Broadcast engineering®

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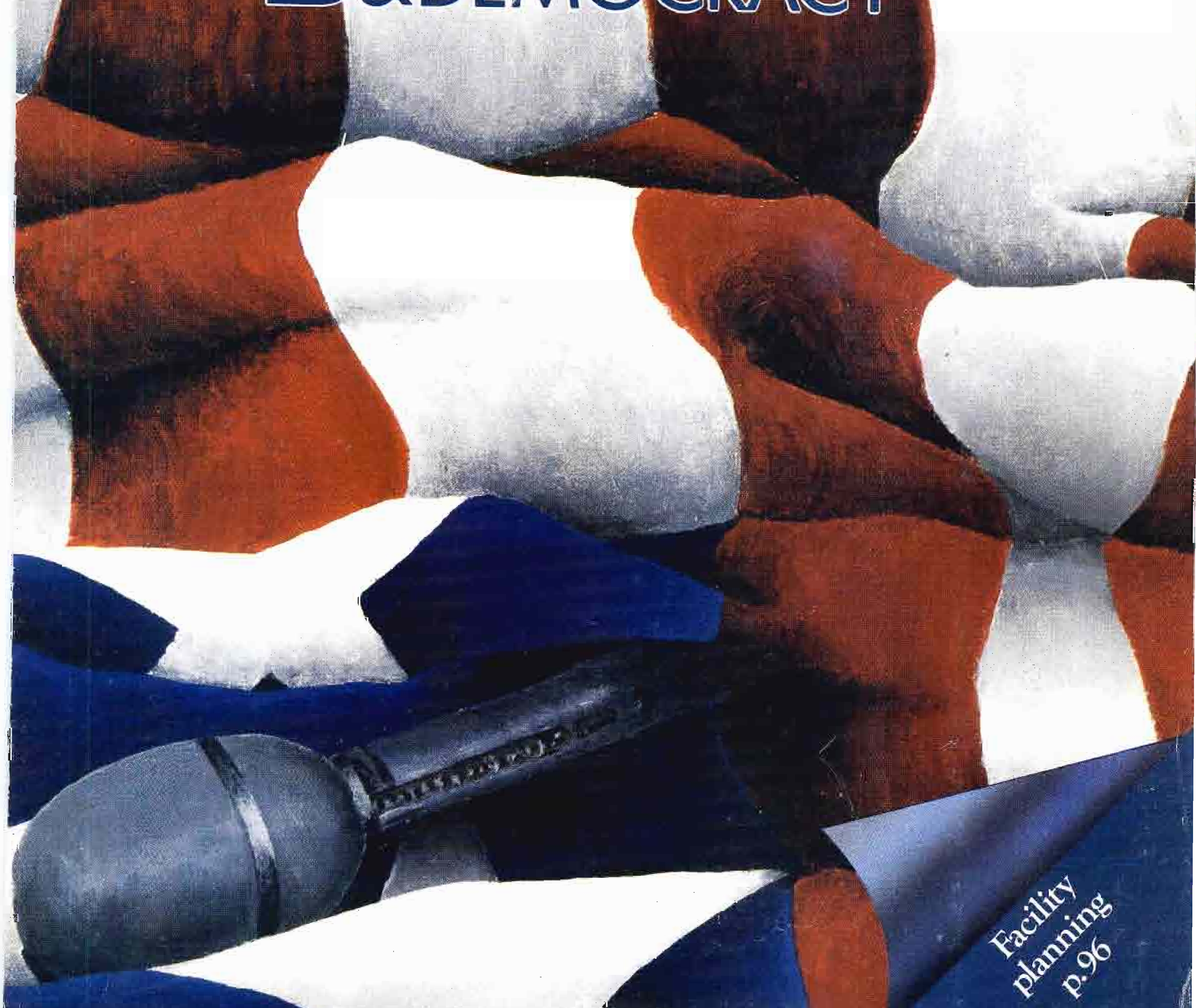
March 1988/$3

NAB '88: Broadcasting & Democracy



Facility planning p.96

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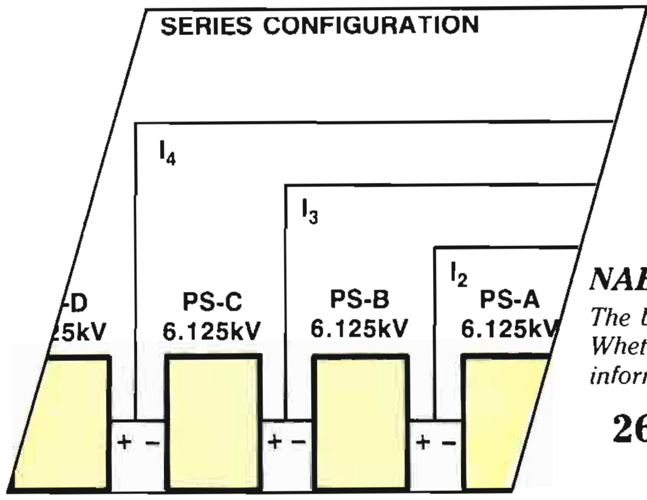

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BROADCAST engineering

ON THE COVER

Broadcasting and Democracy: The Winning Ticket. That's the theme of the 1988 NAB convention to be held April 9-12 in Las Vegas. The broadcast industry's "main event" will feature more technical sessions and exhibit space than ever before. And with the upcoming political conventions, broadcasters are expected to be in a buying mood. Cover design by Kristi Sherman of the **BE** staff.

DEPARTMENTS

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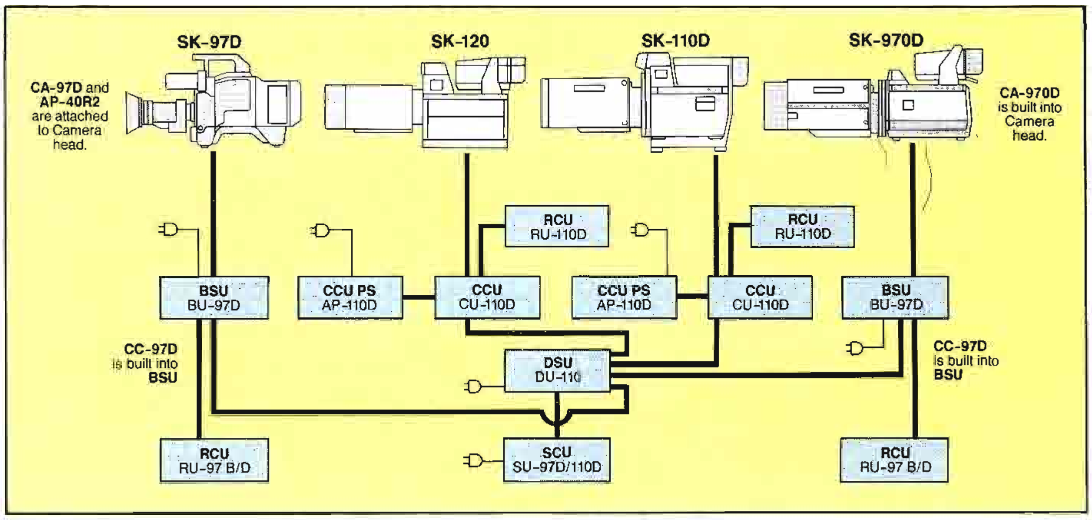
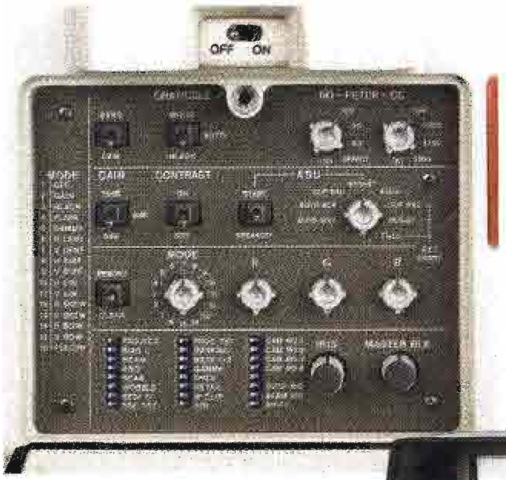
Stop sweating over G-reference setup. With Hitachi Zero Method automatic setup, no adjustments are required. Just fire up, press the auto setup button and within minutes you're ready to shoot. It's that simple.



How Hitachi's SU-97D Auto Setup Control achieves simultaneous setups on four different camera models. System can expand to set up and control 42 cameras.



Rear panel on Hitachi's SK-970D camera. Complete controls for automatic setup and camera operation.

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News

Winter SMPTE reflects transitions

The theme of the 22nd annual Television Conference of the Society of Motion Picture and Television Engineers, "Technology in Transition," was an unintentionally ironic comment in that the conference was, in itself, somewhat of a transition. The meeting, Jan. 29 to 30 at the Opryland Hotel in Nashville, TN, marked the last time equipment exhibitions per se will be part of the winter conference.

Acting on industry input, SMPTE leaders decided that, in the future, the only exhibitions will be technology demonstrations by the various working groups of the organization. The equipment exhibit will remain a part of the SMPTE Technical Conference and Equipment Exhibit each fall.

Industry experts from four nations presented papers to the more than 600 attendees on digital tape formats, digital interconnection in facilities, facility design, HDTV, advanced diagnostics and troubleshooting, audio for television and computer graphics.

D1, D2 and summaries of technologies, present and future, comprised the Friday morning session. Speakers touched on the diagnostic packages built into DVTR products, discussed the engineering constraints of a new, small (possibly 8mm) digital format and described a 3-D laserdisc system.

Friday afternoon topics included digital and analog interconnection of equipment, some 6MHz HDTV systems proposals and tests being conducted on terrestrial delivery systems for HDTV.

Facility design, the Saturday morning topic, included papers on CAD (computer-aided design) and control room design for quality stereo imaging. Other papers covered monitor setup, fault diagnosis in digital equipment, audio test tones and computer graphics.

Papers delivered Saturday afternoon addressed audio for television, editing and a conference controversy, the "10-bit brushfire," a proposal to use extra bits in the CCIR 656 digital standard. The purpose of the bits is to lower the visibility of correlation patterns that sometimes crop up as a result of rounding or truncating operations.

Exhibition space was fairly compact at the conference, consisting of two aisles in a room downstairs from the presentation area. However, the 15 or so exhibitors were able to provide great accessibility to attendees with questions.

The conference was opened with a welcoming speech by SMPTE editorial vice president Howard T. La Zare. A "get-together" luncheon Friday featured CBS vice president of engineering and development, Joseph Flaherty, who spoke of how technology keeps coming back to meet us. Flaherty cited historical examples of broadcast pioneers who faced problems of standardization and rapid advancement similar to the ones seen by today's broadcasters.

BROADCAST engineering

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TRUTH: A lot of monitors "color" their sound. They don't deliver truly flat response. Their technology is full of compromises. Their components are from a variety of sources, and not designed to precisely integrate with each other.
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CONSEQUENCES: Conventional magnetic structures utilize non-symmetrical magnetic fields, which add significantly to distortion due to a nonlinear pull on the voice coil.

TRUTH: 4400 Series monitors also feature special low diffraction grill frame designs, which reduce time delay distortion. Extra-large voice coils and ultra-rigid cast frames result in both mechanical and thermal stability under heavy professional use.
CONSEQUENCES: For reasons of economics, monitors will often use stamped rather than cast frames, resulting in both mechanical distortion and power compression.

TRUTH: The JBL 4400 Studio Monitor Series captures the full dynamic range, extended high frequency, and precise character of your sound as no other monitors in the business. Experience the 4400 Series Studio Monitors at your JBL dealer's today.
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The audience is watching

A guest editorial
by Michael Heiss,
consulting editor

In these times of tight budgets, it is hard enough to get funds for required maintenance, let alone to replace aged equipment that is past its efficient life. And yet, as NAB approaches, you'll be urged again and again to consider purchasing items to upgrade your signal. It seems pretty unreasonable, doesn't it?

After all, the dreaded competition from HDTV is a long way off — why worry about it today? Why fight for production and test equipment that doesn't seem to yield immediate benefits? Even Julius Barnathan of ABC said that ". . . people watch programs, not technology. . . ." Perhaps this is true. And everyone knows that no amount of fancy production work or elaborate effects can save a poorly written or directed broadcast.

But a glance at the newspaper movie listings will tell you something different. Why do theaters use their ads to trumpet the fact that they're offering 35mm Dolby Stereo presentations or 70mm prints? Theaters with the Lucasfilm THX sound system go even further. These theaters show a special trailer to plug the quality, proclaiming: "The audience is listening. . . ." Obviously, theater owners present films in high-quality formats because they know it brings in the people.

Movie-goers can choose the theater in which they will see a given film. The quality of the image and the comfort of the theater seats determine a theater's share of the market. But radio and TV audiences have no such choice. To receive your programs, they must tune in to your channel, quality notwithstanding.

So, if you are the only game in town, why should you care whether the audience is listening or watching closely? Because they will come to demand top quality.

There is a new alphabet of high-tech gear on the way to consumers — IDTV* sets that will show your signal's every flaw, S-VHS and ED Beta recorders with "better-than-broadcast" resolution, LV discs with digital audio tracks, and more MTS TVs that will showcase good audio and emphasize the bad.

Radio, too, soon will be competing not only with other radio stations for listeners, but also with CDs, R-DAT and other new services. These and other advances in consumer electronics will make good signals look and sound great and show poor ones for what they are.

Radio and television have lost their monopoly on high-quality software. You are no longer competing just with fellow broadcasters, but with forces that can fragment your audience. The people who produce the technical, as well as the artistic, elements of the new software choices take special care in the preparation of their materials. Does your station?

As you shop the products at NAB, think beyond what you need to merely keep your signal on the air. Think of what you need to improve it. Don't go just for the slick effects gear; go to improve your basic plant. And don't compromise on specs, thinking you'll save money where no one will notice. They will.

**Improved Definition Television is a system that performs extensive signal processing prior to writing the image on the CRT.*

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FCC update

AM stereo policy affirmed

By Harry C. Martin

In January the FCC refused to reconsider its previous decision to let market forces determine the development of AM stereo broadcasting. In 1982 the commission decided not to select a single technical system for AM stereo. This brought about controversy because the resulting competition among systems hindered AM stereo's development.

The commission's decision to hold firm on the marketplace approach was based on a report issued by the National Telecommunications and Information Administration (NTIA). In the report, NTIA said the number of competitors manufacturing AM stereo systems has dropped from five to two. Of the two systems, approximately 70% of AM stations broadcasting in stereo use the Motorola C-Quam system. The report also stated that all of the receivers are C-Quam compatible. The commission concluded that the marketplace is moving on its own toward selecting an industry standard. The commission believes that intervention at this time would be counterproductive.

In connection with the current effort for standardization, several parties suggested the commission should require manufacturers of AM receivers to make the receivers compatible with all stereo transmission systems. The commission rejected this proposal because it would place unnecessary burdens on receiver manufacturers and would be costly for both the manufacturers and the public.

The commission also decided against establishing interference protection for the pilot tones of AM stereo systems. NTIA has suggested the need for such interference protection, but the commission said that although protection of pilot tones may be desirable in some situations, the potential for cross-system interference is not great enough to warrant imposition of government standards. The agency said establishing protection standards could disrupt and delay the development of AM stereo.

Minority and female preferences reinstated

In January, in response to a congressional directive, the commission reinstated its system of awarding racial, ethnic and gender preferences in comparative licensing proceedings. It also terminated its proceeding to investigate the constitutionality of its minority and female preference policies.

Under the minority preference system, applicants that propose to integrate racial and ethnic minorities into the management of a facility are awarded special "enhancement" credit. Such credit can be decisive in a tight comparative contest. A smaller enhancement credit is awarded for female participation in management.

The commission also reinstated its "distress sale" policy. Under the policy, a licencee subject to revocation or whose renewal is designated for hearing on basic qualifying issues, is permitted to sell the station before the hearing if the buying group is controlled by minorities, and certain other qualifying criteria are met. Normally, a licensee with character issues pending against it is not permitted to sell until the issues are favorably resolved.

The issuance of tax certificates for sales of broadcast properties to minorities also is affected by the agency's action. Under the tax certificate procedure, the seller of a station is permitted to defer payment of capital gains tax if the facility is sold to an entity controlled by minorities. This procedure is being examined but has not been suspended during the commission's re-examination of its minority policies.

The female enhancement preference still is under challenge in the U.S. Court of Appeals. However, until the court holds the preference to be invalid, it will continue to be awarded by the commission in comparative licensing proceedings.

FCC asserts jurisdiction over obscene broadcasts

In January the commission reversed an earlier ruling and announced that it would make its own administrative determinations as to whether particular broadcasts are obscene. Prior to the ruling, the commission deferred to the local courts and would not take action in the obscenity area absent a local adjudication on the matter. The agency's deference to the court system was based on its conclusion that obscenity determinations should reflect local community standards.

The commission distinguishes between indecency and obscenity, noting that the latter is governed by standards set by the Supreme Court. To be considered obscene, the material must "depict or describe, in a patently offensive way as measured by contemporary community standards, sexual conduct." The material must be such that an average person, applying contemporary community standards, would find it to appeal to the prurient interest. Also, the material, taken as a whole, must lack serious literary, artistic, political or scientific value.

Indecency, on the other hand, is "language that describes, in terms patently offensive as measured by contemporary community standards for the broadcast medium, sexual or excretory activities or organs, *when there is a reasonable risk that children may be in the audience.*" Although these definitions overlap, the functional distinction seems to be based on the degree of offensiveness and time of broadcast. Thus, a particular broadcast may fall within both definitions and subject the licensee to both criminal prosecution and administrative sanctions.

The commission has never abdicated jurisdiction over indecent programming. In fact, in 1987, it admonished three licensees for broadcasting patently offensive programming when there was a reasonable risk that children would be in the audience. The new ruling extends the agency's authority to deal with offensive programming, no matter when it is aired. However, the commission is not expected to use its new authority except in the most extraordinary circumstances. Most obscenity cases will still be referred to the Department of Justice for criminal prosecution.

Martin is a partner with the legal firm of Reddy, Begley & Martin, Washington, DC.

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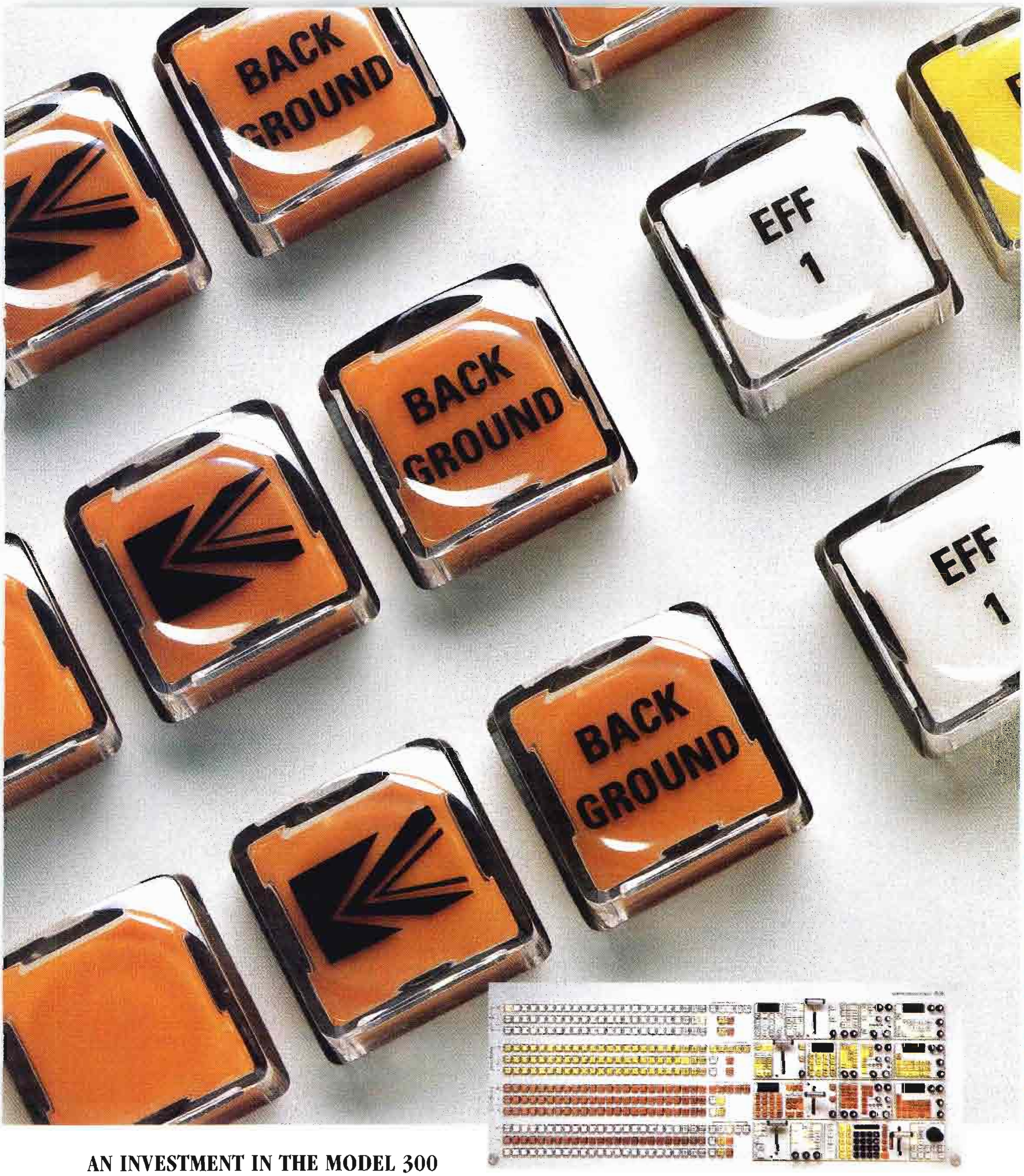

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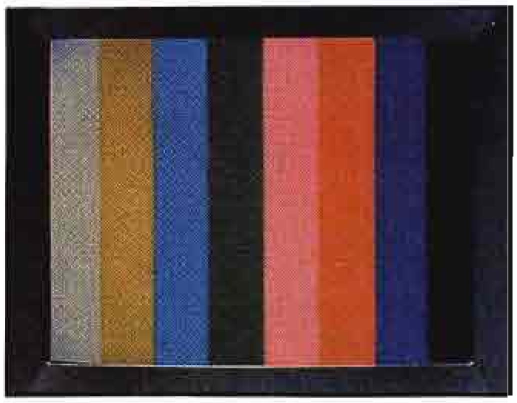
Part 1

Strictly TV



Y/C systems require new test signals

By Dietrich "Rick" Seaman

Video test and measurement procedures were developed in the early 1950s, several years before videotape recording became possible, primarily to check relay and transmission quality. These testing methods also worked well with early monochrome VTRs. The advent of NTSC color necessitated new test signals such as the modulated ramp (see Figure 1) for measuring differential gain and phase and, later, the 12.5T modulated chrominance pulse for determining luminance-to-chrominance delay. These signals applied equally to transmission facilities and VTRs because the first color recorders were direct-recording devices, as were their successors, the 1-inch helical scan machines.

A newer alternative to recording NTSC, component analog video (CAV) recording, avoids combining the luminance and color information. Instead, the luminance (Y) is recorded on one video track, and the two color components (B−Y and R−Y), combined into a single channel, are recorded on another. To achieve the full advantages of this approach, the luminance and color-difference information must be kept separate throughout the signal chain from camera, through switcher, to VTR and monitor. Only upon broadcast or dubbing to another format should it be encoded as NTSC. Of course, equipment considerations make this difficult to achieve, so what one is most likely to find is a series of CAV islands in an otherwise composite plant.

Some of the advantages of CAV signal quality may be compromised if CAV VTRs are used to record and play back NTSC, because the recorder must separate the luminance and chrominance (not a simple matter) and demodulate the chrominance to color components for recording. The procedure then must be reversed at playback. There is opportunity for cumulative errors at each step. Special signals are necessary to ensure the optimum performance of CAV recorders in both the component and NTSC realms. (These signals include dual timing pulses and the timing Bow-Tie for matching the channels in timing and amplitude.)

Seaman is a sales engineer with Magni Systems, Beaverton, OR.

The third and most common color-recording system is *color-under* or heterodyne recording, used in the U-matic, Beta and VHS systems. It involves separating the luminance and chrominance from each other and downconverting (heterodyning) the subcarrier to a new frequency (688kHz or 629kHz), still modulated with the same chrominance information. This divides the amount of phase jitter at playback at the ratio of the original subcarrier to the downconverted frequency. (For example, time base jitter of 10ns would give 13° phase error at 3.58MHz, but only 2.3° at 629kHz.)

The luminance is recorded using FM modulation, and the downconverted subcarrier is directly recorded on the same track in much the same way as audio is recorded, using the FM luminance carrier as its high-frequency bias. Upon playback, the color subcarrier is upconverted to 3.58MHz and added to the luminance signal to reappear as an NTSC signal. Note that the chrominance is never demodulated/remodulated as in a true component recorder, and that it shares a video track with the luminance signal.

Newer versions of these color-under systems are Super VHS and extended-definition Beta. With S-VHS, luminance bandwidth is increased by raising the FM carrier frequency and increasing its deviation. ED Beta has increased bandwidth in both the luminance and chrominance channels.

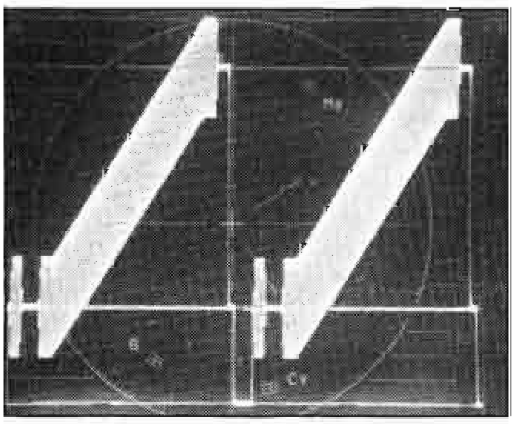


Figure 1. *The familiar modulated ramp, used to measure non-linearity in NTSC systems, becomes less meaningful in the testing of Y/C systems.*

Claims of "better than broadcast" performance have led people to consider these formats for multigeneration work. To facilitate this use, manufacturers are including component inputs and outputs in addition to the ones used for NTSC.

Separate Y and downconverted chrominance connections first appeared as the dub connectors in ¾-inch VTRs. They reduced generational losses, bypassing the steps of upconversion and phase correction, combining as NTSC, Y/C separation and downconversion. TBC makers quickly seized upon these outputs as a much cleaner source of signals for their correctors.

Dub connectors also appear on the industrial S-VHS and ED Beta machines. In S-VHS, the 629kHz subcarrier is advanced 90° each line on one field and delayed 90° each line on the next. This forms an adjacent-track chrominance-rejection scheme. The Beta system uses a modified 688kHz chrominance subcarrier, phase alternated per line one field and phase constant the next for crosstalk rejection. No doubt TBC manufacturers will take advantage of these outputs as well.

In addition to the Y and downconverted subcarrier dub connector, both Super VHS and ED Beta recorders are introducing the so-called S-terminals, which are input and output connectors with separated luminance and 3.58MHz chrominance (Y/C). Because NTSC inputs are separated initially into Y and C within the VTR and the color monitor, common sense says you should not combine signals that you will have to pull apart again. With camcorders that record directly in Y/C, monitors with separate Y/C inputs, and some time base correctors, switchers, and video effects units now becoming available, it is possible to have a low-cost recording system with Y and C kept separate throughout.

Although all this has several advantages, it also has its own set of problems that cannot be measured or corrected using conventional NTSC test signals. We'll investigate these, from a maintenance point of view, next month.

Editor's note: The *Bow-Tie* signal is an invention of Tektronix, Beaverton, OR.

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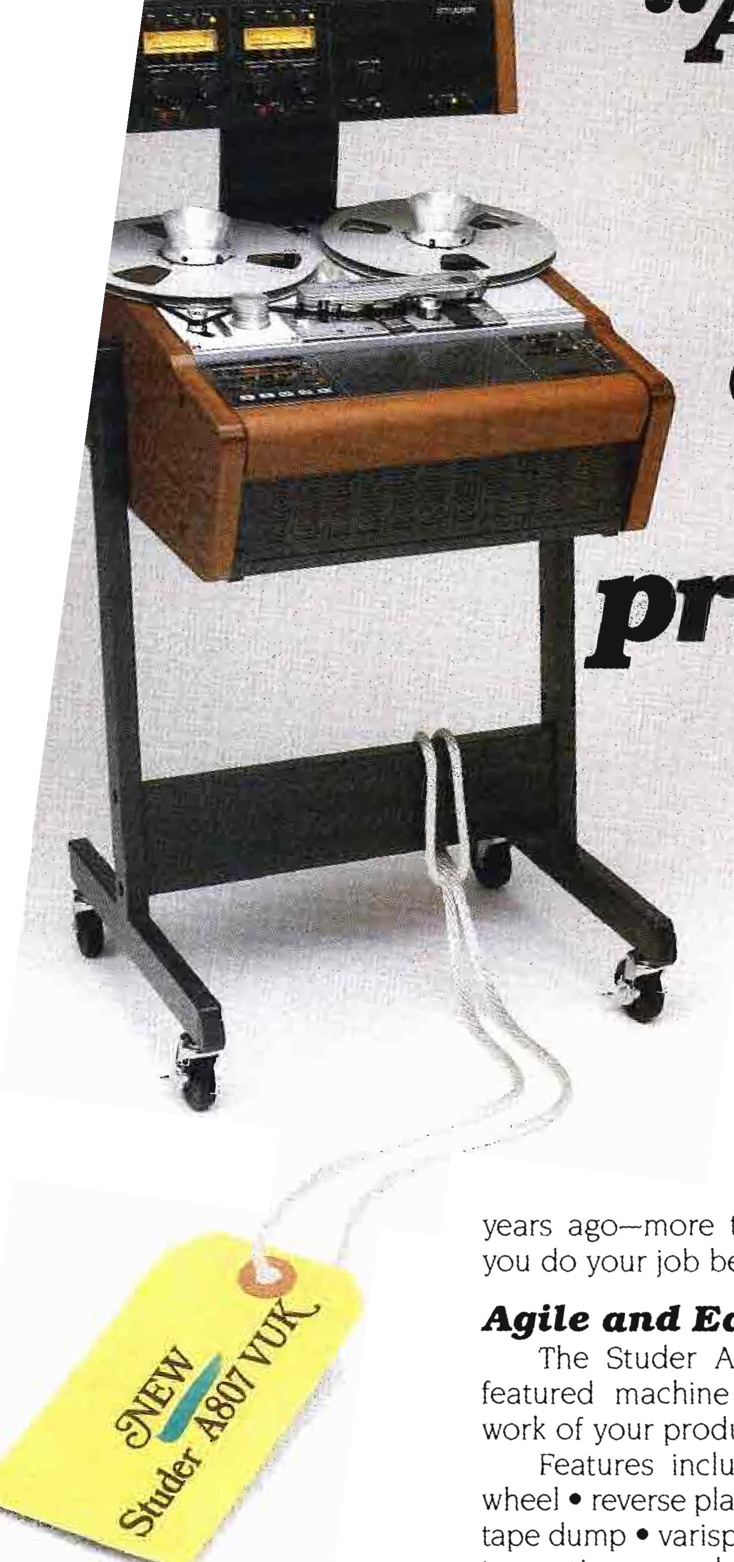

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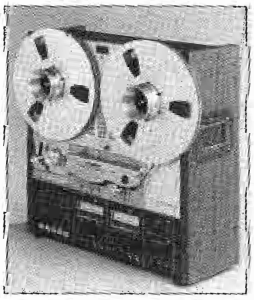

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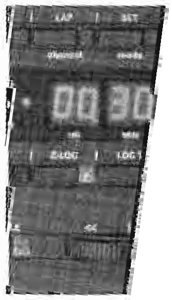

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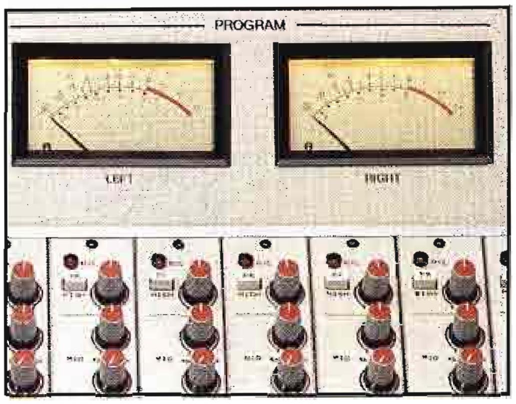
Working with DA design constraints



By John Battison, P.E.

The general shape of the current distribution on an AM tower is that of a sine wave. This generally applies to a vertical straight wire or a uniform cross-section tower. The cross-section tower usually is guyed, but a self-supported tower generally is tapered, with a different and thicker cross section toward the base. Therefore, for a self-supporting tower, the assumption of sine-wave distribution probably is not completely correct.

