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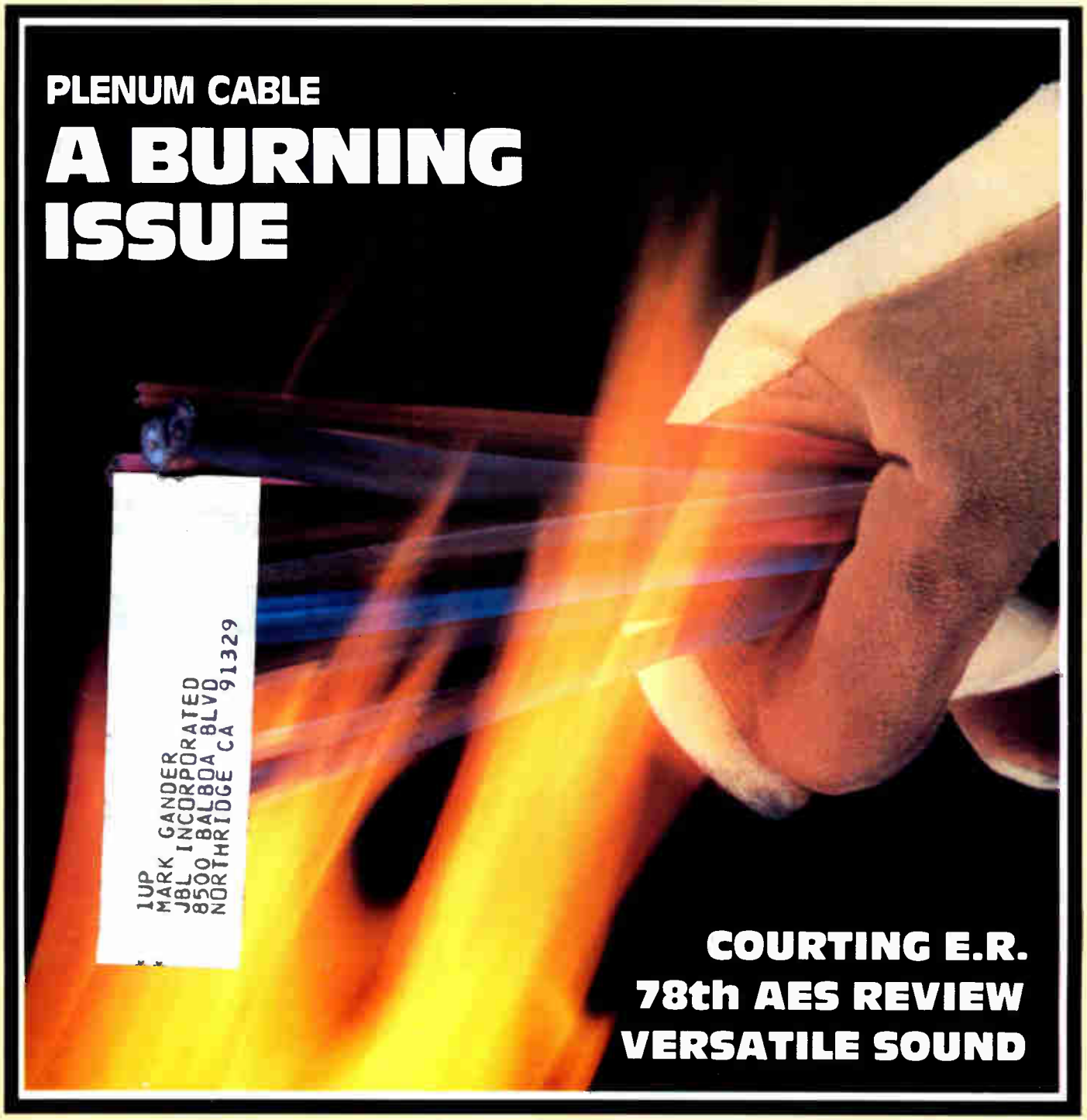
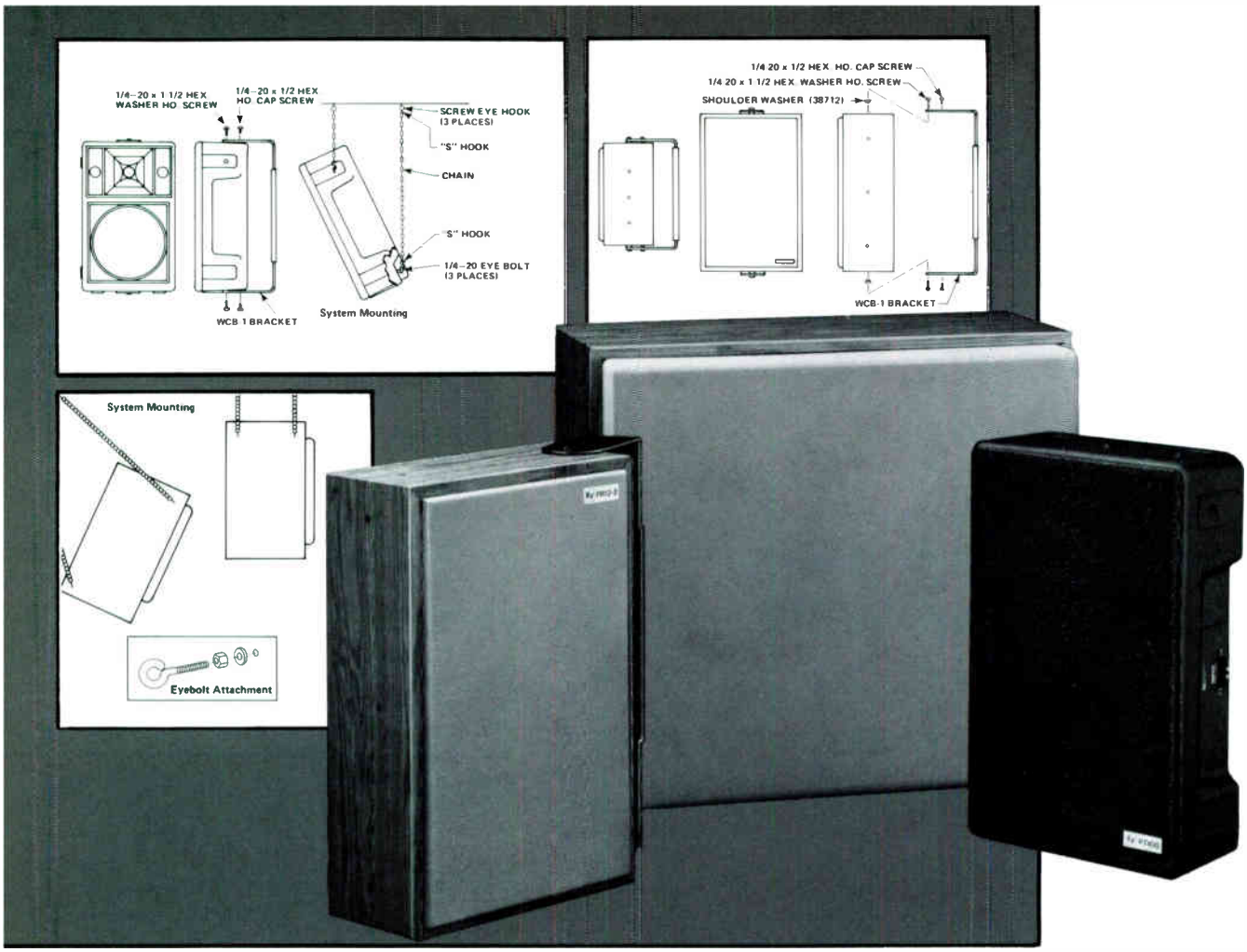
JUNE 1985





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SOUND & COMMUNICATIONS

JUNE 1985 **Volume 31 #6**

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COLUMNS

DEPARTMENTS

ON THE COVER

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IDEAS & VIEWPOINTS

CAN THE SMALL CONTRACTOR SURVIVE?

by Chris Foreman

Probably, but survival may not be pleasant.

Recently *Communications Week* stated, "It's no longer a secret that the interconnect industry is going through some tough times. Most companies are managing to deal with it one way or another and some are even making a few bucks. But more and more interconnect owners are deciding that they've had enough and have decided to sell their companies."

According to *Communications Week*, large numbers of even medium size interconnects, those with between $2 million to $5 million per year in sales, are being bought out or looking for a buyer. One industry official is reported as saying that "the current trend of market concentration could last another 18 to 24 months."

Market concentration implies the end for a lot of small and medium size interconnects. Some will survive being swallowed up by the giants.

Stagnation in the Sound Contracting Business

I just don't see much new in the sound contracting business. Some contractors are doing very well but, in my experience, they are mostly medium and large size companies (well over $1 million in yearly gross sales). Most small contractors (a yearly gross under $1 million) seem to me to be in about the same place they were five to ten years ago: doing small church sound systems and nursing home communications systems and struggling to break even.

Do Marketplace Differences Lead to the Same Path?

Carterphone and the AT&T breakup created new markets in the telephone business. But now interconnect is apparently in the midst of a shakeout.

The only new markets in the sound business in the last fifteen years or so (concert sound, musical sound, and disco) have either matured to a plateau or have declined. Yet the result is the same for small interconnects and small sound contractors, a struggle to survive.

Reading Faces

I always say that those who say they can't read minds have never learned to read faces. And those who say they can't predict the future have never learned to read the past. Clues to the future of sound and communications contracting are all around us in the present, as well as in the past.

One clue for the future of the sound contracting business comes from its recent past. A lot of small contracting businesses got their start during the heyday of rock- and-roll in the late '60s and early '70s. One contractor I know started out as a "pro sound" shop who built and rented portable rock and roll sound systems and later found an opportunity in the permanent installation market in nightclubs and discoteques. When the portable sound system business began to decline, this contractor turned his experience to a growing segment of the church sound market who wanted music-capable sound systems for their gospel and popular music services and for their broadcast services. Eventually, this contractor dropped his portable systems business altogether and moved full-time into the permanent installation business, concentrating on entertainment facilities.

Another clue comes from the growing number of sound contractors who have added interconnect divisions (and vice versa) and from those contractors who have added the ability to do security, alarm, systems and other electronic systems.

In the first example, a contractor changed its marketing focus to survive changes in the marketplace. In the second example, diversification was a route to survival. The key in both examples is *building on experience and skills already present in a company* to meet changes in the marketplace.

Dodging the Giants

If you're a large interconnect, you may well be able to compete successfully with the BOCs, AT&T and the independent "giants." You'll have the right product lines and a growing customer base and your reputation will already be established to the point where you can persuade new prospects that you can meet their needs for years to come.

(continued on page 11)

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ILLUMINATING NEW MARKETS

by Jeffrey Schwartz

A group of manufacturers, most notably Sennheiser Electronic Corporation, is literally illuminating a new market area for sound contractors with wireless transmission systems based on infrared pulses instead of radio waves. The invisible light bursts have already been used to guide museum visitors through exhibits, to give jurors high-quality reproduction of recorded evidence, and to allow airplane passengers the freedom to walk about the cabin while listening to program material through wireless headphones.

According to Horst Ankermann, vice president of engineering at Sennheiser, infrared sound transmission has advantages over radio frequency which is used for the same purpose. "When using infrared signals for sound transmission you are not causing interference with anyone else and you are not interfered with by other radio services," said Ankermann. There is also no licensing problem with the FCC because the transmission stays within the room and therefore does not affect other transmitted services. "The fact that it stays within one room sometimes is a big advantage if confidentiality is required," said Ankermann. Since infrared signals cannot penetrate walls, a confidential signal could not leave the room.

"We use this technology in churches, theaters, classrooms, and other public gathering places—wherever there is a need for good intelligibility and where sound has to travel over a certain distance. The system is a great advantage over purely acoustical transmission of signals. With radio frequency, you would have to assign a large number of channels which are simply not available. With infrared systems, you have an unlimited number of systems functioning within the same building, as long as there are the walls in between each system, they won't interfere with each other.

"Infrared light, light you can't normally see, is the warm side of the visible spectrum. And while it is not visible, it is light and it behaves like light. This means that the amount of infrared light being used for data or speech transmission depends on the room size; just as the amount of light needed to light a room depends on room size."

A transducer converts sound waves to electricity which enters a diode. Infrared light is emmited when electrically disturbed. A photocell takes the light particles and converts them to electricity. The energy is converted back to sound with an amplifier. While any type of light could achieve similar technology, infrared is less distracting than conventional light; and unlike untraviolet light, infrared is safe.

The large theater systems can be found in any major theater in the U.S., accoding to Ankermann. Sennheiser distributes its theater systems through Sound Associates. "That doesn't mean that the average sound contractor can't install it," said Ankermann, "but they will be advised if they call us to get in touch with Sound Associates who will work together with them in order to specify the system correctly. Sennheiser's national distributor for church installations is Siemens Hearing Instruments which is a large company that specializes in assistance devices for the hearing impaired.

Sennheiser also offers a multi-channel system for simultaneous translation of various languages, to be used in international conferences. The system can use up to 12 channels, with each channel carrying a frequency. This multi-channel concept is also in use at EPCOT center, a part of Disney World in Orlando, FL. The multi-channel infrared system there is used to supply foreign language explanations to the foreign visitors.

Court rooms are installing stereo systems either in portable or fixed installations in order to play tapes to the jury. For instance, jurors who recently acquitted John Delorean of cocaine trafficing charges, used the Sennheiser infrared system to hear FBI tapes of what had been alleged to be transactions. "The reason that they're using stereo is that the intelligibility is so much better if you make a recording in a noisy room like a cocktail party. If you only want to hear a conversation, it is almost necessary to record in stereo, said Ankermann.

Transmission of heartbeat signals is used in medical schools where the transmitter is used as a stethoscope, and the students, each equipped with headphones, can hear the patient's heartbeat.

Ankermann explained that basically by using infrared audio transmission, one can do anything that is done with radio frequency. "From a quality point of view it is identical to either FM or pulse code modulation, and frequency response and noise figures are identical to those achieved with radio frequency transmissions.

"An infrared light audio system can be looked at as something like the reverse of a wireless microphone," said Ankermann. "There you have a portable transmitter and a stationary receiver, while where you have a wireless headphone system and a stationary transmitter."

Infrared transmission system assists two hearing impaired committee members. **Photo courtesy of Siemens**

NEWSletter

ACOUSTICAL SOCIETY OF AMERICA NOW ACCEPTING PAPER ABSTRACTS

Deadline for submitting papers to the 110th Meeting of the Acoustical Society of America is July 19, 1985 for receipt of abstracts. The 110th ASA Meeting will be held at the Hyatt Regency Hotel in Nashville, TN, November 4 to 8. Contributions are welcome in all branches of acoustics.

SHURE BROTHERS CELEBRATE 60TH ANNIVERSARY THIS YEAR

Shure Brothers Incorporated of Evanston, IL recently celebrated its 60th anniversary. The company, known for its professional microphones, also manufactures products ranging from mixers and teleconferencing equipment to high-fidelity consumer phonograph cartridges.

JERON ELECTRONIC SYSTEMS CELEBRATES 20TH ANNIVERSARY

Jeron Electronic Systems Inc. of Chicago celebrates its 20th anniversary this month. Jeron manufactures intercom systems for apartment buildings and town houses, tenant controlled apartment security systems, emergency call for health facilities and hospital signalling equipment.

FCC APPROVES ADVANCED CENTREX FEATURES IN RULING

The Federal Communications Commission has approved Centrex's inclusion of several controversial features including automatic route selection. The ruling states that customer-originated class-of-service changes are also permissible as tariffed adjuncts to basic service. The North American Telecommunications Association (NATA) originally filed the complaint claiming it violated the Computer II ban on Bell operating companies.

FCC ADOPTS ANSI GUIDELINES FOR EVALUATING RF EXPOSURE

The Federal Communications Commission has ammended its environmental rules and adopted the ANSI C95.1-1982 guidelines to provide for the evaluation of human exposure to radiofrequency (RF) energy emitted by FCC regulated facilities and operations. Effective Oct. 1, the FCC will treat modifications in exhisting facilities as "major" actions if the facility in question would expose workers of the general public to levels of RF radiation exceeding identified health and safety guidelines as stated in the standard.

WHEN IT'S TOO COLD FOR A QUORUM...

Alaska Governor Bill Sheffield has proposed a bill which would establish the legal use of teleconferencing for governmental administrative bodies, except for other legislative votes. House Bill No. 140 would allow any state or local agency in Alaska to accept material presented by means of audio, video, or computerized media as acceptable and relevant for attendance and participation in public meetings, though state legislators are still required to show up to vote.

DELTALAB AND ADA SETTLE PATENT SUIT AFTER 13 MONTHS

DeltaLab--now the Pro Audio Division of ADS--has settled its patent infringement suit against ADA Signal Processors after the US Patent Office rejected an ADA challenge to the validity of the patents for Adaptive Delta Modulation, according to both Richard E. DeFretias, vice president of ADS Pro Division and DeltaLab founder, and David Tarnowski, ADA president. Specific terms were not disclosed, but it was announced that ADA has taken licenses on four DeltaLab patents. A sonsent judgement was filed in Federal District Court in San Francisco, it was announced at AES. During the proceedings, ADS acquired some of the assets of the former DeltaLab Research, including the patents.

COMPU-TEL INTERCONNECT BUYING CONSORTIUM TAKES OFF

More than 70 interconnect companies ranging in annual sales from $2 million to $15 million have sent letters of intent to join Compu-Tel, a new Coral Gables, FL-based buying consortium, the company reports. The consortium, aimed at giving combined clout and national presence to smaller interconnect companies, requires no up-front investment on the part of interconnect companies, according to Compu-Tel.

EVERYTHING WAS THERE BUT THE ATTENDEES...

When the United States Telecommunications Suppliers Association (USTSA) organized the second annual Intelexpo at Washington, DC's Convention Center, it was advertised as "A World Class Exposition and Telecommunications Event." Turnout predictions were enthusiastic, but justified by the expo's proximity to the heavily registered International Telecommunications Union expo. But despite an excellent line-up of panelists, turnout was poor, a fact its organizers have accepted. They attribute the lack of attendance to a saturation in the exhibition market, though there had been no move to cancel the next scheduled Intelexpo at press time.

YAMAHA REORGANIZATION AIMED AT PROFESSIONAL MARKETS

Yamaha International Corporation has announced a major reorganization of its divisions and staff, including a renaming of its Combo Products Division to reflect the growth of professional products. The newly re-named Professional Products Division contains two marketing areas: Professional Audio and Professional Music products. Bill Hinely remains division manager. Bob Shomaker is national sales manager of pro audio and Gerry Tschetter, assistant national sales manager; Bob Davis, marketing manager.

MITEL PURCHASE WOULD PUT BRITISH TELECOM AMONG INDUSTRY HEAVIES

At press time, the Canadian Government was reviewing a bid by British Telecom to buy a controlling interest of Mitel Corporation, a Canadian manufacturer of high-quality PABXs. If approved, the move and British Telecom's recent purchase of Toronto's CTG Inc. interconnect company would clearly put the operator of the UK's telephone network among the exclusive ranks of Telephone heavyweights: AT&T, MCI, et al. Analysts say the move could preclude a major assault on the US market, fueled by a desire to be in on future datacom markets via digital PABX.

LUCASFILM'S THX MOVIE THEATER SOUND SYSTEM ON THE INCREASE

Lucasfilm's THX movie theater sound system has been seeing increasing installations. Most recently, it was installed at famed Manns Chinese Theatre in Hollywood, using a JBL computer program to optimize placement and number of various system components used. It costs a 35-millimeter facility between $16,000 and $27,000 to upgrade its sound system to a THX, a nd between $16,000 and $45,000 for a 70-millimeter facility. So, the trend is increasing evidence that sound sells.

ANCHA ELECTRONICS TOPS OFF HOOSIER DOME

Ancha Electronics of Elk Grove Village, IL, has added significantly more punch to what is said to be the largest sound installation job to date-the $1.2 million sound system in the Hoosier Dome, Indianapolis, IN. One hundred E-V SC100 horns and 18 28T drivers were added recently to the upper concourse level. The club level got 100 surface ceiling-mounted speakers. Ancha added an emergency sound system for the lower and upper consourse, powered by a UREI 950 noise control amplifier equipped with a sensing microphone to ensure vital messages are broadcast louder than the crowd noise. A coaches' intercom system between the field and team observers in the press box also was installed.

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DIGITAL DEVELOPMENTS

by Chris Foreman

My experience with digital audio started with an early "time delay" (or "signal delay") device from Altec. It was a heat-producing monster with lots of plug-in memory cards and it cost over $8,000. Now, of course, we have very respectable time delay devices for a tenth of that cost in much smaller packages. Digital tape recording has taken a similar path (although I haven't yet been offered an $800 digital tape recorder).

