Gabert, K101, San Francisco, California

A Tape Cartridge Recorder System Employing Integrated Circuit Logic and DC Servo Motor Drive—Ron DeBry, Garon Electronics (A Division of Visual Electronics), Sunnyvale, California

A Sound Augmentation System—Donald C. McCroskey, American Broadcasting Company, Hollywood, California

The Measurement and Control of Loudness Levels of Broadcast Sounds—E. L. Torick, R. G. Allen, P. Milner, B. B. Bauer, CBS Laboratories, Stamford, Connecticut

Panel Discussion: The Control of Loudness in Broadcasting—

Moderator: **Donald C. McCroskey**, American Broadcasting Company, Hollywood, California

Panel: **Kenneth Erhardt**, National Broadcasting Company, Los Angeles, California
Wallace Kabrick, Gates Radio Company, Quincy, Illinois
Joseph D. Kelly, Glen Glenn Sound, Hollywood, California
Emil L. Torick, CBS Laboratories, Stamford, Connecticut

SESSION H

Thursday, April 29, 1971, 9:30 A.M.
Golden State Room

SIGNAL CONTROL—SYSTEMS

Chairman: SHELLEY HERMAN
Allison Research, Inc.,
Hollywood, California

A Different Approach to Multi-Channel Home Recording Systems—John Mosely, Command Studios, London, England and Lou Lindauer, Automated Processes, Farmingdale, New York

A New Disc Mastering Console Designed for Flexibility—Robert M. MacLeod, Jr., Artisan Sound Recorders, Hollywood, California

Double Sound System—Stan Horobin, Supervisor, Audio Operations, Canadian Broadcasting Corporation, Toronto, Canada

Sound Effect Systems, Simple and Complex—David L. Klepper and Vincent Piacentini, Bolt, Beranek and Newman, Inc., New York, New York

A Functional Review of the New Automated 16 Track Recording Console at Capitol Records Studio A Hollywood—Deane E. Jensen, Quad Eight Sound Corporation, North Hollywood, California

Portable Mic-Mixdown Console Kit—B. J. Losmandy, Opamp Labs, Inc., Los Angeles, California

SESSION J

Thursday, April 29, 1971, 2:00 P.M.
Golden State Room

ELECTRONIC MUSIC

Chairman: PAUL BEAVER
Parasound, Inc.,
Los Angeles, California

The Electrical Design and Musical Applications of an Unconditionally Stable Combination Filter/Resonator—Dennis Colin, Tonus, Inc., Newton Highlands, Massachusetts

Synthesis of Moving Sound Sources—Robert B. Easton, Parasound, Inc., Los Angeles, California

SESSION K

Thursday, April 29, 1971, 2:00 P.M.
Los Angeles Room

AUDIO AND MEDICINE

Chairman: DAVID ANNETT
Stanford University,
Stanford Medical Center,
Stanford, California

The Origin and Power Spectrum of Fetal Heart Sounds—Dr. Louis Bartolucci, San Francisco, California

A Doppler Ultrasonic Method for Monitoring Fetal Cardiac Activity—Paul R. Goldberg, Project Manager, Ultrasound Instrumentation for Smith Kline Instruments, Palo Alto, California

A New Approach for Testing the Hearing of the Newborn—Clinton O. Jorgensen, Beckman Instruments, Inc., Fullerton, California

Spectral Analysis of Vascular Murmurs—E. G. Tickner and A. H. Sacks, Palo Alto Medical Research Foundation, Palo Alto, California

Characteristics of Acoustical Holography as Applied to Medicine—Byron B. Brenden, Holosonics, Inc., Palo Alto, California

SESSION L

Friday, April 30, 1971, 9:30 A.M.
Los Angeles Room

AUDIO INSTRUMENTATION

Chairman: BOB BEAVERS
Altec, Anaheim, California

Measurement of Microphone Characteristics—David G. Arnold, Shure Brothers, Inc., Evanston, Illinois

Wideband Microphone Calibrator—Ronald Brown, Advanced Technology Center, Grand Prairie, Texas

Low Power Drain Instrument Preamplifier—Robert F. Downs, OAS/Western, Ocean and Atmospheric Science, Inc., Santa Ana, California

Determination of Loudspeaker Signal Arrival Times—Richard C. Heyser, California Institute of Technology Jet Propulsion Laboratory, Pasadena, California