With a ¼-wave tower, current is zero (minimum) at the top and approximately maximum at the base. For ¼-wave towers the sampling loop typically is placed about 10 feet above the tower base. When a sampling transformer is used, the sampling loop is placed immediately following the ATU and the base current meter. For ½-wave towers, the sampling loop has to be placed much farther up the tower (about a quarter of the way up) in order to obtain a satisfactory reading. A current transformer is now generally acceptable to the FCC.

Nowadays it seems that many directional arrays use ¼-wave towers. This may be for economic expediency and also to facilitate and simplify antenna-performance measuring systems. It is not advisable to use towers less than 65° in height or spacing of less than 70° between towers. This proscription can be modified somewhat in the case of simple 2-tower directional antenna systems because there is only one mutual impedance to be considered—between tower No. 1 and tower No. 2—and such an array is seldom unstable.

For multitower arrays (more than two towers), certain design factors are reflected in the choice of a transmitter site, total cost, aeronautical hazard considerations (which sometimes control the allowable tower height) and, occasionally, electrical considerations. The amount of space available also becomes a determining factor. The desired vertical radiation characteristics must be considered in the case of full-time operation.

In the case of DAs to be operated only in the daytime, the vertical radiation characteristic usually is not important unless operation is to be on a frequency at which critical hour constraints must be observed. Generally speaking, the most suitable tower height is the one selected. However, for nighttime considerations, it sometimes becomes necessary to use towers of unequal heights, and to pay close attention to the vertical radiation characteristics produced by the DA's design.

When short spacing of less than about 75° is used, the final design often will produce one or more negative impedance towers, because the mutual impedances are larger than the tower-operating impedance. In this case, the negative towers actually return power to the system, which, in itself, is not a difficult situation to handle. However, a negative tower frequently has a low impedance and "floats" between zero and a few ohms positive and negative. This results in an unstable operation that is extremely difficult to control.

On the other hand, a tower with a reasonably large negative resistance usually is as stable as one with reasonably positive resistance and can be controlled without difficulty. When problems are encountered with a negative tower, it usually is the result of the operating impedance changing when the array is tuned. As the impedance changes, the resistance of the tower moves through zero to positive and begins to take power from the system. This produces unanticipated changes in the operating parameters and makes tune-up difficult.

Battison, **BE**'s consultant on antennas and radiation, owns John H. Battison & Associates, a consulting engineering company in Columbus, OH.

HEIGHT* IN DEGREES	SELF-SUPPORTING TYPE		GUYED-MAST TYPE		UNIFORM SECTION GUYED TOWER	
G	R	jX	R	jX	R	jX
50	7	−j100	8	−j220	9	−j170
60	9	−j 70	13	−j170	14	−j108
70	14	−j 25	19	−j 75	21	−j 46
80	20	+j 11	28	−j 28	30	0
90	40	+j 35	36	+j 0	50	+j 68
100	60	+j 80	80	+j140	83	+j136
110	90	+j 90	140	+j320	133	+j210
120	175	+j 80	220	+j500	240	+j285
130	190	+j 15	370	+j600	425	+j310
140	165	−j 70	660	+j480	760	0
150	130	−j 85	1100	+j 0	430	−j280
160	82	−j 55	550	−j250	360	−j380
170	60	−j 25	280	−j450	210	−j340
180	40	−j 5	180	−j500	132	−j283
190	28	+j 25	120	−j430	86	−j225
200	23	+j 50	80	−j400	60	−j170

*Physical height in degrees = height in feet x frequency in kilocycles x $1.016 \times 10^{-6} \times 360$.

Table 1. *Base impedances for various vertical antenna tower designs. Guyed and uniform cross-section antennas are similar, but note the difference between those designs and the self-supporting design. This is caused by the "fat" lower section of these towers.*

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Communications plans brew controversy

By Elmer Smalling III

Two areas of communications are enjoying renewed interest, but the fanfare does not come without controversy. Mobile satellite service is entangled in allocation questions, and the issue of satellite vs. fiber-optic communications is something of a tug of war between the pros and cons of each method.

Mobile satellite service

You might call mobile satellite service (MSS) the ultimate cellular system. After all, it would allow a caller to speak directly with someone on any other phone in the world, or at least within a large geographic area.

Satellite communication from aircraft, automobiles, trucks and trains has long been in the planning stages. A number of corporations have been founded to provide the service, once operating frequencies and regulations have been established and the satellites have been launched. These corporations wish to provide mobile-to-satellite emergency and standard telephone communications on frequencies in the lower L-band (1,625MHz to 1,660MHz) for uplinking and 1,530MHz to 1,560MHz for downlink return.

The hitch in the plan involves different allocation schemes by two regulatory agencies, the FCC and WARC (World Administrative Radio Conference). WARC has broken up the allocated frequency spectrum into various discrete services, such as aeronautical mobile, land mobile and marine mobile satellite services and safety and distress, while the FCC has allocated the entire band to be shared *as needed*, letting use dictate allocation.

Smalling, **BE**'s consultant on cable/satellite systems, is president of Jenel Systems & Design, Dallas.

The FCC also has indicated that aeronautical telephone calls (passenger and administrative communications) are not the intended use of the aeronautical section of the mobile satellite communications band—a decision that perturbs prospective MSS operators. The commission does not really point to any particular mode of communication, such as aeronautical, mobile or marine, but says the entire band should be open to any kind of communication.

BE will keep you abreast of this situation, as appeals and rulings develop. It is hard to believe that a mere 30MHz has been allocated to a band that has the potential to become the busiest of all.

Satellite-vs.-fiber-optic communication

The controversy about satellite and terrestrial fiber communications continues, with proponents of each system calling it more reliable, more economical and easier to access. Ten years ago, satellite communications would have been the *hands-down* winner, especially over long distances. Recently, a good deal of fiber has been laid across the United States, to the extent that most systems have greater than 50% dark or spare fibers. Few locations are not served by fiber. By the same token, no communications satellites have been launched for more than two years.

Proponents of fiber-optic transmission maintain that:

- Communications are free from electromagnetic interference.
- Fiber point-of-presence locations are less expensive than satellite earth stations and do not require licensing.
- Fiber systems easily can accommodate at least 150Mb/s on a single fiber, roughly the equivalent of 150MHz bandwidth, for high-quality digital video, audio or data.
- Fiber transmission lineside equipment can be repaired, expanded or replaced at any time.
- Echoes caused by the path length of satellite transmissions do not exist with fiber transmission.
- Satellites cannot be accessed in some locations because of signal blockage or terrestrial interference.

Satellite proponents, on the other hand, say:

- Terrestrial barriers to cable paths (such as oceans, mountains and harsh terrain) and protracted installation time do not exist.
- It is easy to implement soft networks, which include rarely used nodes, for purposes such as the national broadcast of an event originating from an obscure location.
- News events at almost any location accessible by van can be covered via satellite.
- Satellites are well-suited for communicating with moving vehicles such as airplanes, boats, cars and trains.

Although other advantages and disadvantages exist, these are discussed most frequently. The potential user must weigh the characteristics of each and judge their bearing on a particular application. Eventually, one mode or the other may triumph due to economic or political pressures, but a system that includes both satellite and fiber elements would seem to be a safe bet at this time. The development of less expensive, broad-use fiber terminal equipment and realistic tariffs will do a great deal to help the cause of fiber, while more high-power, broadband satellites must be launched in the near future to sustain the momentum of satellite communications.

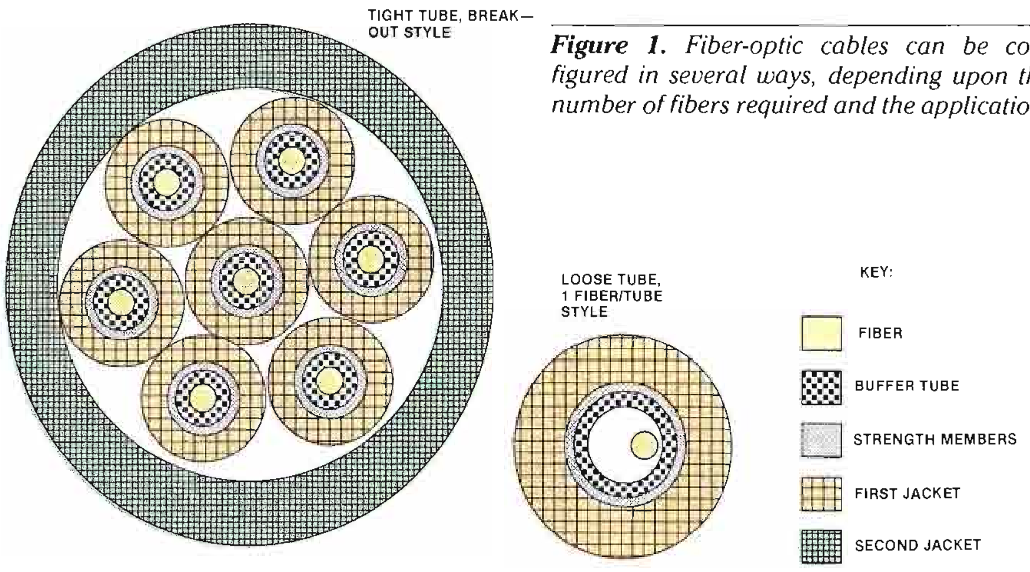

Figure 1. *Fiber-optic cables can be configured in several ways, depending upon the number of fibers required and the application.*

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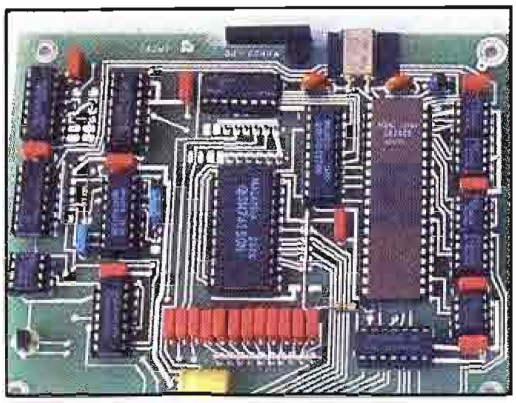

Inside digital technology

By Gerry Kaufhold II

Because many values in the real world cannot be represented as whole units, fractions are necessary for accurate numeric expressions. For example, you measure millivolts (thousandths of a volt) and microfarads (millionths of a farad).

Fractions come in two forms: *rational* and *irrational* numbers. Those that can be expressed as simple ratios between two integers, such as ½ as the ratio of 1 to 2, are rational numbers. Fractions that cannot be expressed as ratios between two integers are irrational. The square root of 2, epsilon (the base of the natural logarithm system) and pi are examples of irrational numbers.

Fractions can be written in decimal form by placing digits to the right of the decimal point. Each shift to the right changes the digit's weighting value downward by a factor of 10. Many rational numbers convert easily to decimal form, such as ¼ = 0.25. However, a few, such as ⅓ and all irrational fractions, end up as repeating decimals or as non-repeating decimals that go on forever. This can be quite inconvenient.

Working with irrational and binary fractions

To calculate using irrational or repeating fractions, you must first decide how much accuracy is required. Normally, engineers round off decimals to a set number of places. Four digits are usually sufficient, because you can express fractions to within one part in 9,999, an accuracy of 0.01%. You just have to live with the difference between actual values and their decimal representations, and take "round-off" error into account.

Kaufhold is an independent consultant based in Tempe, AZ.

Just as the decimal point is used to express fractions in decimal form, a binary point is used to express binary fractions. See Figure 1. Note that the first binary bit to the right of the binary point has a value of ½ (0.5 decimal). The next bit has a value of 1/(2x2), or 0.250 decimal. The next has a value of 1/(2x2x2), or 0.125 decimal, and so on. The 16th bit has a value of 1/(256x256), or one part in 65,536.

Decimal to binary conversion

To convert a decimal fraction such as 0.175 to its binary fraction equivalent, a "subtract and shift" procedure is used. First place a binary point, then try to subtract the first binary bit (0.5) from the decimal fraction. If the value of the weighting factor of the binary bit is larger than the value of the decimal fraction, put a 0 in that bit position of the binary fraction you are building. If the value of the binary bit is less than the value of the decimal fraction, write down the remainder obtained by subtracting the binary weighting value from the decimal fraction. Then put a 1 in that bit position of the binary fraction you are building.

Continue subtracting the weighting value of each binary bit from the remainder of the decimal fraction until all the binary bits have been tried. As long as you use all 16 of the binary bits, your error is never greater than one part in 65,536. This means that 4-digit decimal fractions can be expressed in binary with an accuracy of better than 0.002% (one part in 50,000).

Various errors can result from attempts to express fractions with binary machines. For example, if the "round off" leaves the last bit 1, the answer might be 0.002% too high. In a long sequence of calculations, in which similar errors are accumulated and carried forward, the answer might be off by as much as 1%. Sometimes anomalies occur, such as expression of the number 1.0 (decimal) as 0.1111 1111 1111 1111 (binary); or 0.5 (decimal) might be expressed as 0.0111 1111 1111 1111 (binary), when it actually should be 0.1000 0000 0000 0000.

Converting from binary

Converting binary fractions to hexadecimal fractions is easy. Once the decimal fraction has been converted into binary using the subtract-and-shift method previously described, simply group the bits into groups of four, beginning immediately to the right of the binary point. Rename each group with its hex symbol (0 through F).

Unfortunately, there is no easy way to convert directly from decimal fractions into hexadecimal fractions. Each conversion must use the basic binary subtract-and-shift scheme first.

To create a decimal fraction from a binary fraction, simply begin at the first bit to the right of the binary point, and successively add the weighting factors for each bit position that contains a 1. For example, the binary fraction 0.1001 = 0.5625 decimal.

Next month we'll take a close look at expressing floating-point decimal numbers using binary integers and binary fractions.

BIT POSITION	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
BINARY POINT →	0	1	1													
DECIMAL VALUE	0.5	0.25	0.125	0.0625	0.03125	0.015625	0.000122...ETC.									
FRACTIONAL VALUE	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256	1/512	1/1,024	1/2,048	1/4,096	1/8,192	1/16,384	1/32,768	1/65,536

Figure 1. *Weighting values of the first 16 bit positions of binary fractions. The fraction shown is 0.6000 hex = 0.3750 decimal.*

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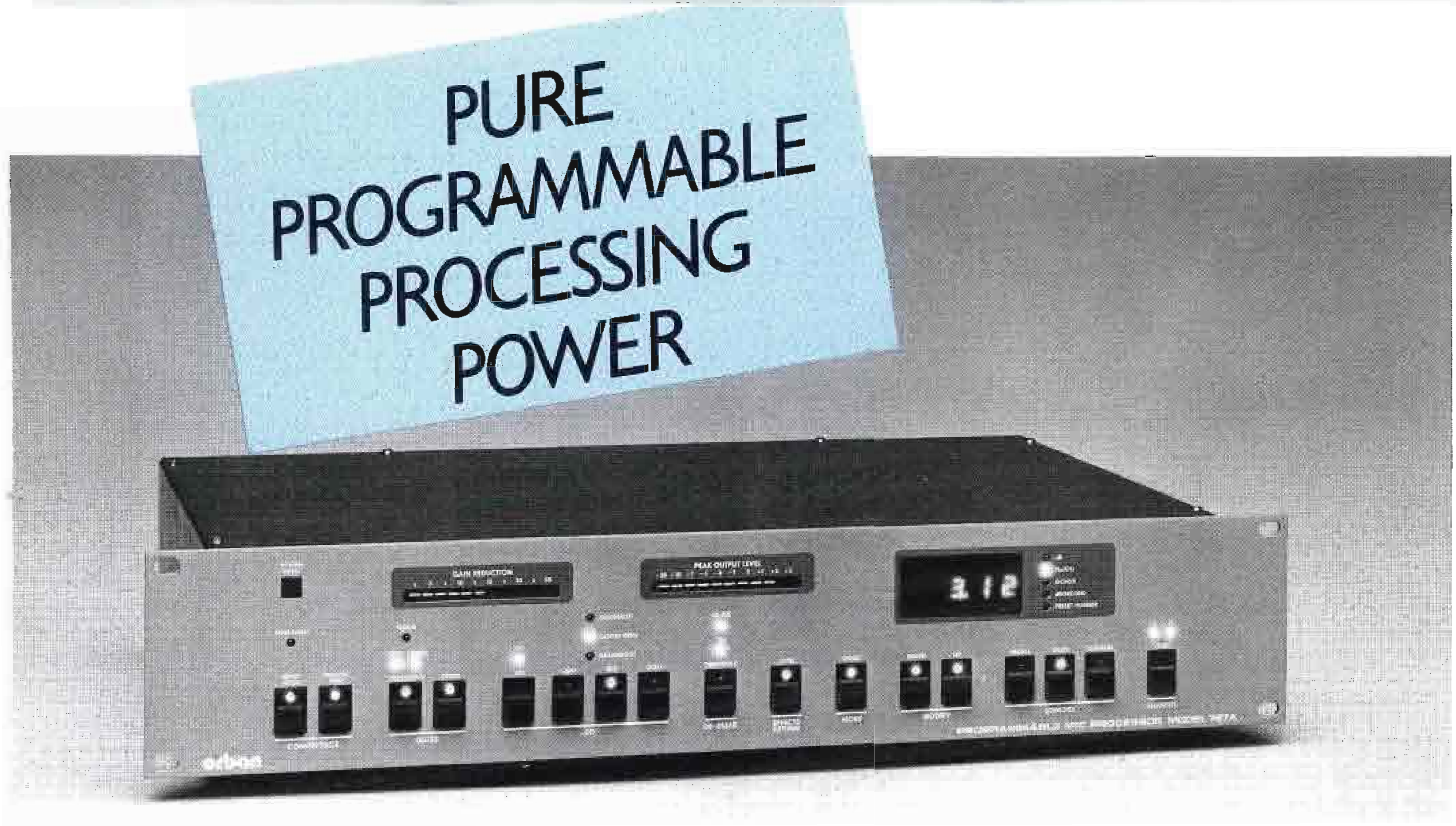

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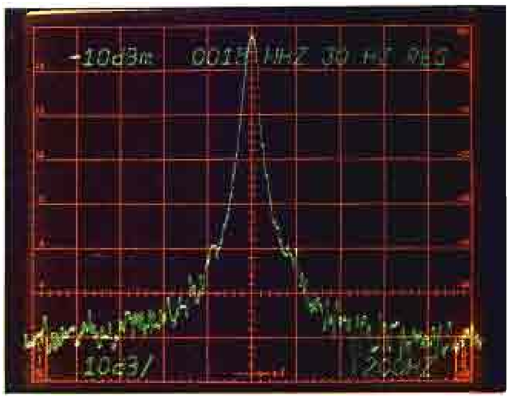

Monitoring the digital bus

By Carl Bentz, technical and special projects editor, and Ron Marquez

Tracing through the video signal path of analog video equipment is pretty straightforward. By working through the circuit in conjunction with a schematic, you can use an oscilloscope to read the circuit activity. What you find at any point will vary among dc levels, pulses and typical video waveforms, but at least they are recognizable. A multiple trace scope makes the project even easier, because it allows simultaneous monitoring of several locations in the circuit. The source of trouble is often found by comparing the signals present on each end of a key component.

Tracking down problems in a system with digital control circuits can be a bit more difficult, but the same approach can be useful. A multichannel oscilloscope displays several digital bitstreams at the same time and shows whether logic gates are providing the proper coincidence conditions. As control circuits become more complex, the next step in troubleshooting equipment is probably the logic analyzer or signature analyzer. These multiple-channel devices display bit conditions of a digital stream moving through databuses of a system.

Without a doubt, analyzers are valuable pieces of equipment in the digital repair shop, but understanding what they are showing may be quite difficult. One of their more interesting aspects is that they may be programmed to wait for specific bit conditions to appear, at which point they produce an alarm and print out a status report of the incident.

Monitoring a digital video signal may not be as easy. There is repetition in a video signal, but one of the more commonly repeated waveforms of video won't look like you might expect it to—if it shows up at all. Most engineers are used to seeing video waveforms on oscilloscopes or on waveform and vector monitors. When it is necessary to view a number of separate traces across the screen (the activity of an 8- or 10-bit digital bus, for example), the resemblance to classic video is nowhere to be found. At any instant, the condition of each trace is only a part of one pixel on the screen.

Marquez is product manager, TV signal processing group, Tektronix.

Digital video probe

A solution to this dilemma is the digital video probe, which is connected directly to a databus. The probe system contains a buffer to avoid loading of the circuit. From the bus, the signals are directed to a high-speed digital-to-analog converter capable of operating at high clock rates.

In many cases, a direct output of the D/A converter displayed on a waveform, vector or picture monitor would be sufficient, but there will be some evidence of the digital sampling artifacts in that image. A switch-selected reconstruction filter can be inserted to attenuate high frequencies above 5.5MHz.

Figure 1. *SMPTE color bars, as viewed from a digital bus with a logic analyzer.*

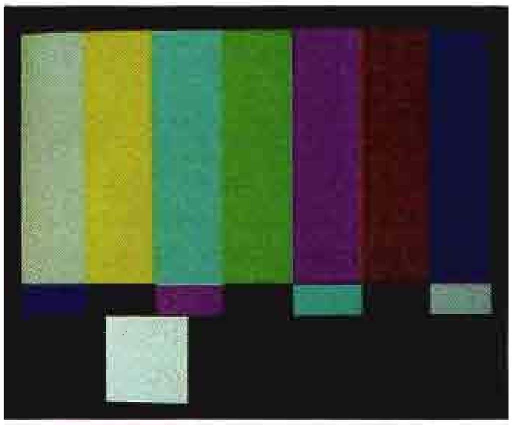

Figure 2. *SMPTE color bars on a picture monitor, developed from a digital bus with a digital probe (TEK DP-100).*

In many digital video products, sync (as you normally think of it) may not appear, except at input and output ports. Inside the system, there is no need for it. However, for monitoring equipment that typically is driven with external sync signals, the display will be better if you can tap into system sync and recreate an appropriate drive that is timed to the video. It might be advantageous to be able to change sync timing, in effect creating a cross-pulse form of display. A control to allow movement of the cross-pulse position on the CRT is provided on the video test probe.

There is a good deal of emphasis on standardization in digital designs, but that goal has not been achieved yet. Because sampling rates vary from 10.7MHz or 14.3MHz to much higher frequencies, the system needs to have an adaptable clock system, one that can track a wide range. Clocking frequency and phase adjustments are essential for a D/A conversion that encompasses the correct set of bits. Adjustment of the clock frequency allows the device to accommodate 525/60 or 625/50 systems.

For those of us who have grown up with analog circuits, and who are fighting to understand digital concepts at the same time we are suddenly expected to maintain them, devices such as a digital video probe will be welcome additions to the maintenance arsenal. The probe also simplifies the preparation of training material for others trying to learn how to maintain digital equipment.

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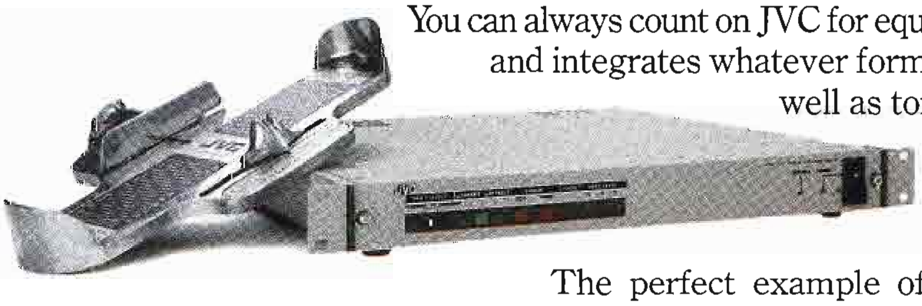

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When your style cramps leadership

By Brad Dick, radio technical editor

Success—Frank could almost taste it. Sitting in his new office, he looked around at the trappings of a chief engineer. Frank had often looked toward the day when he would command a private office, have access to secretarial help, control a budget and travel to many conventions and seminars. Now, as the TV station's new chief engineer, he had these resources at his fingertips.

Frank's excellent abilities as a technical leader were well-known. He had developed a warm, informal style of leadership as he progressed from master control operator to shift supervisor, then to studio supervisor. In these positions, his management style allowed his crews considerable freedom to get their jobs done.

Those under Frank's supervision seemed to like his "hands-off" attitude. His supervisor, while sometimes skeptical of his methods, recognized results. Those results had brought Frank to his new position as chief engineer for one of the corporation's TV stations.

Complaints

In his new position as chief engineer, Frank established good relationships with his boss and his peers. After several months, however, two of the shift supervisors and the ENG crew began complaining about him. The supervisors thought that Frank was not providing the needed support for their work. Even the union, with which Frank previously had good relations, was beginning to complain.

One supervisor said that Frank failed to understand the overall objectives and station policies. Another said he failed to provide direction and didn't care what was happening. The ENG crew members said they never knew what to do, and the union complained that Frank expected too much from his staff. Upon investigation, the personnel department found that the basic complaint came down to one point: Frank was not providing the leadership his people believed they needed.

What happened? Frank had been successful in his previous position, so why wasn't he succeeding in his new job? After all, he was practicing the same management techniques that had served him well for many years.

Leadership styles

Success as a manager often depends more upon style of leadership than any other single characteristic or skill. In fact, if you fail to develop an effective style of leadership, you may never be promoted to a management position. Many different models have been used to describe leadership and its characteristics. Let's examine one.

A model developed by Tannenbaum and Schmidt separates leadership style into four categories: *tell, sell, consult* and *join*. They are based on the contrast between the amount of authority retained solely by the leader and the amount of decision-making authority shared with the group.

The least democratic style is the tell approach. In this case, the supervisor does not ask for input from others, but simply makes decisions and directs their implementation. An example of someone who uses this style might be the crew chief at a remote broadcast. The truck has arrived, and the crew needs to be told where to park and set up for the broadcast.

The second style, sell, is closely related to tell in that it allows the supervisor to make the decisions. However, the reasons behind decisions and actions to be taken are explained to the workers. The supervisor, in essence, justifies decisions through explanation.

Through the consult style, moving toward complete democracy, the manager solicits suggestions from the workers. In this approach, the manager shares some of the authority—the right to decide. The manager uses less force, but still retains the right to use authority when necessary.

The fourth leadership category in the model is the join style. Here, the manager defines the objectives, such as constructing a new studio, then joins the staff in reaching decisions (such as equipment selection). The manager delegates all authority. Decisions are made as and by a whole group. Any countermanding or other use of force by the manager means a departure from the join process and a move along the continuum toward dictatorship.

Adapting your approach

Armed with this information, can you identify a cause for Frank's failure as a chief engineer? His problem simply was that he tried to manage just as he had done before. Frank expected people who didn't know him to act like those he previously supervised. He assumed that his new subordinates would pledge him their trust and operate with minimal direction just as his previous staff had done.

Frank's failure, then, was based on his inability to adapt his leadership style to the new environment and situations. Next month, we will begin to examine the choices available to a leader and discuss ways to help you develop your own leadership style.

ABSOLUTE DICTATORSHIP	
TELL	Manager makes decisions and announces them.
SELL	Manager makes decisions and explains them.
CONSULT	Manager gets suggestions, then makes decisions and explains why.
JOIN	Manager defines objectives and lets group make decisions.
COMPLETE DEMOCRACY	

Figure 1. *Management styles can range from dictatorship to democracy. An effective manager uses a range of styles.*

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McKinney receives Fellowship award

By Bob Van Buhler

Former mass media bureau chief James McKinney was presented with an SBE Fellowship Award at an awards luncheon hosted by the executive committee on Jan. 13 at the Marriott Hotel in Washington, DC. The Fellowship had been announced at the national convention in St. Louis. McKinney is now deputy assistant to the President of the United States and director of the White House Military Office, which controls military support of the president. Attendees at the luncheon included members of the FCC staff, representatives of the NAB's Office of Science and Technology, members of the trade press and SBE officials.

Convention plans confirmed

The society now has firm convention arrangements for the next three years. Eddie Barker Enterprises of Fort Worth, TX, has been hired to provide professional convention management services through 1990. Barker manages many successful trade conventions and expositions, including the annual Radio and Television News Directors Association (RTNDA) convention. Barker was one of three applicants to present proposals to the board of directors at the annual meeting in November.

Agreements have been made with this magazine to promote and conduct the **Broadcast Engineering** Conference in conjunction with the national convention for the next three years. The contract also secured the continuing services of conference chairman John Battison.

The 1988 SBE National Convention and **Broadcast Engineering** Conference will be Sept. 22 to 25 in Denver. Future convention dates and locations are Oct. 5 to 8, 1989, in Kansas City, MO. and Oct. 11 to 14, 1990, in St. Louis.

Membership dues increase

An increase in membership dues will become effective with the next renewal. The board of directors approved the increase upon recommendation by the executive committee at the Jan. 14 meeting. The annual dues for all membership categories (except student membership) will increase by $10. Dues have been $20 per year since the birth of the society in 1963. According to president Jack McKain, the additional revenue is necessary to improve the organization's solvency.

Of nine board members voting on the issue, seven voted "yes," one voted "no" and one abstained. In the last general election, members approved bylaw changes permitting the board to change the annual dues. Certification application fees are not affected by the increase.

Current voting procedures

Major SBE concerns are decided on the advice and consent of the board of directors. The executive committee, composed primarily of non-voting members, is not empowered to undertake major policy shifts or projects without board approval.

The dues increase decision is a good example of this process. The executive committee, in itself, does not have the power to make such a change. A quorum vote of board members is necessary, and the composition of the executive committee rules this out. The executive committee makes recommendations to the board, and the board votes whether to approve the recommendation.

Questions may be decided via a telephone poll (vote) or conference call. Issues of a controversial nature are the subject of full debate at formal semi-annual board meetings. The selection of a convention management firm is an example of an issue that required a consensus of the entire board.

In accordance with the revised bylaws, officers and ex officio board members are ineligible to vote. Only the 12 elected board members may vote on such matters. In the event of a tie, the president will vote.

Frequency coordination handbook

A draft of the "Policy and Procedure" and "Database" portions of the NFCC coordinator's handbook, which is largely SBE's contribution, was presented to the NFCC for editorial evaluation in January. Members of the NFCC met Jan. 12 at the NAB headquarters in Washington, DC, to review the document. Substantial and constructive editorial input was received from NAB's Ed Williams, SBE past president Richard Rudman, NFCC chairman Jerry Plemmons and other representatives.

Certification exams at NAB

Certification examinations will be Saturday, April 9, during the NAB convention in Las Vegas, NV. Candidates must have submitted their applications for examination to the national office by Feb. 15. The exams will be held in the Las Vegas Convention Center, Room 17 North, from 9 a.m. to noon. Certification examinations also will be given at the national convention in Denver. Contact any chapter's certification chairman or the national office for deadlines and further details. Study guides are available.

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Van Buhler is chief engineer for WBAL-AM and WIYY-FM, Baltimore.