First Hints of Things to Come

But lower prices and improved performance are not exactly newsworthy. What is important is the implication that lower-cost, higher-performance digital technology will begin to invade new areas of audio.

Anybody who follows the music business knows that digital technology has its roots well planted there. Attempts at standards, like MIDI, show that digital technology in music is well beyond its infancy and has actually reached the beginnings of *maturity.*

Digital recording standards are beginning to take hold and one company now has an apartly fully digital mixing console to support the newer digital recording decks.

Last month we published the sound and communication industry's first lab test report on a fully digital power amplifier from Peavey. I have always found it remarkable that so many power amplifier designs keep turning up when the power amplifier is perhaps the closest thing to perfection in the whole audio chain. Yet, the designers' efforts have paid off. Here we have the first generation of what will almost certainly become the standard type of power amplifier in the future.

Digital Telephony

Telephones are going digital, too. It's clear that, in a few years, all telephones (with the possible exception of "plain vanilla" residential phones) will be digital. As we recently reported, a 56 kbit public switched (digital) network has been announced by AT&T Communications. The Bell Operating Companies are beginning to develop local versions. It's my understanding that 56 kbits can ride on a twisted pair of copper wires. This seems to indicate that the existing copper telephone network, or at least a substantial portion of it, can be converted to switched digital service. Digital phones now have to convert back to analog to ride the public network. That may be a thing of the past before we know it. Imagine, too, using the existing wiring coming into your residence for both a 32 kbit phone line and several low-speed data lines.

What We Can Gain From Digital Conversions

Sometimes it's not much, at least at first. When any new technology displaces an old one in an existing application the gains are often balanced by new problems. So it was with the first solid state power amplifiers which used germanium transistors (prone to thermal runaway) and had very poor reliability records. Digital audio devices promise decreased weight and size and less heat buildup. The potential for problems exists in increased circuit complexity, analog to digital conversion distortions and so on.

The real gains in an existing application from a new technology usually come well after the introduction of the first product or two. So it will be with digital audio devices.

New Features and Diagnostics: The First Gains

The gains have already started in telephony. Digital PBXs, and the telephones that go with them, have features which simply weren't possible in the old mechanical/analog switched systems. Some key systems are now going digital, too. But if all they did was replace the old analog phone with a digital phone, what would be the gain? The gain comes from multi-number memory, last-number redial, call-forwarding, and so on. Features like this are difficult if not impossible without the aid of digital (computer) technology.

One feature that has almost become standard in the telephone business is remote diagnostics capability. The larger PBXs (and some smaller ones) can be diagnosed, if not repaired, over the phone. This capability will, most likely, be extended to smaller systems and perhaps even to residential phones.

More likely, residential phones will become self-diagnosing, which is a powerful tool in alleviating a major service problem with digital products—their complexity. If the device can tell a technician what's wrong, the repairs get easier.

Lessons for Audio

Digital audio device designers can take lessons from what has already happened in the telephone business. Simply replacing an analog device with a digital one may bring about some improvements. But the real gains come when the technology is used to add new features, improve maintenance capabilities and even bring about entirely new products. What can we expect? It depends on the creativity of the designers but a few trends can be predicted.

Diagnostics for Digital Audio

I cut my teeth in this business repairing guitar amplifiers in a music store. I remember fighting manufacturers for accurate schematics of the umpteenth variation on a design. Remembering the problems I had with devices as simple as those, I cannot imagine trying to troubleshoot and repair a digital mixing console without some sort of self-diagnostics. It simply has to happen. One thing I can say for sure, I wouldn't buy such a console for my facility unless I knew for a fact that the manufacturer had provided diagnostic aids.

Digital Control of Analog Devices

Today's best fighter planes are as good as they are because of very sophisticated computer controls. The engines and materials have improved in the last ten or fifteen years but the real advances are in the computer systems. The next generation of fighter planes will use computer controls in such a way as to make an aerodynamically unstable shape out-fly and outmaneuver anything now in the air.

The point is that digital (computer) controls can be used to improve the performance of a lot the tired old analog devices we now put up with in audio, like loudspeakers, for example. It's unlikely that a fully digital loudspeaker will be perfected for some time (although Bell Labs has shown a prototype for the receiver in a telephone).

Nevertheless, digital audio can be expected to come to the rescue of loudspeaker technology probably in the form of "smart" feedback control amplifiers that sense the motion of the loudspeaker and compensate in complex ways not possible with analog-only amplifiers and control systems.

Another way to use digital devices is to put them in control of analog electronics. Most recording studio automated mixing consoles begin to depend more on digital electronics to perform the control and, of course, the storage functions.

Digital electronics can also be used to analyze and control other types of analog electronics. Hybrid digital/analog power amplifiers can use digital de-

vices to analyze the condition of the amplifier and control its bias and protection circuits in sophisticated ways that analog control circuits just can't match.

We've already seen equalizers with memory and even an equalizer that will perform the equalization process for you. I have had my doubts about allowing a computer to perform what is an artistic process, but the capability is there, nonethe-less and the memories are valuable in some applications. I can imagine digital technology being used to control the filters in a parametric equalizer. The value of this would be to optimize the combinations of filter settings or possibly to allow the equalizer to mimic the functions of some other type of equalizer as well as provide parameter storage and recall.

The Advantage of Fully Digital Audio Devices

A few years back, in Los Angeles, I remember watching a prototype of a digital lighting control console. (Those of you who follow theater lighting trends know that lighting consoles have taken full advantage of digital technology.) Anyway, this "console" was actually a CRT monitor with a light pen and a pair of large slide controls sitting on a box at the side of the CRT. Using the light pen, the operator interacted with a graphics display on the CRT that allowed an amazing number of lighting control functions. The two sliders were used for actual dimming and were assigned to a given bank of lights by more light-pen work. The demo I saw was given by a woman who had obviously practiced a lot but I got the feeling that using this console was almost as easy as she made it look. The quantity and complexity of control functions she was able to perform were nothing less than astounding to me. I got the feeling that, on a normal (multi-fader) lighting console, it would have taken an octopus to equal her performance.

I don't know if this ever became a product but the group that had built the prototype knew two important secrets. First, they had utilized computer storage and control to its fullest. Second, they had created a brand new, and very human, operator interface that was easy to learn and yet offered amazing control capabilities.

Looking at the enormous, two or three-person, control consoles used in theater cinema re-recording, then looking at the increasing complexity of recording studio automated consoles, I wonder when someone will have the courage to try out an idea like that one.

A Fully Digital Audio System

This is only the beginnings of an idea, but it represents what I expect to see when fully digital audio becomes a reality.

Imagine a control console like the one I have just described with a CRT and light pen (or mouse if you prefer). This is the "control and command" center. The "works" of the de-

(continued on page 36)

IDEAS & VIEWPOINTS

(continued from page 6)

If you're a small interconnect, however, and you want to remain independent, you'd better learn to dodge the giants because you probably won't be able to compete. You will need to keep your eyes open for one or more market niches the giants haven't discovered. Maybe that niche will be a geographic one like smaller, rural areas the giants don't want to serve. Maybe it'll be an application, like brokerage firms, that the giants don't understand. Maybe you have a technical specialty, like LAN/PBX combination, that'll give you a foot in the door where the giants don't a product.

The alternative looks bleak. A small interconnect may end up doing no-frills, three-line key systems for supermarkets and struggling to survive.

Avoiding Stagnation

Small sound contractors have a somewhat different problem but one that may require a similar solution. There just aren't a lot of new churches, schools, nursing homes, or hospitals being built. The contractor who has concentrated on selling sound systems to customers like these is faced with a mostly replacement market.

For a small contractor, the alternative of the large system business is, in most cases, not dependable. In a few major metropolitan areas, a *larger* contractor can depend on new sports or entertainment facilities. A successful background music contractor in a growing industrial area may have a dependable source of large sales. But, how many *small* contractors get the chance to do more than one large stadium system in their lifetime?

The only apparent way to increase sales for these small contractors is to take business away from a competitor! The alternative is a small business that may be able to survive for many years but seems to always be on the borderline between profit and loss.

One way out, for some small contractors, has been diversification. Intercom, fire and security systems, the small key phone business, and the A/V and video systems businesses are examples.

Survival Strategies

The two survival strategies I have discussed are a side-step into a new market focus (the pro-sound company turns church installer) and diversification. Both are risky, but here's one

(continued on page 48)

VERSATILE SOUND

MULTIPURPOSE FACILITY SYSTEMS

by Barry McKinnon

The past few years of economic pressures have led to increases in efficiency in every aspect of our lives. We have cars that are more fuel efficient, homes that are better insulated and use heat more effectively, more efficient light bulbs, and even buildings that make more efficient use of space. It is no longer economically feasible to construct single purpose buildings; the high cost of property and construction require that buildings that are funded by public money offer the public as versatile an end product as possible.

New buildings are called upon to host events that range from a hockey game or basketball tournament to a classical concert, a trade show, or a convention. In the past, many of these uses have provided the designer with such conflicting requirements that it was not possible to do any one requirement justice. New materials and design techniques are beginning to produce real changes in the effectiveness of buildings.

In the wake of these demands, audio technology has been called upon to meet new demands as well. Advances in component design, especially in the area of performance predictability, have led to a new design philosophy that allows these designer of sound systems to translate on-paper designs into viable final products. The requirements for flexibility in sound system use in the new multipurpose buildings are stretching the boundaries of design in new directions. Bold steps can be taken now in sound system function and the designer can be more confident of the performance of the finished system in the room for which it was designed.

This new philosophy of design also means the role played by acoustical consultants in early design stages of the building has increased. Rather than an after thought, the new buildings incorporate the sound system as an integral part of the design—an overall system that includes the electronics, loudspeakers, and room design. This presents new opportunities for the sound contractor who is staying at the leading edge of the new technology.

In general, the public has an elevated level of concern for audio quality. People expect wide bandwidth, high fidelity sound systems when they go out to participate in or to view events. This has meant an increase in the bud-

get allotments for audio equipment and acoustical design. This isn't just a matter of 2,000 seat concert halls or 80,000 seat stadiums either; it covers everything from community and civic centers to arenas and coliseums. These are the sort of installations that can become money makers for the contractor, as they are accessible to many smaller or local businesses without straining the credit lines and manpower available.

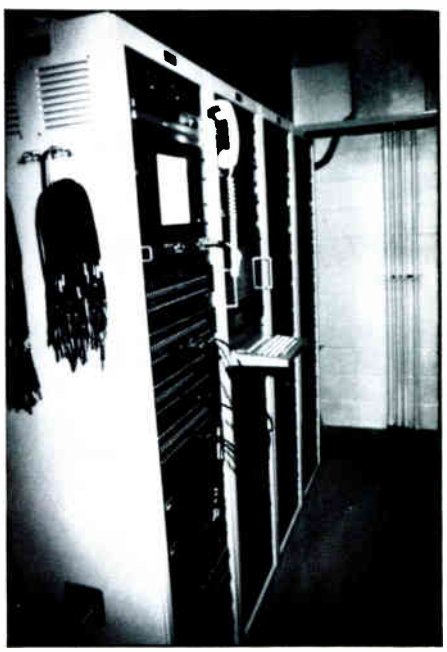
The underlying bond between the three buildings described in this article is an early involvement of the acoustical consultant in the design of the building and sound system and close contact between the consultant and the contractor during installation and testing. All three buildings represent the current trend toward multipurpose versatility in their use and the highest requirements for fidelity and flexibility in their sound systems.

Manatei Civic Center
Manatei, Florida

The 4,000 seat Manatei Civic Center in Manatei, FL, is an excellent example of a building designed to maximize the return on the investment of space and money. This new facility opened in January 1985 to a week's worth of variety entertainment, a true acid test for a new building and its sound system. Already it has been called upon to host minor league basketball games, religious conventions, trade shows, dinners, concerts, boxing and tennis matches.

The acoustical consultants on this project were Coffeen Anderson Fricke and Associates of Mission, KS, John Fricke heading the project design. They have been involved in acoustical consulting since 1965 and have done many projects of this type; the Manatei Civic Center was the most recently completed.

Due to the wide variety of events the building was to accommodate, it was decided to make the building relatively dry to complement music and entertainment. The upper walls of the main hall are acoustically treated and the entire ceiling is equipped with acoustical ceiling tiles in a suspended grid hung below the 35-foot high steel truss roof structure. This treatment, combined with overall room design, reduced reverb times to the two second range over the majority of the bandwidth.



Manatei Civic Center's control room.

The main hall features a movable partition that can divide the seating area in half. This also divides one of the speaker clusters in half. The independently operable halves of the room have produced a need for a very advanced loudspeaker switching and control system that was designed for this application by Fricke.

The system design incorporates the flexibility of mixing location place-

ment, offering five locations on the floor, as well as a soundbooth location for sporting events. The main mixers are a pair of Yamaha M916s that can be used together or separately as required; the system is designed to use the same control systems for the two stage monitor channels as well as main house feeds. The consoles feed White Instruments equalizers and the processed signals are then fed to the control electronics. These consist of switching and line level amplifiers and mixers by Innovative Electronic Devices that are controlled by a Sony personal microcomputer. This control system not only routes line level signals appropriately, but also controls signals to the amplifiers driving the two speaker clusters to provide the necessary coverage for the event or events taking place in the building. An announcement control system is incorporated to allow the building manager to take over all the sound systems in the building for emergency paging and directions.

The system has backup memory so that in event of power failures the speaker and routing selections are not compromised during switchover to emergency generators. Due to the building's location on the north side of a river, power is supplied by a feeder that runs under the river. Consequently, power dropouts are annoyingly common, and the failsafe redundancy was a design consideration in the original specification.

The speaker system consists of two clusters, identical in componentry, one located in the center of the room and one at an end to provide a staging location and a positive localization of the sound source for entertainment events utilizing the house system. Each cluster contains nine Electro-Voice TL606A low frequency enclosures and 20 Electro-Voice HR9040 and 6040 horns with DH1012 drivers. The central cluster is actually bisected by the movable partition. The stage monitors are Electro-Voice FM12-3 vented midrange monitors, with SH1202 speakers for spot fill and side fill. Microphones are Electro-Voice RE11.

The contractor chosen for this installation was Long Communications of Winston-Salem, NC. Previously known as Long Engineering, after 35 years in business they found it expedient to change their name to reflect the growth into additional market areas of telephone interconnect and industrial audio-visual equipment.

Due to construction hold ups, the crew from Long Communications, under the supervision of G.K. Hale, was unable to start until the middle of December, which left very little time until the building opening on January 26. Once started, the installation proceeded without hangups. The final aspect of the job was the testing and equalization of the system with John Fricke.

The system performed as expected during the first week of major entertainment assembled for the grand opening; even the failsafe computerized switching system was tried during a power failure that first week.

The Lawlor Event Center
University of Nevada at Reno

The University of Nevada recently opened its new multipurpose building, the Lawlor Event Center, a 12,000 seat sports arena, with its primary application being college basketball, but also playing host to everything from the circus to rock concerts. This structure is circular, approximately 300 feet in diameter with an oval seating bowl, it has a modified flat roof sloped in four directions for water shed.

The acoustical consultants for this project were Boner and Associates of Austin, TX. A familiar name to the consulting community, they were originally started in 1935, and have

The Manatei Civic Center covers everything from sports to cultural events.

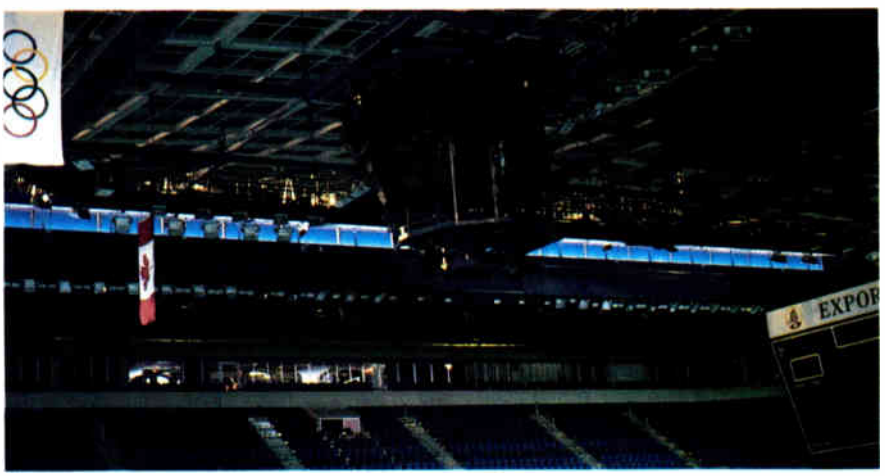
operated since 1961 under the guidance of Charles and Richard Boner.

This building was erected primarily for basketball, but because of its location on the University of Nevada, Reno, site it had to be versatile enough to house other events. Acoustical treatment was chosen to be both economical and efficient. Rather than a drop ceiling using acoustical tile, a spray on cellulose treatment was selected and applied directly to the structural steel. Being a more classic arena style structure, it has a very high ceiling. By selecting very controlled coverage devices this did not represent a compromise in audio quality.

The system design is based around a central cluster that had to fit inside the electronic scoreboard; this provided a size constraint of 14-foot square maximum for the cluster frame. The cluster contains 12 Electro-Voice double 15-inch low frequency systems and Electro-Voice HR 9040 and 6040 horns with JBL 2441 high frequency drivers. The high frequency drivers are protected by a specially designed passive fuse/limiter circuit developed by Charles Boner.

The cluster is driven by Crown power amplifiers, with one amplifier dedicated to each speaker. White Instruments equalizers provide signal shaping for the system. All power amplifiers are located in a rack room below the sound booth. The sound booth contains the Yamaha PM1000 mixer that is the main signal path control for the system. In addition to the house system, there are a number of portable speakers and amplifiers for monitoring and small PA applications.

The contractor chosen for this project was Spectrum West of Murray, UT. In business since 1970, they have done many systems of this type. According to Sean Greenwell of Spectrum West, this job presented one difficulty. Due to budgetary considerations approximately half of the loudspeakers originally specified were dropped. This required quite a bit of work by Boner and Associates and Spectrum West to achieve the level of performance desired with fewer components. With the equalization and proof of performance done all involved parties are very much satisfied.



The Saddledome will be the site of the Olympic Hockey games in 1988.

The Saddledome Calgary, Canada

The Olympic Saddledome in Calgary, Canada, is one of Canada's newest multi-purpose facilities. Constructed as a venue for Olympic hockey for the 1988 Winter Olympics, it also is the home to Calgary's NHL franchise, the Calgary Flames. This 17,000 seat building is located on the grounds of the Calgary Exhibition and Stampede and as such finds many unusual sues, such as tractor pulls, indoor motocross, and indoor rodeo, as well as more usual events such as hockey, volleyball, tennis, basketball, concerts, and closed circuit TV presentations.

The acoustical consultants on the Saddledome project were Barron and Associates of Vancouver, B.C., Canada. Cliff Frazer, chief engineer for Barron, worked closely with Ken Klimchuk of AME Engineering of Edmonton, Alberta, to design the sound system in context of the room's acoustical characteristics.

The roof is what gives the building its name. It's a negatively curved surface to keep interior volume down and provide a non-focusing shape for good acoustical characteristics. The near 100,000 square feet of surface is covered by acoustical absorption. This and the upholstered seats give the building its impressively low reverberation times in the three to four second range.

The sound system consists of a Soundcraft 24×8 console feeding UREI limiters and equalizers. The selection of speakers and zoning is done by switching the line level signals with an AMP pin matrix controlling Modular Audio Products audio switches and line amps. The amplifiers are UREI, as are the crossovers. To reduce the length of speaker wires and eliminate the need for 70 V transformers, all of the amplifiers for the two clusters are in the catwalk with the speaker systems.