Group and Phase Velocity Requirements for Audio Systems—J. R. Ashley and T. A. Saponas, University of Colorado, Colorado Springs, Colorado

Oscilloscope Adaptor Presents Twenty-Four Simultaneously Different Voltages or Events for Comparison—J. Earl Chapman and Victor M. Hall, Communications Company, Inc., San Diego, California

SESSION M

Friday, April 30, 1971, 2:00 P.M.
Los Angeles Room

SIGNAL CONTROL—CIRCUITRY

Chairman: ROBERT A. BUSHNELL
Bushnell Electronics Corp.,
Van Nuys, California

A Variable Decay Reverberation System—Johan Van-Leer and John Windt, Quad-Eight Sound Corporation, North Hollywood, California

The Foster Freqy—A New Tool in Audio—Don Foster, Inventronics—Division of Amos Productions, Canoga Park, California

Electromechanical Line Transducer—G. Kirby Miller, GTE Sylvania, Inc., Mountain View, California

An Audio Delay System Using Digital Technology—Barry Blesser and Francis F. Lee, Massachusetts Institute of Technology, Cambridge, Massachusetts

SESSION N

Friday, April 30, 1971, 7:30 P.M.
Golden State Room

A RECORDING STUDIO WORKSHOP

Chairman: WILLIAM L. ROBINSON
Sunset Sound Recorders,
Hollywood, California

A Recording Studio Workshop—Bill Lazerus, Recording Workshop Participant, Senior Mixer, Sunset Sound Recorders; Brian Ingoldsby, MCA Recording Studios, Recording Studio Participant; another to be announced later.

Three of the top recording engineers will present a live recording session, a mix-down session from sixteen track. A detailed explanation will be given for the use of signal processing equipment, microphone techniques, and the use of specialized equipment. A question and answer period will follow each phase of the workshop.

PEOPLE, PLACES, HAPPENINGS

Friends of Rupert Neve of England will be interested to learn that they have formed a new company in the United States—*Rupert Neve Incorporated*. Their facilities are located within easy road or rail travel of New York City and they look forward to welcoming many old and new friends to their premises. A new Canadian Sales and Service Company has also been formed and is located in Toronto, Ontario. Their highly qualified professional design and audio engineers, now this side of the Atlantic, are ready to offer even more efficient service to their customers. For information contact Dave Neve, Rupert Neve Incorporated, Berkshire Industrial Park, Bethel, Connecticut 06801. Phone 744-6230, or Rupert Neve of Canada Limited, P.O. Box 182, Etobicoke, Ontario, Canada.

Ultra Sonic Recording Studios had an open house for the industry at their new Hempstead, N.Y. studios on February 26th. It was a gala affair attended by most of the recording and allied people in the area. The new studios are very impressive and include a number of firsts in the Long Island area as well as in the industry. db will have a story on this new facility shortly. One interesting note: the premises of the studio was formerly the main office of a large stock brokerage firm. Maybe it is trying to tell us something?

A look into the future of i.c. construction is provided by an announcement that **Philips Research Laboratories** in Eindhoven has a new process of i.c. mounting that is believed highly suited for automation. Contact patterns are first made on an inexpensive flexible plastic tape. Then flip chips are mounted on this tape and a final measuring station discards the poor chips. Finally a header with pins adapted to the product converts the i.c.'s to rugged components for use on conventional printed circuit mounting. Technical details are soon to be published by Philips.

An inexpensive method of background noise reduction said to considerably improve f.m. reception has been announced by Dolby Laboratories. Recent experiments in London and Chicago have estimated that the improvement is equivalent to that obtained by an increase in transmitter power of 5–20 times, while actual area coverage of a station can be more than doubled by use of the system. Implications for broadcasters and listeners are of extreme importance.

Derived from the Dolby B System, the technique is already in use for home tape recording and playback of commercially-recorded cassette tapes. At present, about a dozen companies in the United States, Europe, and Japan are licensed to manufacture products incorporating the system with many more currently making arrangements for licensing.

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mca tech

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GAUSS

World leader in the manufacture of high-speed tape duplicating systems, speakers and professional recording equipment.

LANGEVIN

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ELECTRODYNE CORPORATION

Engineering, development and manufacture of professional custom audio control consoles and components.

OPTIMATION

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UNIVERSAL DATA ACQUISITION COMPANY

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