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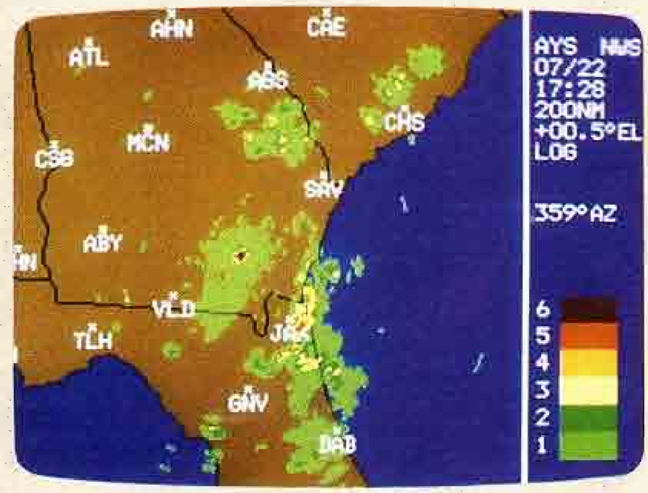

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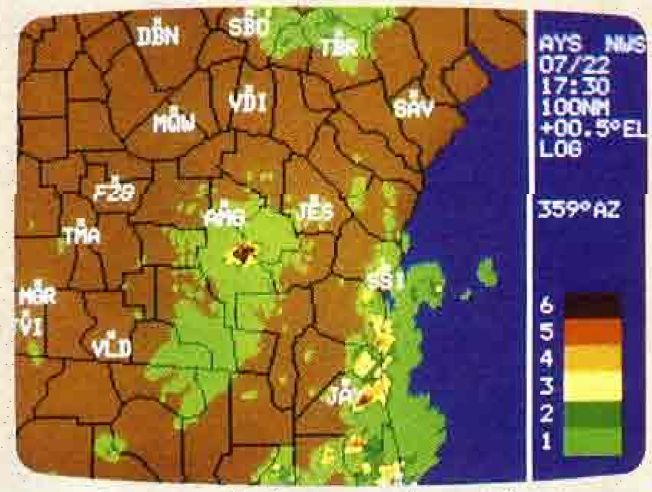

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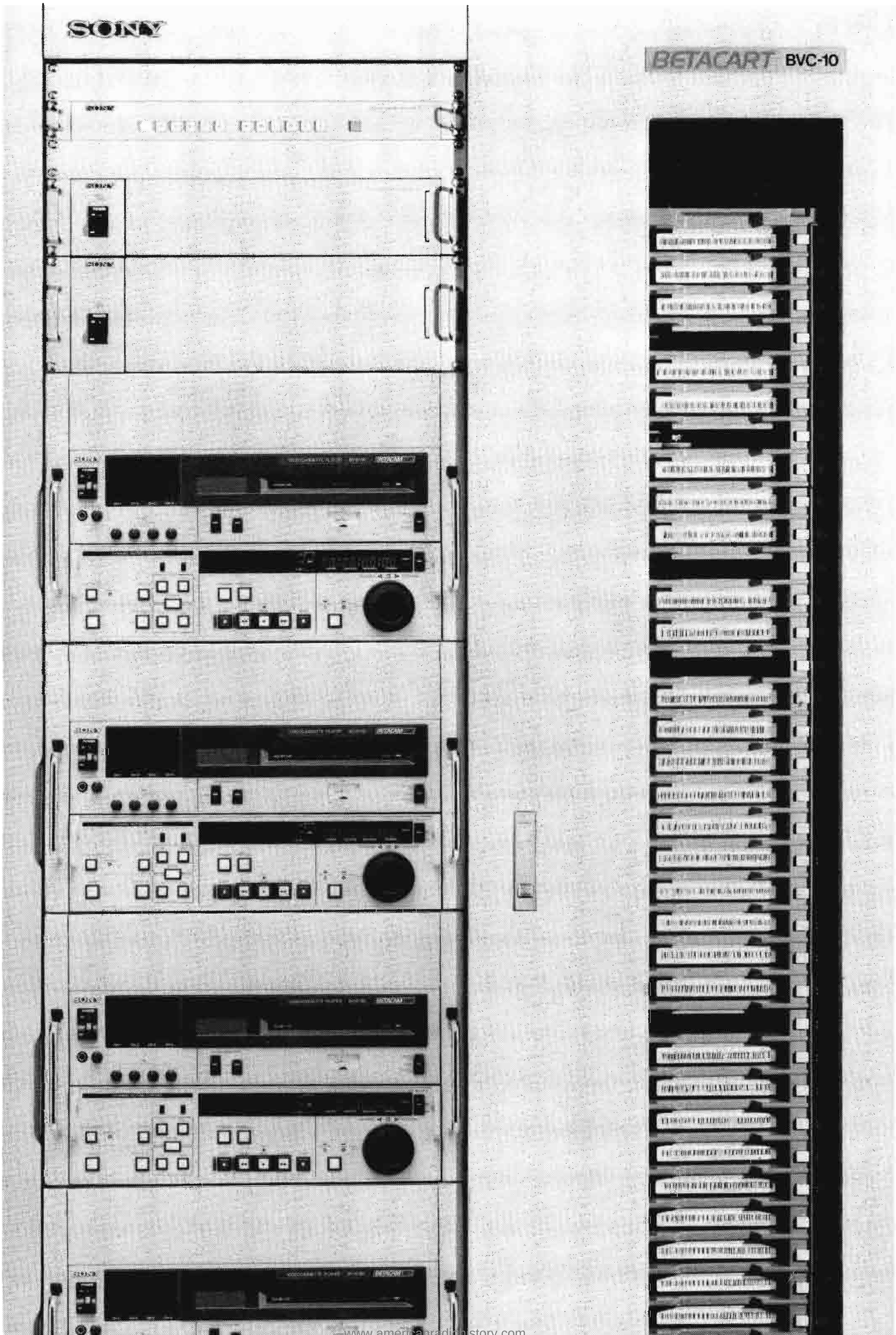

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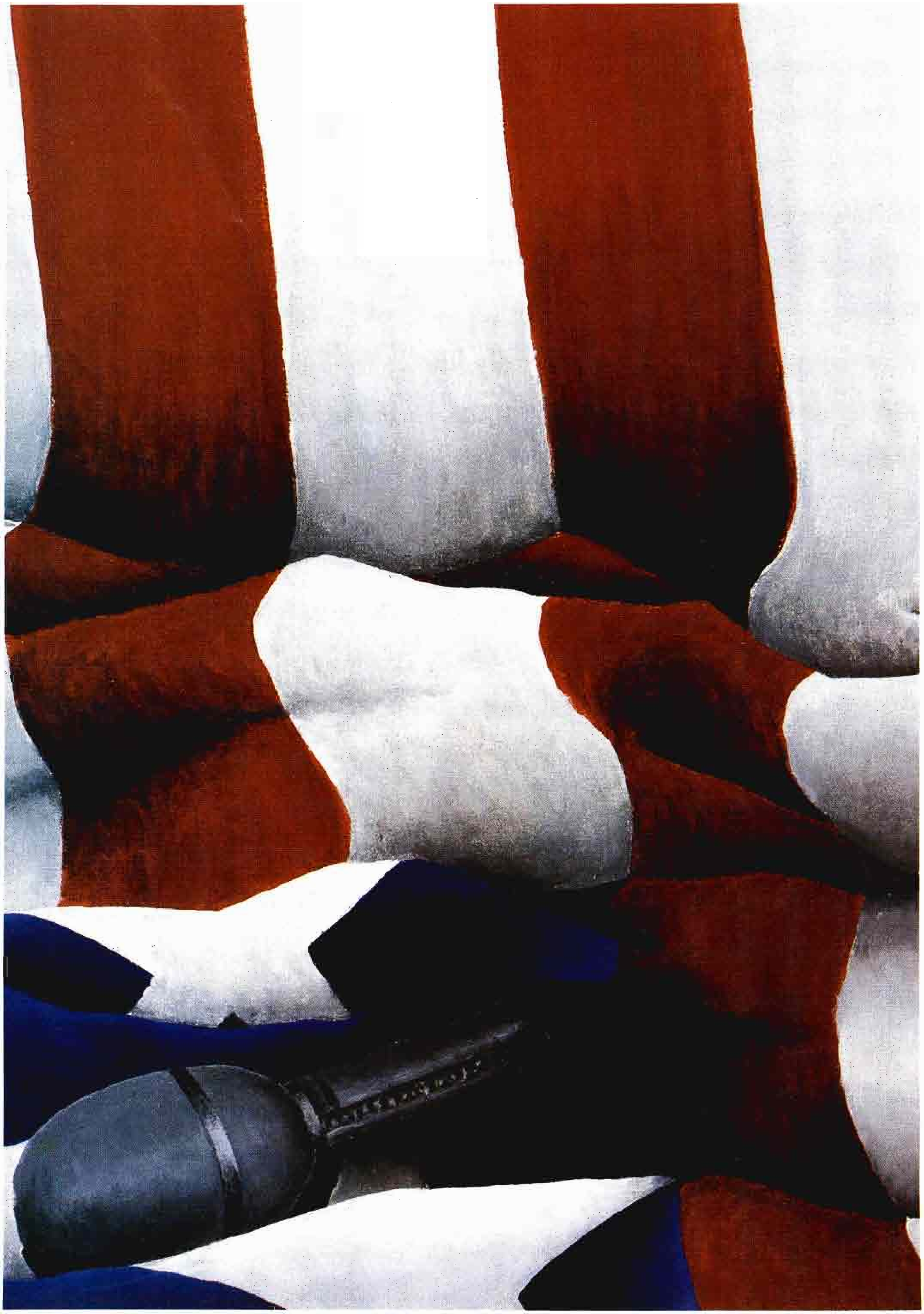

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By Ed Williams

NAB '88:

BROADCASTING &DEMOCRACY

It's back to Vegas and bigger than ever.

This year's NAB convention theme, "Broadcasting and Democracy: The Winning Ticket," echoes the contribution of broadcast engineers to the election process. Combined with the exhibition is the 42nd annual broadcast engineering conference. The 1988 exhibitors will occupy more space than ever before, and the engineering conference will feature 27 technical sessions with 150 papers, four panel discussions and four workshops.

Friday opening

Once again, the engineering conference program will begin one day before the exhibits open. This arrangement permits broadcast engineers to attend technical sessions without the temptation to sneak away and view the exhibits.

The sessions will begin at 9:30 on Friday morning and will cover *AM improvement, TV automation systems* and *graphics and animation*. An informal lunch will be held in the area between the meeting rooms. When the sessions resume in the afternoon, additional AM improvement topics will be discussed, and other sessions will cover *TV audio and stereo* and *TV studio production*.

Williams is director of broadcast systems engineering, NAB, Washington, DC.

The AM improvement sessions will cover field experiences with the new NRSC standard, new antenna designs, electrical interference, control and monitoring of adjacent channel splatter and the subjective aspects of service-area protection.

The TV automation systems session will examine TV automation, including equipment interfacing, camera control systems, tape, switching and distribution. The impact of this technology on the newsroom also will be discussed.

The graphics and animation session will provide interesting and informative papers that will keep you up to date with the election and 3-D graphics, weather displays and animation techniques.

TV sound and stereo will be the subject of a Friday afternoon session. Presentations on surround sound, testing multichannel sound systems, new transmitter stereo exciters and a report from the SMPTE multichannel recording committee are scheduled.

A studio production session will feature presentations on preparations for the Olympics, camera lenses, news set design, communication systems, editing and the production of TV specials.

Saturday sessions

The real work will begin on Saturday. You don't need to make the choice between visiting the exhibits or attending the technical sessions, because with careful scheduling you can do both. Check the schedule for sessions you don't want to miss, set your digital watch alarm, and head for the exhibit floor.

The *radio and TV new technology* sessions will be presented on Saturday morning, along with the opening of the giant equipment exhibit. The TV session will feature papers on video transmission system noise-reduction techniques, a new solid-state video recorder, smart video monitors, new-generation test equipment and digital video modulation transmitters.

The radio session will look at ways to reduce FM multipath effect using FM boosters, FMX multistation FM antennas, measuring AM noise in FM transmitters and new audio switching and routing techniques.

The TV post-production session, also on Saturday morning, will feature presentations on editing movies for television, music and effects. A variety of viewpoints and techniques will be presented. Examples of recent developments will be shown on large-screen video projectors.

Saturday luncheon

Plan to attend the engineering luncheon

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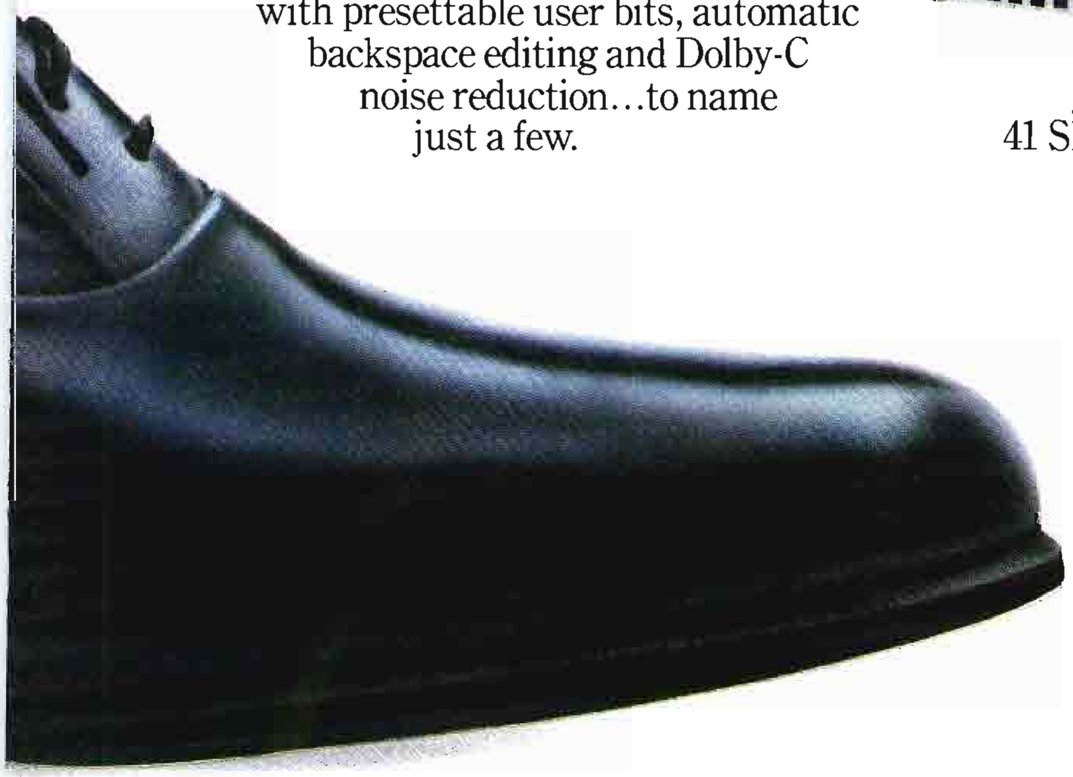

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on Saturday. In addition to a good meal and a chance to relax, you also will hear Richard C. Kirby, director of the International Radio Consultative Committee (CCIR), speak on the importance of international standards for broadcasting.

Also at the luncheon, Jules Cohen of Jules Cohen & Associates, broadcast engineering consultants, will be presented with the NAB EngineeringAchievement Award, the most prestigious award in the broadcast industry. Cohen is known throughout the country for his dedication, engineering knowledge, unquestioned integrity and diplomatic prowess. He retired this year after 50 years in broadcast engineering. Join the ceremonies and extend your congratulations to him.

Because there are no technical sessions scheduled for Saturday afternoon, engineers may tour the exhibits with their managers and take in the convention's opening ceremonies and entertainment.

Sunday

Broadcast engineering and *high-definition television (HDTV)* will be the topics of technical sessions scheduled for Sunday morning. The radio engineering session will feature papers on grounding guy wires on AM towers to improve performance, broadbanding equipment, DA array adjustments, circularly polarized FM receive antennas, AM pattern stability and adding an AM signal to FM towers.

The TV engineering session will cover several topics including reducing downtime with solid-state transmitters, new-generation VTRs, election information via teletext, mixing component and composite video, a new-generation camcorder and other TV developments.

A separate HDTV production session will continue all day Sunday, and feature reports and products from a variety of HDTV production facilities around the world. Examples of HDTV productions will include the "Movie of the Week." Other papers to be presented will include implementing HDTV in today's studio, HDTV production for the Olympics and HDTV camera tubes. An HDTV giant-screen video projector will provide the audience with theatrical-quality presentations during this session and throughout the conference.

Sunday afternoon will bring sessions on *studio construction and acoustics* and *broadcast auxiliary operations*. The studio construction session will look at project management, acoustical troubleshooting, CAD drawing standards and studio facility design. Multiple, wireless mic planning, 40GHz systems, new-generation RPU systems and frequency-coordination issues will be part of the broadcast auxiliary session.

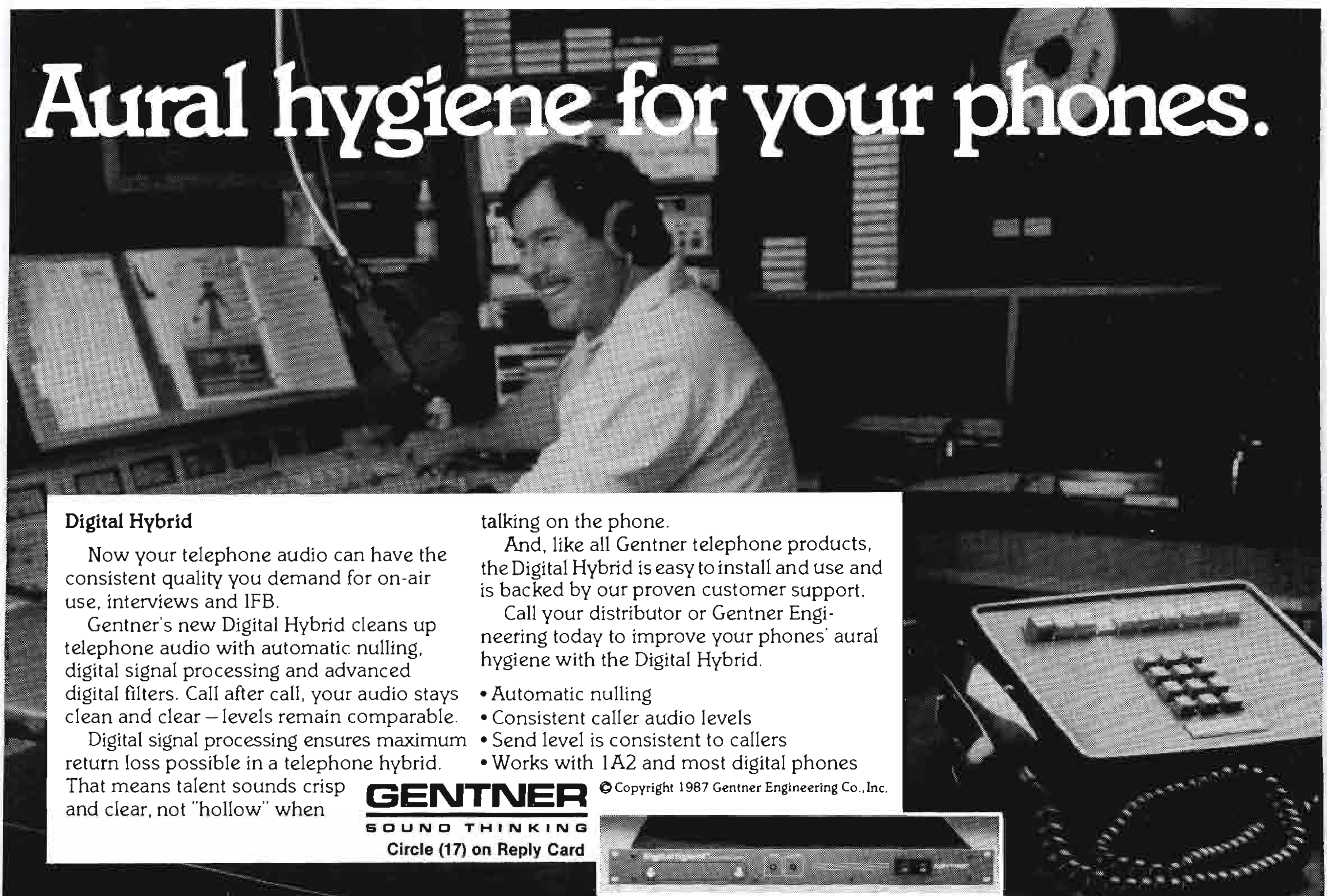
At 4 p.m. Sunday, a special workshop and participation panel will demonstrate how broadcast engineers can use personal computers for broadcast engineering applications. Software and hardware demonstrations will be covered.

Once again, four Sunday evening engineering workshops on *contract engineers, RF radiation, AM and antenna tuning* and *acoustics* will be held. Each workshop will feature expert panelists and will encourage audience participation.

Monday

The Monday morning sessions will focus on *the digital radio studio, advanced TV transmission systems, AM-FM allocations* and *environmental concerns*. The digital radio studio session will examine tapeless audio production, digital production facilities, R/P digital disk equipment and digital editing.

The advanced TV transmission systems session will include reports from the ATSC and presentations from six HDTV system design proponents. The AM-FM alloca-



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tions session will have a report from the FCC on recent changes in AM and FM allocations, using directional FM antennas and AM band propagation.

The environmental concerns session will contain important information about working close to high-power RF devices, a new RF ammeter, taming lightning near towers, community-wide PCB cleanup and a review of tower lighting regulations.

Monday afternoon is reserved for sessions on *radio production and audio processing, UHF-TV transmission systems* and *radio-TV satellite systems*. The radio production session will include presentations on designing highly functional remote units, putting the "Morning Zoo" on the "tube," new cart machine systems and novel methods for processing remote audio feeds.

The UHF-TV transmission systems session will feature papers on updating older UHF transmitters, high-power, solid-state facilities, and using CP and directional UHF antennas. Because satellites are critical for broadcast news departments, the satellite session will feature papers on field-testing Ku-band antennas, station-designed SNVs, low-cost satellite programming for radio and highly portable uplink antennas.

Calling all hams

Don't forget the annual *ham radio operators reception* Monday evening in the Hilton Hotel. There will be refreshments, good times and, of course, door prizes. Bring your QSL or business card for posting, meet old friends, make new friends, compare walkie-talkies and, maybe, win a prize. Plan on enjoying this relaxing break in the convention. The Las Vegas radio clubs will have repeater frequencies available for general use.

Tuesday

The technical sessions will continue with *fiber optics and digital transmission systems, alternate power* and *grounding systems* and a major report from the FCC Advanced Television Systems Committee. The fiber-optics session will feature fundamentals, applications, telephone company-to-home delivery systems and high-speed digital TV transmission. Papers on solar-powered stations, power conditioning and important broadcast applications of uninterruptible power systems will be included in the alternate power session.

Following the morning sessions at 11 a.m., the NAB will host the annual *FCC engineers forum*, chaired by Otis Freeman of WPIX-TV, New York. The forum will feature Alex Felker, the new mass media bureau chief; Bill Hassinger, engineer; Tom Stanley, chief engineer of the office of engineering and technology; Dick Smith, chief of the field operations bureau; and a field engineer. These engineers will be able to answer your questions about deregulation, rule compliance, inspections and remote control and other technical issues. There will be no better opportunity to get an insider's viewpoint on the technical condition of the broadcast spectrum.

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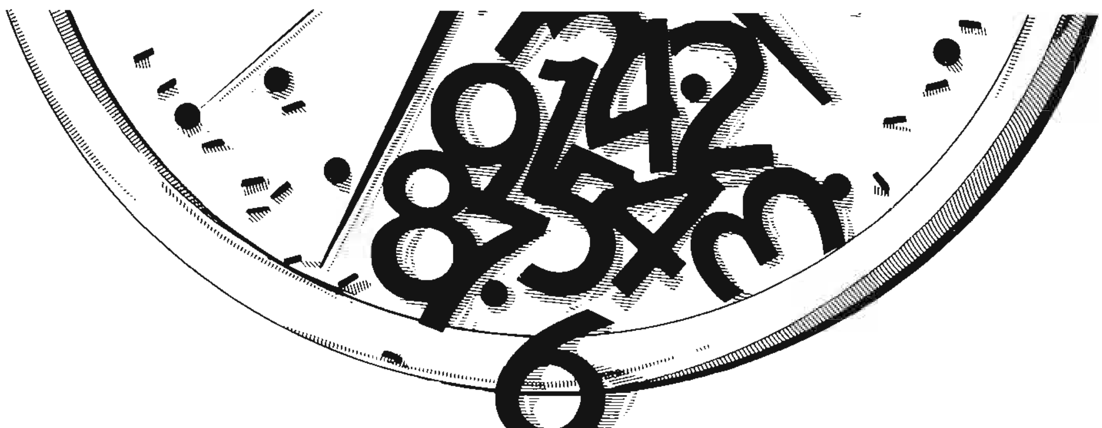
The broadcast industry has become more innovative, competitive and technically sophisticated than ever before. This year's conference represents an excellent opportunity for all broadcast engineers to become more informed, more imaginative and more efficient in the performance of station operations.

Select the technical sessions and papers as carefully as you plan your tour of the floor. Plan your visit to the convention with the same precision you'd use to install a new transmitter, and make the most of the time and facilities available. Just as building a broadcast facility requires careful planning, so too does attending the 1988 NAB convention.



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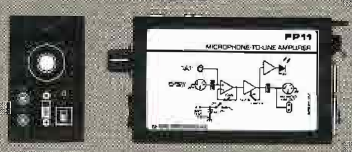

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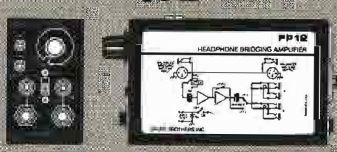

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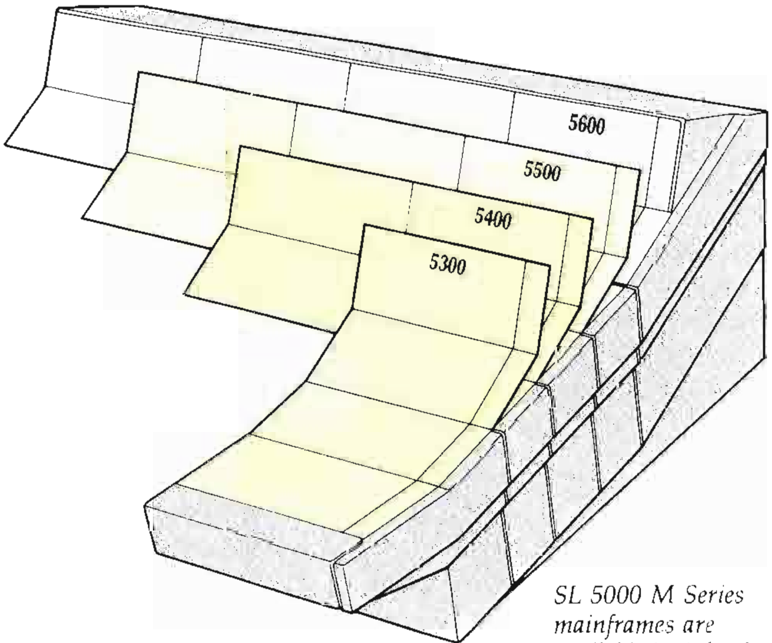

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Economics is the driving force behind advancements in broadcast technology.

Radio and TV stations live by technology. Advancements in component design and implementation have given broadcasters a whole new range of products from which to choose.

All of this is well and good, but the development of technology for technology's sake isn't going to sell any products. Technology that makes sense is based on real needs. And real needs are best defined by economics.

Think about the major advancements in broadcast equipment during the past 10 years. Here's a brief list of what comes to mind:

- Graphic paint systems
- Computer-based equipment of all kinds
- Stereo television
- Digital audio-video recorders and editors
- Fixed and mobile satellite transmitters/receivers
- Fiber optics
- Small-format video cameras
- Smart remote-control systems

The list could go on and on. There is, however, a common thread woven through all successful product lines: The inherent technology fills a need. That need may be for more efficient station operation, faster production of program material or an improved on-air look or sound to keep up with the competition.

The application of technology all boils down to the marketplace. It is our greatest challenge and our greatest ally. It drives stations and, thereby manufacturers, to ever-greater levels of efficiency and performance. We examine some of the key areas of the technology-driven marketplace this month.

The past decade has brought developments and products that few broadcasters would have dreamed of in 1978. With the rapid pace of technology today, we can only speculate on what the next decade will bring.

Jerry Whitaker

Jerry Whitaker,
editorial director

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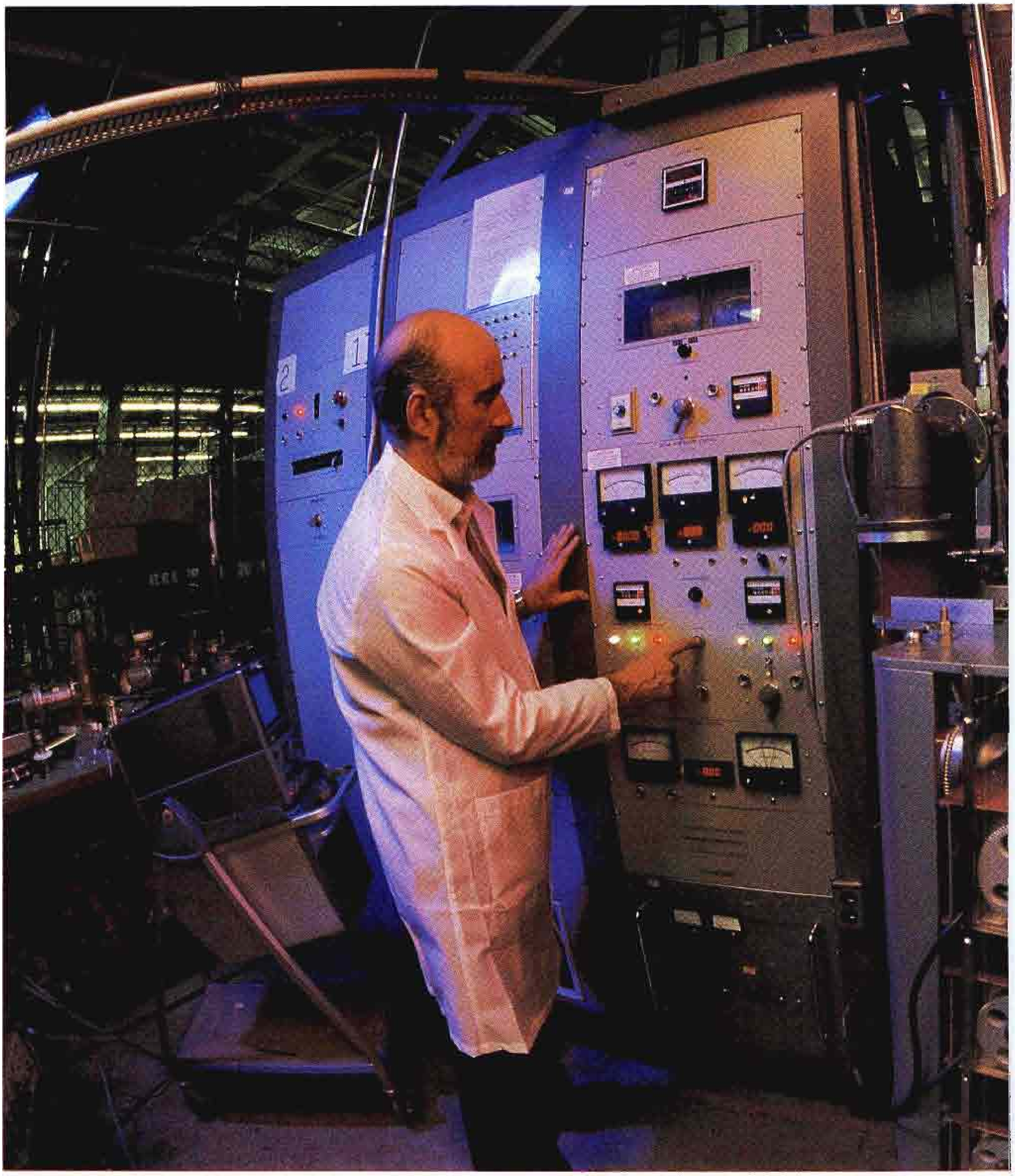

Breaking

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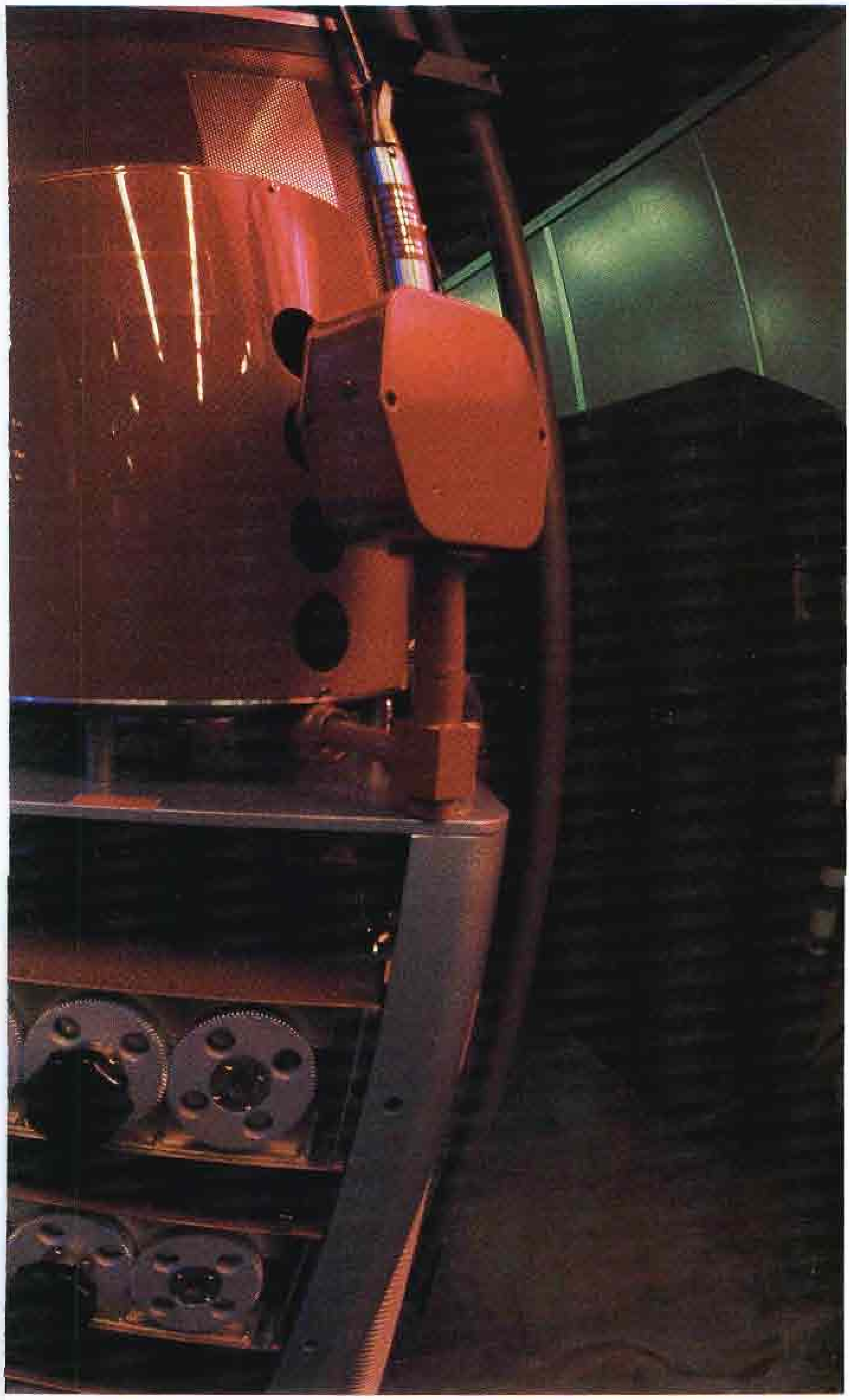

new ground: the MSDC klystron

The multistage depressed collector klystron holds the promise of cutting power bills in half for UHF-TV broadcasters.