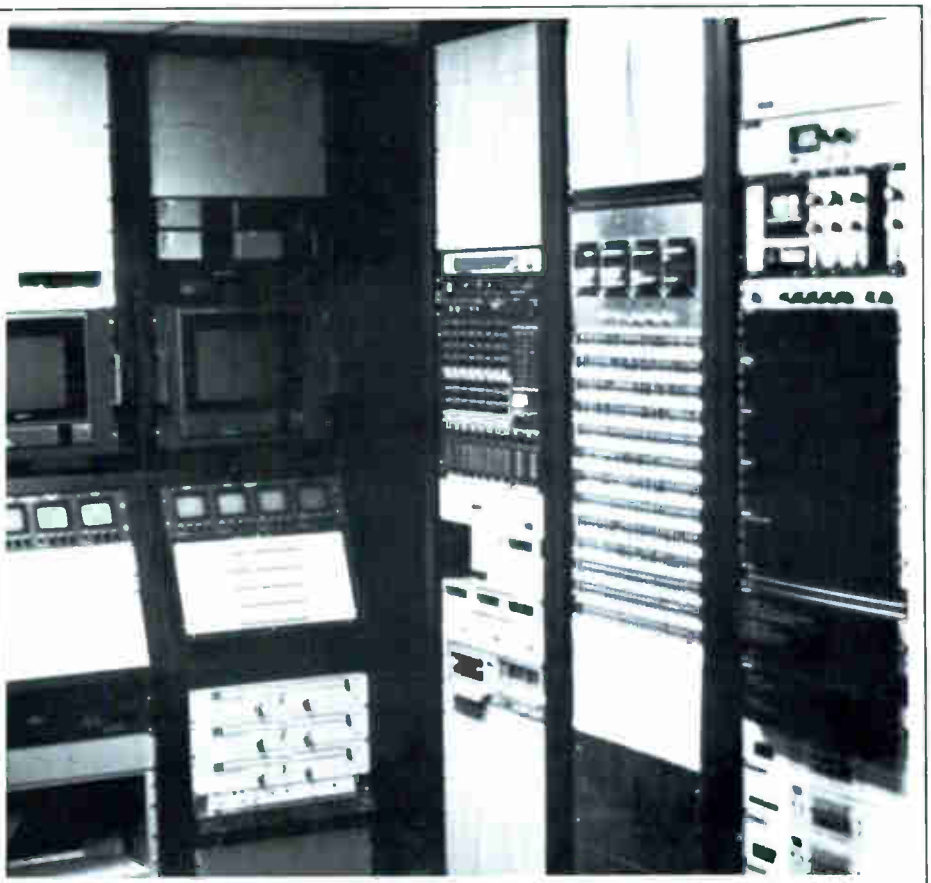
The two speaker clusters offer complete coverage of the seating bowl while permitting source localization to one end for stage productions by appropriately switching in the Lexicon delay. The clusters consist of 28 JBL 4560 low frequency cabinets with 2220B drivers and 54 JBL biradial

horns with 2441 drivers. There are additional speakers located to fill shadowed areas also driven from the Lexicon delay.

The contractor chosen for the project was International Aeradio Ltd. of Calgary, Alberta. They have several large projects to their credit, including the Calgary Center for the Performing Arts. Because of the involvement of the Calgary Exhibition and Stampede in operated and maintaining the building, the Stampede's own Communications Department was actively involved in the installation.

The building has received praise for the quality of its sound system.

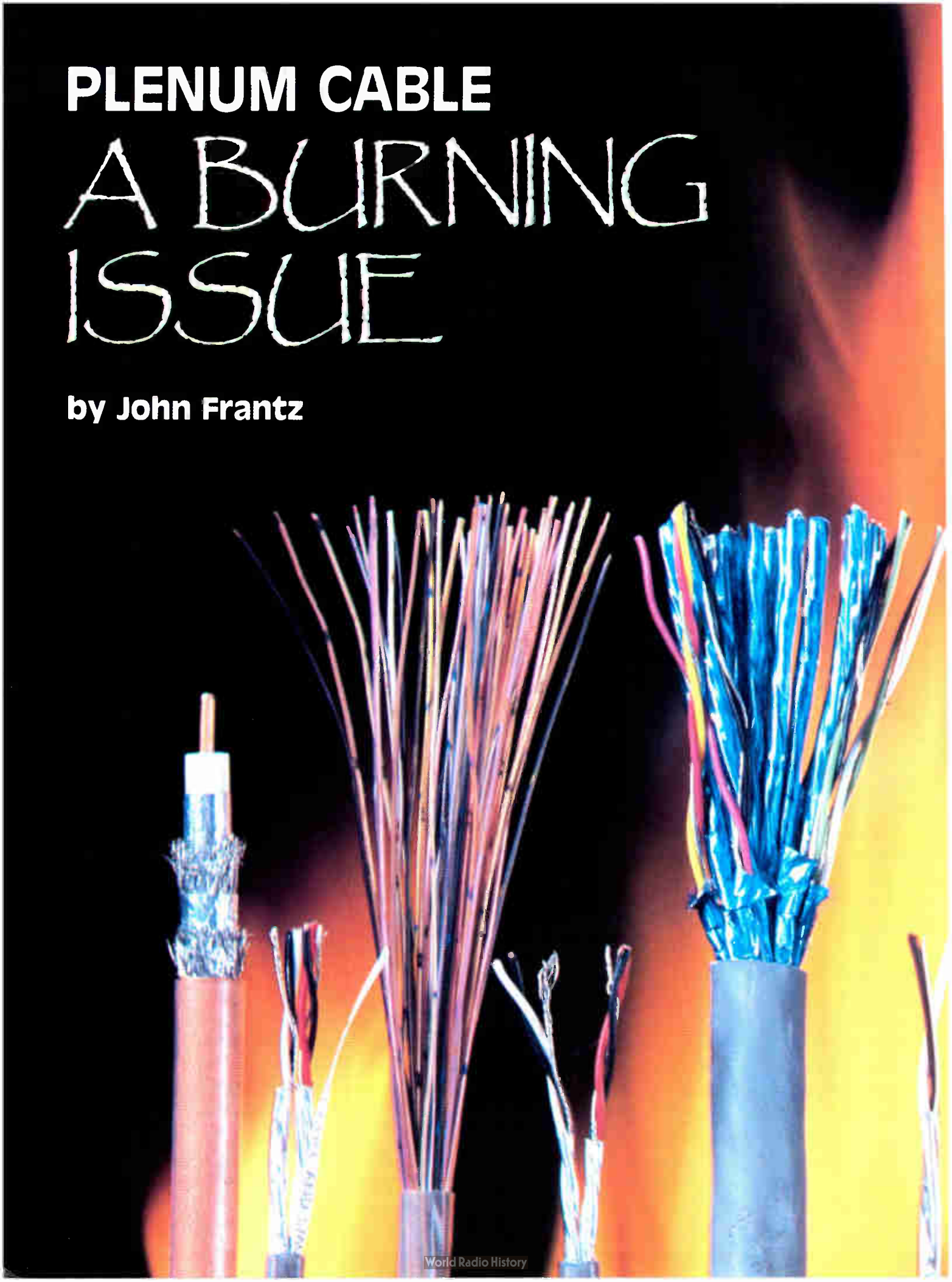
The trends shown by these building are sure to continue and expand to other types of facilities as well. As the value of the work of acoustical consultants in the early stages of building design becomes more obvious to the layman, the contractor will likely find larger amounts of the budget going toward high-quality sound systems integrated intelligently with the overall building design. As people are exposed to more and more no compromise sound systems, their level of expectations will rise and they just won't accept mediocrity any more.



The nerve center of the Saddledome in Calgary, Canada, sends signals to the sound system which serves the 17,000 seat building.

PLENUM CABLE
A BURNING ISSUE

by John Frantz



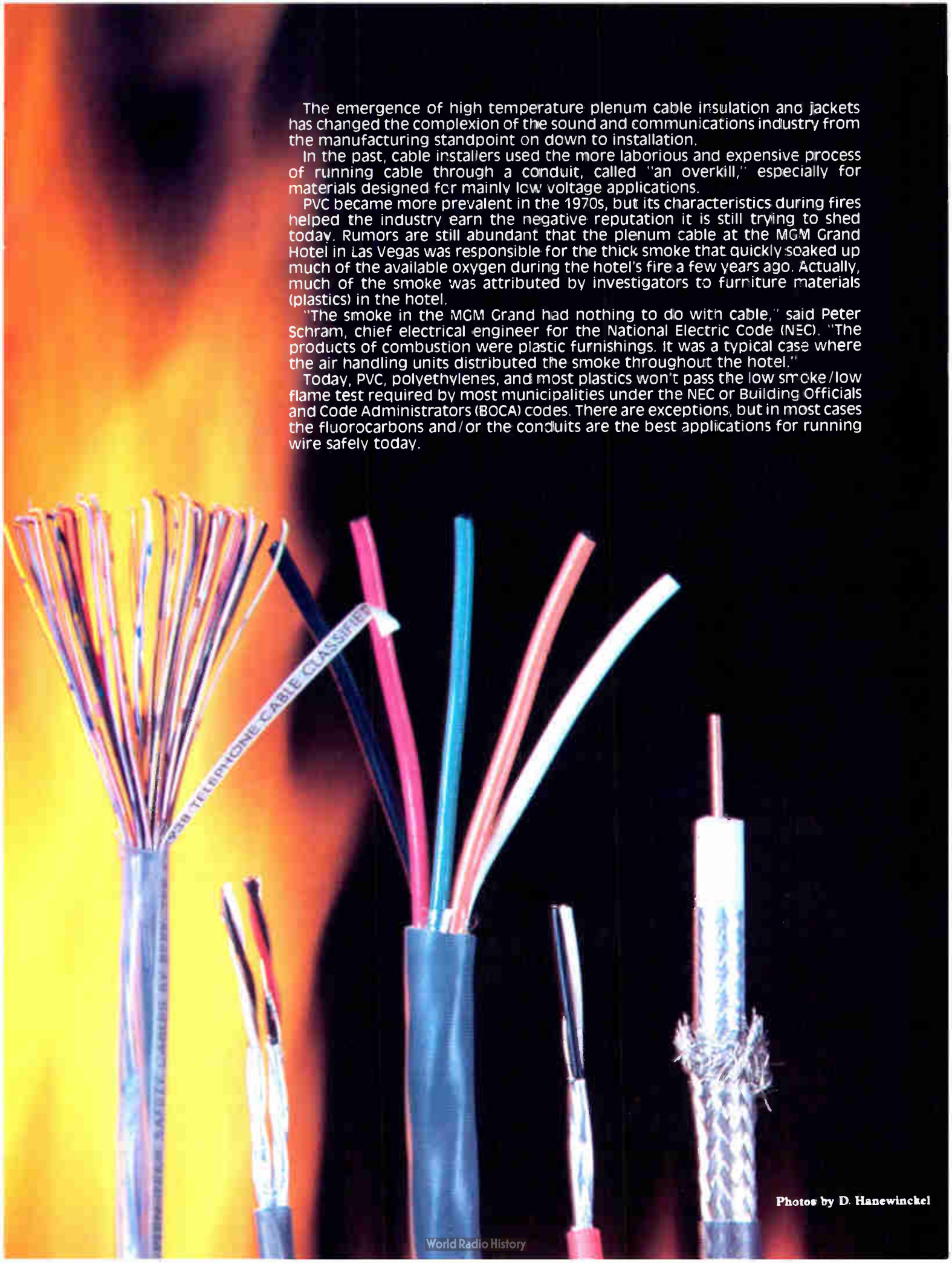
The emergence of high temperature plenum cable insulation and jackets has changed the complexion of the sound and communications industry from the manufacturing standpoint on down to installation.

In the past, cable installers used the more laborious and expensive process of running cable through a conduit, called "an overkill," especially for materials designed for mainly low voltage applications.

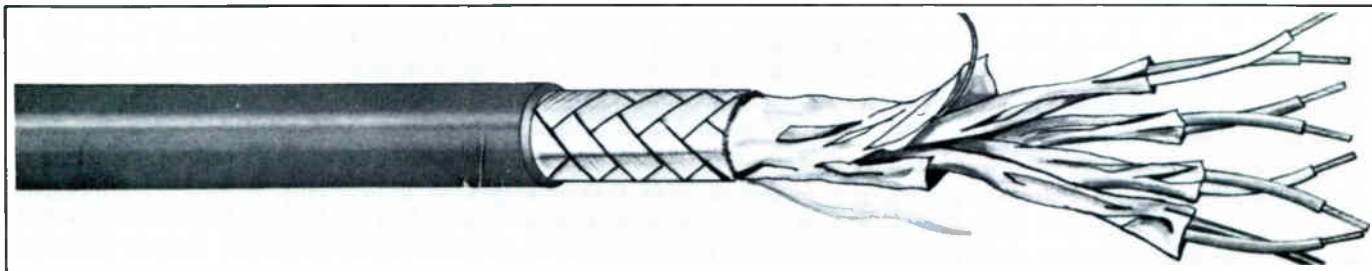
PVC became more prevalent in the 1970s, but its characteristics during fires helped the industry earn the negative reputation it is still trying to shed today. Rumors are still abundant that the plenum cable at the MGM Grand Hotel in Las Vegas was responsible for the thick smoke that quickly soaked up much of the available oxygen during the hotel's fire a few years ago. Actually, much of the smoke was attributed by investigators to furniture materials (plastics) in the hotel.

"The smoke in the MGM Grand had nothing to do with cable," said Peter Schram, chief electrical engineer for the National Electric Code (NEC). "The products of combustion were plastic furnishings. It was a typical case where the air handling units distributed the smoke throughout the hotel."

Today, PVC, polyethylenes, and most plastics won't pass the low smoke/low flame test required by most municipalities under the NEC or Building Officials and Code Administrators (BOCA) codes. There are exceptions, but in most cases the fluorocarbons and/or the conduits are the best applications for running wire safely today.



Photos by D. Hanewinckel



An air plenum control cable from Phalo Corporation, used for computer interconnect, LAN control cable and intercoms.

Generally, cable manufacturers are using either Du Pont's FEP Teflon, Allied Chemical's Halar, or Pennwalt's Kynar for plenum cable insulation coatings. All the materials are fluorocarbons including the new concept, the insulating jacket called Solef by Soltex Corp. of Houston, TX. The Eaton Corporation's No-Hal is also a jacket material, however it's a non-flourocarbon.

All materials on the market have been subjected to the Underwriters' Lab's (UL) 910 test, referred to more commonly as a modified Steiner tunner test. This test, which takes place in a closed tunnel, measures smoke density.

Today, the MGM Grand crisis is still turning some city officials away from approving plenum cable, although it is widely used elsewhere. Even though extensive lobbying efforts have been launched to get plenum cable accepted in mass markets, the cities of Chicago, Pittsburgh, Philadelphia, and Las Vegas among other smaller markets have not approved plenum cable. One former major hold-out city, Boston, adopted the NEC code earlier this year.

Some industry experts link the problem to the strength of trade groups and unions that insist on plenum cable in conduit applications to promote more work for their members. Usually made up of older and conservative principals, city inspection departments are sometimes very often unaware of industry changes.

Pittsburgh has received a little extra lobbying effort from West Penn Wire Co., Washington, PA, since the plenum cable manufacturer resides "in Pittsburgh's own backyard," according to Louis Valente, national sales manager for West Penn. Surprisingly, there haven't been any catastrophies in the Pittsburgh area to tarnish plenum cable's reputation. Pittsburgh officials have been acting on intuition, Valente said. "They can't seem to accept the fact that plenum wire insulation is very rigid," explained Valente. "It's not going to break, or get squeezed. They just feel more comfortable with wire in conduit."

"You have to remember an electrical inspector's background," Valente added. "He's been raised with *wire in pipe* and it's hard for him to accept the *wire out of pipe* concept."

Even surrounding suburban areas sometimes fall back on their nearest large municipality's standards. Eaton's industrial polymer division found this to be true with the Chicago suburb of

(continued on page 31)

AT-RMX64 4-Track Cassette Recorder/ 6-Input Mixer

A Powerful New Tool for:

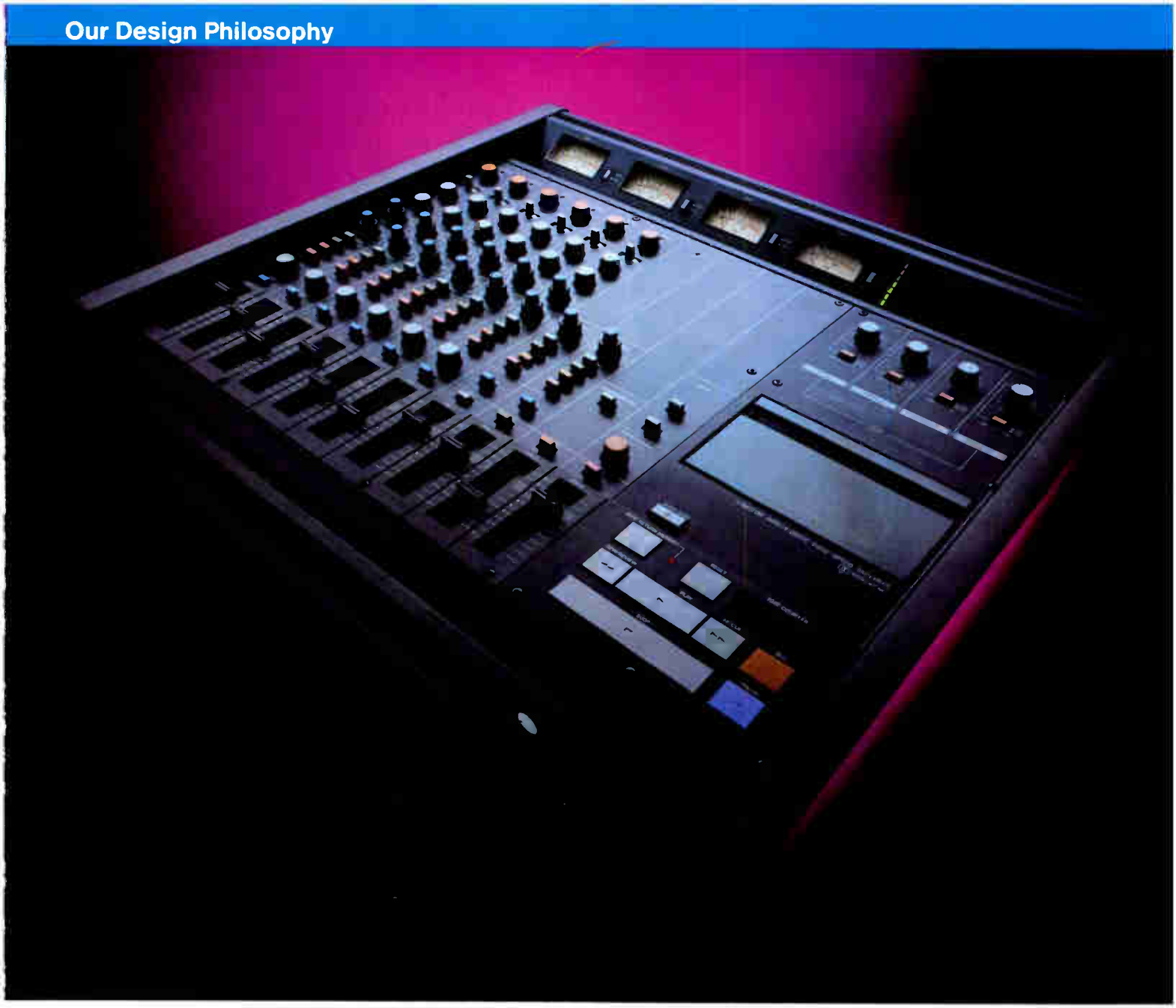
Professional Musicians
Songwriters
Audio-Visual Production
Church Sound Reinforcement and Recording
Theater Sound
Institutional Sound
Radio/TV Sound Production

audio-technica®

The new AT-RMX64 . . .
The only professional-quality, complete recorder/mixer virtually anyone can use, and everyone can afford.

Once you've seen, heard, and touched the Audio-Technica AT-RMX64 recorder/mixer, you'll immediately realize that this is a unique tool that will enhance your creativity in sound. Whether you are making a recording, controlling a sound reinforcement system, or perhaps both at once. Whether you are an accomplished expert or a novice. Whether you are using state-of-the-art, semi-pro, or home equipment.

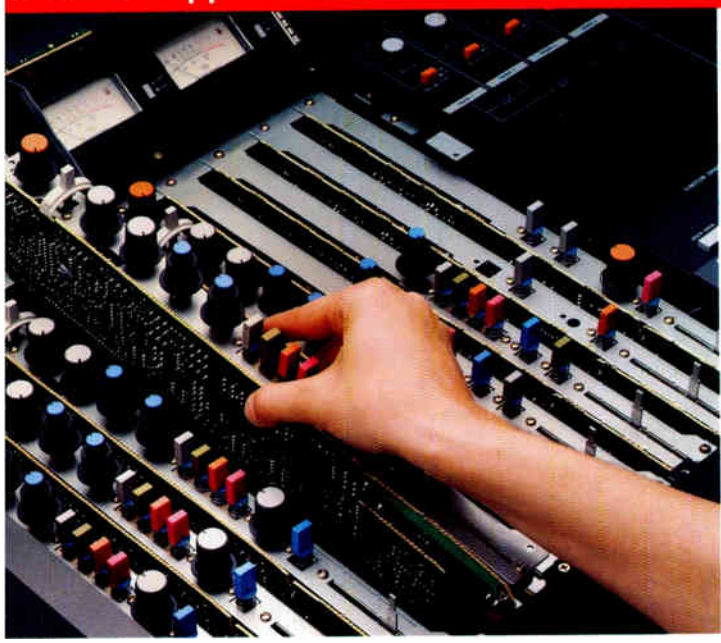
Our Design Philosophy



We started with one overriding basic: There can be no compromise with performance So the AT-RMX64 interfaces with other equipment on real-world terms. Inputs handle everything from home and semi-pro equipment to the finest professional microphones. The tape recorder is fully compatible with home and professional cassettes. And outputs meet all professional standards, in every respect, as both a recorder and a live mixer.