By Jerry Whitaker, editorial director

Much work has been devoted to improving the efficiency of klystrons for UHF-TV broadcasting. The driving force behind this work has been economics. UHF broadcasters use high transmitting power to provide adequate coverage to their service areas—and that high power costs money.

Developmental work on the multistage depressed collector (MSDC) klystron began several years ago. A joint project of NASA, NAB, PBS, several transmitter manufacturers, Varian Associates and others, the effort has produced a working tube that is capable of efficiency in UHF-TV service that was impossible with previous technology.

The MSDC device has potential for both broadcast and non-broadcast applications. NASA originally became involved in the project as a way to improve the efficiency of satellite transmitters. With limited power available on board a space vehicle, efficient operation is critically important. Such transmitters traditionally operate in a linear, non-efficient mode.

Inside the MSDC tube

The MSDC device is essentially identical to a standard integral cavity 60kW klystron, except for the collector assembly. Researchers took an off-the-shelf klystron design (the Varian VKP-7555) and added the new collector to produce the test device. This approach was important for several reasons. First, it provided a test fixture with essentially one variable. Any research project can become needlessly lengthy and complicated if several variables are changed at once. If problems develop with the device, it may be unclear where the fault lies. However, by using a proven gun and drift tube design, attention could be focused on changes in the collector assembly.

Use of existing technology in the test device also provided a measure of assurance that the new MSDC klystron would operate in current transmitter designs. A wealth of technical data exists on klystron operation and performance in the field. Adapting new technology onto an existing device allows more accurate predictions of the ultimate in-service performance of the unit.

Although the MSDC device was built around an integral cavity klystron, researchers are confident that similar

Editor's note: This article is based on information supplied by E. W. McCune, senior scientist, Microwave Tube Division, Varian Associates, Palo Alto, CA.

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	RF OUTPUT POWER	TIME	AVG RF POWER	FOR COLLECTOR DESIGN 4G PEAK dc POWER	FOR COLLECTOR DESIGN 4G AVG dc POWER
SYNC	55	0.075	4.1	84	6.3
BLANKING	31.4	0.105	3.3	64	6.7
AVG PICTURE	11.1	0.82	9.1	44	36.1
TOTAL:			16.5kW		49.1kW

dc INPUT POWER REDUCTION $\frac{49.1}{118.8} = 0.413$

AVG EFFICIENCY $\frac{16.5}{49.1} = 0.336$

EFFICIENCY IMPROVEMENT $\frac{0.336}{0.139} = 2.42$

"FIGURE OF MERIT" $\frac{55}{49.1} = 1.12$

Table 1. *Figure of merit calculation for the MSDC klystron in TV operation. The efficiency improvement compared with a conventional klystron is 2.42. The overall figure of merit for the device is 1.12.*

results can be obtained with an external-cavity tube. One area of concern, however, is the mechanical rigidity of the system. An integral-type tube has a larger-diameter beamstick than an external device. Consequently, the integral cavity design can support more weight on its collector than an external tube. This is a concern because the collector assembly in the MSDC design is larger and heavier than a common collector. To implement an MSDC collector with an external cavity klystron may require additional mechanical supports for the tube assembly.

Cooling for the MSDC is, not surprisingly, more complicated than for a conventional device. The trade-off, though, is that, because of the higher efficiency of the device, there is less heat to remove. Water cooling is provided on each electrode of the MSDC tube.

The project has not been without its trying moments. Maintaining the structural integrity of the device, mechanically more complicated than a standard klystron, at first gave designers problems. However, those problems were overcome.

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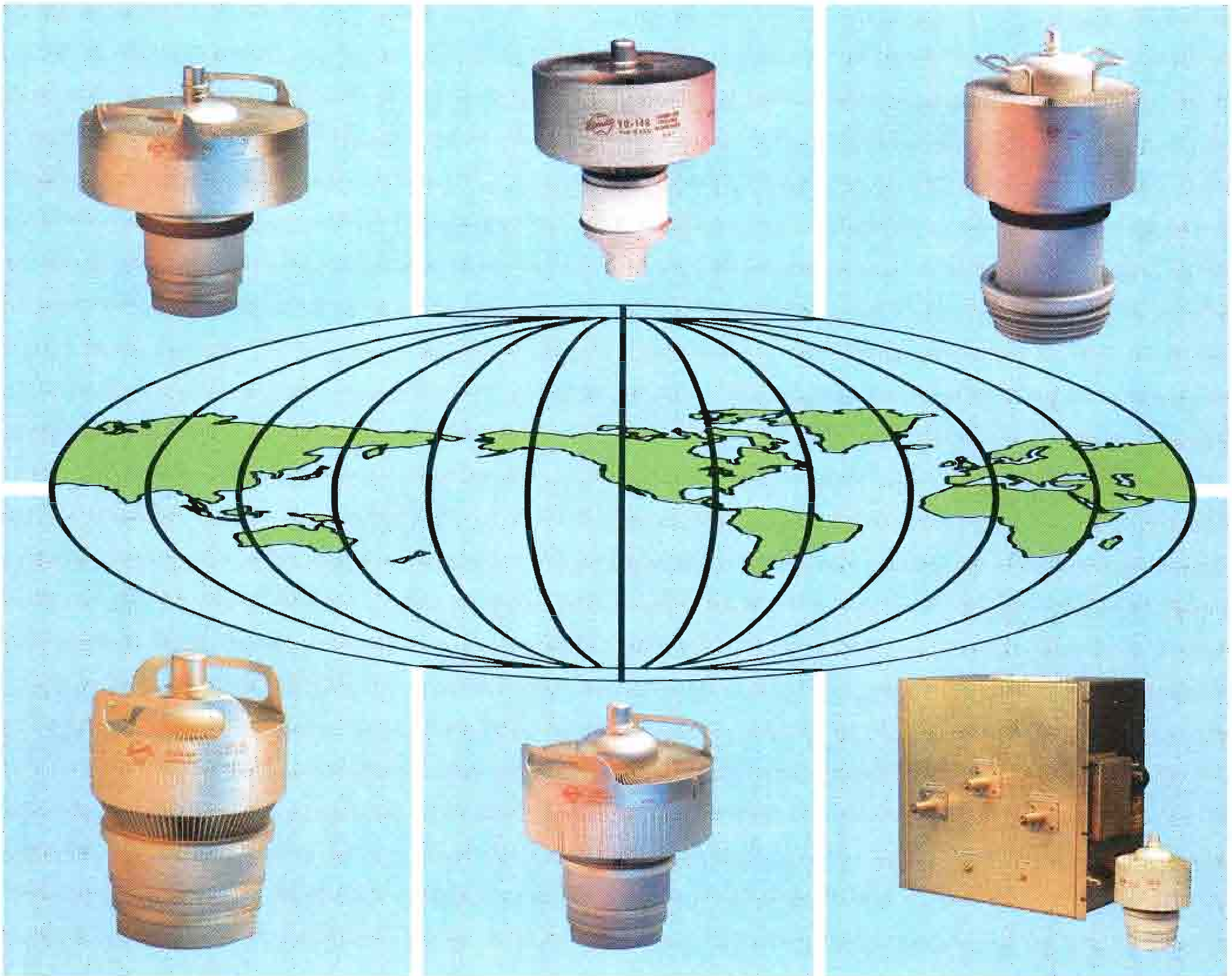

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Mathematical models

Researchers had planned to build 10 experimental models of the MSDC. Only two have been constructed so far, however, because of improved computer characterization of the operation of the new device. New mathematical models, based on computer-aided design (CAD), provided valuable information that in previous projects was obtained only through the construction of test devices.

Mathematical models designed on CAD systems provided researchers with detailed information on the interactions of electrons in the collector region. A series of collector designs were analyzed with the newly developed programs, permitting optimization of the system using the computer rather than actual test devices.

The main benefit of such a mathematical approach is that it is unnecessary to build hardware to test a theory. The appropriate data can be entered into the computer, and tests can be run to determine what the system would do, if constructed.

Computer modeling also provided the basis for optimization of a *beam-reconditioning* scheme incorporated into the MSDC klystron. Beam reconditioning is achieved by including a *transition region* between the RF interaction circuit and the collector under the influence of an intermediate magnetic field. Computer analysis allowed optimization of the refocuser geometry and the magnetic field before a test device was built.

The mathematical models made for the MSDC project translated well into practice when the actual device was constructed. This background data is expected to provide designers new tools in developing additional products for broadcast and other markets.

Why 4-stage MSDC?

From the electrical standpoint, the more

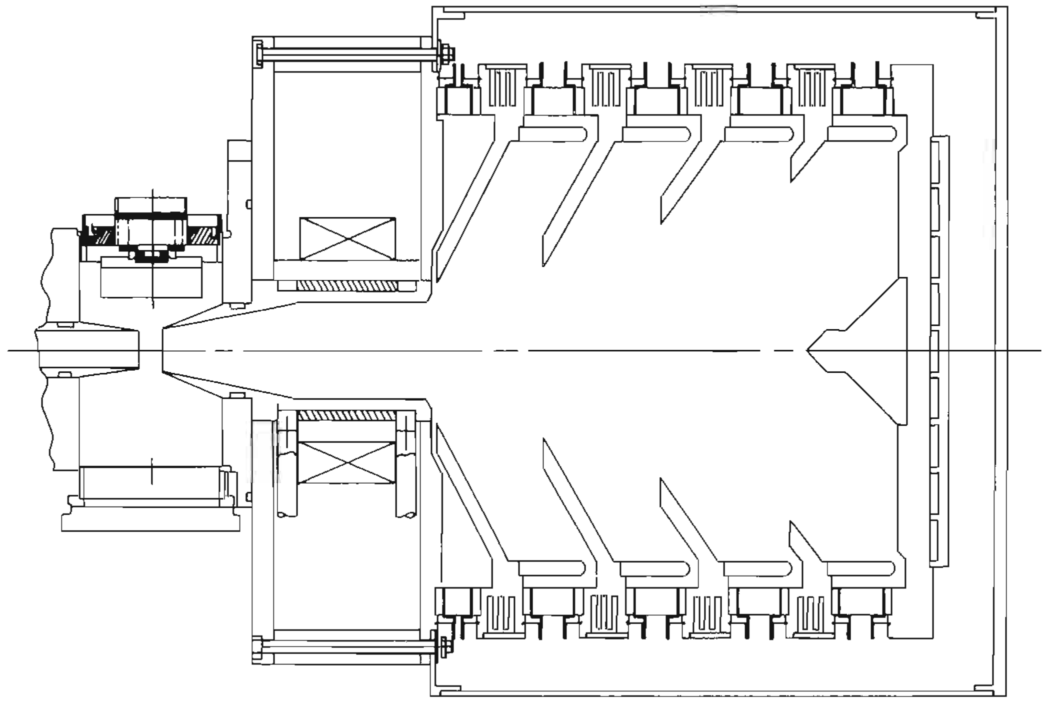

Figure 1. *Mechanical design of the multistage depressed collector assembly. Note the "V" shape of the 4-element system. (Illustrations courtesy of Varian Associates.)*

stages of a multistage depressed collector klystron, the better. The predictable tradeoff is increased complexity and, therefore, increased product cost. Also, a point of diminishing returns is reached as additional stages are added to the depressed collector system. A 4-stage device was chosen for the test unit because of these factors. As additional stages are added above four, the resulting improvement in efficiency is proportionally smaller.

The mechanical configuration of the 4-stage MSDC unit is shown in Figure 1. Note the "V" shape that was found, through computer studies, to provide the best "capture" performance, minimizing electron feedback.

Figure 2 illustrates the dispersion of electrons in the collector region for a zero output operating mode (white picture). Note that there is little dispersion of electrons between stages of the MSDC. Most are attracted to electrode No. 4, the element at the lowest potential (6.125kV).

Collector electron trajectories at 25% saturation are shown in Figure 3. The electrons exhibit predictable dispersion characteristics during the application of modulation, which varies the velocity of the electrons. The Figure 3 waveform is a reasonable approximation of *average modulation* for a typical TV waveform.

Figure 4 shows electron trajectories at 50% saturation, approximately the blanking level. Note the increased number of electrons attracted to electrodes No. 2 and 3, the higher-potential electrodes.

Electron dispersion at 90% saturation, as shown in Figure 5, is at approximately the level of sync. As modulation is increased, increasing numbers of electrons

Continued on page 44

	RF OUTPUT POWER	TIME	AVG RF OUTPUT	BEAM INPUT POWER		AVG BEAM POWER	
	kW		kW	kW	*	kW	*
SYNC	55	0.09	4.95	94	74	8.46	6.66
BLANKING	31.4	0.177	5.56	61	45	10.80	7.97
AVG PICTURE	11.1	0.733	8.14	32	20	23.46	14.66
TOTAL:			18.65			42.72	29.29

AVG EFFICIENCY = $\frac{18.65}{42.72} = 0.437$ * $\frac{18.65}{29.29} = 0.673$

FIGURE OF MERIT = $\frac{55}{42.72} = 1.287$ * $\frac{55}{29.29} = 1.878$

* WITH MSDC

Table 2. *Figure of merit calculation for a Klystrode, and a Klystrode fitted with a multistage depressed collector. The figure of merit calculated for the combined technology device is 1.878.*

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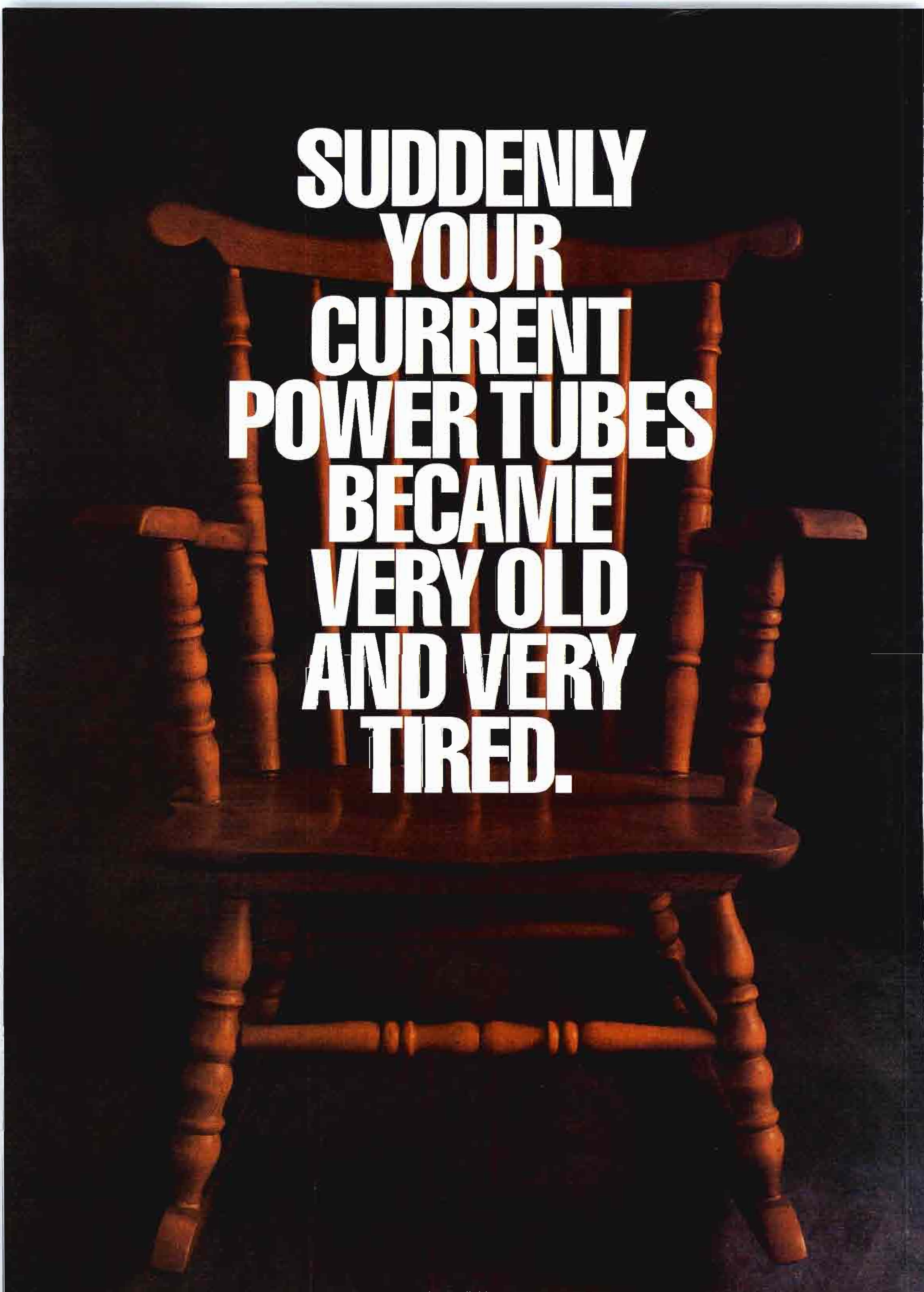

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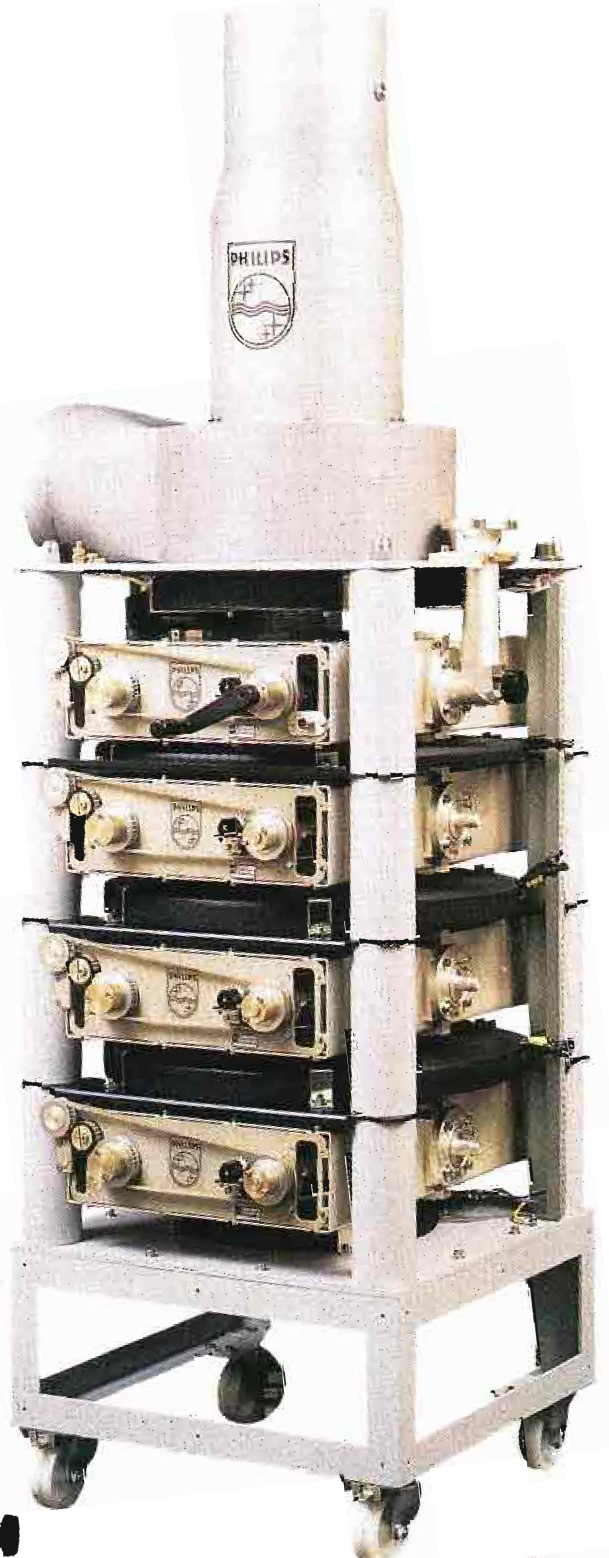

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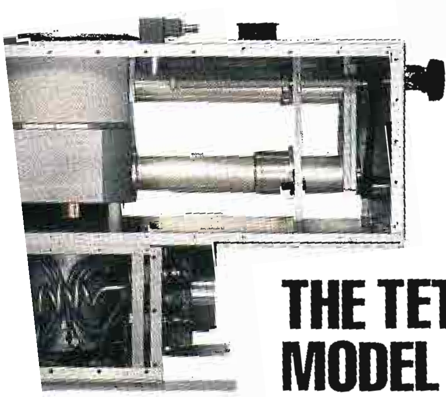

THE TETRODE MODEL YL1630

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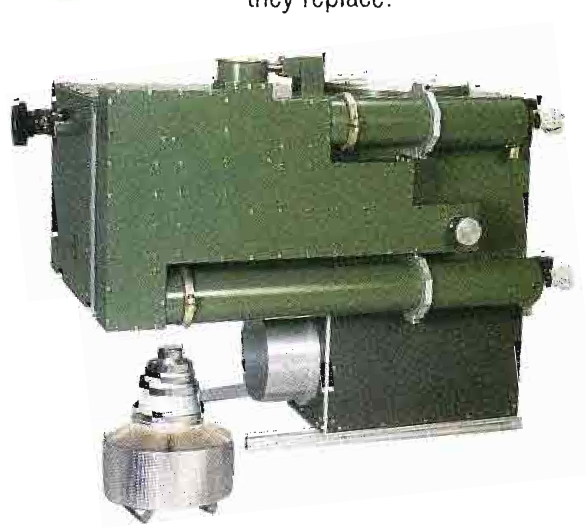

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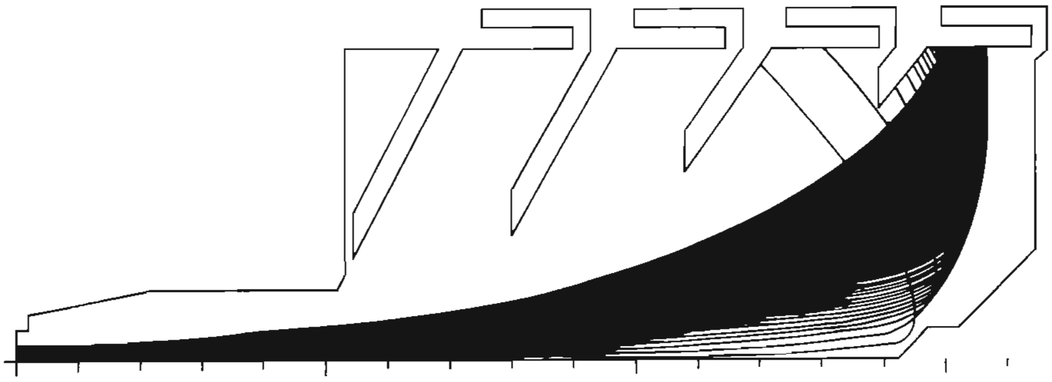

Figure 2. *Collector electron trajectories for the zero RF output condition. Note that nearly all electrons travel to the last electrode (No. 4), producing electrode current I_4.*

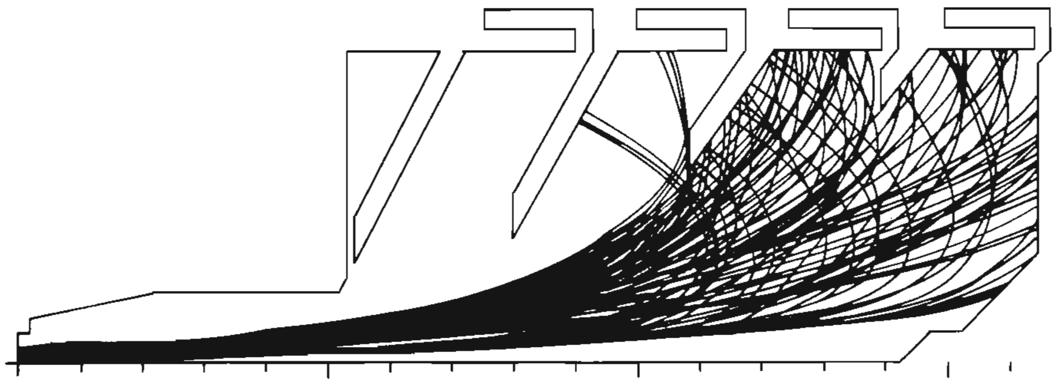

Figure 3. *Collector trajectories with 25% saturation. With the application of modulation, the electrons begin to sort themselves out.*

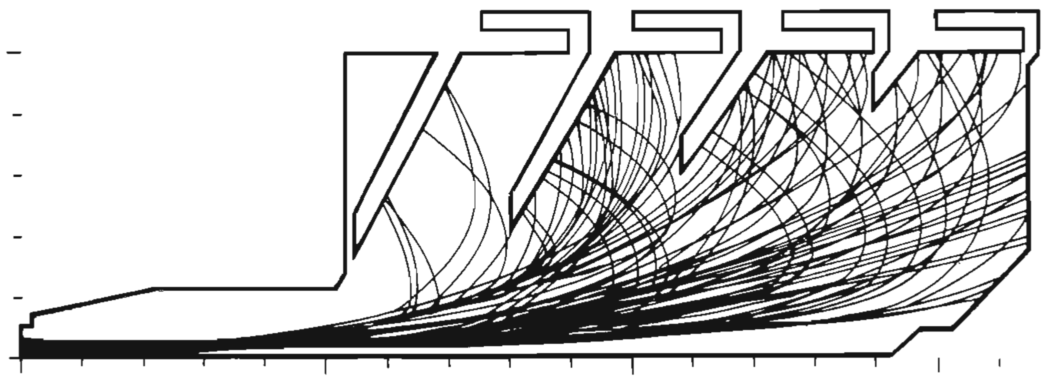

Figure 4. *Collector electron trajectories at 50% saturation, approximately the blanking level. The last three electrodes (Nos. 2, 3 and 4) share electrons in a predictable manner, producing currents I_2, I_3 and I_4.*

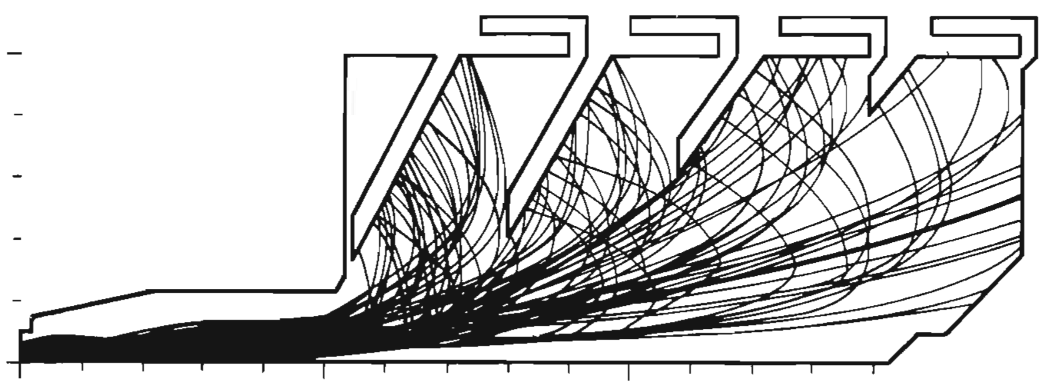

Figure 5. *Collector trajectories at 90% saturation, the sync level. Note the significant increase in the number of electrons attracted to the first electrode, producing I_1.*

Continued from page 40
are attracted to the higher-energy electrodes. The dramatic increase in electron capture by electrode No. 1, the highest-potential element at a voltage of 24.5kV, can be observed.

The electrons sort themselves out in a predictable manner. Notice the arc that is present on many electron traces. The electrons penetrate the electrostatic field of the collector, then are pulled back to their respective potential.

The completed MSDC assembly is shown in Figure 6 with the collector shield partially removed to allow visibility of the collector elements. The collector of the 4-stage MSDC design is actually composed of five elements mounted between ceramic rings for electrical insulation. The fifth electrode is at cathode potential. Each electrode contains passages for water cooling.

Figure 7 shows the distribution of collector current as a function of drive power. With no RF drive, essentially all current goes to electrode No. 4, but as drive is increased, I_4 drops rapidly as collector current is distributed among the other elements. It is interesting to note that the current to electrode No. 5 (cathode potential) peaks at about 10% of beam current. This suggests, according to researchers, that the *secondary yield* of the collector surfaces, a concern addressed during the design stage of the MSDC tube, is within acceptable limits.

Inserted between the klystron and the collector assembly is a refocusing electromagnet that controls the electron beam as it enters the collector region.

Researchers believe that the MSDC design will have little, if any, effect on the lifetime of the klystron. The electron beam is essentially unchanged. The tube is identical to a conventional integral cavity klystron except in collector design. Researchers have simply found a more efficient method of recovering electrons from the cathode beam and returning them to the power supply.

Power savings are realized because the electrostatic forces set up in the MSDC device slow down the electrons before they contact the copper electrode. The heat that would be produced in the collector is, instead, returned to the power supply in the form of electrical energy. In theory, peak efficiency would occur if the electrons were slowed down to zero velocity. In practice, however, that is not possible.

Problem areas

The general concept for the collector was developed at NASA's Hughes Research Center in Cleveland. Researchers had been working on the problems of achieving highly efficient operation from tubes operated at UHF frequencies and above. They recommended to Varian that the configuration shown in Figure 1 be tried. It had been used successfully on traveling wave tubes. Whether it would work on a klystron, however, was unknown.

The prevention of feedback within the MSDC device was cited as a potential problem area for designers. Feedback would occur if electrons in the collector not attracted by any of the electrodes were to return to the drift tube area of the klystron. Such an occurrence would serious-

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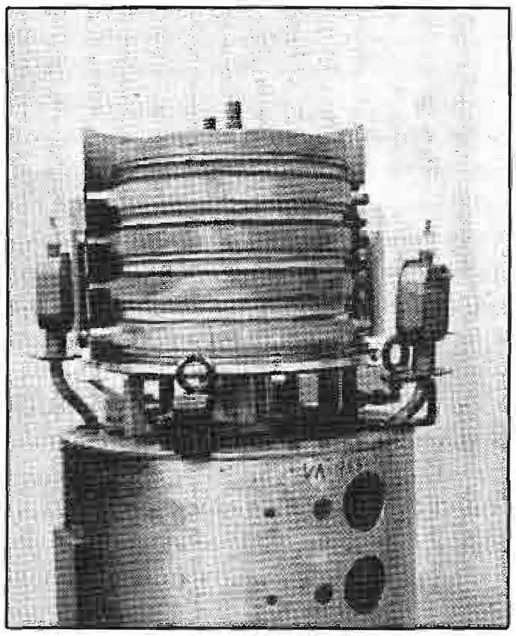

Figure 6. Photograph of the construction of the collector region of the MSDC test device. The 5-element design (four stages plus one electrode at cathode potential) includes cooling ports on each electrode.

ly distort the linearity of the device. Particular attention was given to ensuring that the mechanisms that could lead to feedback within the MSDC tube did not occur. Other areas of some concern involved suppression of secondary electrons, collector cooling and RF radiation.

Suppression of secondary electrons was accomplished both through the mechanical design of the collector and through the use of special materials on the collector surfaces. Materials were available that exhibit low secondary yield, such as carbon. But carbon is known to absorb gases, a potentially serious problem in a vacuum-tube environment. The solution was to apply only enough carbon to keep secondary electrons at a low level. If the carbon coating on the collector assembly was kept thin, only a small volume would be available to absorb gases.

To achieve the necessary thin carbon layer, a *sputter-coating* system was used. This equipment, originally designed for use in producing semiconductors, uniformly applied the thin carbon coating. Each element of the collector is coated separately, then assembled.

Cooling for any complicated mechanical device can be a concern, especially when high voltages are present. Cooling is accomplished through water jackets on each collector electrode.

Another area of concern was the potential for RF radiation. Video currents exist in the elements of the collector, and the design of the power supply must take that into consideration. Interestingly, it was determined that the main problem relating to radiation would probably come from the video component of the klystron waveform, rather than from the RF component.