The AT-RMX64 operation is also quite logical . . . almost intuitive. With all its features, we hesitate to claim the AT-RMX64 is simple to use, yet you can readily master the basics, adding complexity and sophistication as you need it and can utilize it. The built-in capability of the AT-RMX64 seems to grow as your own ability evolves.

The design and construction of the AT-RMX64 meets the high standards for quality and reliability which are a hallmark of every Audio-Technica product. Computer-grade components and thoughtful layout insure dependable operation in the studio or on the road, while service accessibility is outstanding. But of all its attributes, flexibility is the one characteristic you'll find most welcome. No matter where or how you use it, the AT-RMX64 is ready to meet the challenge.



High-quality printed circuit construction insures reliable operation, while modular assembly speeds trouble-shooting and repair if needed.

The list of features for the AT-RMX64 is indeed impressive, but a list gives you only a taste of its unique capabilities. And, because it is so versatile, the AT-RMX64 will prove far more valuable than other multi-purpose "portable studio" equipment currently offered.

For instance, you have six input channels, not four. With electronically-balanced low-impedance inputs (no transformers to saturate) and 48V phantom power you can use the very finest professional condenser microphones if you wish. You have the capability to create both a "house" mix and several monitor or recording mixes at the same time. There's full provision for outboard signal processing and patch connections for every input. The output levels of +4 dBM, not just −10 dBM, properly drive most power amps, telephone line sends, slide projectors, and other related equipment.

And the recordings you make at slow speed are fully compatible with any standard stereo cassette unit for speed, track width, spacing, and track assignments. With either Dolby B or C encoding if you wish. Or you can double the speed and get the very most from the cassette medium, including four discrete tracks.

Which features you'll use most will depend on who you are and what you need to do. Here are just some of the capabilities you'll discover in the AT-RMX64:

The AT-RMX64 makes the ideal demo recording mixer/recorder. The specially designed parametric EQ, normally found only in the most expensive recording mixers, provides a far greater variety of EQ options than you could expect to find in one with standard fixed EQ. Mix top-quality, phantom-powered pro condensers with any other mikes, and with direct inputs from your guitars, drum machines, or keyboards. Add special effects to any input or the entire board. Pan inputs across the standard stereo channels. Provide one mix to the recorder, and another to the musicians. Feed a separate headphone mix as needed.

Lay down a track wherever you wish in the 4-track high-speed mode. With Dolby B or C to control noise. Play from one combination of tracks while you record on the rest. Punch-in/out wherever you wish on one track or all. Adjust speed up to ±15% to match instrumental pitch. It's the most complete, most versatile personal recorder/mixer you can find.

On Stage

With six inputs plus two returns available, you can set up the AT-RMX64 any way you need it. Feed separate mixes to one or two monitors, or add echo or other effects to individual channels or the entire mix . . . or a little of both! Feed mono or stereo, or even four channel to the house system. Provide equalized sound to one or all outputs, make reference recordings as you play, or mix prerecorded tape with live sound . . . the possibilities are almost endless!

Or the AT-RMX64 can be used as a sub-mixer for your keyboards, drums, vocals, etc. With either microphone or direct inputs for any channel. And, unlike other 4-channel "portable studio" recorders, there's plenty of output (up to +18 dBM) to feed any PA amp directly. And, since you can use the same mixer for recording and on stage, you've saved money over two separate dedicated units.

In the Church

Using the AT-RMX64 you can send different mixes to each part of a large church (the nursery, overflow room, and main sanctuary, for instance, or one mix to the nave and another to the choir). Create a sound reinforcement mix with individual gain controls for room level, while also maintaining independent level controls for your recording. Or use the AT-RMX64 to control both the sound system and a telephone feed for radio broadcast in mono or stereo, while simultaneously making a slow-speed, standard format stereo tape recording of the service for shut-ins. With individual level controls for each output of each mix. Make 4-track master tapes of the choir or other events, complete with Dolby B or C noise reduction. Use outboard signal processing, such as limiters or other electronics on any channel or the entire signal. The AT-RMX64 can be the single most useful item of sound equipment in the church.

A-V Production

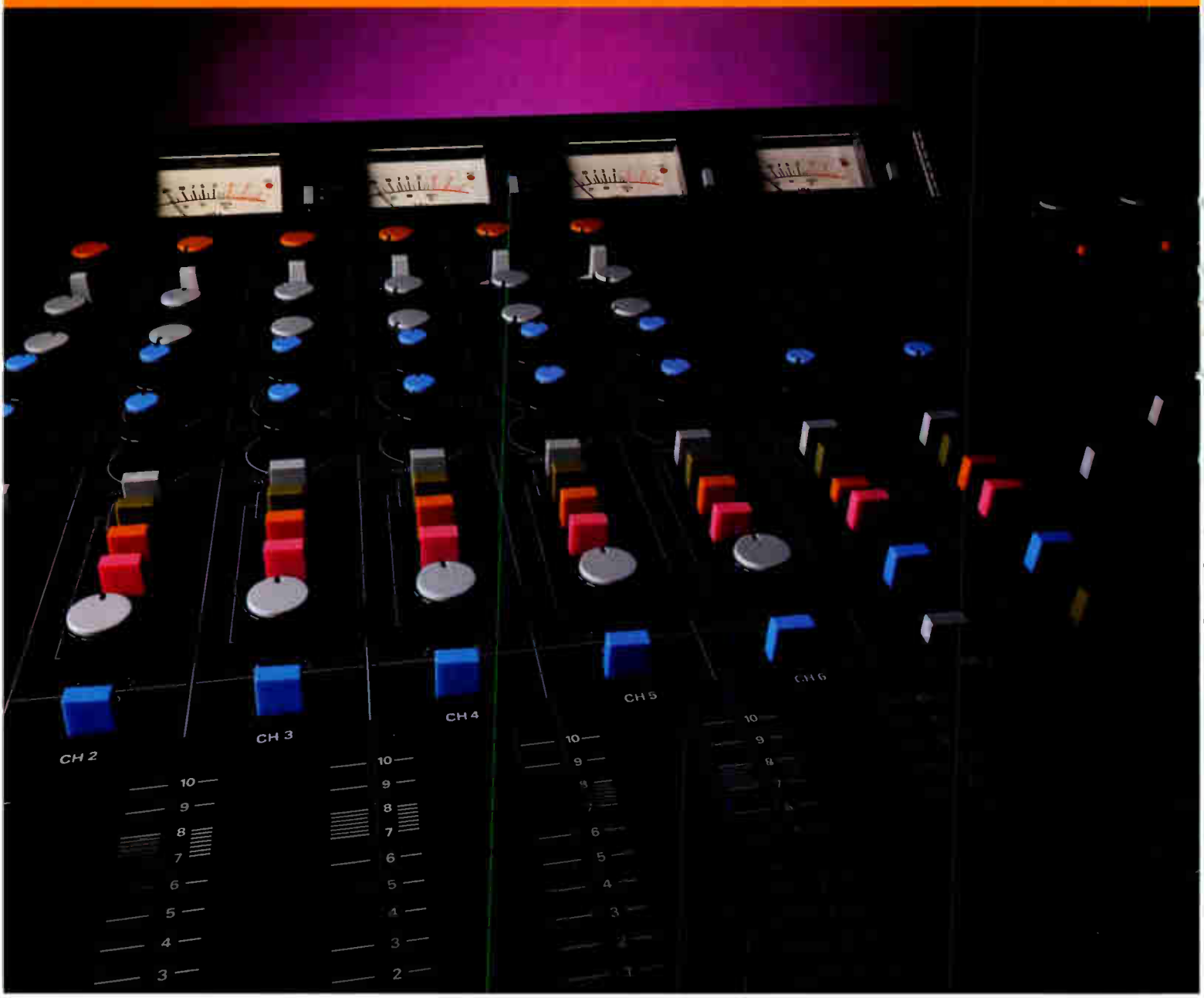
The AT-RMX64 can be equally useful in creating master tapes for slide, film, and video productions, and as a "live" mixer in the field. With six input channels plus two return busses you can actually control as many as eight audio sources. Assign any input to any of the four recording tracks or sub outputs. Feed mono, stereo, or even four channel sound to your sound system. Use any of the four tracks of the recorder for audio or control signals. Or create a stereo cassette which plays on any other home or professional equipment.

The specially designed parametric EQ of the AT-RMX64 provides useful shelving/peak-dip equalization on each input to overcome environmental problems or alter sound character. And the added benefit of a variable high-pass filter on each input channel helps control popping and wind noise. You can feed the output to an external film or tape recorder while making a 1-track to 4-track safety cassette. And both inputs and outputs correctly match a wide range of equipment, from home stereos to fully professional recorders and power amplifiers.

For Everyone

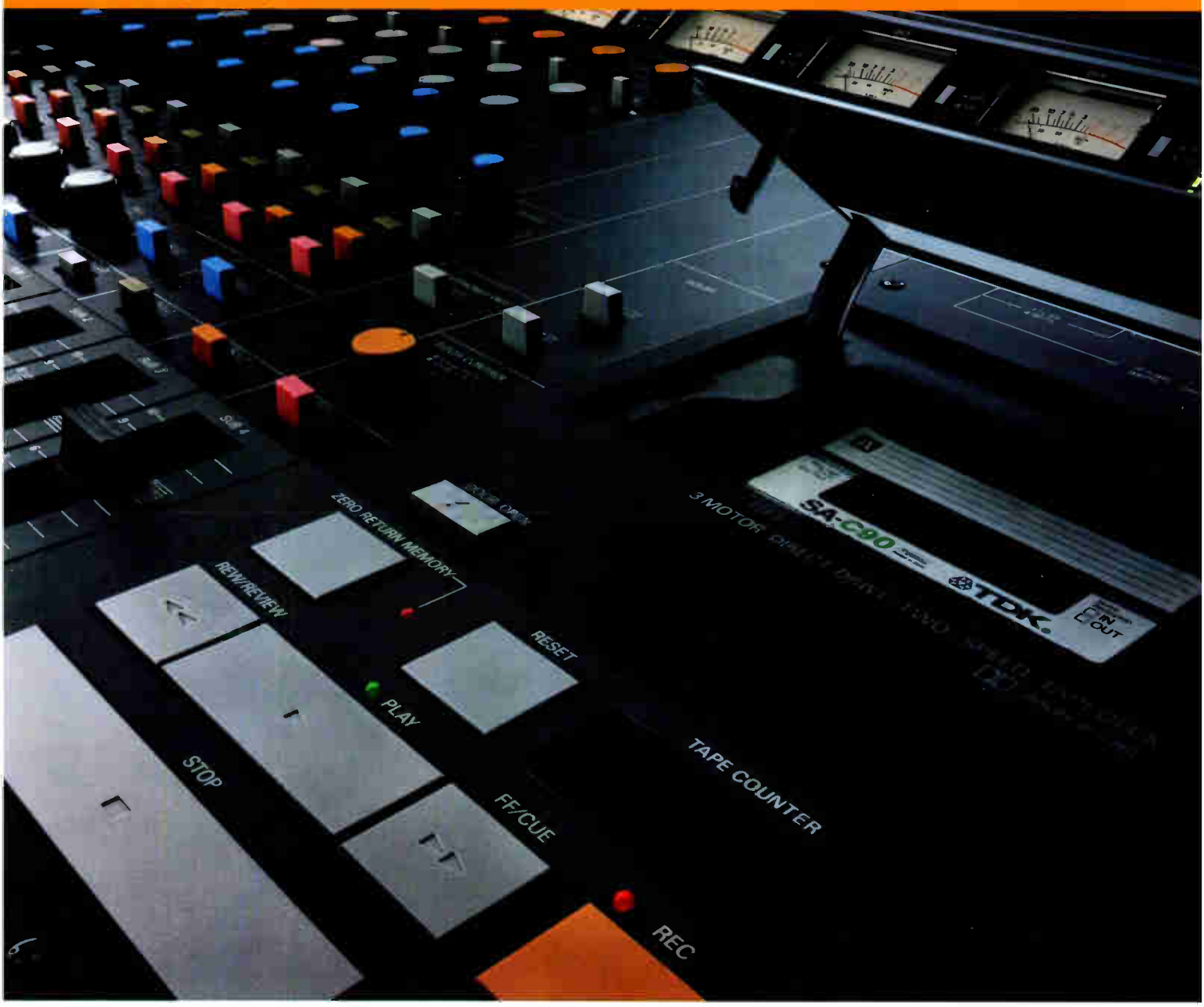
Other uses and applications for the AT-RMX64 will occur to you as you investigate its design and capabilities. With its careful integration of recorder and mixer, plus the host of connection options, the AT-RMX64 is far more than just a 6-channel mixer or a 4-track recorder. It is a unique production center with possibilities for creative audio not found in any other equipment. The AT-RMX64 is truly one of the great values in sound. Explore the opportunities at your Audio-Technica dealer today.

Basic Mixer Features



- 6 Input channels plus 2 return inputs
- Balanced low-impedance, unbalanced low-impedance, or direct inputs
- Auxiliary stereo input
- 48V phantom power on all microphone inputs
- Overload LED on each input channel
- 20 dB fixed pad plus 40 dB variable trim pad for each input channel
- 72 dB total gain available (microphone input to sub output)
- Direct in/out connections for each input
- Two send busses with gain controls for each input
- Each send bus may be switched pre- or post-EQ and faders
- 6 low frequency variable high-pass or peak/dip parametric equalizers
- 6 high frequency shelving or peak/dip parametric equalizers
- Each input assignable to any sub output
- Latching Solo buttons monitor any input, return, or sub output
- Pan pot for each input and return assigned to sub/track 1-2
- Four VU meters plus overload LED for sub or tape output
- 7-segment LED for solo level display
- Balanced and unbalanced sub outputs
- 4 independent tape outputs
- Solo bus output
- 4 stereo headphone jacks with gain control to monitor tracks (stereo) 1-2, sub outs (stereo) 1-2, or solo bus

Basic Recorder Features

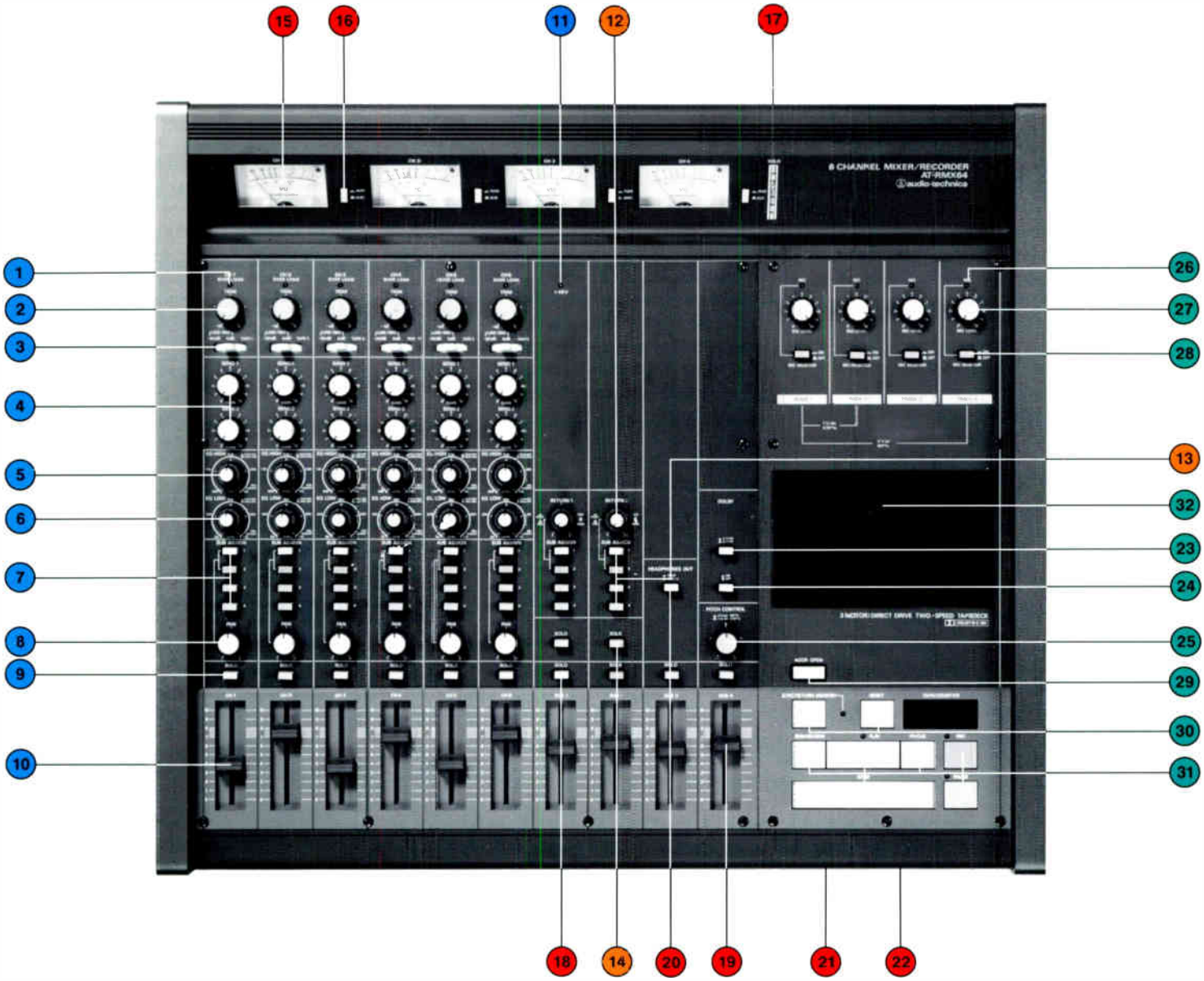


- 3-motor direct drive
- Two speeds: 1⅞ ips (4.75cm/sec) and 3¾ ips (9.5cm/sec)
- Pitch control varies speed ±15%
- Dolby* B and Dolby C noise reduction available with full encode/decode capability on each track

*Dolby is a registered trademark of Dolby Laboratories Licensing Corp.