The MSDC tube is now, according to researchers, essentially buildable. In fact, a second unit has been assembled with no unusual problems. The major construction problem during assembly of the first device was coming up with a method to deal with differential thermal expansion of the various parts of the MSDC assembly. Because of the large parts used in the collector, differential expansion was exhibited from one section to another. This effect was noted during the evacuation process, during which time the tube is exposed to high temperatures.

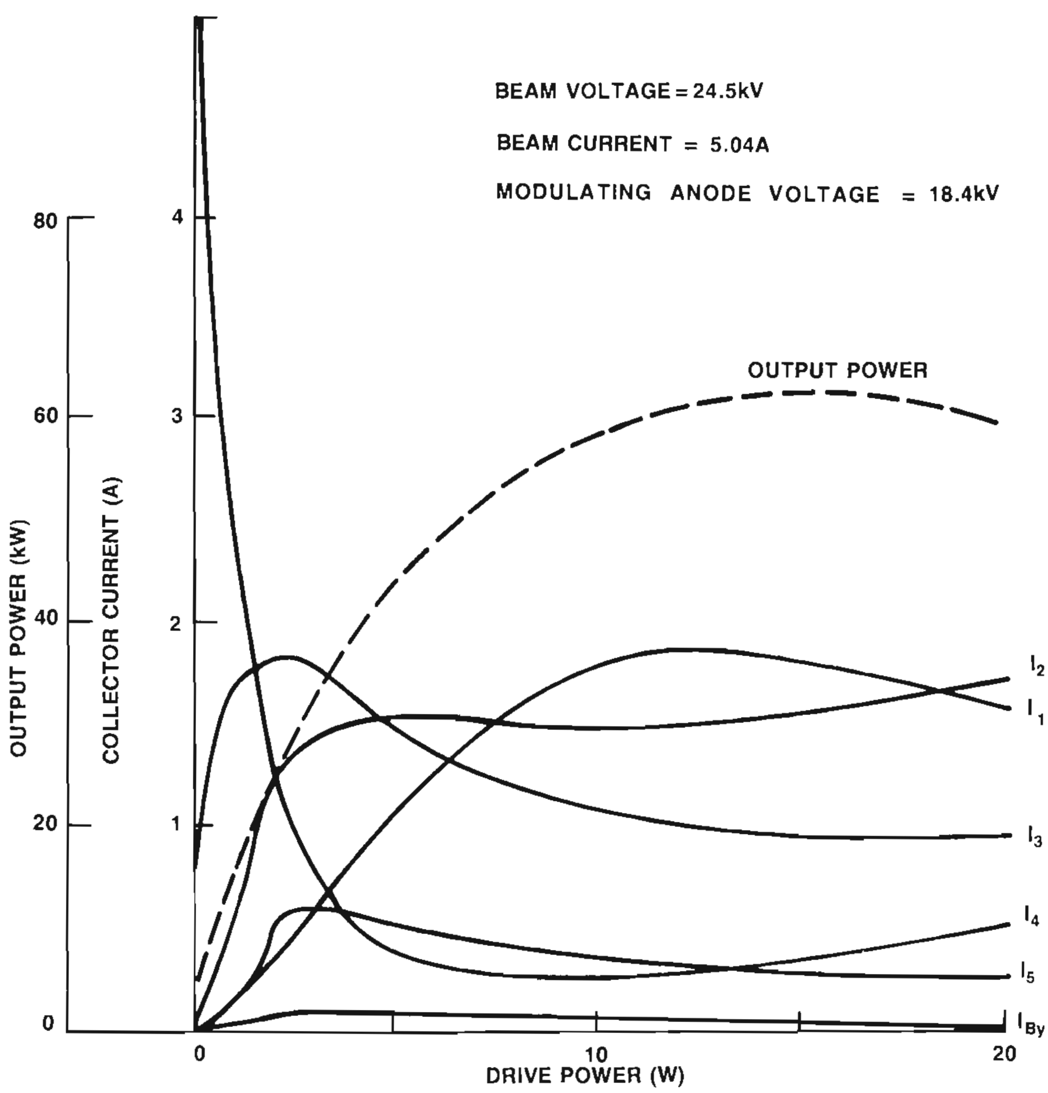

Figure 7. The distribution of electrode current as a function of drive power. Note the significant drop in I_4 as drive power is increased. I_5 is the electrode at cathode potential.

MSDC power supply

Design criteria for the collector power-supply system create a mixed bag of requirements. The critical parameter is the degree of regulation between the cathode and anode. The relative differences among the elements of the collector do not appear to be significant. Consequently, the bulk of the power supplied to the tube does not need to be well-regulated. This is in contrast to current klystron operation, in which the entire beam power supply must be regulated. This factor effectively decreases the amount of power that needs to be regulated to 1%-2% of the dc input, offsetting to some extent the additional cost involved in constructing multiple supplies to facilitate the 4-stage MSDC design.

Two approaches can be taken to collector supply design, as illustrated in Figures 8 and 9. Figure 8 shows a power supply using parallel arrangement of the power units, and Figure 9 shows a series-constructed system. In both cases, the collector electrodes are stepped at a 6.125kV potential difference for each element.

Performance

The improvement in efficiency achieved with the MSDC is impressive. Figure 10 shows the overall tube efficiency of a 60kW device, compared with a standard collector klystron. The depressed collector actually performed better than predicted, as shown in the illustration. Test data showed the MSDC klystron operating in a pulsed mode to reach almost 64% efficiency at 55kW peak of sync power output. The typical performance of a pulsed klystron is 45% efficiency.

Particular attention was given to the bandpass performance of the test device. Figures 11 and 12 chart power output as a function of frequency and RF drive. Figure 11 shows the full power test case, and Figure 12 shows the tube in a beam-puls-

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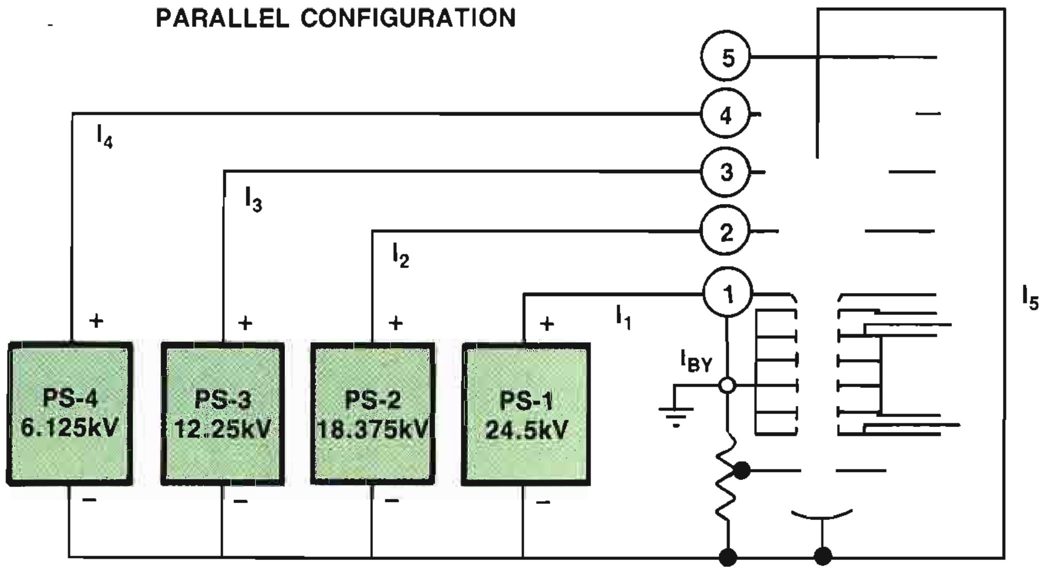

Figure 8. *Parallel configuration of the MSDC power supply. Note that each power-supply section has an output voltage that is an integral multiple of 6.125kV.*

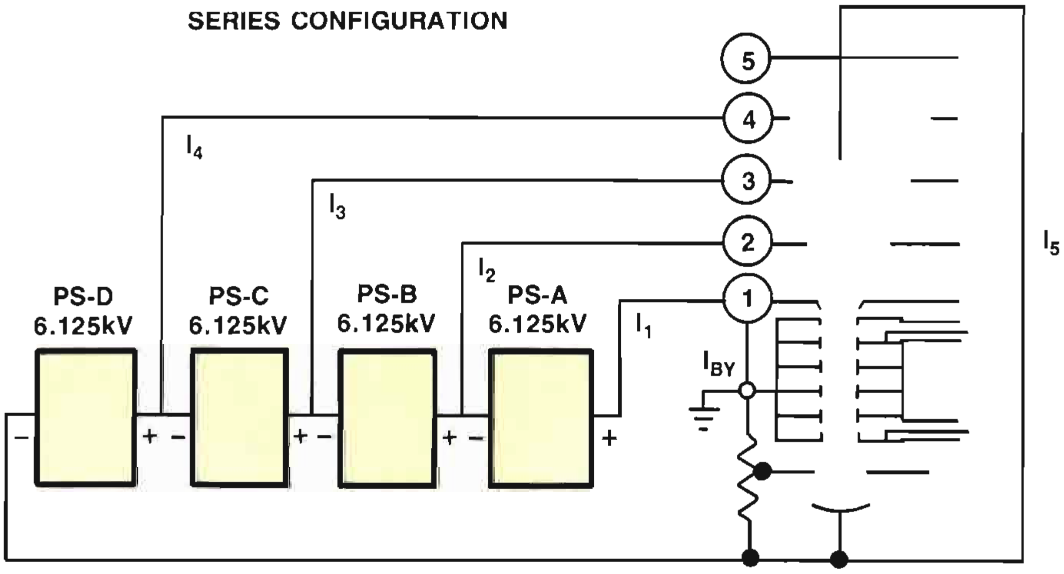

Figure 9. *Series configuration of the MSDC power supply. This arrangement uses four identical 6.125kV power supplies connected in series to achieve the needed voltages.*

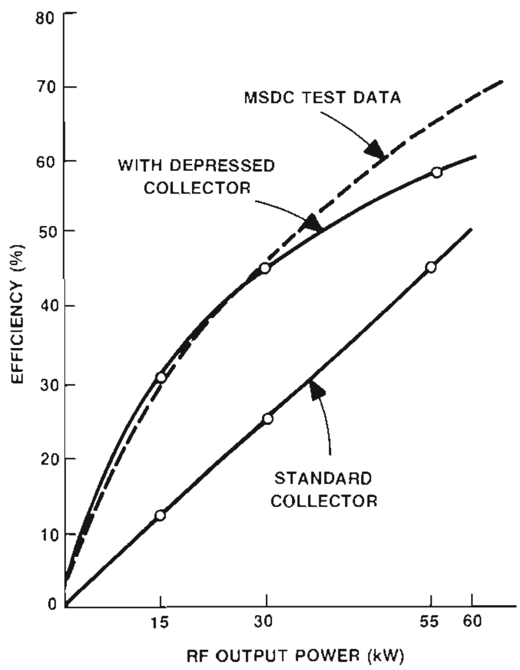

Figure 10. *Overall tube efficiency for the MSDC test device operating in the pulsed mode. The tube performed better than predicted by computer simulation, reaching an efficiency of nearly 64% at 55kW peak of sync.*

ing mode. Drive power is charted from 0.5W to 16W in Figure 11 and from 0.5W to 32W in Figure 12. Note that the traces provide good linearity above 6MHz. Gain, as a function of frequency and power, is essentially constant and undisturbed.

Additional tests taken on the MSDC tube showed that regeneration was not a problem with the device. To determine the regeneration level, the tube was retuned for narrow bandwidth to increase gain. Although regeneration effects were evident, operation was stable with no oscillations.

Figure 13 illustrates the dramatic power savings realized with the MSDC device. The shaded "power saved" area of the diagram represents the energy returned to the power supply by the new collector.

The figure of merit calculations procedure for the test device is presented in Table 1. The data shows an improvement in efficiency of 2.42 compared with a conventional klystron. The figure of merit for the MSDC tube is 1.12.

Future work

The MSDC is expected to be available

The klystron's golden anniversary

The klystron truly revolutionized the modern world when it was quietly developed in 1937. Indeed, it may have helped save the world as we know it. And, more than 50 years after it was first operated in a Stanford University laboratory by Russell Varian and his brother Sigurd, the klystron remains irreplaceable, even in this solid-state electronic age.

For Stanford, the klystron represents one of its best investments: $100 in seed money and the use of a small laboratory room turned into $2.56 million in licensing fees before the patents expired in the 1970s, three major campus buildings and hundreds of thousands of dollars in research funding.

Russell and Sigurd Varian went on to found their own company.

Birth of the klystron

The Varian brothers were unusually bright and extremely active. Mechanically minded, they produced one invention after another. Generally, Sigurd would think up an idea, Russell would devise a method to make it work, and Sigurd would build the device.

Through the influence of William Hansen, a former roommate of Russell and, at the time (the mid-1930s), a physics professor at Stanford, the Varians managed to get non-paying jobs as research associates in the Stanford physics lab. They had the right to consult with members of the faculty and were given the use of a small room in the physics building.

Hansen's role, apparently, was to shoot down ideas as fast as the Varians could dream them up. As the story goes, the Varians came up with 36 inventions of varying degrees of impracticality. Then they came up with idea No. 37. This time Hansen's eyes lit up.

On June 5, 1937, Russell proposed the concept that eventually became the klystron tube. The device could amplify microwave signals. With $100 granted by Stanford for supplies, Sigurd built the tube.

The device was simple. A filament heated by an electric current in turn heated a cathode. A special coating on the cathode gave off electrons when it reached a sufficiently high temperature.

Negatively charged electrons attracted by a positively charged anode passed through the first cavity of the klystron tube. Microwaves in the cavity interacted with the electrons and passed

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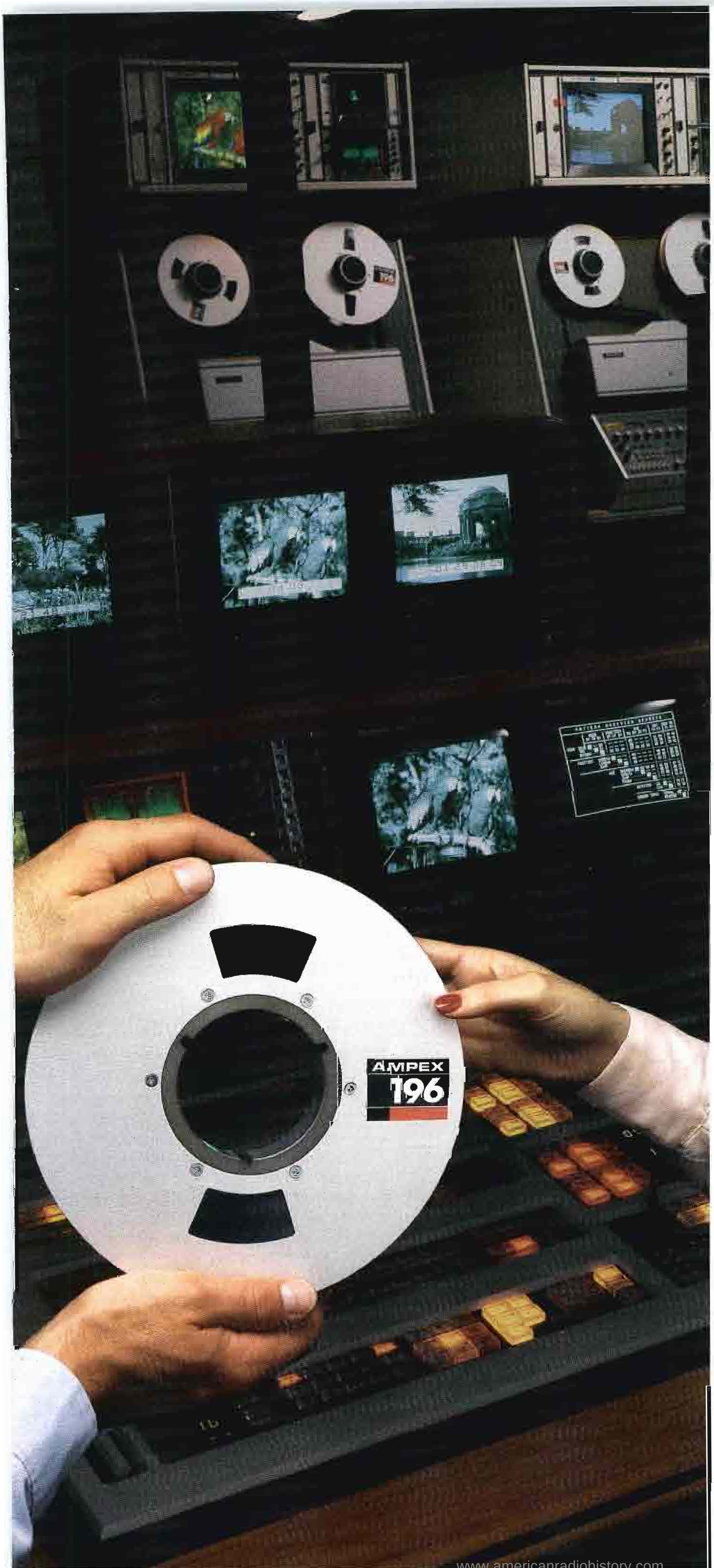

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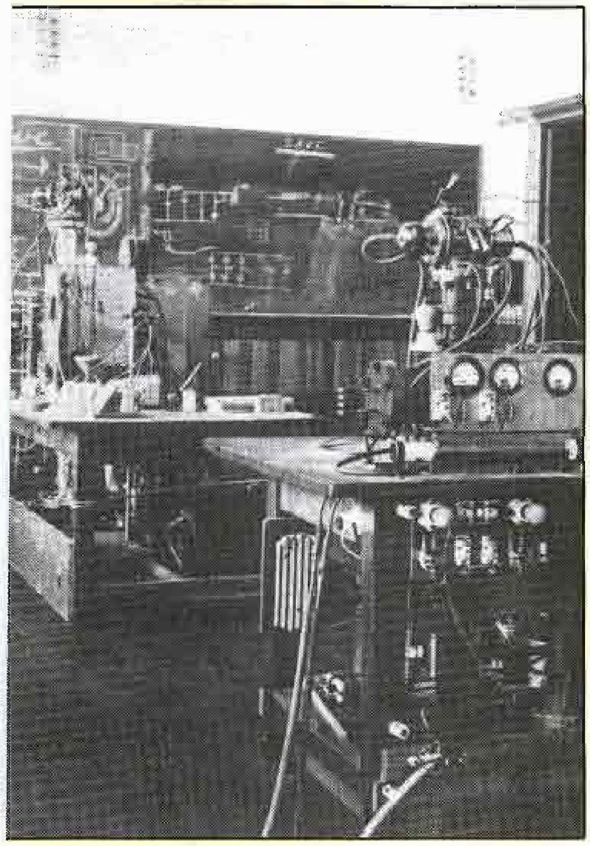
through a narrow passage called a drift tube. In the drift tube, the electrons tended to bunch up; some sped up, some slowed down. At the place in the drift tube where the bunching was most pronounced, the electrons entered a



The first klystron transmitter under development in the Stanford University laboratory of Russell and Sigurd Varian during the summer of 1938.

second cavity, where the stronger microwaves were excited and amplified in the process.

The first klystron device was lit up on the evening of Aug. 19, 1937. Performance was marginal, but confirmed the theory of the device. An improved klystron was completed and tested on Aug. 30.

The Varians published the results of their discovery in the "Journal of Applied Physics." For reasons that have never been clear, their announcement immediately impressed British scientists working in the same field, but was almost entirely ignored by the Germans.

The development of the klystron allowed British and American researchers to build smaller, more reliable radar systems. The British had adopted the Varians' invention to the point that it could spot German bombers on their way to England. The device, in fact, was a key element in winning the Battle of Britain. So valuable was the secret of radar employing klystrons that the British decided not to put radar in planes that flew over occupied Europe in case one of them crashed and the klystron was discovered.

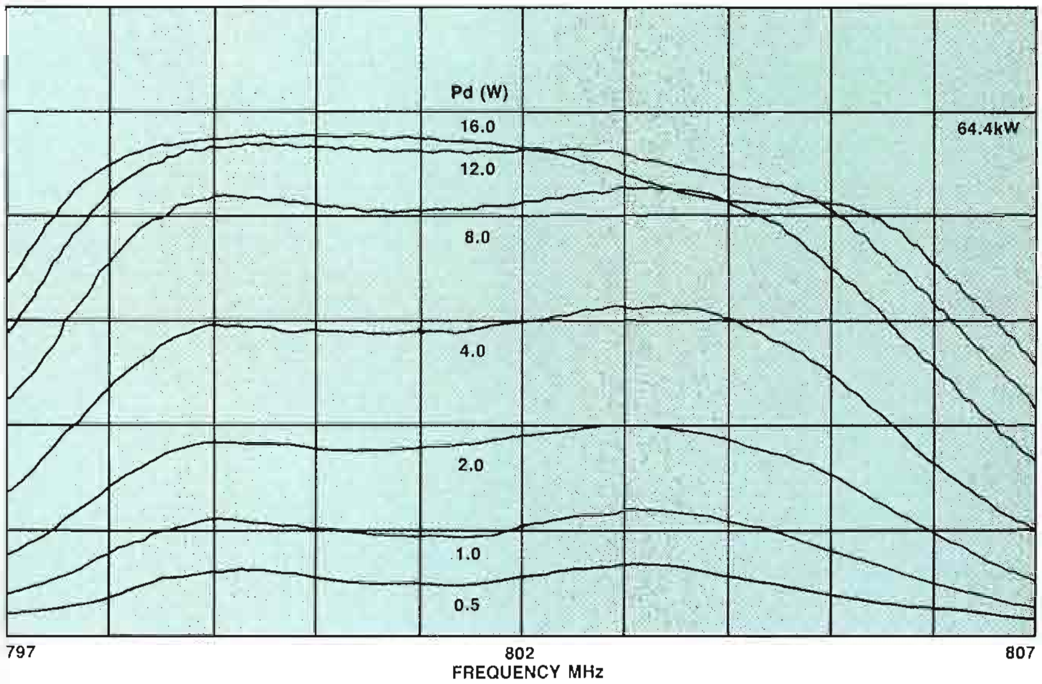


Figure 11. *Device bandwidth as a function of frequency and drive power. Beam voltage is 24.5kV, and beam current is 5.04A for an output power of 64kW. These traces represent the full-power test of the MSDC device.*

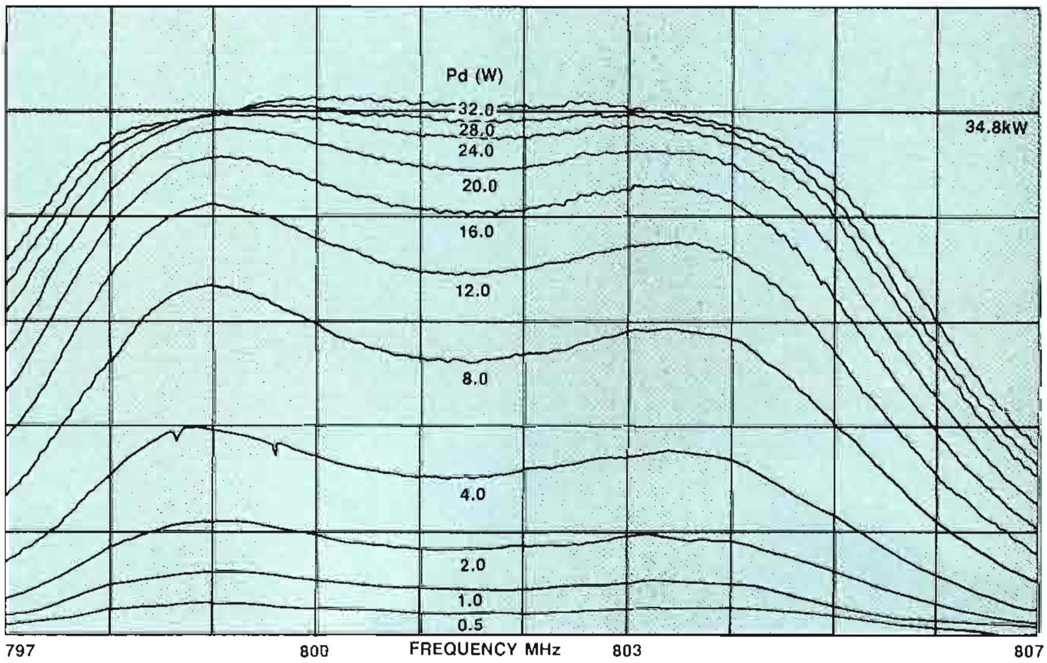


Figure 12. *Device bandwidth in the beam-pulsing mode as a function of frequency and drive power. Beam voltage is 24.5kV, and beam current is 3.56A with an output power of 34.8kW.*

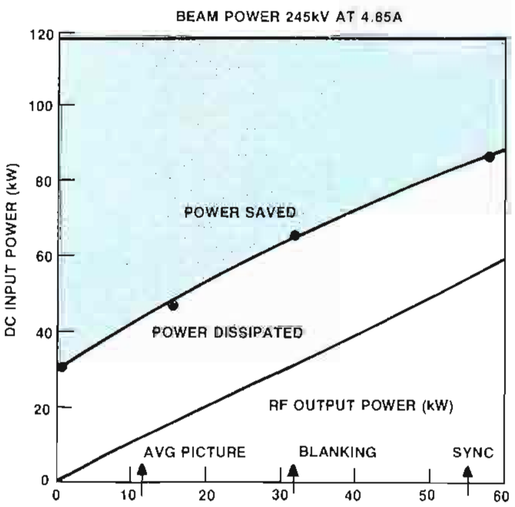


Figure 13. *Calculated power savings realized with the MSDC tube. The shaded area of the chart represents the energy recovered and returned to the power supply. In a conventional klystron transmitter, all this energy would be converted into waste heat.*

eventually to broadcasters at a price of about 10% to 20% more than a conventional klystron. Even though the collector is more complicated than a conventional unit, the pieces are smaller. Therefore, it is not clear that an MSDC klystron will cost significantly more than integral or external devices of comparable power. This would make the device cost-competitive in the marketplace, especially in light of the potential power consumption savings.

There is interest in applying the MSDC to a Klystrode device. The combination of a highly efficient collector with an efficient tetrode "front end" for the klystron could prove highly beneficial, as shown in Table 2. The calculated figure of merit for such a device would be 1.878.

Work still needs to be done, but the MSDC and Klystrode technologies appear destined to be married into a single device.

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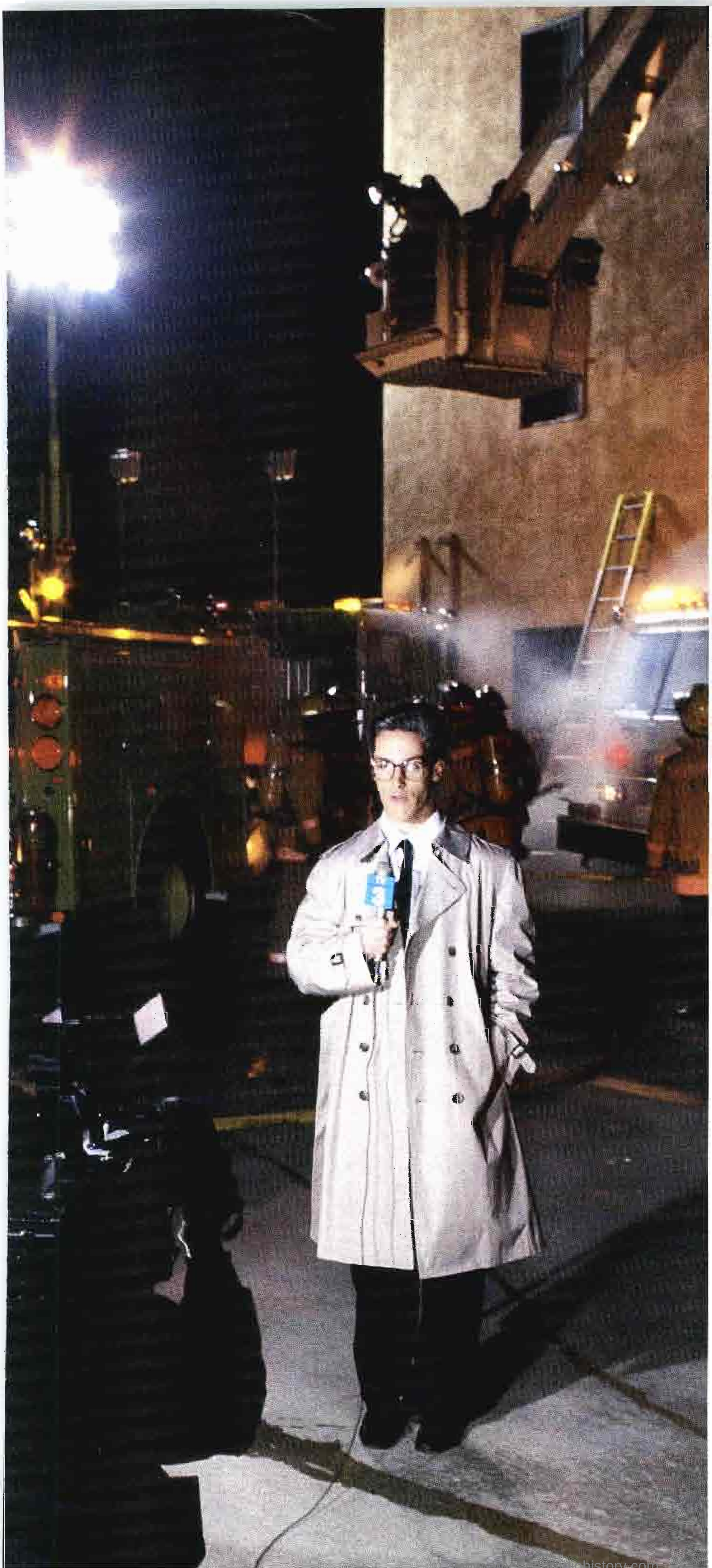

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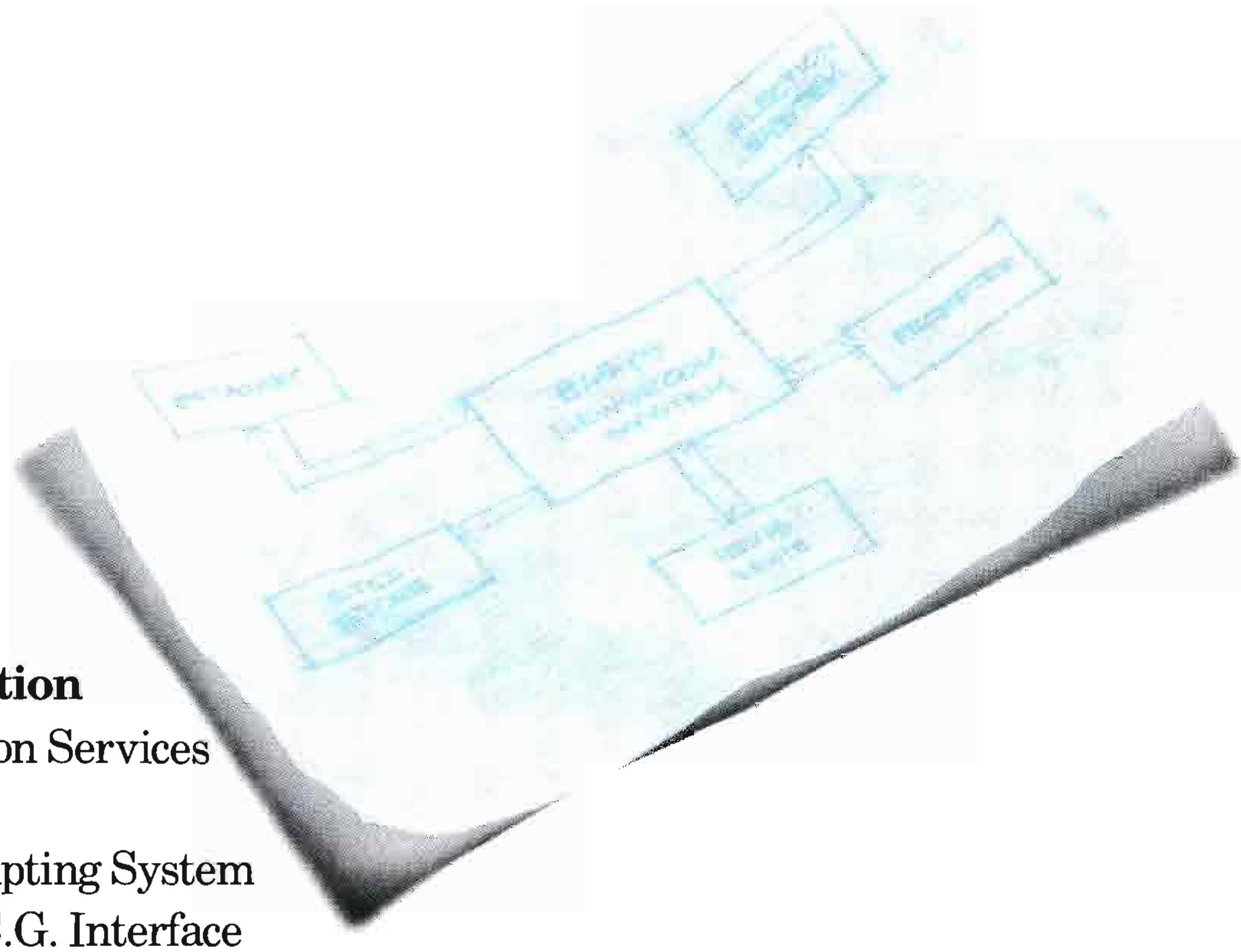

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Comparing klystron designs

By Jerry Whitaker, editorial director, and Earl Blankenship

The long-running debate about integral vs. external cavity klystrons stems from misconceptions about both types of tubes.