- Normal-speed recordings on tracks 1 & 2 fully compatible with all stereo cassette players
- High-speed recording on any combination of tracks from 1 to 4
- Full solenoid control of tape motion
- Pause control
- Punch in/out footswitch connection

- Digital tape counter with zero memory return function
- Individual LED recording ready light for each track
- Any input or return signal can be assigned to any tape track
- Individual recording level control on each track



Input Section (six inputs)

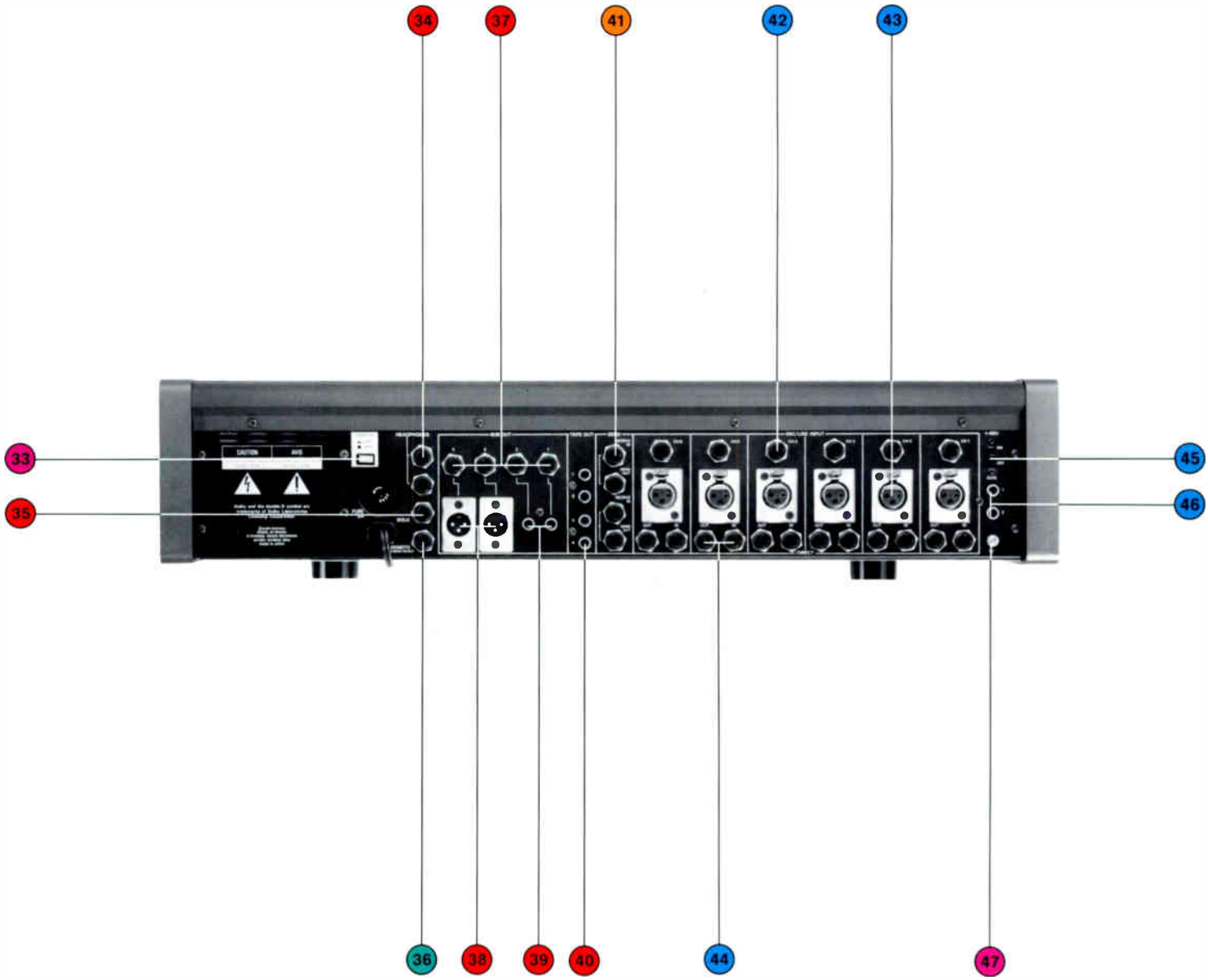
1. Input overload LED
2. 40 dB variable input trim pad
3. 20 dB fixed input pad and tape/aux input switch
4. Send 1 and 2 gain controls
5. Concentric high frequency EQ gain/frequency controls with push-pull shelving/peak-dip switch
6. Concentric low frequency EQ gain/frequency controls with push-pull high-pass/peak-dip switch
7. Output assignment switches
8. Channel 1-2 pan control
9. Solo monitor pushbutton
10. Linear input fader
11. 48V Phantom power LED indicator

Return Section (two returns)

12. Concentric return gain/pan control with push-pull pre-/post-EQ and fader assignment switch
13. Return output assignment pushbutton
14. Return solo monitor pushbutton

Output Section (four sub outputs plus solo and headphone monitors)

15. VU meter with overload LED
16. Sub output/tape VU meter selector switch
17. Solo output 7-segment LED display
18. Solo monitor pushbutton
19. Linear output fader
20. Headphone channel 1-2/solo selector switch
21. Headphone level control with push-pull solo or sub 1-2/tape out select
22. Two stereo headphone jacks



Recorder Section

23. Dolby B-Type/C-Type selector pushbutton
24. Dolby On/Off pushbutton
25. Push-pull 3¾ ips/1⅞ ips switch with variable speed (pitch) control
26. LED record indicator
27. Record level control
28. Record Ready pushbutton
29. Door access pushbutton
30. Zero return memory control with LED indicator, reset control and digital display
31. Tape motion controls, including play, fast forward, rewind, record, stop, and pause, plus play LED indicator
32. Two-speed, variable-pitch, direct drive, four-track tape recorder
33. Power On/Off switch
34. Duplicate stereo headphone jacks
35. Solo bus output
36. Punch in-out remote switch jack
37. Unbalanced sub outputs (4)
38. Balanced sub outputs (channels 3-4)
39. Unbalanced sub outputs (channels 1-2)
40. Tape outputs (4)
41. Send and Return inputs and outputs
42. Unbalanced inputs (6)
43. Balanced low impedance inputs (6)
44. Direct in-out jacks (6 pairs)
45. 48V phantom power on-off switch
46. Auxiliary inputs
47. External system ground point

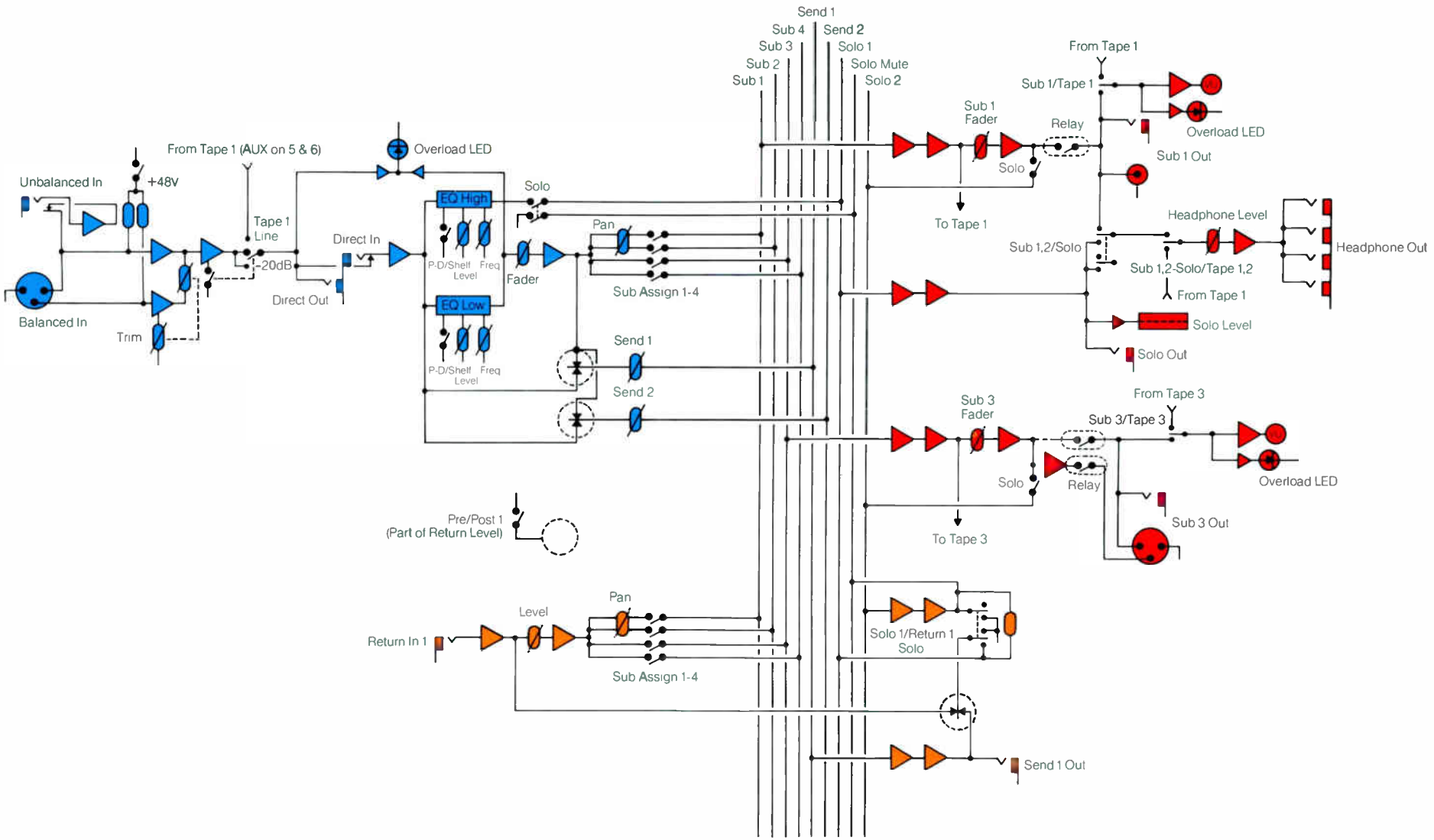
AT-RMX64 Specifications

Mixer	Specification
Mic Input Sensitivity (balanced)	Max: +4 dBm (Pad –20 dB, Trim –40 dB) Min: –55 dBm (Pad 0 dB, Trim 0 dB)
Mic Input Impedance	4,000 ohms
Line Input Sensitivity (unbalanced)	Max: +2 dBm (Pad –20 dB, Trim –40 dB) Min: –54 dBm (Pad 0 dB, Trim 0 dB)
Line Input Impedance	33,000 ohms
Aux Input Sensitivity	+4 dBm
Aux Input Impedance	100,000 ohms
Return Input Sensitivity	+4 dBm (Return gain at max)
Send Output (send gain at max)	+3.2 dBm (Post EQ/Fader) +4.6 dBm (Pre EQ/Fader)
Sub Output	+2 dBm (Ch 1 & 2, Pan Center) +4 dBm (Ch 3 & 4, Pan Center)
Solo Output	+4.6 dBm (Ch Solo) +2 dBm (Ch 1 & 2) +4 dBm (Ch 3 & 4)
Maximum Output	+18 dBm
Headphone Output	1.2 Watts at 8 ohms, 1 kHz (@ 0 VU with headphone gain at max)
Hum and Noise	–122 dB equivalent input noise (Trim 0 dB, Pad 0 dB)
Total Harmonic Distortion	Less than 0.05% (20 to 20,000 Hz)
Frequency Response	20 to 20,000 Hz ±1.5 dB
Equalization Frequency Range	60 to 1,500 Hz (Low) 600 to 10,000 Hz (High)
Equalization Gain/Loss Range	±15 dB

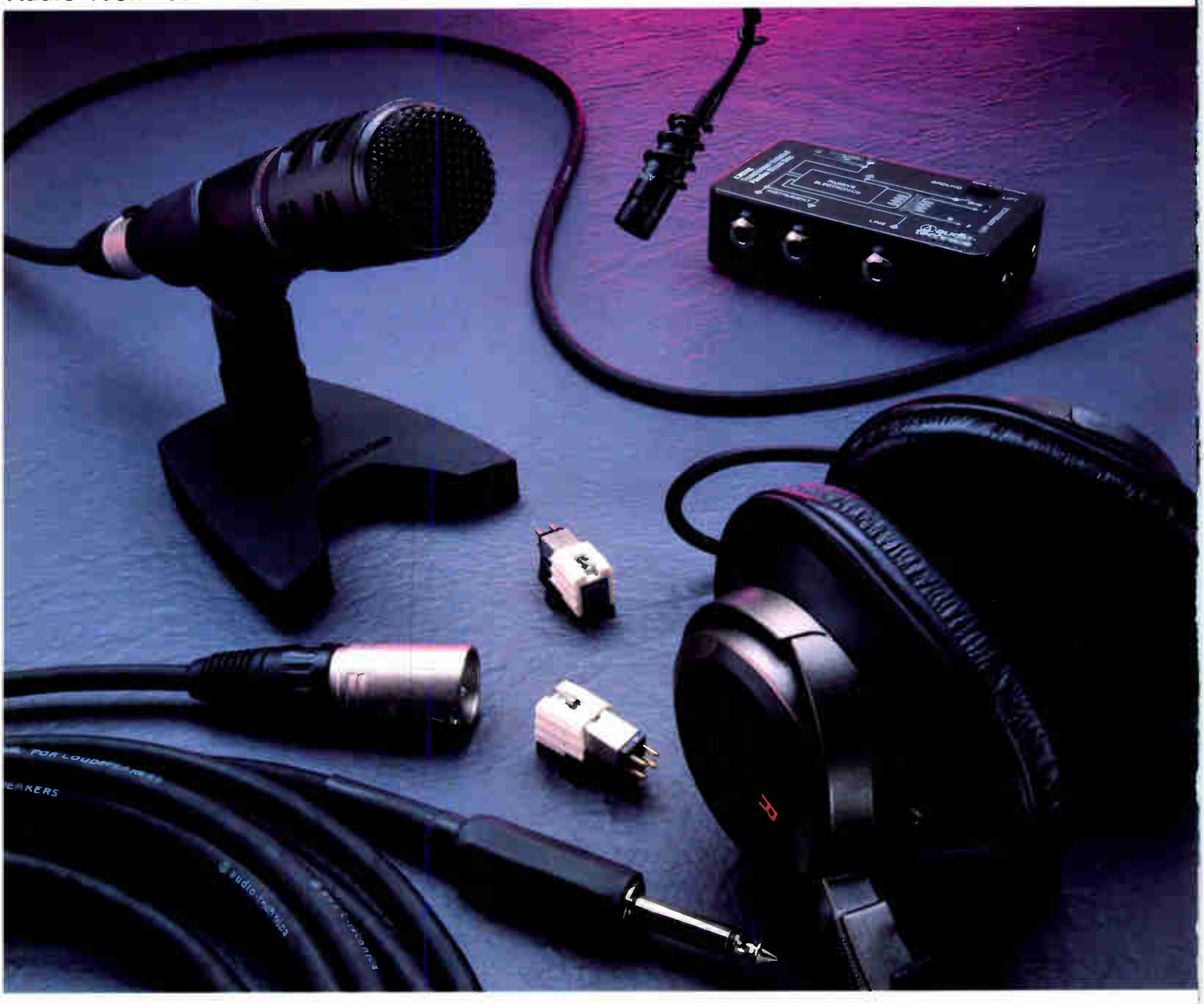
Recorder	Specification
Tape Output Level	+4 dBm
Tape Output Impedance	100 ohms
Frequency Response (rec/play)	20 to 18,000 Hz (±3 dB from 40 to 15,000 Hz)
Bias Frequency	85 kHz
Signal to Noise Ratio Dolby NR Off Dolby B On Dolby C On	 55 dB 64 dB 68 dB
Total Harmonic Distortion	Less than 1.5% at 0 VU/1 kHz
Channel Separation	Better than 60 dB at 1 kHz
Peak Level Indicator	+8 dBm (+4 VU)
Tape Type	Compact Cassette High Bias 70 μs EQ Type II
Tape Speed	1⅞ ips (4.75cm/sec) and 3¾ ips (9.5cm/sec)
Track Format	4 tracks @ 3¾ ips standard stereo @ 1⅞ ips
Pitch Control	±15%
Wow and Flutter	0.04% RMS (JIS-A)
Fast Wind/Rewind Time	80 seconds for C-60
Tape Counter	4 Digit LED
Motors	3 DC motors, direct drive servo-controlled capstan

General	Specification
Dimensions	23.3" wide, 20.4" deep, 5.4" high
Weight	48.5 lbs
Power Requirements	120VAC, 60 Hz, 65 watts

Specifications subject to change without notice.



Audio-Technica Professional Sound Products



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PLENUM CABLE

(continued from page 22)

Schaumburg, IL. Its Woodfield Mall tenant, J.C. Penney, was not permitted to install its 200,000 feet of point-of-purchase cable linking all store cash registers, which Eaton custom makes for it. "Being so close to Chicago caused much of the problem," recalled James Krejsa, an Eaton product manager. "However we sent one of our own engineers to an inspector's meeting and presented a test which in turn was accepted."

Generally, a contractor should have a UL letter showing a material's approval. Most manufacturers can provide copies of the letter assuming its product was UL tested and approved.

"It's physically hard for firemen to put out fires in plenum spaces," said fire protection specialist for the National Fire Prevention Association (NFPA), Greg Kyte

"Plenums or dropped ceilings used as plenums lead to air handling units that can distribute smoke to the entire building or a large portion of the building. The NFPA is always on the alert for problems and a cable inside a plenum could add more smoke," Kyte added.

Today the NEC has three articles in its code with exceptions for plenum cable made of low smoke/low flame materials. Article 800 covers telephone and communications, Article 725 covers power limited systems (low voltage signaling, communications and Article 760 is for fire alarm cable.

For a while, the NEC never defined low smoke/low flame emission. Local Law Five in New York City, which went one step further and defined the standard in detail, helped lead to the NEC decision.

Whether a plenum cable is UL listed or not, some state governments such as that in California and New York require a material to be subjected to its own tests. Approval many times depends upon samples, UL listing letters, and extensive lobbying efforts. Du Pont's Teflon, the first high temperature cable material approved by New York City, took over a year to reach approval. Du Pont's breakthrough enabled the other materials to break into the market more easily.

Eventually those cities will adopt the plenum code, according to Chester Klinke, sales operation manager for Berk-Tek Inc., Reading, PA, and that will help the plenum cable market.

The adoption of the NEC's standard for plenum cable is surfacing more and more by smaller municipalities. The enforcement of the code however, is another problem that remains unsolved in many areas, Klinke said.

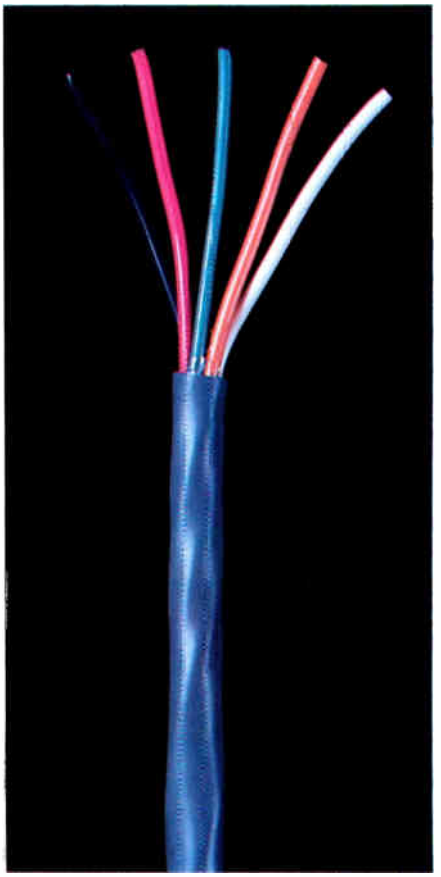
Even though most areas have a standard for running wire, many installers don't abide by the rules. "I used to have a problem with installers putting fire lines to dampers, HVAC (heating, ventilation and air conditioning), and vacuum lines in plenum spaces without giving it a thought," said Kyte, a former inspector. "Workers usually don't know what's not supposed to be in the plenum, but the engineers know."

Over 30 firms are making plenum cable today versus only the handful from the early 1980s. This has forced a glut and a price deterioration resulting in fierce competition in the plenum cable market. "Every day, it seems, there's a new competitor," said Klinke. "This makes it increasingly difficult for manufacturers to make a profit in plenum. The price has eroded to where you better have a good handle on the technology and efficiency in order to make money at it."

From a distribution standpoint, Cabletronix of Newburgh, NY, believes it's important to carry many

Berk-Tek power limited coaxial trunk cable

Plan-Tek® safety cable



Multi-conductor audio cable

brands and all types of insulation on cable.

Price declines are best described by Cabletronix's president, Stephen Roth, who once sold 25 pairs plenum cable at $1,800 per thousand feet five years ago, is now selling it between $600 to $700.

"I don't care what Reagan says," said Roth, "business stinks. Collections are getting harder. More and more people are going out of business. We made a good profit last year, but a lot of it got eaten by those kinds of losses."

Depending upon the materials used to insulate and jacket the wire, some cable may be better suited than others for various applications. West Penn for example, uses Halar/Kynar (Halar for insulation and Kynar for a jacket) versus the popular Kynar/Kynar combination. Kynar is a good jacketing material, but as an insulator, its dielectric constant (capacitance level) is too high, according to Valente. "We've always used Halar or FEP Teflon for insulation at West Penn," Valente said. "With today's state-of-the-art electronic communications and fire alarm systems that work from a microprocessor base, a low capacitance is required. Kynar can slow the speed of your transmission and shut a system down."

West Penn's cable is called Plenecon, and it manufactures mainly Articles 725 and 760 cable.

Eaton disregards the whole insulation concept and manufactures an insulating jacket called No-Hal, an elafotemric material.

"Ours is different because it's the only non-fluorocarbon material on the market," claimed Krejsa.

The advantages No-Hal offers over the fluorocarbons is price and stripping ease. Price-wise, the fluorocarbons range from $4 to $10 per pound versus No-Hal's approximate $2 price per pound.