If you want to start a fight at your next local SBE meeting, solicit the opinions of your fellow broadcasters on which type of UHF-TV transmitter is best to have: an integral cavity system or an external cavity system. Few of them would agree. And much of the disagreement would be based on personal opinion rather than on hard facts.

In terms of market, integral cavity klystrons are estimated to be used in 70% of the installed sockets in the United States. Most newer transmitters, however, incorporate external cavity tubes. A major factor in this shift has been the demise of the RCA Broadcast Products Division, which built transmitters using integral cavity klystrons.

The primary areas of concern for any user selecting a device for UHF-TV applications are:

1. efficiency,
2. reliability and
3. cost.

Fundamentally, klystron theory applies equally to integral and external cavity tubes. In both cases, a velocity-modulated electron beam interacts with multiple resonant cavities to provide an amplified output signal. Whether the tuning mechanism is inside or outside the vacuum envelope has no bearing on the resonant cavity interaction gap and drift length requirements for optimum performance, including conversion efficiency. High-efficiency integral and external cavity klystrons have been designed to provide maximum conversion efficiency consistent with TV signal bandwidth requirements. The saturated conversion efficiency is essentially identical for integral or external cavity klystrons *with equal numbers of resonant cavities.*

Four vs. five

When comparing the efficiency of integral vs. external cavity klystrons, you really have to talk about four cavities vs. five cavities. Four-cavity external tubes are standard. If you have an external cavity transmitter, it uses a 4-cavity klystron. For mechanical and electrical (voltage standoff) reasons, it is not practical to produce 5-cavity external tubes.

Integral devices permit the addition of a fifth cavity to the design for two primary reasons. First, the device itself is mechanically more robust. The addition of a fifth cavity to an external klystron adds length and weight to the device. Because of the size of the drift tube in an external tube, as opposed to an integral unit, the additional weight is hard to support. Second, because the cavities are enclosed in a vacuum in the integral design, voltage standoff problems are greatly reduced.

The tuning mechanism of an integral cavity klystron is enclosed in a rigid steel shell. In the external cavity unit the tuning mechanism is in air. Within the region of the tuning mechanism, the fields can reach high levels, especially at the high end of the UHF-TV band. The highest energy field occurs in the area of the last cavity. Because of the high dielectric properties of a vacuum, dielectric breakdown is less of a problem in the integral design, which places the tuning mechanisms with-

Blankenship is engineering manager, UHF-TV klystrons, with Varian Associates, Palo Alto, CA.

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in a vacuum envelope. This situation is of particular concern at the higher end of the UHF band, where the tuning elements are more closely spaced.

Four-cavity integral-type klystrons are manufactured, but only for power outputs of 30kW or less. However, 60kW integral klystrons, the bread and butter of UHF-TV broadcasting, are produced with 5-cavity designs.

The physics of the integral and external cavity klystrons are essentially the same. When comparing integral and external units of like design—that is, with the same number of cavities—performance should be identical. The two units follow the same laws of physics and use basically the same components up to the beam stick. When manufacturers take advantage of the relative merits of each design, differences in performance are realized.

For the sake of easy comparison, assume a power level of 60kW, and assume that all integral cavity devices use five cavities and that external cavity devices use four. These conventions represent the products being delivered to customers today. It should be noted that most transmitters installed in the United States during the past five years were 60kW units. There was, you may recall, discussion of 110kW klystron designs several years ago. However, with the withdrawal of RCA from the transmitter market, that power level was abandoned. (RCA was the major proponent of socket power levels above 60kW.) The industry is essentially in a 60kW-per-socket world in the United States. And as far as the authors know, all 60kW integral cavity klystrons are 5-cavity devices.

Efficiency

All klystron manufacturers rate their tubes' performance in terms of *saturated efficiency*. The saturated efficiency is determined by dividing the saturated RF output power by the dc input power.

The 5-cavity integral S-tuned klystron is inherently at least 20% more efficient than a 4-cavity tube. The 5-cavity klystron generally is specified by the manufacturer for a minimum efficiency of 52% (saturated efficiency). Typical efficiency is 55%. Four-cavity devices are characteristically specified at 42% minimum and 45% typical.

This efficiency advantage is achievable because the fifth cavity of the integral design permits tuning patterns that allow maximum transfer of RF energy while maintaining adequate TV service bandpass response. Tighter bunching of electrons in the beam stick, a function of the number of cavities, also contributes to the higher-efficiency operation.

In actuality, the fifth cavity allows design engineers to trade gain for efficiency. S-tuning refers not only to the physical design of the device, but also to the method used to tune the tube to enhance efficiency. The 5-cavity tube, however, still has significantly more gain than a 4-cavity device. The 5-cavity unit, therefore, requires less drive, which simplifies the driving circuit. A 5-cavity klystron requires less than 25W of drive power, while a 4-cavity tube needs as much as 90W.

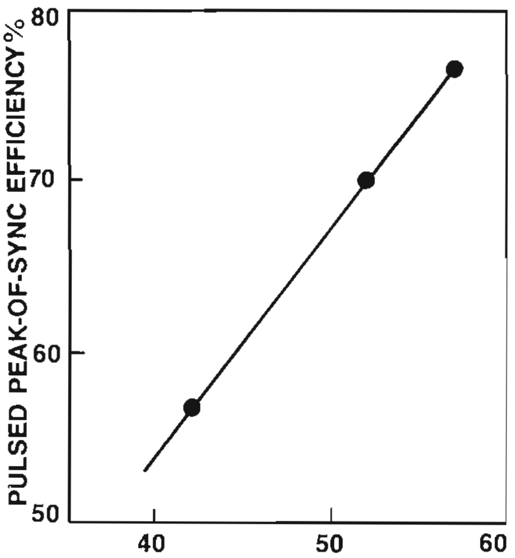

Figure 1. *The relationship between saturated klystron efficiency and pulsed peak-of-sync efficiency with 25% beam reduction provided by beam pulsing.*

With pulsed operation, approximately the same reduction in beam current is realized with both integral and external cavity klystrons. When *peak-of-sync figures of merit* are compared, the efficiency differences will track. There is, fundamentally, no reason that one type of klystron should pulse differently than the other.

The klystron's saturated efficiency governs the maximum peak-of-sync efficiency available when beam-pulsing techniques are employed. Peak-of-sync efficiency is the commonly used figure of merit expression, defined as the peak of sync output power divided by the dc input power. Figure 1 shows the relationship between the klystron's saturated efficiency and the peak-of-sync efficiency when 25% beam reduction is provided by beam-pulsing techniques. The slope of the curve will change when more or less beam reduction is achieved, depending upon the degree of precorrection available, but the relationship always is determined by the saturated efficiency of the klystron.

Trade-offs

It is a designer's choice whether to locate the klystron cavities inside or outside a vacuum envelope. When the cavity resonators are a part of the tube, the device becomes more complicated and more expensive. But the power-generating system is all together in one package, and that significantly simplifies installation. In principle, a 4-cavity tube of one type or the other should work essentially the same. There are advantages to each approach, however.

When the resonator is made separate from the tube, it can be made with more *compliance* (adjustability) and, consequently, the device can be tuned for operation over the entire UHF-TV band. This feature is not possible if the resonant cavities are built into the device. To cover the entire UHF-TV band, three integral cavity tubes are required. The operational divisions are:

- channels 14 to 29,
- channels 30 to 51 and
- channels 52 to 69.

This practical limitation to integral cavity klystron construction may be a drawback for some stations. For example, it is not uncommon for group operations to share one or more spare klystrons. If the stations have operating frequencies outside the limits of a single integral device, it may be necessary to purchase more than one spare. Also, when the cavities are external, the resonators are in air and can be accessed to permit fine adjustments of the tuning stages for peak efficiency.

The advantages of tube changing are significant when an integral device is used. Typical tube maintenance change time for an integral klystron is one hour, compared with four to six hours for an external device. The level of experience of the technician also is more critical when an external-type device is being changed. Tuning procedures must be followed carefully by station engineering personnel to avoid premature device failure.

When an external cavity klystron is installed, care must be taken to move the tube with proper mechanical support. The electron beam tunnel supports all the cavities and is not designed to be a load-carrying structure. Even if a bend in the beam stick appears to be minuscule, it could cause beam interception, vacuum deterioration or a melted drift tube. Small irregularities in the tunnel can result in degraded klystron performance and frequency instabilities.

It is, of course, only fair to point out that rough handling during shipment or installation for either an external or integral cavity tube can significantly shorten the life of the device.

Maintenance requirements during the life of the transmitter vary depending upon the type of klystron. An integral cavity tube requires little or no routine maintenance. Tube manufacturers generally recommend cleaning to remove any dirt on high-voltage surfaces and regular visual inspection of the device. Both tasks can be accomplished while the tube is in the

Continued on page 60

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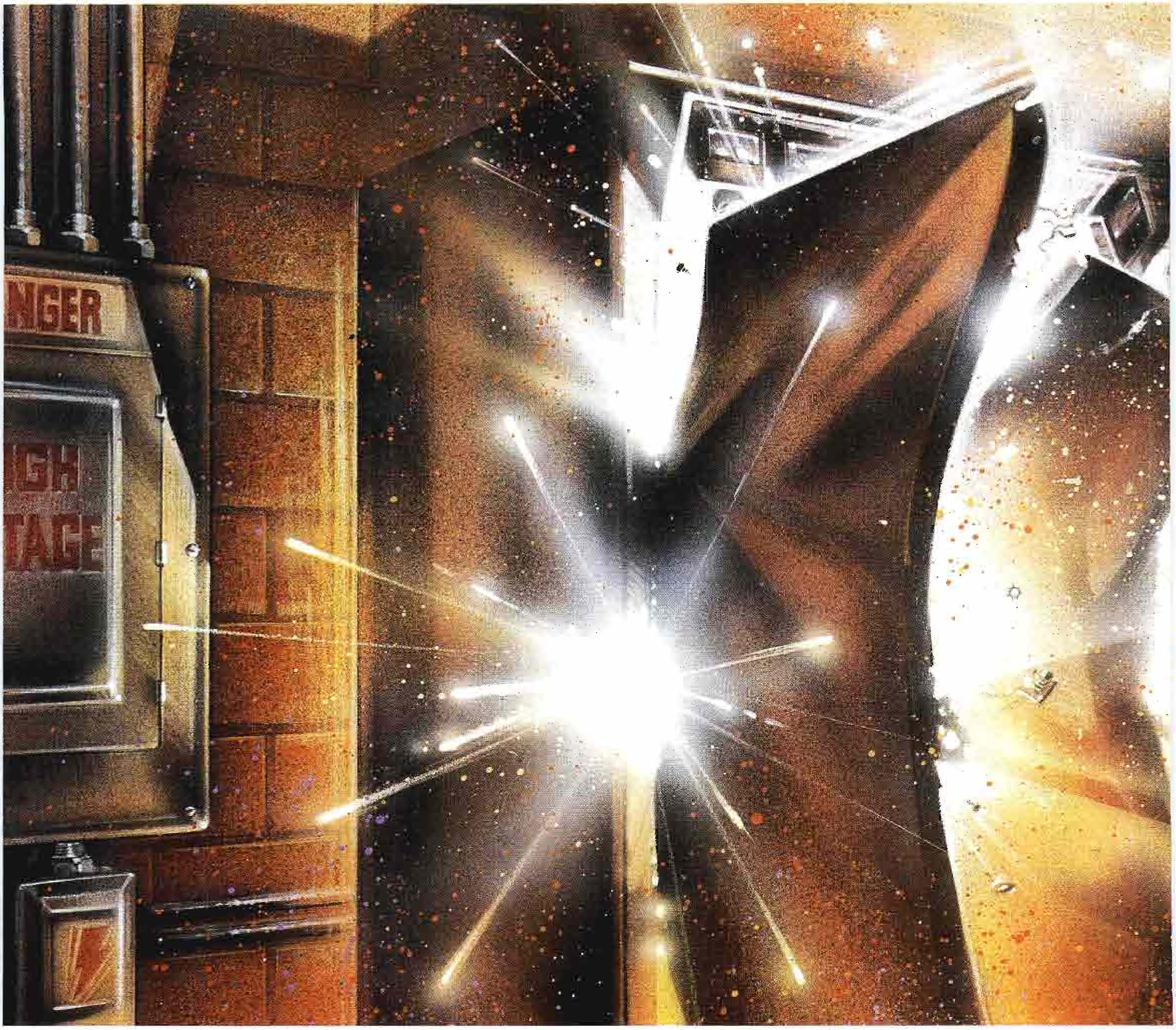

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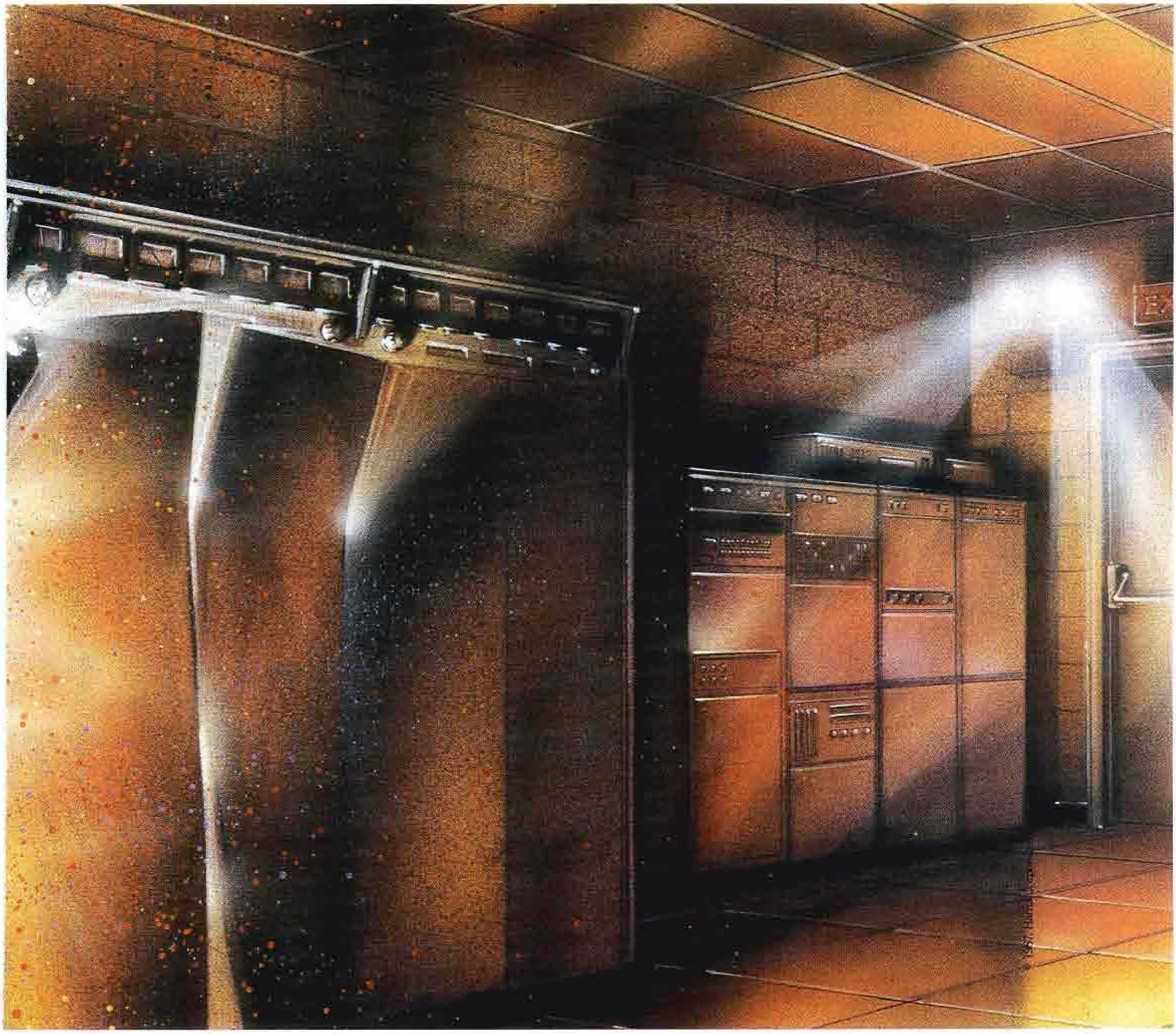

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Increasing efficiency through beam pulsing

Modern UHF-TV transmitters use precorrection of the modulated drive signal and sync-pulsing techniques to reduce visual klystron beam power requirements. The resulting improvement in efficiency can be 25% or more. Sync pulsing is accomplished by raising the beam current during the synchronizing interval through voltage control of the klystron annular beam control electrode (ACE or comparable element) or modulating anode, then returning to a lower current mode during the color burst and video interval.

In theory, the amount of beam current reduction achieved and the resulting efficiency improvement are independent of whether annular beam control or modulating anode pulsing are used. In practice, however, differences are noted.

With existing mod anode pulsers, an efficiency improvement of about 19% in beam current, compared with nonpulsed operation, typically is achieved. A beam reduction of 30% to 35% has been recorded through use of an annular control electrode tube. A peak-of-sync figure of merit for the integral cavity klystron without ACE or equivalent control is 0.67 to 0.68. With an ACE-type tube, the figure of merit becomes 0.80. Similar improvements in efficiency can be realized for external cavity tubes.

Use of the ACE-type gun reduces user concern about the reliability of beam pulsing, because it is accomplished at a much lower voltage. The ACE-type klystron fits the same socket as a standard integral cavity klystron. Modification kits are available for some transmitters to produce the lower-voltage (with respect to the mod anode pulser approach) pulser signal, which provides a significant level of improved performance. Because the newer-design gun pulses at a lower voltage, the pulser must be integrated with a new exciter equipped with sync-reduction circuitry to realize the improved performance.

Continued from page 57

transmitter.

External cavity klystrons, on the other hand, generally require more care. The RF cavity boxes and ceramics, which are open to the environment, should be kept clean. In a particularly dirty environment, cleaning may be required on a regular basis.

For this type of maintenance, the external cavity klystron may have to be removed from its socket and the cavities disassembled. The frequency of such service is difficult to predict because the operating environments of different transmitter sites vary widely. Needless to say, it is critically important to keep the transmitter site as clean as possible.

Reliability/lifespan

Any discussion of the lifespan of a tube must first identify the parameters that define life. The only identifiable *wear-out* mechanism in a klystron is the electron gun at the cathode of the tube. In principle, the cathode eventually will evaporate the activating material and cease to produce the required output power. The cathodes used in UHF-TV transmitters are designed for long life—about eight to 10 years. More often than not (depending up-

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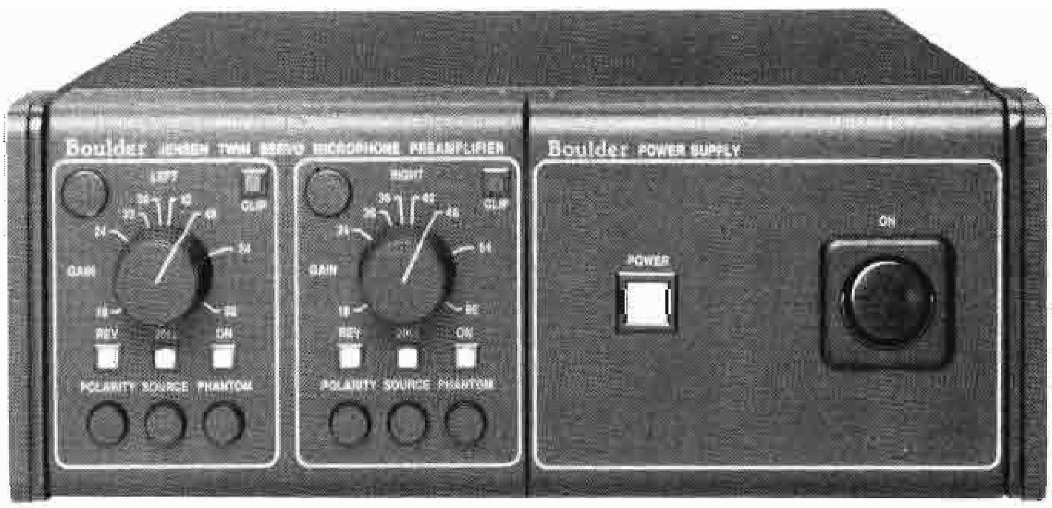

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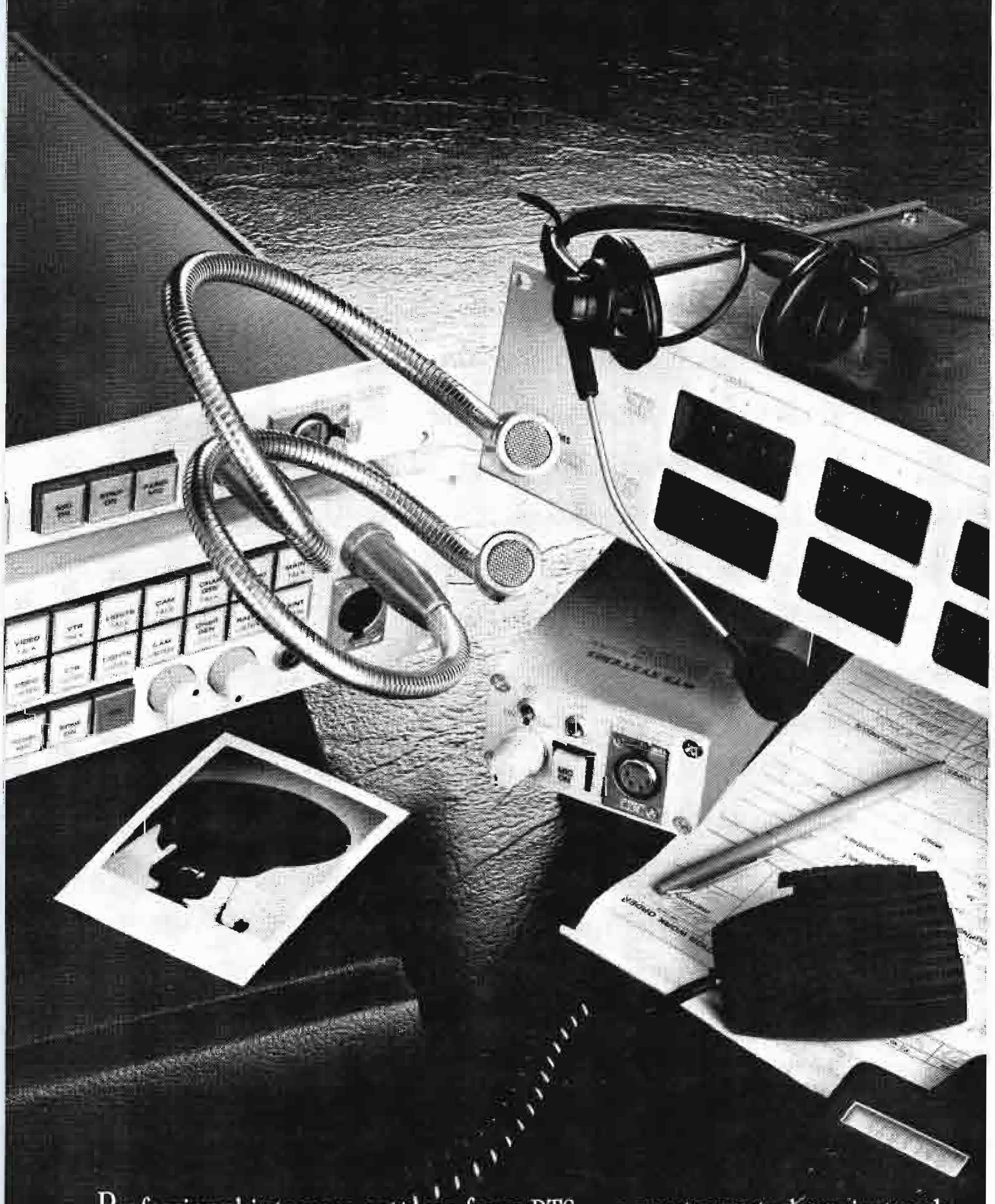

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on the manufacturer), the cathode assembly is identical between the integral and external cavity designs. Therefore, from the standpoint of the predictable wear-out mechanism of cathode depletion, both tubes should perform the same.

Tubes, however, rarely fail because of low emission, but for other reasons that usually are external to the device. Overvoltage or cooling faults of one form or another are the primary causes of catastrophic failure of klystrons. It is fair to acknowledge that the output window tends to be more of a problem with the external cavity tube when load mismatches are present. The window experiences greater stress because it is in close proximity to the output of the device. It is, in fact, within the cavity resonator.

Cooling-induced faults are as much of a problem with the integral as the external cavity device.

Klystron lifespan data has been developed by the manufacturers of integral and external tubes. Usually these figures are based on surveys of users and represent actual installed life. It is difficult to separate tube failures resulting from external forces, such as lightning or power-line transients, from true tube faults.

The data available from klystron manufacturers varies. However, one representative lifespan survey shows an average tube life of 41,260 hours for an integral cavity device. Most published lifetime data for external cavity designs indicates shorter life expectancy (about 30,000 hours). This comparison can be somewhat misleading, however, because more integral cavity tubes than external cavity tubes have been installed in sockets in the United States for a longer period of time. Therefore, more life-cycle data is available for integral cavity devices.

Until 60kW external tubes have been in the field for a longer period of time (another five to 10 years), accurate comparisons of life expectancy for integral vs. external cavity devices will be difficult. An argument can reasonably be made that after enough statistical data has been gathered on both types of devices, the life expectancy of each type will be shown to be essentially the same.

It should be emphasized that because of the way life-cycle data is gathered, the projected number of operating hours is not directly a function of the tube itself, but rather of the tube and transmitter combination operating in the on-site environment.

There is essentially no difference between integral and external devices in susceptibility to damage from transients. From time to time, manufacturing problems in a product batch will result in a given device being more susceptible to failure caused by overload. These occur-

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MTTR: Be prepared

A key factor in the selection of any type of transmission equipment is the *mean-time-to-repair* (MTTR), which defines the maintainability of a system. In the case of a UHF-TV transmitter, the time required to change a klystron is an important consideration, especially if the station does not have a standby transmitter. The time change estimates shown in Table 2 of the main story (one hour for an integral tube and four to six hours for an external cavity tube) assume that no preparation work has been performed on the spare device.

In the case of a station that does not have a backup transmitter, being off the air for one hour during prime time would be a major problem. Being off the air for four to six hours during prime time would be a disaster.

One solution to this problem is to install the spare tube during a maintenance period and tune the device for proper operation. After documenting the positions of all tuning controls, remove the tube and return it to its storage container, along with the list of tuning control readouts. In this way, the external cavity klystron can be placed in service much faster during an emergency.

This procedure will not, of course, result in a klystron tuned for optimum performance. However, it may provide a level of performance that is acceptable on a temporary basis.

Consideration of MTTR is important for a UHF station because most klystrons fail from a mechanism other than reduced cathode emission, which is a *soft failure* that can be anticipated with some degree of accuracy. Catastrophic failures, on the other hand, offer little—if any—warning.

rences, however, are anomalies that cannot reasonably be considered in an analysis of inherent tube life.

Focusing magnet-induced failures, at this point in development, are basically a thing of the past. Several years ago, external cavity devices of certain designs were susceptible to failure of the drift tube caused by focusing magnet failures. Improved cathode designs, however, prevent this problem in newer tubes.

The external cavity tube is more fragile in the area of the beam stick because of its smaller diameter, compared with the integral cavity klystron. The steel shell of

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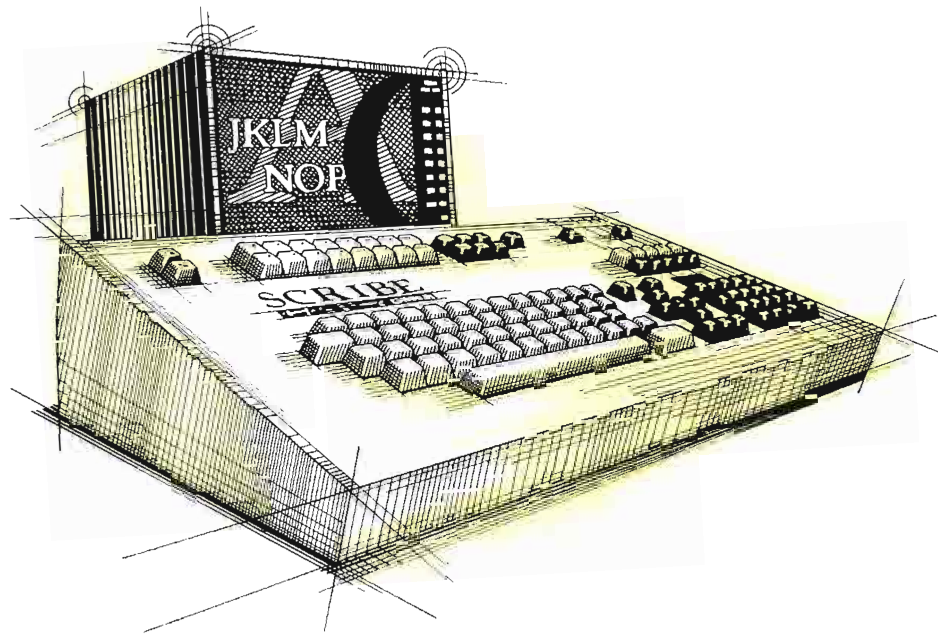

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INITIAL INVESTMENT:		
KLYSTRON	$ 28,000	$ 50,000
MAGNET & CIRCUIT ASSEMBLY	22,000	15,000
VARIABLE VISUAL COUPLER	NOT REQUIRED	5,000
TOTAL POWER COST FOR 20 YEARS ($0.07/kWH IS ASSUMED)	919,800	752,380
COST OF REPLACEMENT TUBES	61,040	109,000
TOTAL COST	1,030,840	931,380
COST PER YEAR	51,542	46,569
COST PER HOUR	7.85	7.09

Table 1. *Approximate cost of operation for integral and external cavity klystron transmitters. A power cost of $0.07 per kilowatt-hour is assumed, and the life expectancy of both tubes is assumed to be the same.*

the integral cavity design provides considerable strength to the overall device. There also are fewer ceramic-to-metal seals in the integral cavity klystron.

Calculating MTBF

Regardless of which type of klystron you may have in your transmitter, an accurate determination of the mean time between failure (MTBF) is important for preventive maintenance and budgeting purposes. A transmitter that goes through tubes every 20,000 hours is not performing as it should. Good engineering practice dictates that accurate documentation be compiled on the in-service performance of the final tubes. Such information also is critically important in formulating an accurate engineering budget. A replacement integral cavity klystron will cost about $50,000, and an external device will cost approximately $28,000. When expenses as large as these are involved, no engineering manager wants to be surprised.

The following formulas can be used to predict klystron life in broadcast years and the number of replacement tubes that will be needed during the life of the transmitter.

$$Y = \frac{MTBF}{H}$$

$$N = \frac{L \times S}{Y}$$

$$R = N - S$$

Where:

Y = Tube life in broadcast years

MTBF = Klystron mean time between failure (gathered from manufacturer literature or on-site experience)

H = Hours of operation per broadcast year
= 365 x hours per broadcast day

N = Number of tubes needed over the life of the transmitter

L = Anticipated life of the transmitter in years

S = Number of klystrons per transmitter

R = Number of replacement tubes needed over the life of the transmitter

Cost of operation

As pointed out previously, there is a considerable replacement cost difference between integral and external tube types. If the same lifespan is assumed, which is a reasonable assumption, the cost of ownership of an integral cavity-based klystron transmitter will be slightly lower than an external tube system over the lifetime of the transmitter because of the higher efficiency of the 5-cavity design. This cost-of-ownership benefit comes despite the substantially higher initial replacement cost of the integral cavity klystron.