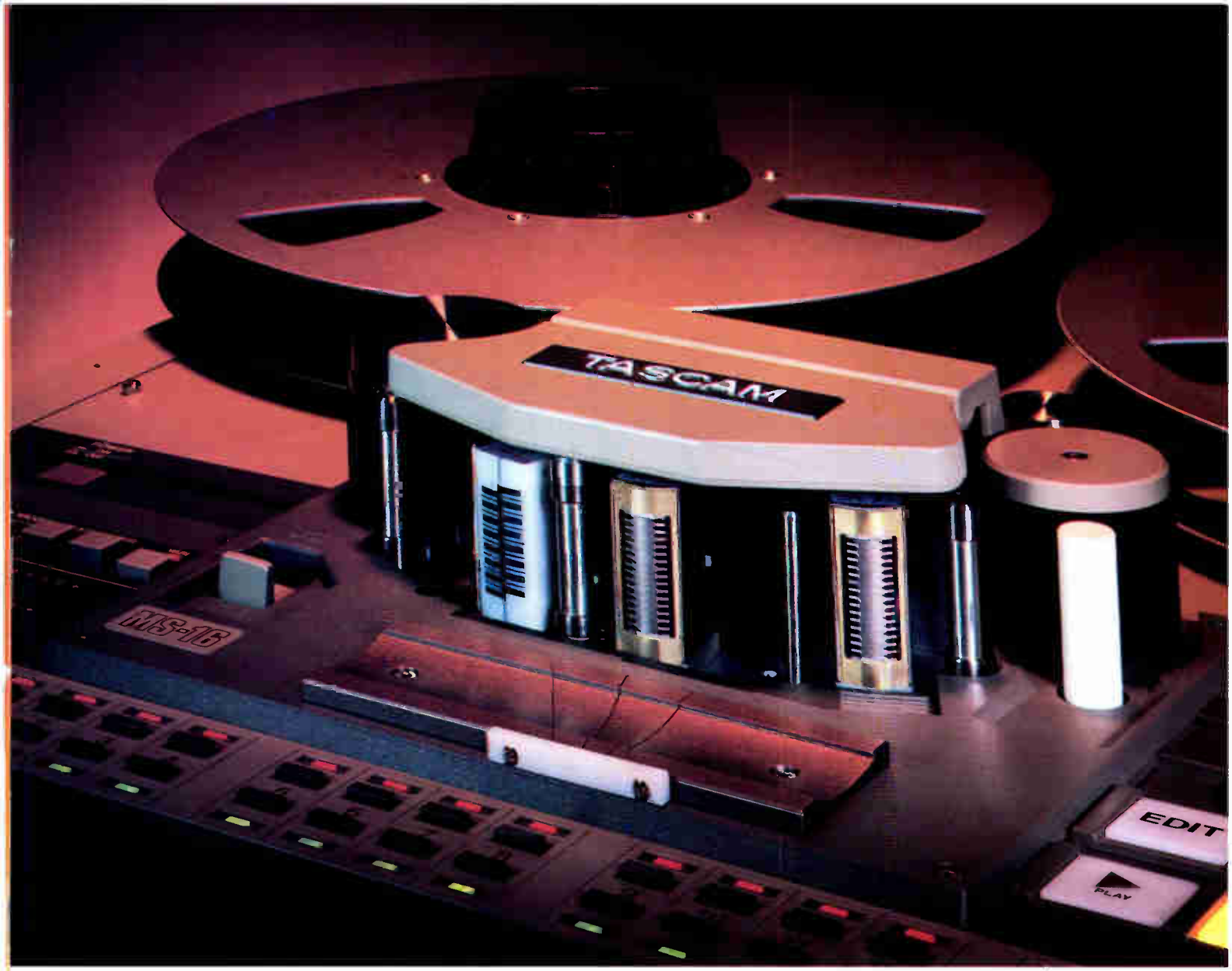
"There's still some elements of discussion concerning the relative merits of toxicity in different materials," said Ron Stier of Belden Corp. "There's an awful lot of horror stories out there that can't be supported by the technical community. For example, does the person die from the heat, from inhaling the toxic fumes, or from lack of oxygen?" Stier asked.

Berk-Tek Inc., Reading, PA, like many manufacturers' carries all of the high temperature resins so that any order requiring different combinations of fluorocarbons is kept in stock or ready to be made. "We try to maintain an inventory of the most popular items accepted by the market place," said Klinke.

For Roth of Cabletronix, educating contractors has become as important as anything in the industry. "Take fasteners for example," Roth explained. "There's still guys using tape to splice because they don't know of anything better."

"Our industry has to continually make the end user or an electrical engineer aware that plenum wire is the way to go because it's more economical," Valente said. "There's savings of 50 to 60 percent over using conduit.

"I continually hold seminars for our customers and I stress using plenum as wire as a marketing tool," Valente said. "I'd use plenum wire as an advantage. I'd say, 'Hey, I'm the better sound contractor. Look at this wire I'm going to use. I'm not going to fill your attic, crawl space and chasers with conduit. I'm going to use this low flame wire."



FINISH UP ON TIME WITHOUT SACRIFICING QUALITY.

You want it quick and you want it good. In today's competitive post-production audio/visual scene, the rewards go to those who can produce results that are quick *and* good. That's why TASCAM designed the MS-16 1" 16-track recorder—to bring together top-notch audio quality plus premium features that streamline production and move you ahead of schedule.

Quality reproduction starts with the heads, and TASCAM has three decades of design experience the MS-16's new micro-radii heads. They bring "head bumps" under control and ensure flat frequency response. And unlike most tape machines, the MS-16 record/snyc and playback heads are identical in performance. Because sync response equals repro response on the MS-16, you can make critical EQ and processing decisions on overdubs or punch-ins without having to go back and listen a second time. You get what you want sooner and with fever headaches.

The MS-16 cuts down on the time you spend locking up with other audio and video machines as well. A 38-pin standard SMPTE/EBU interface affords speedy, single-cable connection with most popular synchronizers and editing systems. It's the easy, efficient way to get the most out of today's sophisticated synchronization equipment. The MS-16's new Omega Drive transport is tough enough to stand up to long days of constant shuttling... while handling tapes with the kid-glove kindness they deserve.

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Take a closer look at the MS-16. See your TASCAM dealer for a demo or write us for more information at 7733 Telegraph Road, Montebello, CA 90640.

THE TASCAM MS-16 SIXTEEN TRACK

TASCAM THE SCIENCE OF BRINGING ART TO LIFE.

Reader Service #243

CALENDAR OF EVENTS DATE BOOK

DATE	EVENT/COMMENT	LOCATION	CONTACT
July 7-12	**ICIA's Institute for Professional Development,** Sales Training for the Communications Industry	Bloomington Campus Indiana University, IN	Terri Campbell, ICIA 3150 Spring St. Fairfax, VA 22031-2399 (703) 273-7200
July 27-31	**Alliance for Action,** International Association of Auditorium Managers Show and Conference	Rivergate Expo Center New Orleans, LA	IAAM 500 N. Michigan Ave. Chicago, IL 60611 (312) 661-1700
August 4-7	**International Background Music Association's** Meeting and Conference	Westin Bayshore Hotel Vancouver, Canada	Roger Van Brackel (419) 782-2741 Bruno Fulde (604) 682-3141
August 27-29	**Interconnect '85** by United States Telecommunications Suppliers Association.	San Mateo Center San Francisco, CA	USTSA 333 N. Michigan Ave. Suite 1618 Chicago, IL 60601 (312) 782-8597
September 26-28	**Electronics Industry Association's** Mobile Communications Show	Washington Convention Center Washington, DC	Jack Wayman EIA, Sr. Vice President (202) 457-8765
October 14-17	**79th AES Convention,** Audio Engineers' Society	Hilton New York	AES 60 East 42 St. New York, NY (212) 661-2355.

COMPUTER & DIGITAL

(continued from page 13)

vice is a bunch of A/Ds and D/As (analog to digital and digital to analog converters) and a very fast and powerful micro or mini computer with a very specialized piece of software in residence.

This isn't a fixed function device, of course but it works something like a mixing console. First you enter the "configuration" menu and select the number of input channels you need. The limit is the number of A/Ds you have but using fewer than the limit allows more processing time for other functions as we will see. Next, select the input channel gain needed for a microphone or other source device. Then select EQ, compression or limiting, reverberation or any other available enhancement function for each channel. These functions are, of course, only software so you can choose whatever you need for each channel up to the processing power of the computer. Choose fewer input channels and you can have more functions per channel.

Now route the signals from the channels to one or more outputs and add submixing if you want. Create a recording studio, sound-reinforcement, cinema, or broadcast configuration as needed (or some modification of these setups).

To operate the system, simply call up the operation menu. Next to you is a box with one or two sliders. The operations menu is a graphics display that has been automatically generated according to your previous configuration setup. To make any specific function happen you simply point with one hand and slide with the other. The slider can operate as a subgroup master, an individual fader, a channel EQ control, or anything else you please.

If you want to change a channel EQ, you can examine a graphic display of the existing EQ and modify it by drawing a new graph. Or you can assign the slider to become a midrange control and do it that way. Want to link one channel's compressor to another? No problem. Want to change the number of regeneration cycles on a single channel's reverberation. Easy. Want to add a special effect to the voices on subgroup B? Go ahead. Want to see the block diagram of what you've done? Call it up on the CRT.

There are problems with this kind of idea. Human interface problems, hardware problems, and the enormous problem of writing the software. The finished product might bear little resemblence to what I have described. Yet I expect this kind of thing (and a lot more) to happen.

I can also imagine a similar product for commercial sound. I cannot tell you how many times I have wished I had that kind of "assemble your own block diagram" electronics package for a commercial sound job. In a limited way you can get this with the various plug-in card frame devices like the TOA 900 series, for example. Yet I always end up wishing I had still another type of module or that I could plug it in at another point in the block diagram. Fully digital audio and software reconfiguration will make this possible.

Closing Thoughts

That's about the end of my crystal ball. Except that I also expect to see analog devices survive for a long time, maybe indefinitely. A digital microphone is going to be quite a challenge. I don't see that any time soon. I wouldn't be surprised, however, to see an A/D inside analog mic with a fiber-optic mic cable.

I also expect to see the boundaries between devices blurring. A clue to that is now happening in telephony. The digital PBX can be used to link digital devices together and can be used as a kind of local area network for personal computers. Local area network people are beginning to tout the use of their products for digital voice transmission, storage, and retreival. Thus, these two seemingly very different devices seem to be moving towards a common functionality. Last, I expect to be surprised. Surprised by new products. Surprised by improvements in existing products. Surprised by entirely new ideas.

PRODUCTS IN REVIEW

TIE INTRODUCES BUSINESSCOM PLUS 8/12

TIE/communications, Inc. has introduced its latest electronic key telephone system—Businesscom Plus 8/12—for the small to medium size business.

The four-wire Businesscom Plus 8/12 system is said to increase office efficiency by saving time in every operation of the phone. For example, single button access eliminates a step in placing an outside call—press the desired line key and begin on-hook dialing. Answering a call is just as simple—pick up the handset or press the speakerphone key, and you're automatically connected to the ringing line. In addition, for speed dialing, you press just two keys to access up to 90 numbers system-wide, and just one key for up to ten numbers per station.

Direct Station Selection (DSS) keys on each set allow single button access to co-workers, and you can also all-call page office-wide, or selectively page one external or two internal zones. System flexibility also permits programming of your intercom to signal two other extensions simultaneously.

☐For further information, contact: TIE/communications, Inc., 5 Research Dr., Shelton, CT 06484; (203) 926-2000.

Reader Service #57

IRP'S NEW POWER AMP FEATURES 100 W/CHANNEL

Indusrial Research Products, a Knowles' company, has a new power amplifier the DH-4020, a lightweight, small dual 100 watts/channel power amplifier intended for high quality audio applications.

The DH-4020 features passive cooling and solid state protection against damage to amplifier or load. A lightweight efficient 100 kHz switching power supply eliminates the heavy 50/60 Hz transformer required in conventional amplifiers. A MOSFET output stage uses signal dependent supply voltages. According to the company, efficiency is improved over conventional fixed supply voltage designs, resulting in very low amplifier heating with audio program material. The DH-4020 may be bridged for higher power requirements. A 70.7 volt, 100 watt transformer is available for outboard mounting. The DH-4020 will drive 25 V systems directly.

☐For further information, contact: Industrial Research Products, 321 Bond St., Elk Grove Village, IL. 60007; (312) 439-3600.

Reader Service #58

CRESTRON EXPANDS LINE OF WIRELESS CONTROLS

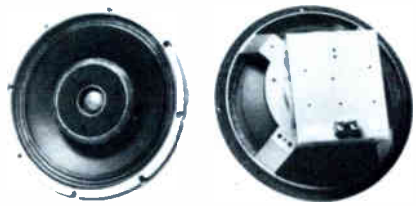
Crestron recently expanded its line of wireless controls with the introduction of the W-5 and W-6 Systems.

Both units provide wireless control of power, forward, reverse, and single-button focus for 35mm slide projectors at distances of up to 250 feet. Accessory equipment, such as electric screens and BTRs, may be conrolled with the remaining one (W-5) or two (W-6) auxiliary functions. These U.L. listed controls may be user assigned as either AC power switching or low voltage (latching or momentary) relay closures.

The W-5 and W-6 Systems can be used for either portable or permanent installations and are typically used in conference rooms, boardrooms, and training centers.

☐For further information, contact: Crestron Electronics, Inc., 101 Broadway Cresskill, NJ 07626; (201) 894-0660.

Reader Service #59



ALTEC LANSING ANNOUNCES DUPLEX LOUDSPEAKER

Altec Lansing Sound Products announced it has begun manufacturing a new duplex loudspeaker and accessories for sound reinforcement, paging, background music, and similar applications. Called the 920-8A, the loudspeaker combines a 12-inch cone for low-frequency reproduction, a dome radiator tweeter for high frequencies, and an integral crossover network.

Accessories for the 920-8A include a satin-finish white grille, four steel enclosures of different sizes for ceiling installations, and two matching transformers of different power ratings to drive the loudspeaker from 70.7-volt lines.

The high frequency dome-voice coil assembly can be removed for service with the 920-8A still in place in the ceiling.

The 920-8A is an 8 ohm system, and covers an angle of 80° at 2.5 kHz.

☐For further information, contact: Altec Corp., Box 26105, Oklahoma City, OK 73126-0105; (405) 324-5311.

Reader Service #60

THE RM-350A, NEW FM/AM RECEIVER,FROM BOGEN

Bogen has announced the RM-350A, a new FM/AM receiver for quality mono broadcast reception plus optional paging for restaurants, stores, offices, and warehouses. The RM-350A incorporates a low-impedance balanced microphone input and features advanced tuning aids, and built-in microphone precedence.

Rated at 35 watts, the RM-350A is

(continued on page 40)

TOA

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CONVENTION REVIEW

by Elliot Luber

Exhibitors set up prior to AES Convention

Sound system design has advanced by quantum leaps in the last few years, though major links in the chain—such as type-B amplifiers and transducers—still retain their basic concepts. But the growth of measurement techniques has eliminated a good deal of the magic and guesswork from designing and optimizing systems, and rooms. The ability to graphically depict what transpires in an empty hall or cabinet has made a mathematical task out of what was once impossible. The term Engineered Sound System says a lot.

So it wasn't a surprise to see this segment of the market quite heavily represented at the Audio Engineering Society (AES) Convention in Anaheim, CA's Disneyland Hotel last month, including many exhibitors, paper presenters, and related attendees. And it was not a tacit representation; innovation being the order of the day.

Among the outstanding innovations introduced at the convention were: Bose Corporation's technical paper refuting direct correlation between loudspeaker directivity and speech intelligibility; Electro-Voice's Transplanar Constant Directivity Horns, which Jim Long, EV's director of marketing for professional sound reinforcement, termed: "a second first-generation CD horn," and Meyer Sound Laboratories' Source Independent Measurement system, enabling Fast Fourier Transfer to be applied to live-performance sources while an audience is present. MSL president John Meyer received an AES Fellowship for his many acoustic research projects over the years.

Many of the engineered sound system advances continue to turn up in the area of touring sound rental companies as opposed to products for the installation market, partly because major touring companies often test prototypes on the road. And also due to the fact that their clients, often major rock acts, have the budget to afford innovation and the names to endorse a successful product. Nonetheless, these innovations continue to trickle down into theaters, arenas, and commercial installations, fueled by improvements in home stereo and movie theater systems which create increasing expectations for quality audio in public places.

The convention was the AES' last scheduled spring convention, as well as the last to be held on the West Coast until 1986, since the AES Board of Governors previously voted only to hold one annual convention which will alternate between coasts. The reason a second convention was held this year, was to avoid future conflicts in scheduling between the AES and Society of Motion Picture and Television Engineers (SMPTE), traditionally attended by many AES studio members.

Donald Plunkett, AES executive director, said the convention was quite successful. "We were very happy with the strong turn-out here," he said. "Both on the technical side and the exhibition side, the quality of attendees was very high." Total attendance was reported to be 6,783, although no breakdown of professions was available.

"The Society has been interested in the areas of concert sound reinforcement for several years, sometimes as a cry in the wilderness. Sound reinforcement, particularly in the area of creative arts performance, is now coming into its own as a quality area. We seldom hear the term PA except for rare occasions. The equipment necessary for sound reinforcement has been there for some time, but it was never utilized as such until fairly recently,"

he said. "I think we will see that trend continue in October 1985 in New York, whether it represents new exhibitors or expanded lines from traditional exhibitors."

Ron Whigham of RFI Electronics, San Jose, CA, a sound contractor who attended the AES Convention, found a heavier representation of the non-studio installation market. "I was pleased with the display and exhibit side of the convention, as opposed to past years. This year, it wasn't just a console show. The sound contractor and engineer were represented. What I saw was much more applicable to what we do and the products we use.

"In past years, I went more for reasons of getting reacquainted with people in the industry. We have the NSCA Convention for our own educational needs. So, based on previous years, I didn't leave enough time to see any of the technical presentations. If I didn't have that social aspect, I might not have gone at all. But, as I said, it was good to see products I have an interest in. As a hard-core sound contractor, I have to take all these wonderful things (for studios and concerts), and apply them to the world's realities."

Greg Willis, a systems engineer with Pro Media of San Francisco, CA agreed with Whigham's appraisal: "It definitely wasn't a console exhibition, there were enough bells and whistles around for everyone."

But Willis said there were less major exhibitions. In fact, the AES did impose a maximum exhibit size, partly out of sensitivity to the cost to manufacturers, who often try to out do each other.

"It's still good to have communications with a lot of manufacturers directly and to talk face-to-face with dealers. We had a lot of our newer staff with us, and the exhibition gave them a chance to see the products they're selling," he said, explaining that Pro Media does 60 percent of its business in contracting, a lesser precentage as a touring sound reinforcement company, and also sells signal processors and the like.

"Other than going to meet and conduct a little business with a few dealers, the exhibition was pretty boring. One new development which was exciting was Meyer Sound Laboratories' SIM measurement system. We were the original guinea pigs with that product, testing it on our tour with Luciano Pavarotti."

(continued from page 37)

said to be capable of driving up to 100 loudspeakers, provided that the total power consumed does not exceed 35 watts. Tuning aids include digital frequency readout, signal strength and LED center-station indicators, flywheel tuning, AFC and FM interchannel muting. Engineered as a reliable, solid-state product, the RM-350A has a FET front end for FM, silicon transistors, ceramic filters, and integrated circuits.

The receiver's paging-precedence circuitry may be activated either by its own microphone control, an external microphone switch, or a phone paging button.

☐For further information, contact: Bogen, P.O. Box 500, Paramus, NJ 07652; (201) 343-5700.

Reader Service #61

VALLEY PEOPLE OFFER NEW SINGLE CHANNEL PROCESSOR

Valley People, Inc. has introduced the Model 440 limiter/compressor/dynamic sibilance processor, a single channel device offering the convenience of a peak limiter, a high quality compressor/expander package, and a dynamic sibilance processor section, each controlling a common VCA (voltage controlled amplifier). Sophisticated intercoupling of the control circuitry used for each function allows the device to simultaneously limit, compress, expand, and eliminate high frequency components in sibilance.

Model 440's compressor control section features continuously adjustable threshold, attack time, ratio and release time. In addition, an interactive expander control is intergrated with the compressor control circuitry to reduce residual noise which would otherwise be "pumped up" or accentuated by the compression process. Special release coupling makes the transition from compression to expansion imperceptible, thus eliminating problems associated with the use of separate single-function units.

The limiter control section exhibits extremely fast attack characteristics, typically 1 us/dB or less, continuously variable threshold, a fixed 60:1 ratio, and variable release time.

☐For further information, contact: Valley People, Inc., P.O. Box 40306, 2821 Erica Place, Nashville, TN 37204; (615) 383-4737.

Reader Service #62

EV INTRODUCES CONSTANT-DIRECTIVITY HORNS

With a patented blend of flared and conical surfaces and the precision of directivity-opimized size, Electro-Voice's new TransPlanar™ HP high-frequency horns offer the most uniform beamwidth control in the industry, according to the company.

The series' three large HP horns maintain rated beamwidth control down to 500 Hz in both the vertical and horizontal planes. The four small HP horns maintain horizontal beamwidth control to 500 Hz and, with smaller, more convenient vertical dimensions, exhibit vertical control to 1,500 Hz.The HP horns have mouth sizes only as large as needed to maintain the rated coverage angles down to the low-frequency limits. This permits both compact cluster design and directivity control.

Cast into the metal throat section of every HP horn, angled waveguides restore full coverage patterns above 10,000 Hz, correcting the problem of high-frequency beaming, or narrowing of coverage angle.

HP horns prices frange from $180 to $645.

☐For further information, contact: Jim Long, Electro-Voice, Inc., 600 Cecil St., Buchanan, MI 49107; (616) 695-6831.

Reader Service #63

FACES AND PLACES

EV Names Fromm
Key Accounts Manager

Electro-Voice Inc., has added to its pro sound marketing team by naming Janine Fromm key accounts manager as announced by Jim Long, director of Marketing/Professional Sound Reinforcement.

"In her position as key accounts manager, Ms. Fromm will augment our existing rep force and act as a marketing resource for specifying contractors," Long said. "By advising the contractor about everything from appropriate products to writing proposals or effective techniques of competitive bidding, Ms. Fromm will help Electro-Voice serve a wide variety of contracting professionals and enlist support for Electro-Voice sound reinforcement products."

Fromm comes to Electro-Voice from Altec Corporation where for three years she acted as district manager of the Southeast part of the U.S.

JANINE FROMM

C.R. DUFFIE, JR.

Audio Group Names Duffie
Director of Market Development

C.R. Duffie, Jr. has been appointed director of market development for Audio Group, the distributors of business music, in-store sales messages, paging systems, sound masking, and phone-on-hold sales messages, according to David Oberle, general manager of Audio Group.

Duffie will have two major areas of responsibility. He will service the needs of major regional and national customers. Duffie will also establish a sub-carrier network throughout the Northwest.

Duffie has been with Audio Group for more than seven years. Audio Group has been in business for more than thirty years with offices in Oregon, Washington, Nevada, and Minnesota.

NorthCom Names Hazlett
Sales Engineer for West Coast

Wendy Hazlett has joined NorthCom Group, Inc., an equipment manufacturer of telecommunication products, as a sales engineer. Hazlett will develop and support west coast dealers and customers of NorthCom's electronic key telephone equipment.

Hazlett has worked in the telecommunications industry for seven years. Most recently she was a sales consultant with a major business equipment manufacturer.

WENDY HAZLETT

ROGER FAIRCHILD

Interline Names Fairchild
Marketing Vice President

Interline president John Jester announced that Roger Fairchild has been appointed vice president of marketing and training. Previously, Fairchild was a corporate vice president and technical officer. The appointment fills a position vacated by Jack Patterson who was appointed chief operating officer last February.

Fairchild joined Interline at its inception in 1983 serving as vice president of operations. In 1984, he was named vice president and technical officer. Prior to association with Interline, Fairchild was a district manager of Northwestern Bell in Minneapolis, MN.

Electronics Industry Corporation
Elects New Board Members

The Electronics Industry Show Corporation, which operates the Electronics Distribution Show (EDS), has announced the formal ratification of three new members to its board of directors. Newly-elected are Norman A. Ackerman of Perma Power Electronics, Inc; Len Benckenstein of Southwest Electronics, Inc; and Jack Darcy of Sprague. The three newcomers replace retiring directors William G. Little of Quam-Nichols Company, Max Sanders of Ohmite, and Harry Fallon of Federated Purchaser.

The new members will continue to manifest the EDS commitment to reflect in its Board composition the variety of market interests and company types that the EDS marketplace serves, said Bruce Anderson of Sumer Inc., and president of the Electronic Industry Show Corporation.

Augat Appoints Walker
VP, International Operations

Augat Inc. announced that Kevin Walker has been appointed to fill the newly created position of vice president, International Marketing. In the position, Walker will be responsible for all commercial operations outside the U.S., including wholly-owned Augat marketing and distribution subsidiaries in Canada, Japan, and Europe. Walker will report to William P. Miller, president and chief operating officer.

Walker had been vice president, European Operations since 1982, stationed in Milton Keynes, England.

KEVIN WALKER

LARRY SHANK

Tecron Announces Shank
As TEF® Salesman

Tecron, industrial division of Crown International, Inc., has announced the addition of Larry Shank to its staff as a TEF® salesman. Shank will be responsible for the marketing of the TEF® 10 Systems Analyzer/Computer, the TEF® technology, and the coordination of the TEF® markets.

Shank came to Tecron from the Burroughs Corporation where he spent over four years selling mainframe computers specializing in telecommunications and on-line terminals.

BOSE 402 ARTICULATED ARRAY LOUDSPEAKER

by Farrel M. Becker

The Bose 402 is a small, lightweight, rugged and totally weatherproof loudspeaker. Measuring 23 1/4 by 8 1/8 by 7 1/4 inches, weighing 15 pounds, the 402 is built like a tank. Constructed of black mica-reinforced polyethylene copolymer foam, it is vertually weatherproof and may be permanently mounted outdoors. The drivers are said to be immune to water and freezing and may be operated when wet.

The loudspeaker consists of four 4 1/2-inch drivers arranged in a vertical column in what Bose calls an "Articulated Array." In this configuration, the two inner drivers are tilted approximately 20 degrees toward the axis of the loudspeaker, while the outer two drivers are tilted away from the axis. The enclosure features two tuned ports, one at the top and the other at the bottom, which double as drains for all-weather operation.

The grille is constructed of perforated plastic covered with cloth and is secured to a V-shaped "Acoustic Diffractor" that runs vertically in from of the two inner drivers. Two paralleled one quarter-inch phone plugs are provided for input to the loudspeaker. A positive voltage applied to the tip of the plug causes all drivers to move forward. A built-in 3 amp, fast blow fuse provides protection from overdrive beyond the rated power handling capability of 120 W (continuous pink noise).

Bose utilized several techniques in this loudspeaker to achieve its design goals. The Articulated Array is intended to avoid interference effects from the multiple drivers and improve dispersion. In order to minimize narrowing of the vertical polar pattern with increasing frequency (a common problem associated with column loudspeakers) a frequency shading circuit within the loudspeaker itself sends the higher frequencies to the inner two drivers only. (Frequency shading is not new or unique to Bose; it has been in use for at least 20 years.) The Acoustic Diffactor is intended to widen the horizontal polar pattern above 5 kHz.

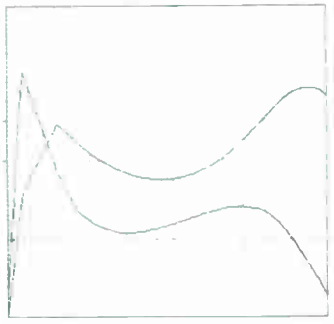
Like all Bose loudspeakers, the 402 is intended to operate with its own equalizer. **Figure 1** shows the amplitude (upper curve) and phase (lower curve) verses frequency for the Bose 402-E active equalizer. This is a two-channel device, presumably for stereo operation. Input and output impedances are 1.2 megohms and 490 ohms, respectively. The input sensitivity at 1 kHz was measured to be 7 V. The L_{AIP} (available input power) measured at the output of the equalizer was 14.8 dBm.

The magnitude of the loudspeaker's impedance is shown in **Figures 2 and 3**. The minimum impedance of 6.6 ohms occurs at 3,157 Hz. The impedance at the resonant frequency of the driver (160 Hz) is 39.2 ohms. The impedance peak of 32.5 ohms at 60 Hz is due to the ports (drains?).

All acoustical measurements were taken with the 402-E equalizer ahead of the power amp and the drive voltage to the loudspeaker adjusted for 2.57 V at 3,157 Hz. This results in 1 W of power applied at the loudspeaker's minimum impedance. **Figure 4** is an Energy Time Curve (ETC) taken on axis with the loudspeaker in its normal condition (grille in place, etc.). The 402 emits significant energy over a period of 1.5 millisecond. The on axis frequency response is shown in **Figure 5** on a linear frequency scale. **Figure 6** shows the phase response. The 1 W/4 foot sensitivity at 1 kHz is 93.7 dB. The 1 kHz EIA rating is 46.2 dB. The deep notch at 16,543 Hz is caused by interference effects and disappears off axis as notches at other frequencies occur.

Figure 7 shows the frequency response (from top to bottom) on axis, off axis vertically 30, 60, and 90 degrees. Each of the off axis curves has been offset (down) by 12 dB from the previous curve for clarity. The variation in response at the higher frequencies is due to interference effects between drives. The vertical polar pattern at 2 kHz is shown in **Figure 8**. The lobing is again caused by interference and varies with frequency (this is typical of column loudspeakers). **Figure 9** is an ETC taken 20 degrees off axis vertically. Here the main lobe of the loudspeakers energy arrives approximately .5 millisecond after the initial arrival. As on axis, energy is

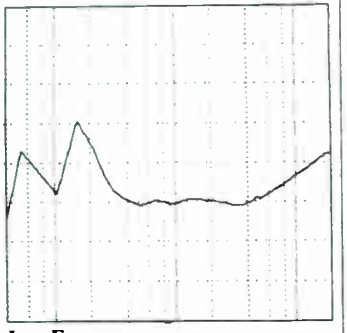
Phase vs Hz (EFC) **Fig 1**



Log Frequency

Amplitude and phase of Bose 402-E equalizer, 6 dB and 45 degrees per division, 0 - 20 kHz, 7 Hz resolution.

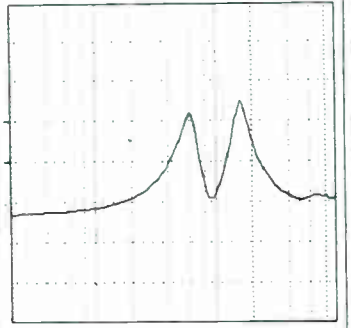
Mag vs Hz (EFC) **Fig 2**



Log Frequency

Magnitude of Bose 402 impedance, 6 dB/division, 0-20 kHz logarithmic, 44 Hz resolution.

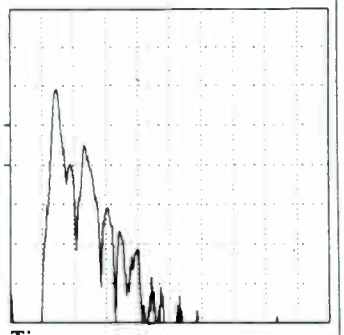
Mag vs Hz (EFC) **Fig 3**



Log Frequency

Magnitude of impedance, 6 dB/division, 0-100 Hz logarithmic, 22 Hz resolution.

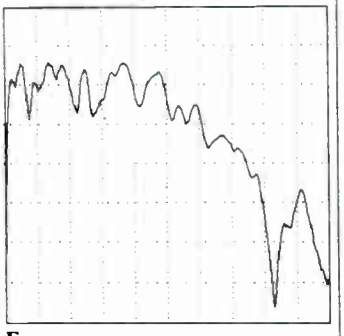
Amplitude ETC **Fig 4**



Time

On axis ETC 6 dB/division vertical, .5 msec/division horizontal.

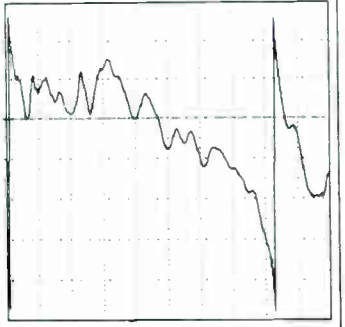
Mag vs Hz (EFC) **Fig 5**



Frequency

On axis frequency response, 6 dB/division vertical, 20-20 kHz horizontal, 226 Hz resolution.

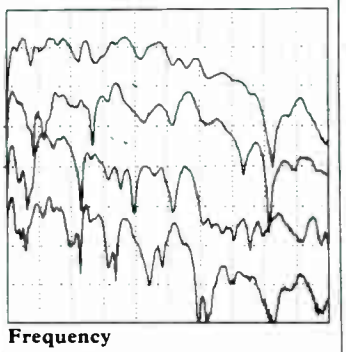
Phase vs Hz (EFC) **Fig 6**



Frequency

Phase verses frequency from data of **Figure 5**, 45 degrees/division vertical.

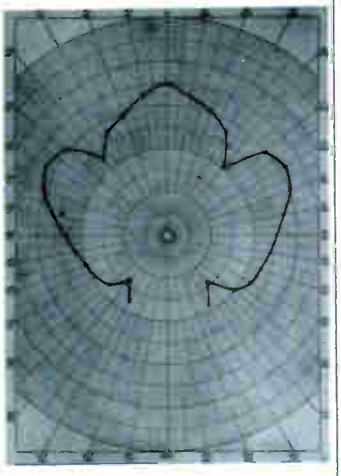
Mag vs Hz (EFC) **Fig 7**



Frequency

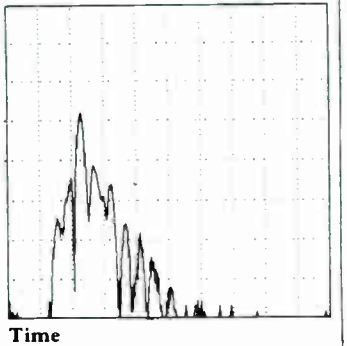
Frequency response 0, 30, 60, 90 degrees off axis vertically (12 dB offsets), 12 dB/division, 20-20 kHz, 226 Hz resolution.

Fig 8



2 kHz vertical polar response, 10 degrees/data point, 5 dB/major division.

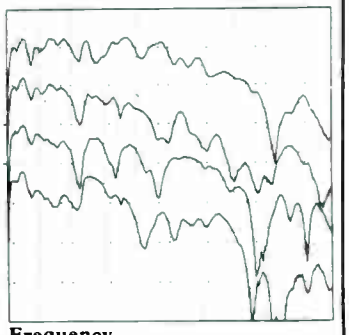
Amplitude ETC **Fig 9**



Time

ETC 20 degrees off axis vertically, 6 dB/division vertical, .5 msec/division horizontal.

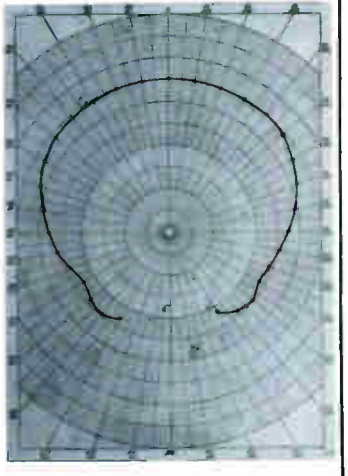
Mag vs Hz (EFC) **Fig 10**



Frequency

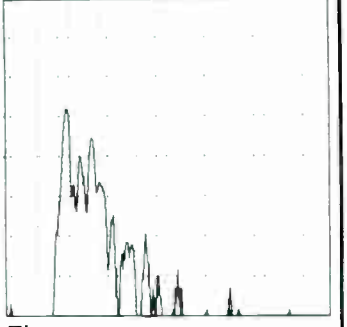
Frequency response 0, 30, 60, 90 degrees off axis horizontally (12 dB offsets), 12 dB/division, 20-20 kHz, 226 Hz resolution.

Fig 11



2 kHz horizontal polar response, 10 degrees/data point, 5 dB/major division.

Amplitude ETC **Fig 12**



Time

ETC 30 degrees off axis horizontally, 6 dB/division vertical, .5 msec/division horizontal.

emitted for over 1 millisecond.

Figure 10 shows the 0, 30, 60, and 90 degree frequency response curves in the horizontal plane (each offset 12 dB). The response remains fairly consistent below approximately 8 kHz. The Acoustic Diffractor does help to increase the high-frequency response off axis. The price paid for this benefit (you can't get something for nothing is a rougher response. **Figure 11** is the 2 kHz horizontal polar pattern. The 30 degree off axis ETC for the horizontal plane is shown in **Figure 12**. Again, the energy is well spread in time.

Bose gives vertical and horizontal beamwidths of 60 and 120 degrees, respectively. The measured polars of **Figures 8 and 11** yield values of 46 and 162 degrees (at 2 kHz). The Q calculated from the 2 kHz polars is 3.89. This is a single frequency Q. The values of 6.9 for the 2 kHz octave band quoted by Bose agrees well with its published polars.

As mentioned earlier, the Acoustic Diffractor generally widens the horizontal polar response, but at the expense of a rougher frequency response. **Figure 13** shows the effects of the diffractor on the on axis frequency response. The reference line here is the normalized response with the diffractor removed and the grille in place. The 10 kHz polars of **Figure 14** shows the apparently random behavior of the Acoustic Diffractor. The wider and smoother polar pattern was obtained with the diffractor removed, while with the diffractor in place, a small amount of lobing occurs on one side of the loudspeaker and a larger lobe occurs on the other.

The grille also affects the response of the loudspeaker as shown in **Figure 15**. I have seen this before in loudspeaker grilles. It is caused in part by scattering from the grille's frame and by reflections from the grille material itself. Often, a significant portion of the energy incident on the grille is reflected once again by the loudspeaker and baffle back to the grille. This game of billiards continues with some of the enrgy passing through the grille on each bounce. The resulting delayed energy causes the observed anomalies in the frequency response.

The Bose 402 has a somewhat blurred sound. When listening directly on axis, some loss of clarity is note. Off axis, the sound deteriorates further, taking on differing qualities depending upon position. This is not

(continued on page 46)

PRODUCTS IN REVIEW

a closer look

by gary davis

AKG D321 Dynamic Hypercardioid Microphone

The D300 Series, introduced by AKG in 1979, included then very advanced methods of capsule design and suspension which were intended to reduce noise due to handling and electromagnetic induction. The D321 is daid to take the concept a step further. (We have not actually seen or heard the mic, so this comes only from the printed word.)

The hypercardioid pattern is narrower that a conventional cardioid, though the rear lobe pattern is somewhat different. It should be very useful on stage, where feedback from monitors and leakage from adjacent monitors and instruments must be controlled. The D321 should be able to stand up to the typical stage-mic abuses: being dropped and banged around. Its capsule is protected not only by a screw-on stainless steel mesh screen with foam anti-pop filter; but by two high-impact plastic "baskets" said to cumulatively withstand *static* stress of up to 500 kg. We don't know what the impact resistance is, but given that the thick-walled case and capsule are probably rugged, what really interests us are the anti-handling noise and anti-impact noise provisions of the D321.

The diaphragm is fixed directly to the transducer case (capsule), whereas the magnet is fixed to the case by an elastic suspension. The magnet and diaphragm are tuned manually to the same mechanical resonance frequency range (we assume sub-audio). The theory is that mechanical vibrations will excite both diaphragm (with coil) and magnet in-phase, so that no electrical output from the mic is generated. Airborne sound, however, will excite only the diaphragm, generating the desired electrical output.

At the higher frequency end of the spectrum, handling and scratching noise are said to be absorbed by the capsule suspension, do not generate electrical output. The capsule is shock mounted to protect it from violent movements; in other D300 mics, this was done with a system of progressive rubber "buttons" that compressed easily to minimize minor shocks, and then required greater compressive force to absorb larger shocks; we don't know if the same approach is used in the D321.

The AKG literature makes a brief, little-explained reference to a compensation system which provides up to 20 dB better S/N than "current systems." We assume this is accomplished by wiring a second, fixed coil in series with the diaphragm's moving coil, but out-of-phase so that electromagnetic fields cutting across the mic will cancel in the output...as was done in the earlier AKG D330BT.

Reader Service #64

Ross Graphic and Paragraphic EQs

The paragraphic is nothing more than a graphic EQ with a three-position toggle switch under each slider so that the center frequency may be changed; it is not sweepable, nor is the Q adjustable as in a true parametric EQ. Nonetheless, the extra control may be useful when trying to reduce a peak to improve gain before feedback, or for creative manipulation of the program.

Scott McKeehan of Ross, clarified the four equalizer models which the company has introduced.

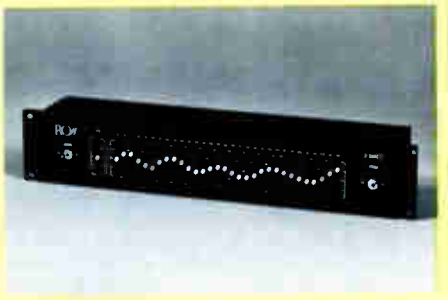
All models provide 12 dB of boost or cut per band, plus an overall ±12 dB level control. The overall control on the R12SP is an output level control, whereas the control on the other models affects input level; we don't know why the design philosophy was changed for one model.

All models are said to have an 85 dB S/N, a 20 Hz to 20 kHz frequency range, and about 0.01 percent THD with controls set for unity gain.

An interesting feature is that the input can be switched to mic (approx. -40 to -60 dBV) or line (-10 to +4 dBu) nominal level. Since the equalizer can to be inserted in line with the microphone, Ross enables it to be used for effects on individual sound sources with mixers that do not have interstage patch points.

Given that only the R31M has balanced input and output connections, there may be noise problems using these equalizers at the output of a mixer to drive a long line to a remote power amp. However, given their adjustable overall gain, these equalizers should be able to work within the effects loops of most mixers, allowing the mixer's balanced output to drive the power amps (or tape machine).