The following formulas can be used to calculate the power costs of a tube:

$$P = Y \times E \times H \times PDC$$

$$T = P \times N$$

Where:

P = Power cost of the tube over its expected lifetime

Y = Tube life in broadcast years

E = Power cost in dollars per kilowatt-hour

H = Hours per broadcast year

PDC = (for external cavity) 100kW per visual socket
= (for integral cavity) 81.8kW per visual socket

T = Total tube power cost over the life of the transmitter

N = Number of tubes needed over the life of the transmitter

Table 1 compares integral and external cavity klystron operating costs. For the sake of comparison, inflation is ignored, the lifetime of the transmitter is assumed to be 20 years, the broadcast day is 18 hours long and the MTBF of both klystrons are the same (41,260). The MTBF assumption provides a "worst-case" comparison of the two types of devices. (*Worst-case* here refers to the perspective of integral cavity proponents.)

As the table shows, the cost per hour of the external cavity klystron is estimated to be $7.85, and the cost per hour of the integral cavity klystron is estimated to be $7.09.

The cost of ac power is a critical variable in life-cycle calculations. The more efficient the tube, the lower its overall costs, especially when utility power rates are increasing.

Options

The user has four basic options with regard to operation of the station's UHF transmitter:

1. Keep the type of device supplied with the transmitter, and replace it with the factory-specified tube when replacement is necessary.
2. Modify the station's integral cavity transmitter to an external cavity system.
3. Buy a new transmitter using one design or the other.
4. Wait until transmitters using the MSDC klystron or Klystrode become available in the marketplace.

The advisability of changing a transmitter to accept an external cavity tube, rather than an integral device, is questionable in view of the preceding life cost-per-hour calculations. Table 2 summarizes the

Continued on page 67

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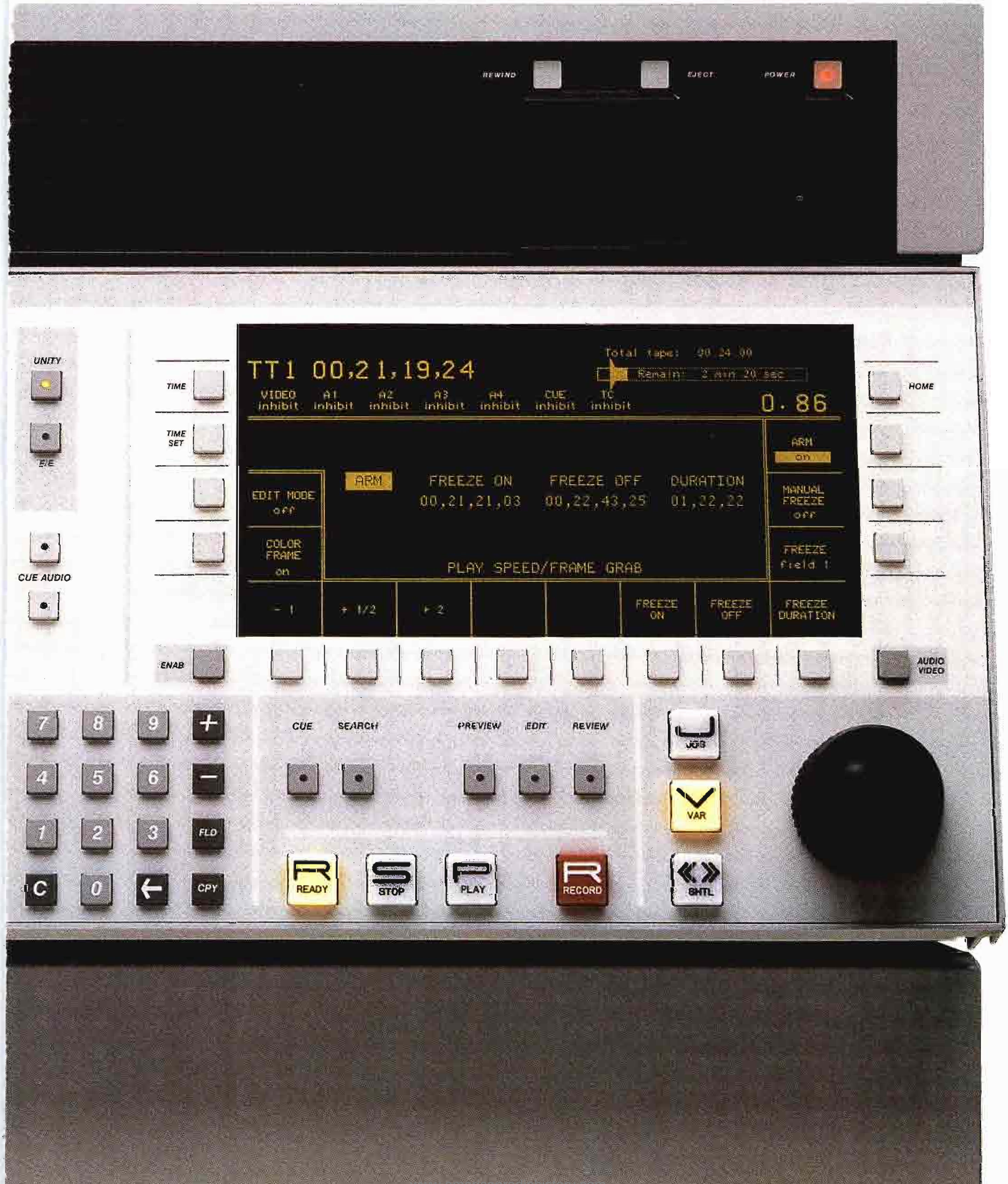

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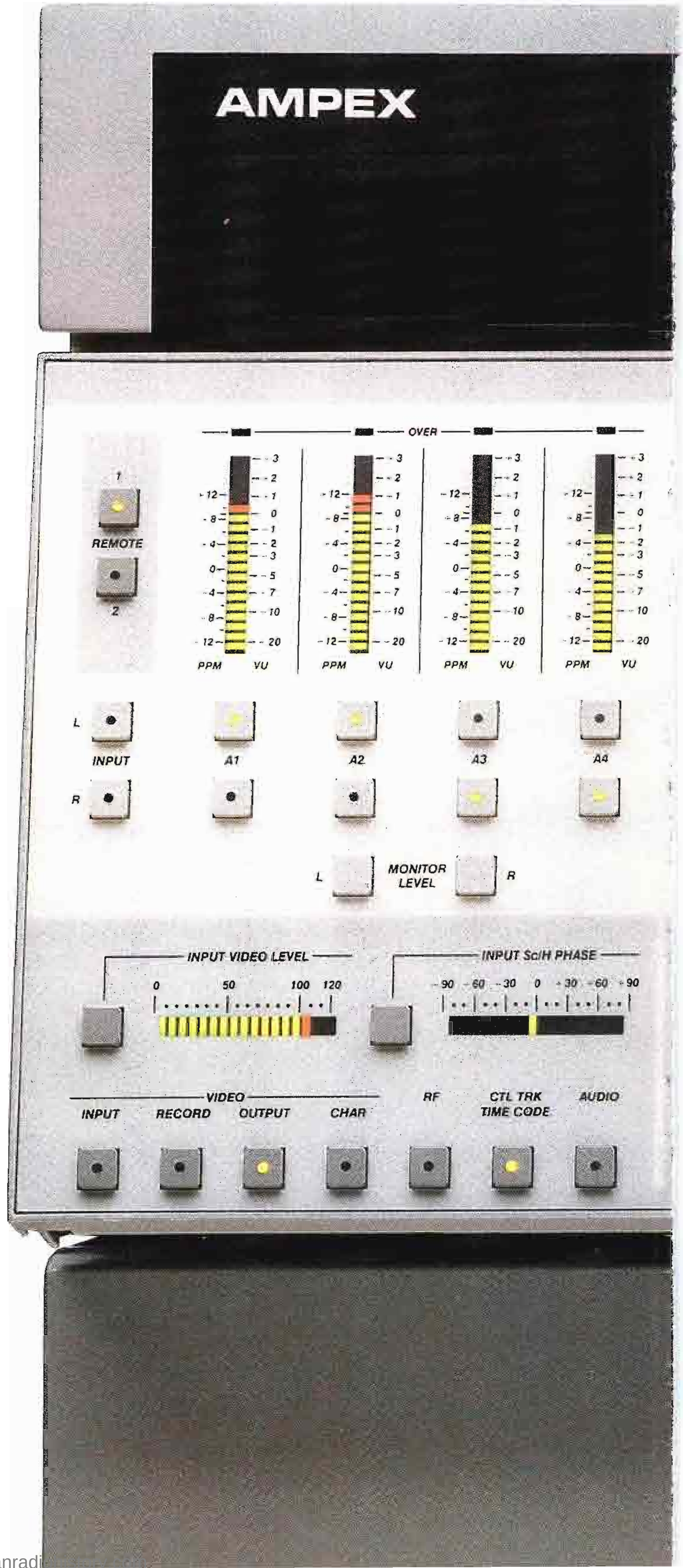

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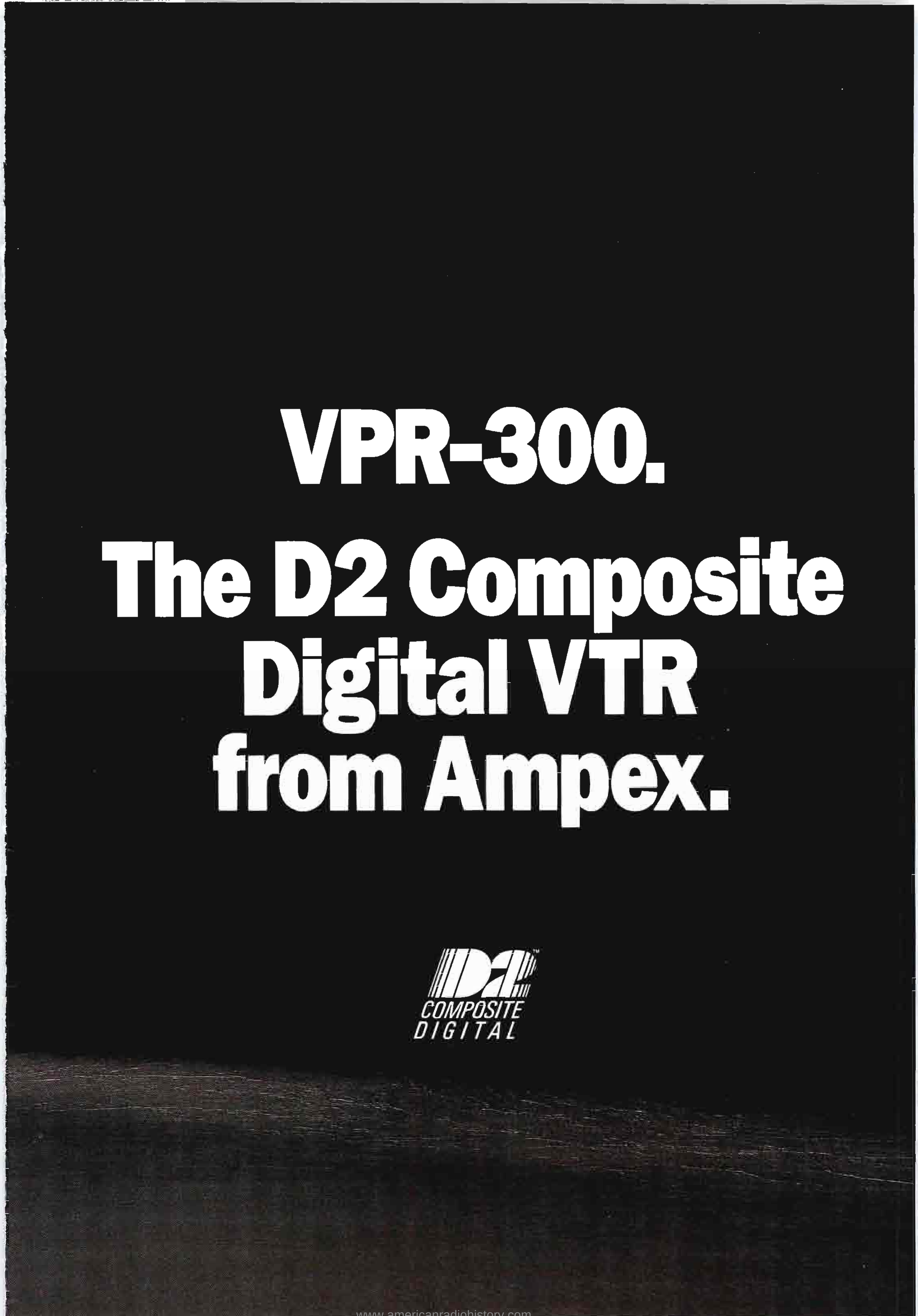

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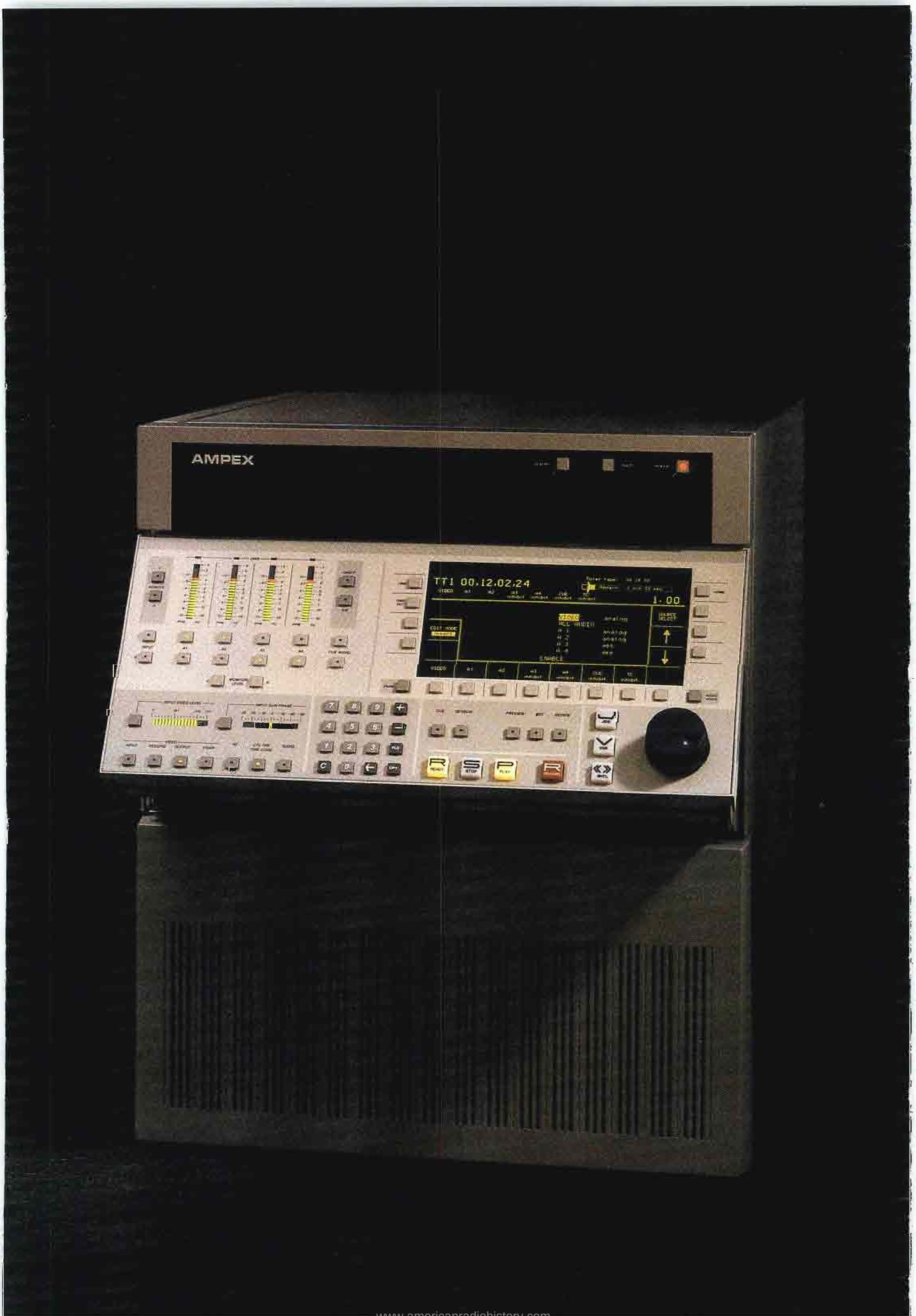

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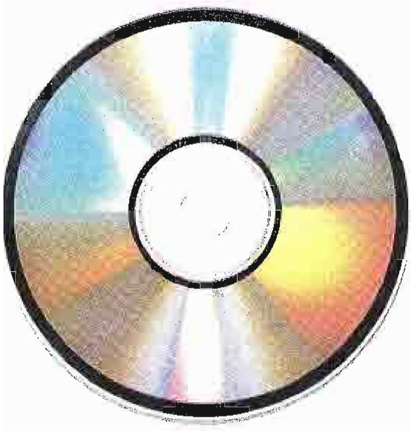

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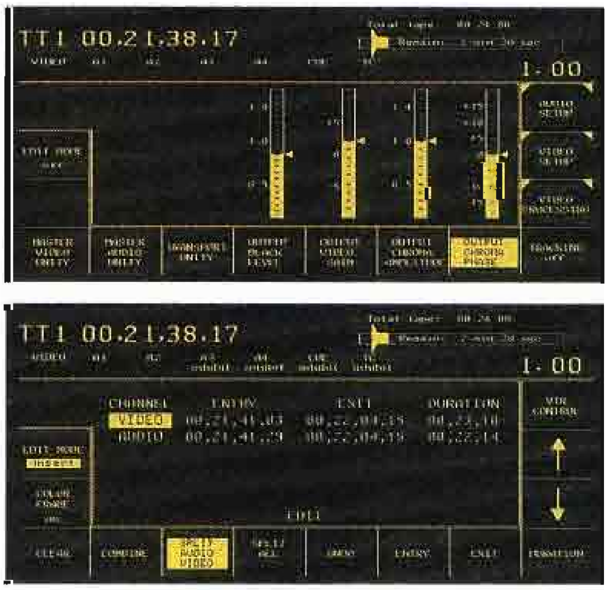

A large, interactive display makes operation easy.

But more importantly, it allows you to take full advantage of all the machine's capabilities.

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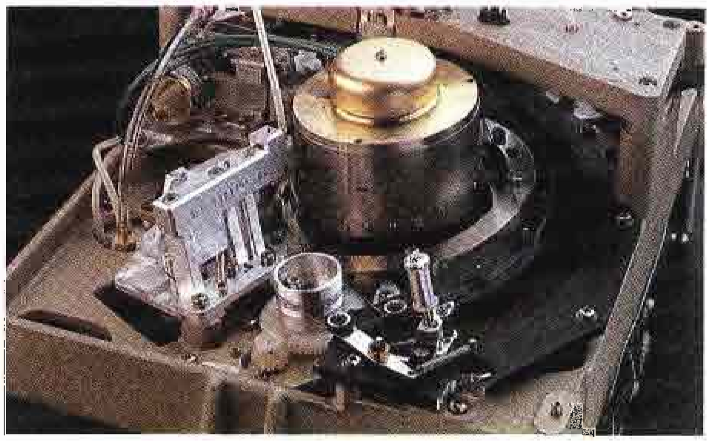

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Continued from page 66

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TYPICAL TRANSMITTER dc POWER REQUIREMENTS FOR 60kW PEAK OF SYNC WHEN PULSING TO 25% BEAM REDUCTION	100kW/VISUAL SOCKET	81.8kW/VISUAL SOCKET
ANNUAL POWER COST PER VISUAL SOCKET BASED ON DAILY POWER COSTS OF $0.07/kWH AND OPERATING 18 HOURS/DAY	$45,990	$37,619
RELIABILITY (MTBF)	ASSUMED TO BE THE SAME	
AVERAGE PRICE OF NEW TUBE	$28,000	$50,000
NUMBER OF HOURS TO CHANGE TUBE	4-6 HOURS	1 HOUR

Table 2. *Comparison of the relative benefits of integral vs. external cavity klystrons.*

relative benefits of integral vs. external cavity klystrons. Any decision on selecting UHF-TV transmitting equipment must include a study of the short- and long-term costs of each option. This makes the product evaluation process more important than ever before for engineering managers. A mistake in product evaluation can directly affect station profitability.

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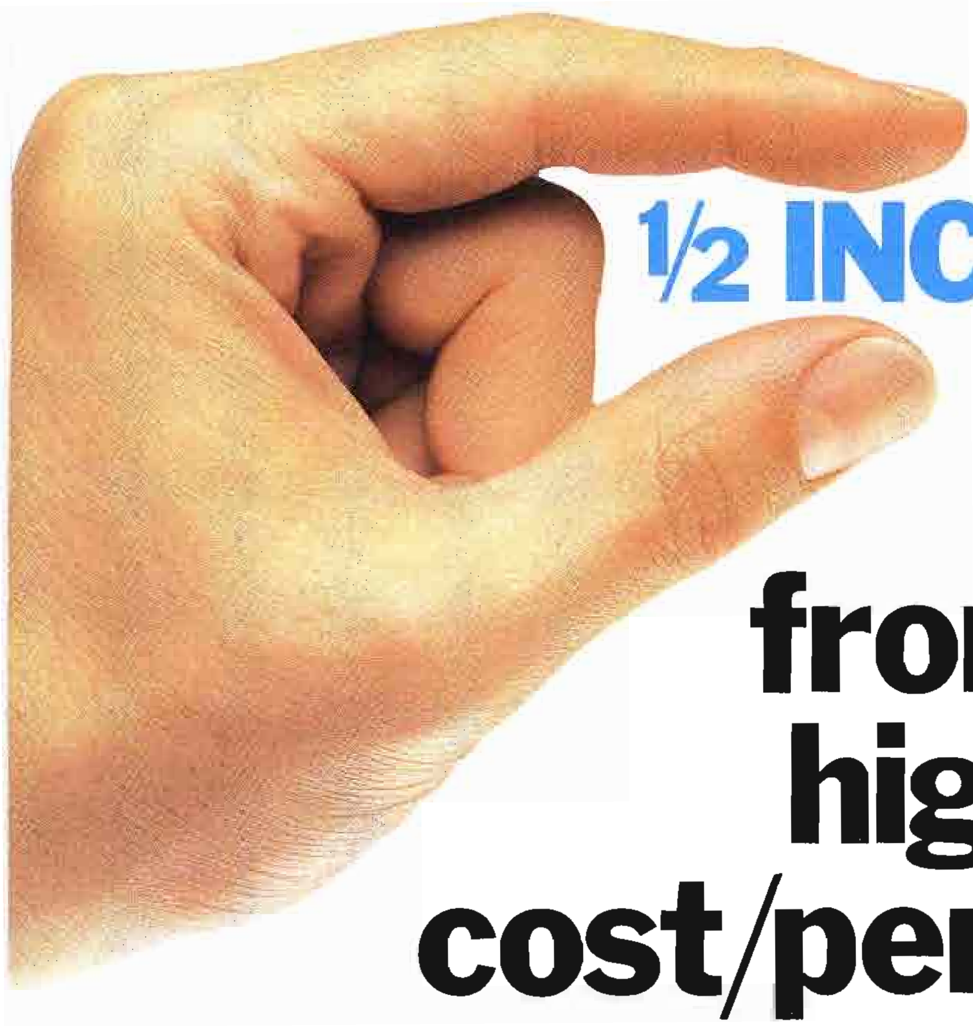

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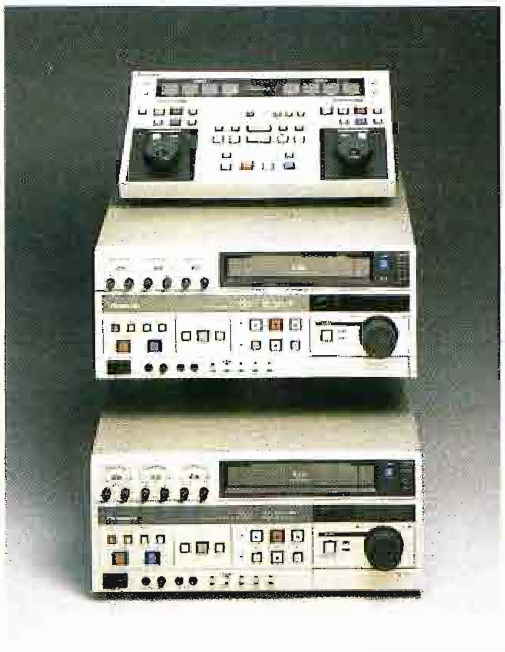

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*Based on a comparison of Panasonic edit machines.

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In the chips

By Terry Pennington and Larry Winter

The operational amplifier is the keystone of modern broadcast equipment.

Consider how important the operational amplifier is to broadcast equipment. The operational amplifier, or op-amp, is used in almost every broadcast device manufactured today. Just think how large and complex equipment would be if each op-amp had to be constructed with discrete components. Although op-amp actually refers to a type of circuit, the term often is used to describe a particular type of device.

In the 1940s and '50s, tubes and transistors were used to produce operational amplifiers. The design was unique and not well-understood by many engineers. It was not until 1965 that Fairchild introduced the μA 709 operational amplifier. It became an immediate success. Engineers who had never given any thought to using operational amplifiers found the small 8-pin TO-5 devices almost irresistible. By the early 1970s, the op-amp had become a common device in broadcast equipment.

Despite their many advantages, you can run into trouble using op-amps. Because gain is so plentiful in op-amp-based equipment, engineers sometimes find it easy to misadjust (mismatch) equipment. The result is that the total system performance is reduced. To better understand how this can happen, we will review some basic op-amp theory.

Operational amplifiers can be constructed with discrete devices: transistors, resistors and capacitors. However, to do so negates many of the advantages of IC-based op-amps. IC technology has developed to the point at which several op-amps often are contained within a single IC chip.

The basic op-amp, shown in Figure 1, contains five terminals: two input terminals, one output terminal and two power-supply terminals. For simplicity's sake, this article will not discuss the power-supply terminals.

The internal circuit for a typical op-amp is shown in Figure 2. A thorough understanding of the math that is used to describe the internal operation of these amplifiers is not necessary for this discussion. We will consider only the math needed to describe the op-amp's basic operation.

The ideal op-amp is a differential amplifier at the input with a single-ended output and a large differential voltage gain. The device has four criteria:

- infinite gain (open loop);
- infinite input impedance (open loop);
- infinite bandwidth; and
- zero output impedance.

Although it's impossible to meet all these criteria, today's IC op-amp comes surprisingly close. Figure 3 illustrates several op-amp configurations. The circuits shown are not practical ones, but will serve for illustration.

Inverting op-amp

The inverting op-amp circuit is shown in Figure 3c. The input signal is connected to the inverting input through resistor Ri. The non-inverting input is grounded. Feedback resistor Rf connects the output back to the inverting input. Let V represent the voltage between the inverting input and ground. With this configuration, the following equation can be written:

$$\frac{V_{in} - V}{Ri} = \frac{V - V_{out}}{Rf}$$

However, because the input impedance is (ideally) infinite, no input current flows into the op-amp and $I_{Ri} = I_{Rf}$. The equation becomes:

$$\frac{V_{out}}{V_{io}} = \frac{-Rf}{Ri} = A_c \text{ (the closed-loop gain)}$$

The negative sign indicates that the output signal will be 180° out of phase with the input signal. The *open-loop* gain (see Figure 3a) can be represented by A_o, and is assumed to be infinite. The input

Pennington is director of technical marketing and development, and Winter is vice president of marketing for the Rane Corporation, Mountlake Terrace, WA.

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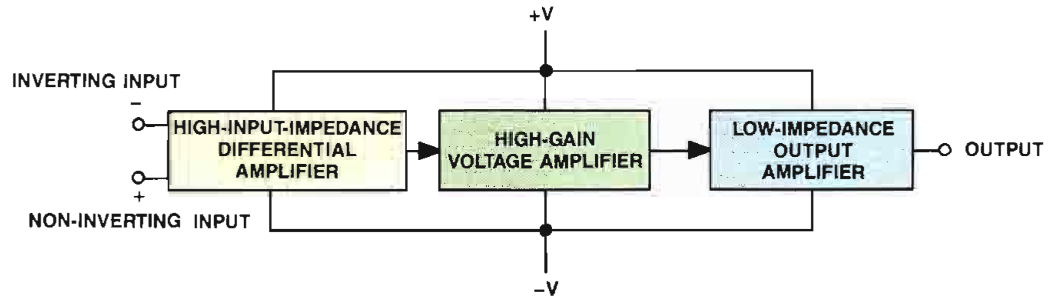

Figure 1. *Block diagram of an op-amp.*

impedance of Figure 3c will equal the input voltage divided by the input current:

$$R_{in} = \frac{V_{in}}{\dfrac{V_{in} - V}{Ri}}$$

Because voltage V is approximately zero, the equation can be reduced to:

$$R_{in} = Ri$$

Non-inverting op-amp

The operational amplifier also can be connected in a non-inverting configuration, as shown in Figure 3d. Here the negative terminal is shown grounded through Ri. If the voltage between two input terminals is negligible, the voltage across Ri should be equal to V_{in}. If no current (ideally) is drawn by the inverting input, the currents through both Rf and Ri are equal:

$$\frac{V_{out} - V_{in}}{Rf} = \frac{V_{in}}{Ri}$$

The closed-loop gain can be calculated by rearranging the equation to:

$$A_c = \frac{V_{out}}{V_{in}} = 1 + \frac{Rf}{Ri}$$

Thus, the gain is determined by the two resistors, Ri and Rf, and the output is not inverted.

In actual practice, some finite value of input resistance exists within the op-amp. Manufacturers usually specify this as the open-loop resistance Z_{in}. In the feedback mode, this impedance is multiplied by the ratio of A_o to A_c, allowing the closed-loop impedance of the non-inverting input to be calculated by:

$$R_{in} = Z_{in}\frac{A_o}{A_c} = \frac{Z_{in}\,G_o}{1 + (Rf \div Ri)}$$

Operating parameters

For audio equipment, four op-amp operating parameters often are mentioned as being important to the equipment's final performance: common-mode rejection ratio (CMRR), slew rate, noise and drive-current capability. Although these characteristics alone will not guarantee superior performance, they are important considerations.

Common-mode rejection ratio

Years ago, discrete devices were used to construct differential amplifiers for laboratory and measuring instruments. These measuring devices often were required to amplify extremely small signals in environments with large amounts of extraneous signals. This is the same type of problem faced by console and other broadcast equipment manufacturers.

The basic op-amp design allows the difference amplifier technology to cancel any signal appearing identical to both inputs. In other words, if the same voltage is applied to both the non-inverting and inverting inputs, the resultant output

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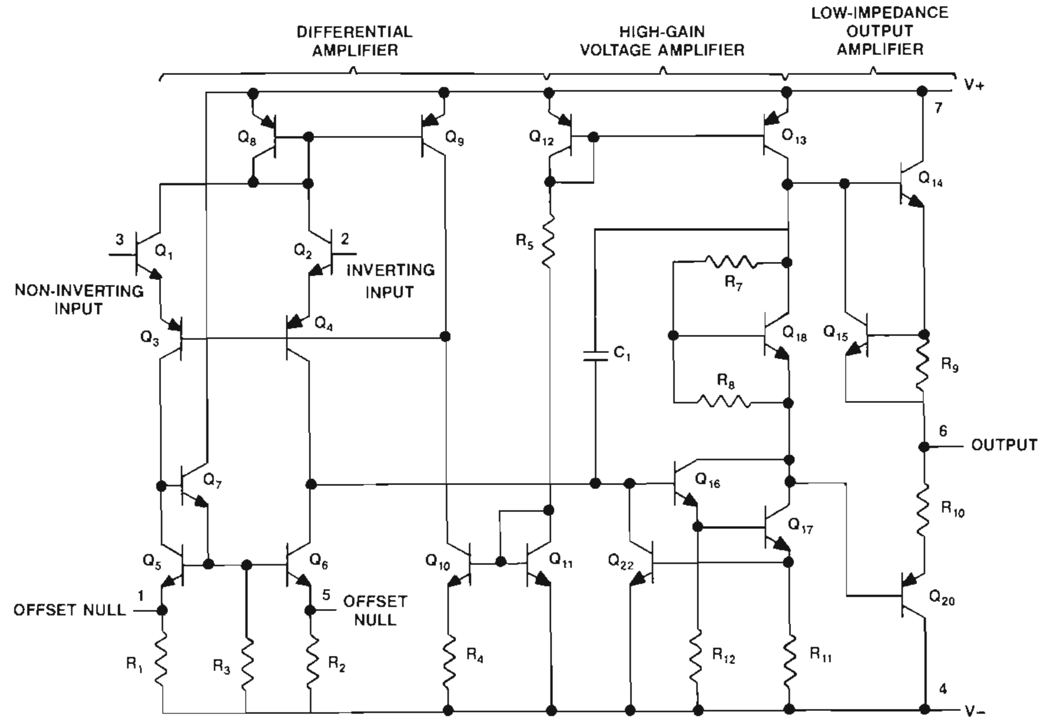

Figure 2. *Typical op-amp circuit diagram.*

voltage will be zero.