Reader Service #65



Model	# of bands	# of Channels	Type	Input/Output Connectors
R31M	*31*	*1*	*Graphic*	*one-quarter-inch TS phone & Bal. XLR*
R15S	*15*	*2*	*Graphic*	*one-quarter-inch TS phone*
R10S	*10*	*2*	*Graphic*	*one-quarter-inch TS phone*
R12SP	*12*	*2*	*Paragraphic*	*RCA & one-quarter-inch TS phone*

ELECTRONIC RECORDERS

(continued from page 35)

to bumble with a myriad of knobs. The recording equipment developed specifically for courtroom used, solves most of the problems in simple fashion if the equipment is correctly use. They all utilize double transports, for example, if a tape breaks or jams, the standby deck can be loaded with fresh tape and quickly brought on line. Gyyr's machine, which is microprocessor based, even automatically detects tape failures or end of tape and switches transports automatically. But our purpose here is not to detail the individual features of each manufacturer's recorder. It would suffice to say that the hardware at this stage is well ahead of the other aspects. Those other aspects all involve people.

Successfully using E.R. is not a technical problem. It's a people problem. The people who make the laws have to permit its use in jurisdictions where it is currently barred. Judges and court administrators have to want to make it work. If they have a closed mind and a negative attitude no level of success will be acceptable. The people who layout courtrooms, the architects, contractors and designers, must make allowances for it. And the sound contractors must do a good job of installing it. That's all workable with some basic understanding of the individual disciplines involved. But the biggest people problem is the need for skilled operators.

Now, this may not seem like a big deal to you. You probably sat down at your computer today and worked out the equations for maximizing hall effect using time delay in the new church sound system you're designing. But you're euphamistically called a technophile, someone who not only appreciates the benefits of technology, but actually likes it. Most people tolerate it, but are neutral in their attitudes toward technology, that is, they neither like nor dislike it, but appreciate whatever benefits it can bring to their lives, assuming the cost in money, time and work is not too dear. So don't underestimate how intimidating using a tape recorder in a courtroom can be.

Remember when you learned to drive a car? You mastered the basics easily, and probably spent your first hour driving the wheels off your learner car in some vacant parking lot. But then when you got into city traffic for the first time, it was a much different story. You panicked; so much to remember, and you were not yet conditioned to react automatically. You can quickly train someone how to operate a courtroom sound recording system. But in the heat of a trial, they are likely to panic if something goes wrong, or if they forget how to do something.

LAB TEST

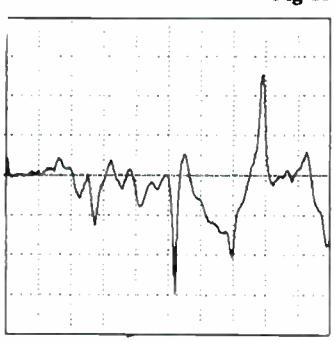
(continued from page 44)

unexpected in light of the above measurements.

The engineers at Bose packed a lot of features into this loudspeaker. The packaging has been so thoroughly thought out that the 402 is capable of handling a great many jobs. Two 402s and a single 402-E equalizer are neatly carried in a single "Transit Kit." Once on the location, two thumb screws carried on the rear of each loudspeaker are used to mount the unit on a folding stand. For stage monitor use, the loudspeaker is laid on its side and a short "leg" that is carried in the transit kit is screwed into the back to maintain the proper angle. For a more aesthetic installation, the wood-grain finished 402-W model may be used.

The versatility of the Bose 402 makes it a good choice for a small portable sound system. For a permanent outdoor distributed installation that must be exposed to direct weather, it is ideal.

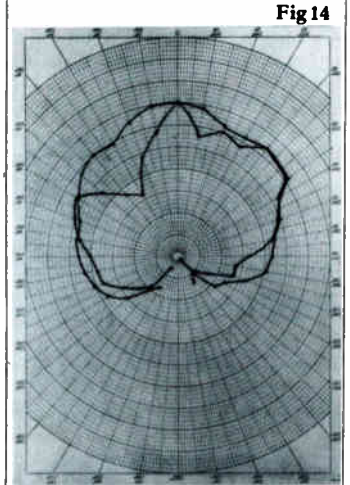
Mag vs Hz (EFC) Fig 13



Frequency

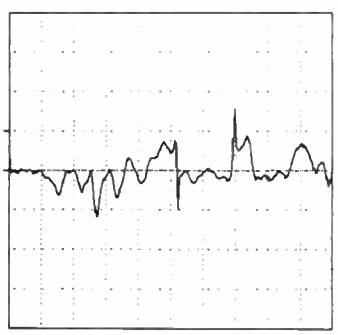
Effect of diffractor on axis, 6 dB/division vertical, 20-20 kHz horizontal, 226 Hz resolution.

Fig 14



10 kHz polar response with and without diffractor, 10 degrees/data point, 5 dB/major division.

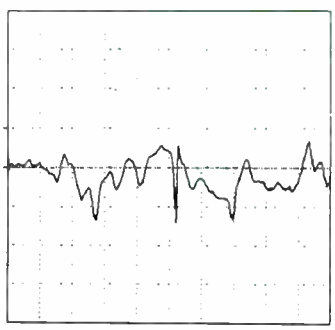
Mag vs Hz (EFC) Fig 15



Frequency

Effect of grille on axis, 6 dB/division, 20-20 kHz, 226 Hz resolution.

Mag vs Hz (EFC) Fig 16



Frequency

Combined effects of grille and diffractor on axis, 6 dB/division, 20-20 kHz, 226 Hz resolution.

BOOK REVIEW

by Ted Uzzle

Getting Down to Basics

Wadsworth, Raymond H., *Basics of Audio and Visual Systems Design, Howard W. Sams & Co., 1983.*

Many books have ambitious titles; this is one of the very few which fulfills the promise of its title. It presents the basics in a thorough and comprehensible way, without ever watering them down into useless, treacly pap. It deals with systems, the way components work together; and it is aimed throughout at the designer who must make the system work on paper before large resources are committed to buy and install. The graphic artist for this handsome large-format paperback has illustrated the cover with figures from solid geometry, and these perfectly represent the book, as clearsighted and as carefully reasoned as Euclid's.

Almost any high school kid can set up a slide projector and an amplified podium. There are fewer than a dozen world-class audiovisual designers, however, who can calculate the exact performance of the equipment, regularly squeeze astonishing image quality from it, and shoehorn it into impossible spaces. The rest of us learned what we know from a variety of Kodak brochures. A few of us have been lucky enough to run across a small book by Will Szabo, published by the Public Health Service for use in the design of medical classrooms, which covers some of the same material with the same rigor. Here at last is a designer's goldmine, a compendium of techniques available to every one. There are no "secrets" here, only solid engineering, with equations worked out in their most practical form, and drawings that truly illuminate the subject.

The 125 pages are divided into eleven sections, starting with the formats (size and shape) of projected images and a variety of media. Each system has two sets of standard dimensions: the carrier (i.e., 2 foot × 2 foot slides, 35mm KS sprocket hole film, etc.) and the image area contained within the carrier. The characteristics of each are described for 18 formats.

The next two sections deal with screen size and ceiling height, and the relative advantages of front versus rear projection. Ceiling height is not an idle cavil; too many designers use nice big screens, with most of them hidden behind the heads and shoulders of those seated in front.

In the fourth section, Wadsworth shows a precise approach to screen reflectivity, and a way to predict with precision what viewing angles (and thus, seats) will enjoy projected images with light attenuated any given amount. There's no lack of trigonometry here, but it leads to the correct solutions where we used to guess.

Section five reviews lens optics, not just the "infinitely thin lens" equations we all studied in freshman physics, but also the characteristics of compound, multi-element lenses, as the projection designer needs to know about them. The following section deals with light output from projectors, and shows how to evaluate projector manufacturer's claims about light output. You *can* use those dim specifications to predict brightness, but you have to know how.

The next section turns to the "audio" in "audio-visual." As you may expect, Wadsworth does not shrink from a sophisticated, mathematical treatment that is based on a correct understanding of both loudspeaker and room behaviors. For the first several pages here we see, alas, too many of the same old figures and tables published in all the other surveys of the subject. The audio-visual designer is enlightened as to the sound power of the pneumatic chipping hammer. Why? Because most other books show it. Well, I forgive Wadsworth three derivative pages, because thereafter he leaves these traditional beginner's descriptions far behind. Three typical problems solved in a schematic way highlight a direct, practical approach to the same conservative solutions most truly professional designers would achieve.

The next section presents some of the most complicated mathematics in the book. It deals with keystoning of images not projected exactly perpen-

(continued on page 48)

ADVERTISING TABLE OF CONTENTS

IDEAS & VIEWPOINTS

(continued from page 11)

way to evaluate the risk.

In any kind of business, the least riskiest way to expand sales is to look for new customers for your existing products. A somewhat more risky way to expand sales is to look for new products to sell to your existing customers. The most risky way to expand sales is to look for new products to sell to new customers.

Both of my strategies are a mix of the three ways to increase sales. A side-step strategy finds a contractor selling existing products (musical sound systems) to existing customers (nightclubs). A diversification strategy finds a contractor selling new products to existing customers. It may also find a contractor selling new products to new customers (most risky).

It seems to me that a prudent contractor will look first to ways to find new customers for existing products (selling interconnect to brokerage firms) before attempting a side-step or diversification strategy. Yet, for those contractors who believe they have exhausted the market for their existing products or who find themselves pushed out of their market by a giant competitor, one of these strategies may be the route to survival.

Does Survival Mean Growth?

One irony of all this is that a successful small contractor may very well grow past my definition of "small" (less than one million U.S. dollars in yearly sales). Growth of this kind can bring its own problems, of course, and growth is only one way to survive, but not the only way. For example, a shift in market focus may bring about new profitability without a sales increase.

Can Small Contractors Survive?

Some small contractors will undoubtedly make me look foolish by surviving and growing without the kind of changes I have discussed. Other small contractors will make changes and fail as a result. Still others will do what I predict and perform a market side-step or diversify and find that their sales and profits benefit greatly as a result.

The one thing I do know, all of our markets and our businesses are changing and most of us will have to change to survive. We will continue to report on as many segments of the sound and communications marketplace as we can, while trying to avoid over-diversification ourselves!

BOOK REVIEW

(continued from page 47)

dicularly to the screen. The density of mathematics is appropriate, because Wadsworth disproves an ancient canard: that keystone image distortion is a simple function of projection angle. This problem is much more complicated to evaluate. There could be more frosting here: Wadsworth doesn't consider the visual distortion created by the angle of view from the viewer to the projection screen. Sometimes this will add to, and sometimes this will subtract from the projection keystoning. Image distortion criteria should consider the location of the viewer in relation to the screen, because this has definite effects on acceptable versus marginal seating locations.

Section nine explains the techniques of projection through mirrors, and illustrates the special advantages and problems of this technique. Section ten covers video for the audio-visual designer, both as electronic system design for signal distribution, and as visual design for legibility. Video is funny, in that many people who know how to set up a slide projector lose all common sense when they set up monitors, "Let's watch the monitor" becomes an invitation to use binoculars.

The book concludes with a short essay on audio-visual contracting, and its relationship to clients, consultants, and general contractors. There's no news here, but it's practical and fair you just may want to send it anonymously to some clients, consultants, and contractors you've dealt with.

Although I find this book done well, I think it could be made just a little better:

First: drop the question-and-answer format, the text would flow lucidly and seamlessly without it.

Second: add more! Turn this insight to theatrical projection formats, for 35mm and 70mm film. Those who work in this narrow specialty don't have anything nearly as good as this book for their projection design problems.

Third: add even more! The case studies in the chapter on audio are so well analyzed, an excellent concluding chapter should include case studies with analytical solutions for both image and sound, for classrooms, boardrooms, and conference rooms.

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The cable is UL listed for use with high speed computer and data systems, and features polyethylene insulation, braided shield (96 percent coverage) with black PVC jacket. It is available in standard reels of 1,000 and 2,500 feet, and is also available for plenum applications.

Contact: Olflex Wire & Cable, Inc., Dept. A55, 30 Plymouth St., Fairfield, NJ 07006; 1-800-225-1336 or in New Jersey (201) 575-1101.

Reader Service #66

NEW STAINLESS STEEL TOOLS FROM DESCO INDUSTRIES

Desco Industries' new solid stainless steel soldering tools aid in avoiding flakey circuits. Many soldering aids are made of chrome plated steels but chrome plating can flake or peel causing microscopic conductive materials to be deposited in circuits. With high density circuit geometry, plated soldering aids can cause problems. Desco soldering aid blades are precision machined from stainless steel to eliminate the problem of flakey circuits. The soldering aids come in 24 different styles with either plastic or hardwood handles. Six stainless steel blade styles are available including prober, reamers, forks, and stainless steel brushes.

Desco soldering aids are available from distributors throughout the U.S. and Canada. Desco will send a complete catalog of tools for electronics and a free sample soldering aid to anyone who requests it on company letterhead.

Contact: Desco Industries, Inc., 761 Penarth Ave, Walnut, CA 91789; (714) 598-2753.

Reader Service #67

SOUNDOLIER INTRODUCES WIDE ENCLOSURES

Soundolier, Division of American Trading and Production Corporation, has started to produce a new series of steel cabinets and racks functionally designed to house the extra-wide control equipment frequently used in telecommunications, transmitter, and studio facilities.

The modular enclosure systems are available in either 24-inch or 30-inch widths, and in a choice of vertical heights varying from 36-inch to 77-inch. They complement the ten select series models of standard 19-inch width and similar height options.

While designed to be used as individual free-standing housings, the enclosures can be grouped for coordinated multiple bay-type installations.

Based on anticipated use in high visibility areas, such as electronic PBX centers, security monitoring headquarters, or broadcast and video facilities, all the select series enclosures emphasize visual appeal.

Contact: Soundolier, 9380 Watson Industrial Park, St. Louis, MO 63126.

Reader Service #68

JENSENS'ELECTRONIC TROUBLE SHOOTER

Jensen Tools has introduced a time-saving device, the Octpus, that is said to provide a fast, efficient method of troubleshooting electronic assemblies to the component level, both in and out of circuit. The device can be used in conjunction with any dual trace oscilloscope having "X-Y" function or with a single trace scope that accepts "external horizontal" sweep output. The Octopus generates sinusoidal test signals of approximately +/- 3Vp-p at 60 Hz. When applied to the component under test (resistor, capacitor, semi-conductor, inductor, etc.) it will display the component's current/voltage response on the oscilloscope.

Contact: Jensen Tools Inc., 7815 S. 46th St., Phoenix, AZ 85040; (602) 968-6231.

Reader Service #69

PANDUIT INTRODUCES TIN PLATED CONNECTORS

A new line of tin plated connectors is available from Panduit Corporation, for use with the company's Lat-Con .050-inch flat cable connector system.

Designed for applications which do not require selective gold plating, tin plated connectors are said to offer lower component cost with the same fast, reliable termination capability. The new units are available in 20, 26, 34, 40, and 50 circuit sizes, with either .114-inch or .177-inch straight or angle pins.

Contact: Manager, Inside Sales Dept., Panduit Corp., 17301 Ridgeland Ave., Tinley Park, IL 60477-0981; (312) 532-1800.

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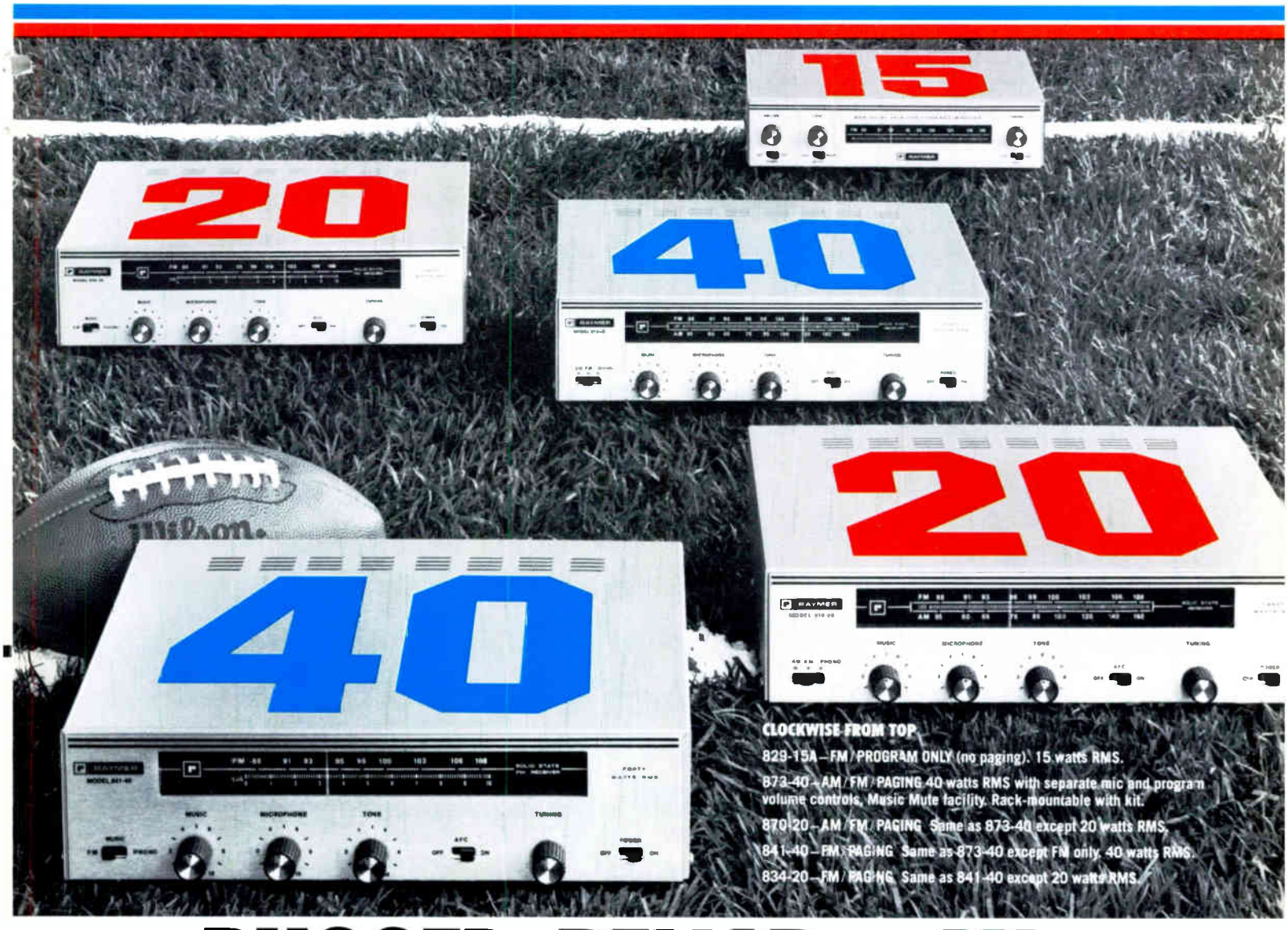

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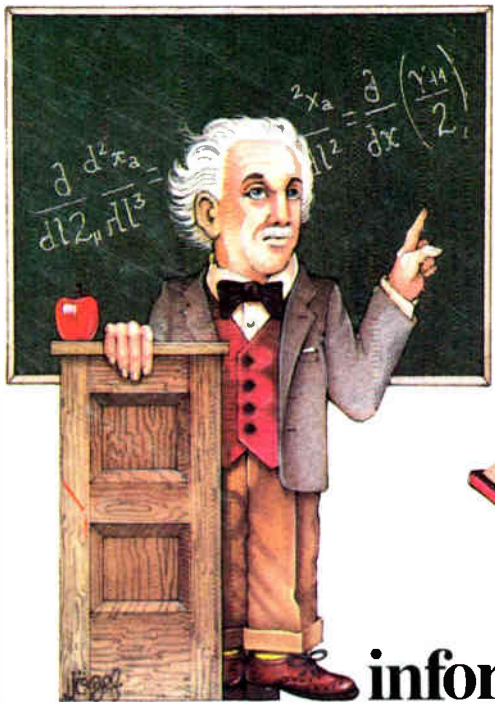

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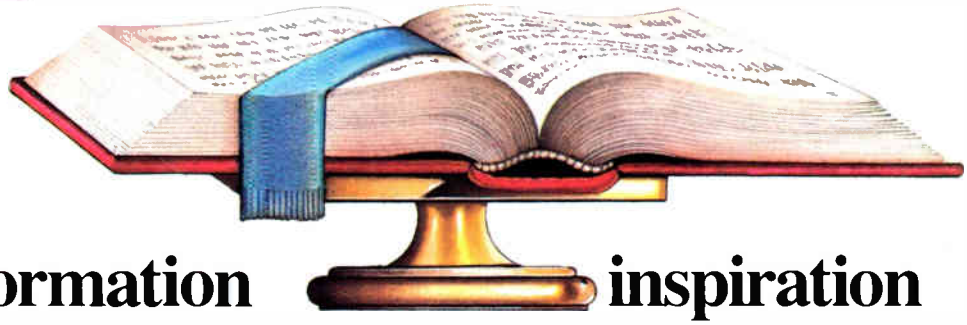

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