Only a difference of potential at the inputs will produce an output voltage. For instance, a 1,000Hz signal is applied to the inverting input of the op-amp shown in Figure 4. The same frequency signal is applied to the non-inverting input, but is 180° out of phase, representing the differential signal. The configuration is typical to many audio devices.

In addition to the 1,000Hz signal, a 60Hz hum is induced on the cable connecting the signal to the op-amp. Because the hum is induced on the cables (both input wires) in phase, the 60Hz signal arrives at both op-amp terminals as a common-mode signal.

The differential amplifier tends to reject the 60Hz common-mode signal while trying to amplify the differential 1,000Hz signal. The op-amp's capability to perform the rejection is called *common-mode rejection ratio* (CMRR). The ratio can be expressed by:

$$\text{CMRR} = \frac{A_D}{A_{cm}}$$

Where A_D = differential gain and A_{cm} = common-mode gain

CMRR is expressed in decibels. Circuit performance seldom matches the actual performance capability of the op-amp. The decrease often is caused by low-precision resistors in the circuit's input stage. Optimum design requires the use of 1% precision or better resistors.

Slew rate

Ideally, an op-amp provides some desired gain without adding anything to or subtracting from the signal. One parameter, slew rate, affects the op-amp's capability to handle rapidly changing (high-frequency) signals. If the op-amp response time is too slow for higher frequencies, the output lags, or slews, and distortion are produced. Examples of

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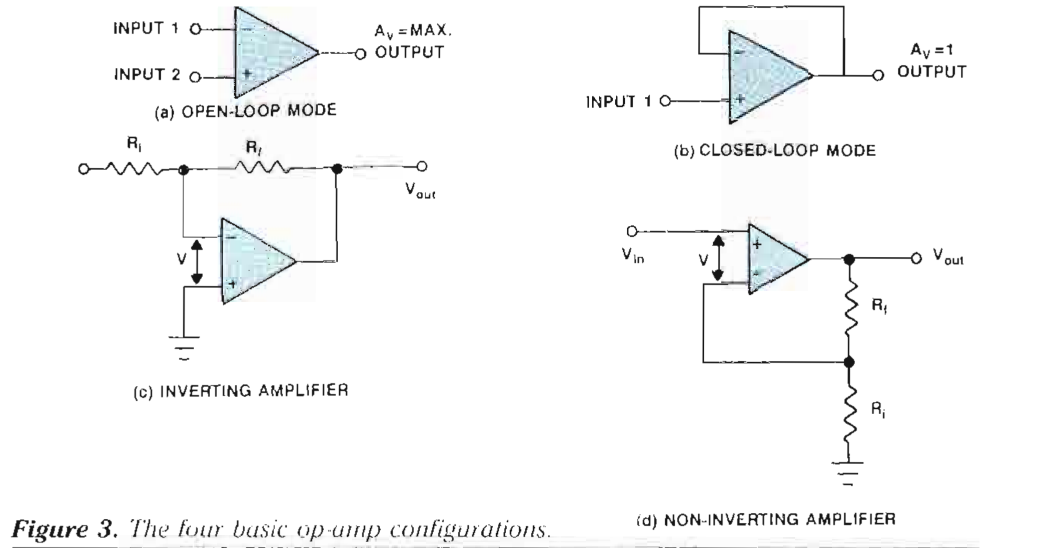

Figure 3. *The four basic op-amp configurations.*

slew distortion on a waveform are shown in Figure 5.

For high-frequency circuits, such as tape-machine bias oscillators, an op-amp slew rate (expressed in volts per microsecond) must be higher than required for conventional audio applications.

Because of the considerable controversy about slew rate and transient distortion, the question becomes: *How fast is fast enough for high-quality audio applications?* Theoretically, an op-amp needs only to be fast enough to reproduce 20kHz at +20dBu, which requires approximately 1.4V/μs. In practice, it turns out that two to five times that amount, or 3V to 8V per microsecond, is necessary to guarantee inaudible distortion levels.

An op-amp with an excessively high slew rate may become unstable at high frequencies. High-frequency oscillations may be triggered by many factors, including cable capacitance, temperature changes or line-voltage variations.

Although the oscillation itself may not be heard, its effect on overall distortion, op-amp heating and component failure can be an ongoing nightmare that is difficult to trace. Also, because the equipment's overall slew rate may be limited by internal coupling capacitance, substituting a high-speed op-amp may not improve the equipment's performance.

It is important to maintain a realistic perspective and to keep in mind that a broadcast studio or system is comprised of many pieces of gear connected together. The system will perform only as fast as the slowest component. It makes little sense to spend large sums of money on a superfast microphone input stage if the summing bus or tape deck amplifiers can't possibly keep up.

Op-amp noise

Internal op-amp noise is produced by the device's components, bias current and drift. The op-amp amplifies noise, just as it amplifies offset voltages and signal voltages.

The op-amp's internal noise can be minimized if series input resistors and the feedback resistor are kept as low in value as the circuit design will allow. Bypassing the feedback resistor with a small capacitor also can reduce the noise gain at high frequencies.

When designing the input stage of a high-quality audio device, care must be taken to use low-noise devices. The overall gain structure also must be carefully designed in order to keep the final output noise to a minimum. One basic rule is to take as much gain as possible at the microphone input stage. If excessive gain is taken after this stage, even the best ICs will not be able to overcome the built-up noise.

If you want to improve the performance of a piece of equipment, simply replacing old ICs with new high-performance and more expensive ICs may not help. A better approach is to restructure the gain stages by using low-noise resistors instead of less expensive (and more noisy) carbon resistors.

Similarly, consoles with true input pads are likely to yield lower noise figures than those with separate, variable-gain trim stages. Restructuring the gain stages requires that the unprotected input stage have lower gain, to prevent possible input overload that cannot be alleviated by reducing the trim. A true input pad network, using high-precision resistors, allows maximum gain right at the input stage. This also helps preserve the necessary headroom to prevent overload.

Noise specifications for op-amps are somewhat tricky to interpret. Technically, the noise rating of an IC is expressed in nanovolts per root hertz. To determine how much noise the op-amp will produce in a circuit, multiply the nanovolt value by the circuit's gain. Then, multiply the result by the square root of the bandwidth, which is usually 20kHz for audio applications.

Some newer devices have become available that merit close consideration when superior noise performance is required. National Semiconductor's LM833, NEC's 4570/4574 series and Solid State Micro Technology's 2134 all are capable of providing extremely quiet operation.

Insufficient drive current

Another cause of op-amp distortion is lack of drive current. If the op-amp cannot supply enough drive current into the receiving circuit, it can clip or switch into a protective current-limiting mode. If this happens, high distortion levels will be produced. The need to supply large output currents has been met by new-generation op-amps such as the NE5532 and SSM2134. These op-amps are highly valued as output driver chips because they can supply the high currents required to drive multiple devices, low-impedance (600Ω) loads or long cable lengths at high signal levels. Despite the advantages of such devices, retrofitting them into older equipment can pose problems, which will be discussed in this article.

Gain control

As stated previously, the op-amp is capable of providing tremendous gain. The maximum amount of gain is referred to in the specifications as *open-loop gain* (see Figure 6). This is the gain provided by the device without feedback. Today's op-amps are capable of open-loop gain figures of 100,000 or more, which is far too much for most audio applications.

Applying the appropriate amount of feedback is the way an op-amp's gain usually is controlled. The more output signal routed back to the input, the lower the actual gain and the wider the frequency response. This is referred to as *negative feedback*. One advantage of using large amounts of negative feedback is that, usually, it reduces distortion.

Adding capacitors in parallel or series with the feedback resistor will affect the amount of feedback. As the reactance of the capacitor changes with frequency, so will the feedback voltage. This frequency-dependent gain is used in filters and equalizer circuits. Capacitors also are used to reduce the high-frequency gain of the op-amp to prevent it from oscillating.

Component selection

Because most op-amps obey the rules in a similar manner, what are the differences between the various models and types available? Almost all differences can be attributed to either noise or distortion characteristics. One op-amp may be fast—capable of reproducing high frequencies with low distortion—and yet exhibit noise that becomes a problem in audio circuits.

Because there is no single best op-amp for all applications, you must first determine the purpose of each specific circuit. Only then is it possible to prioritize important specifications in order to choose the correct op-amp for the job.

When replacing pin-compatible op-amps, be prepared for some possible surprises. Some ICs might oscillate unless additional power-supply bypass capacitors are installed. It's nearly impossible,

Continued on page 80

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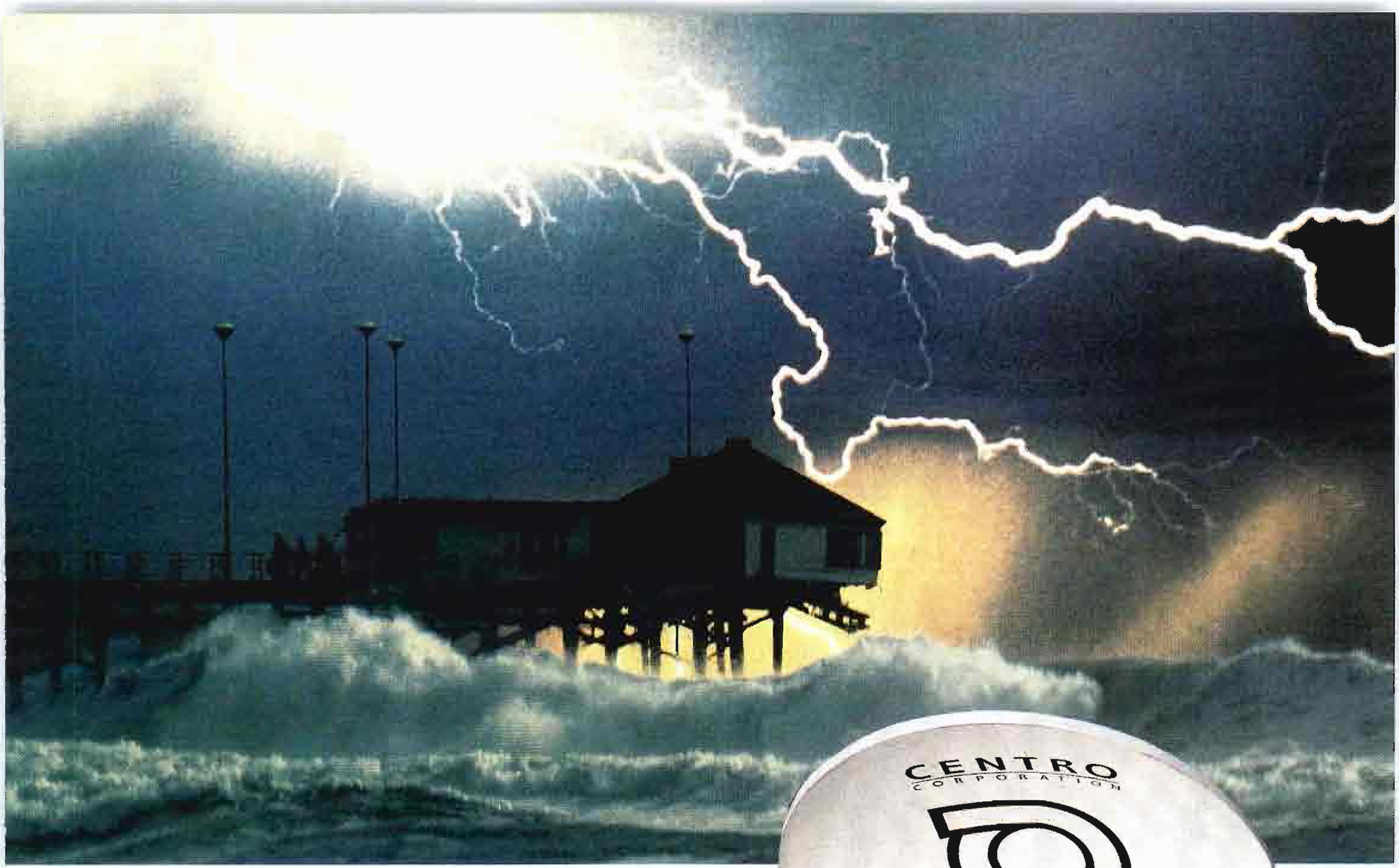

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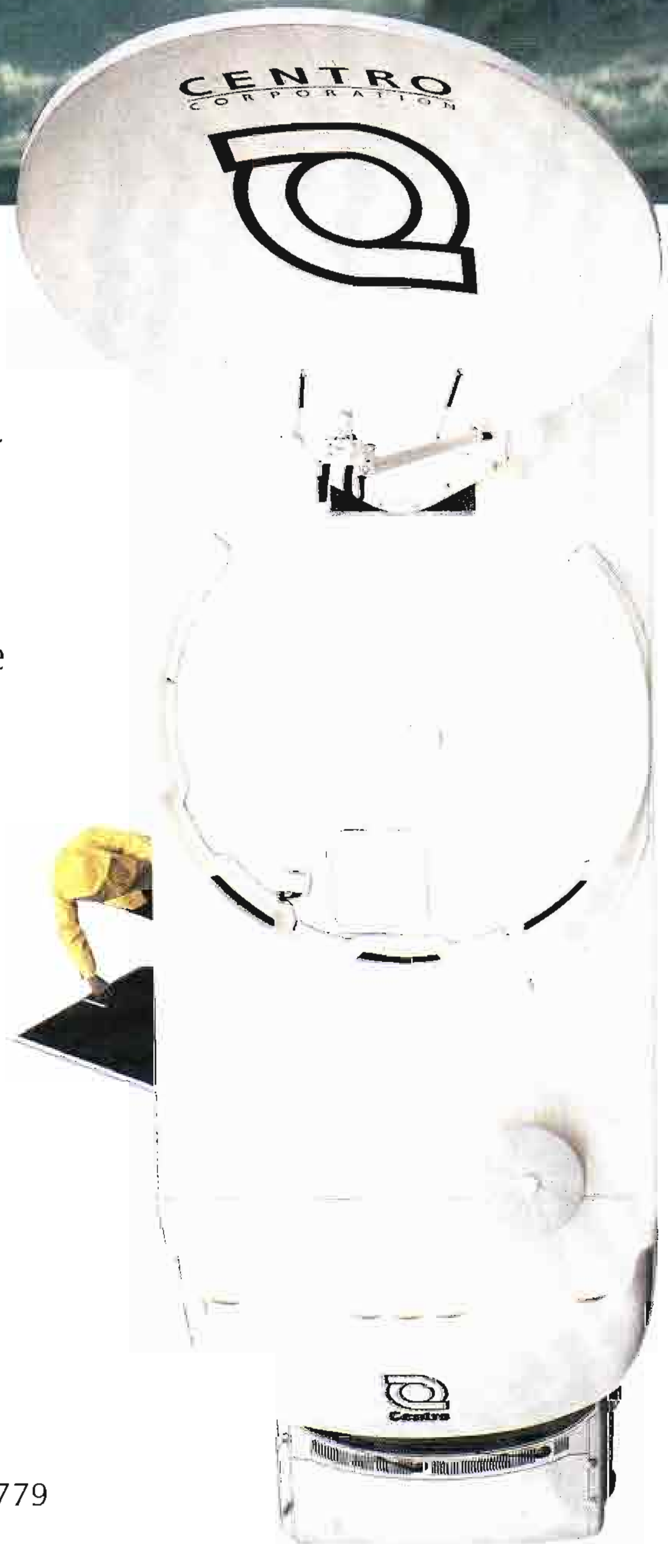

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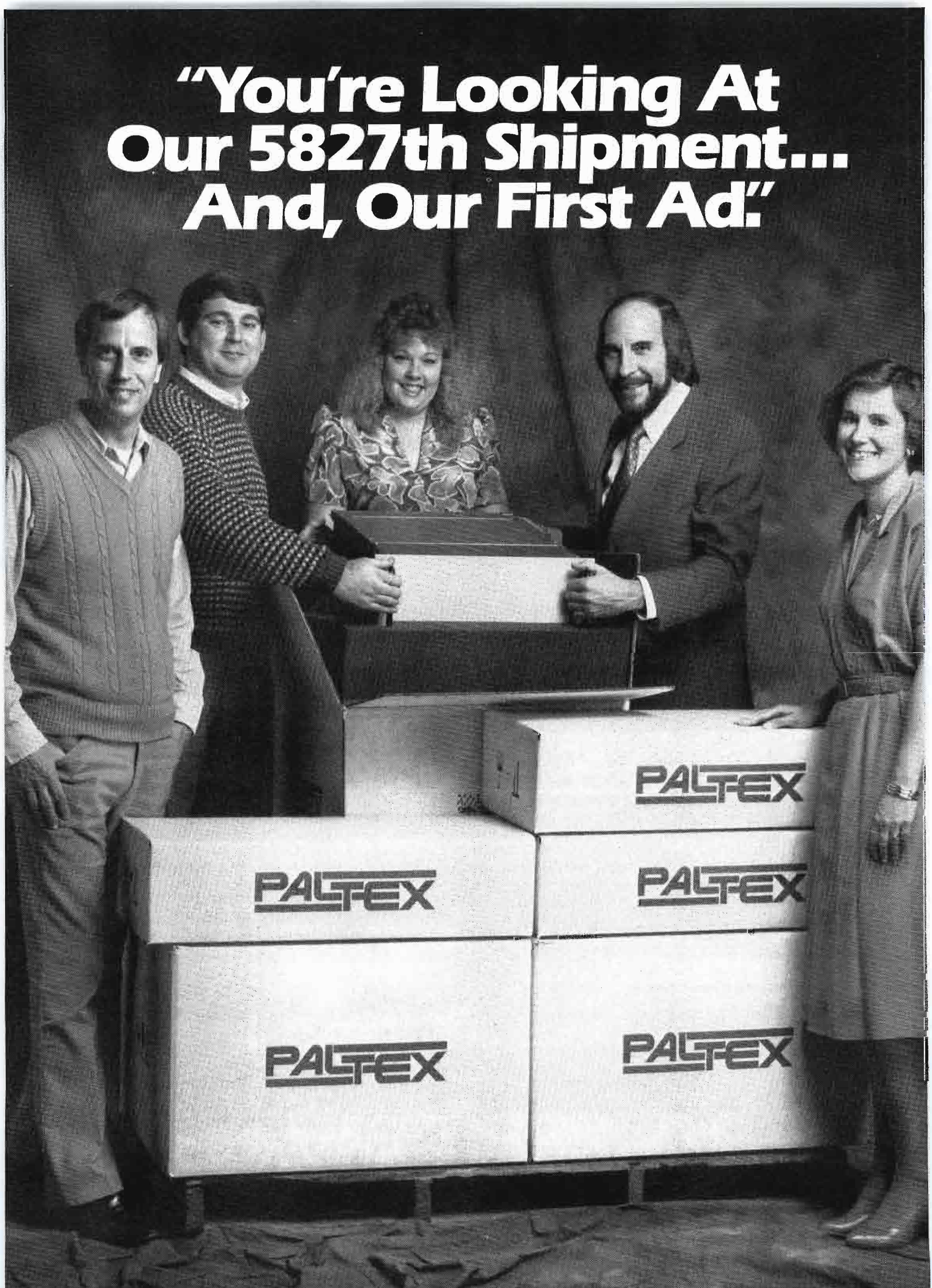

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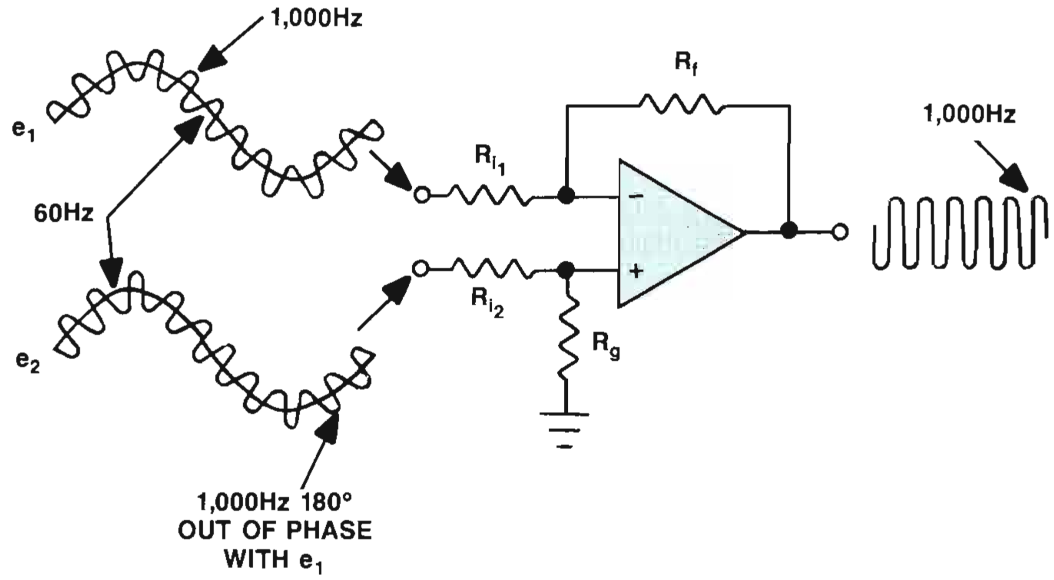


Figure 4. *The common-mode rejection provided by a differential amplifier prevents common-mode signals from being amplified. This feature often is used in low-level audio stages.*

Continued from page 76
however, to predict what might happen. Also, some op-amps cannot be operated at unity gain, so carefully heed the comments in the tables. Be sure you understand the circuit requirements at each IC location before attempting to use high-performance replacements.

Although using some of the new high-current devices might seem to be a good idea, be cautious. Because these high-current line drivers require a lot of power, updating a mixing console with a number of these chips can place an excessive drain on the console's power supply. Furthermore, these line drivers produce much more heat and need proper cooling to maintain reliability and long life.

Check with the equipment's manufacturer before performing any modifications. Although it may appear simple enough just to plug in new chips, there may be other important factors to consider.

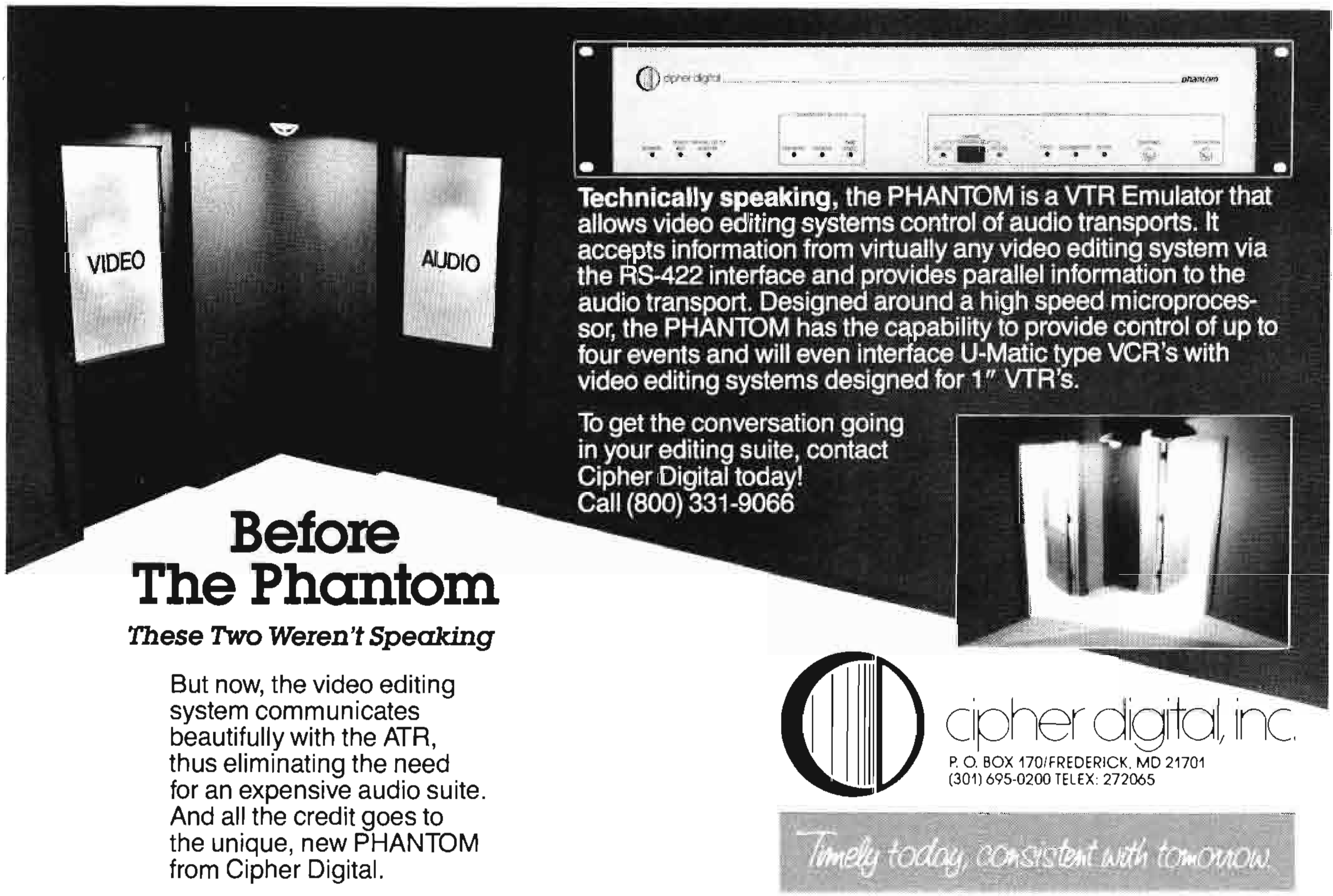
If you are evaluating new equipment, or are considering upgrading your present equipment with improved op-amps, the devices listed in Tables 1, 2 and 3 will help you. With the information, you can compare performance and compatibility to your intended use.

System interface

A few words of advice are appropriate concerning noise and equipment matching. Whether you operate a radio or TV station, several pieces of equipment will be connected in series. Each device may contain the latest op-amps and boast impressive noise specifications, but still you can wind up with excessive noise. Why?

Engineers often label noise problems as mismatched impedances when they actually are caused by gain mismatch. Excessive gain often is added downstream in a system because of improper level-control settings.

Thanks to the op-amp, you seldom have to worry about impedance matching of equipment. Most equipment can drive 600Ω-or-higher impedance loads without difficulty. And, most input stages



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These two new Audio-Technica studio condenser microphones represent a small revolution in shotgun design…inside and out. Meet the Model AT4071 (just 15½" long) and the AT4073 (a mere 9"). They may look like other shotguns (although somewhat shorter than most), but the resemblance stops as soon as you plug them in.

New Coaxial Tube Design

First, both 40-Series microphones perform far "longer" than their actual size. In effect, the ingenious coaxial interference tubes perform as though the microphones were half again as long. Our unique tube design goes far beyond the normal phase cancellation that occurs in a simple resistance-damped tube. There is actually a tube-within-a-tube, creating a separate, acoustically longer path for the lowest frequencies. Low frequency directivity (normally a simple function of tube length) is maintained, yet the microphone size is reduced to a far more practical length.

The Result: Far More Versatile

This shorter length for a given acceptance angle is a practical benefit in the studio and the field. It's easier to avoid shadows and to stay well out of the frame. Cancellation from the back is also impressive, making exact mike placement less critical. And their very light weight (far less than the others) will be appreciated by every user.

As a bonus, the nested internal construction makes the 40-Series shotguns unusually resistant to accidental damage.

Clean Transformerless Output

Listen carefully to the 40-Series sound. The transformerless output insures fast, distortion-free response to transients. You'll hear crisp, natural dynamics over an extended frequency range, even under high SPL conditions. Output is extremely high, making the 40-Series hotter than any other shotgun available. A built-in high-pass filter is included, of course.

Quiet in Every Way

The low noise of these new microphones is impressive. Self-noise is almost immeasurable at about 12dB for the AT4071, and just 14dB for the shorter AT4073. Equally important, the rejection of wind and handling noise is outstanding. Coupled with excellent sensitivity, the 40-Series design allows you to take full advantage of the finest digital and analog studio electronics.

Compatible and Competitively Priced

Finally, both can be powered from any 12-48V phantom power supply. They come complete with foam windscreen, stand clamp, and case. Yet, with all their advances and performance superiorities, the new A-T 40-Series microphones are priced competitively with the best known shotguns.

The significant performance advances of these new 40-Series microphones demand a trial in your most difficult environment. Heft them. Hear them. Compare them in every way. This bold new technology has raised the standards for shotgun performance!

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*Model AT4071 compared with Sennheiser MKH816P48-U. For complete shotgun comparison, call or write.

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TYPE	MFGR	ABS MAX[1] SUPPLIES	NOISE[2] ($nV/\sqrt{Hz}$)	SLEW (V/µs)	STABLE[3] GAIN	CURRENT[4] TYP/MAX	MIN[5] LOAD	COMMENTS
741	NSC	±18V	25.0	0.5	All	1.7/2.8	2kΩ	Reference only; do not use.
LF356	NSC	±18V	12.0	12.0	All	5.0/10	2kΩ	Drives 10,000pF. Large current drain. Generally too noisy.
5534	SIG	±22V	3.5	6.0	22pF	4.0/8.0	600Ω	Audio reference standard. Large current drain. Poor supply ripple rejection.
OP27	PMI	±22V	3.2	2.8	All	3.3/5.7	2kΩ	Poor cost/performance ratio.
OP37	PMI	±22V	3.2	17.0	5.0	3.3/5.7	2kΩ	De-compensated OP27.
MA362	AS	±26V	2.5	17.0	All	2.8/4.5	600Ω	THD = 1PPM. Very expensive. Performance increases generally not worth the cost.
2134	SSM	±22V	2.8	7.0	22pF	4.0/6.5	600Ω	Best cost/performance ratio.
1028	LTC	±22V	0.9	15.0	All	7.6/10.5	600Ω	Lowest noise. Expensive. Very large current drain. May require additional compensation.

[1]Values exceeding absolute maximum power supply ratings may destroy the chip.
[2]Spot noise at 1kHz. Multiply by 141.4 ($\sqrt{20kHz}$) to calculate equivalent input noise (EIN).
[3]Fully compensated op-amps are unity-gain stable and marked "all"; de-compensated op-amps are unconditionally stable only when used in circuits with gains equal to, or greater than, that shown; un-compensated op-amps require capacitance indicated to be unity-gain stable.
[4]Total power-supply current in milliamps (mA).
[5]Minimum load resistance (ohms) for +20dBu output swing at rated slew rate and THD. Op-amp will drive all loads greater than, or equal to, this value (load capacitance<100pF). Op-amp will drive lower loads at reduced output swing, slew rate and THD. Typically, all op-amps will drive 600Ω to +19dBu at one-half slew rate, with THD <0.1%.

Author's Note: The data presented in Tables 1, 2 and 3 was compiled by Dennis Bohn, vice president of research and development at Rane Corporation.

Table 1. *Cross-references to single op-amps. All specifications are for an 8-lead DIP package, at commercial temperature range.*

TYPE	MFGR	ABS MAX[1] SUPPLIES	NOISE[2] ($nV/\sqrt{Hz}$)	SLEW (V/µs)	STABLE[3] GAIN	CURRENT[4] TYP/MAX	MIN[5] LOAD	COMMENTS
4558	RAY	±18V	25.0	0.8	All	3.3/5.7	2kΩ	Reference only; do not use.
LF353	NSC	±18V	16.0	13.0	All	3.6/6.5	2kΩ	Very stable. Generally too noisy.
TL072	TI	±18V	18.0	13.0	All	2.8/5.0	2kΩ	Generally too noisy.
5532	SIG	±22V	5.0	9.0	All	8.0/16	600Ω	Audio reference standard. Large current drain. Poor supply ripple rejection.
OP227	PMI	±22V	3.2	2.8	All	3.3/5.7	2kΩ	Low current drain. Poor cost/performance ratio.
5102	HAR	±20V	4.3	3.0	All	3.0/5.0	2kΩ	Maximum differential input voltage only ±7V makes part unusable in many applications.
5112	HAR	±20V	4.3	20.0	6.0	3.0/50.	2kΩ	De-compensated 5102.
LM833	NSC	±18V	4.5	7.0	All	5.0/8.0	2kΩ	Excellent cost/performance ratio. Some applications may require local decoupling.
4570	NEC	±18V	4.5	7.0	All	5.0/8.0	2kΩ	Second source for LM833. Very
2043	RAY	±18V	3.5	6.0	All	6.0/8.0	600Ω	Medium cost/performance ratio.
5535	SIG	±18V	30.0	15.0	All	7.2/11	2kΩ	Very fast, but too noisy for most circuits.

See Table 1 for relevant footnotes.

Table 2. *Cross-references to dual op-amps. All specifications are for an 8-lead DIP package, at commercial temperature range.*

consist of 100kΩ-or-higher impedances anyway. Today, it is not necessary to match the input impedance of another device. You should, however, be concerned with minimum impedance of the devices.

A signal output line loaded with too low an impedance can exhibit loss of headroom or frequency-response degradation. This is because lower impedances require more drive current from the op-amp. As discussed previously, this can

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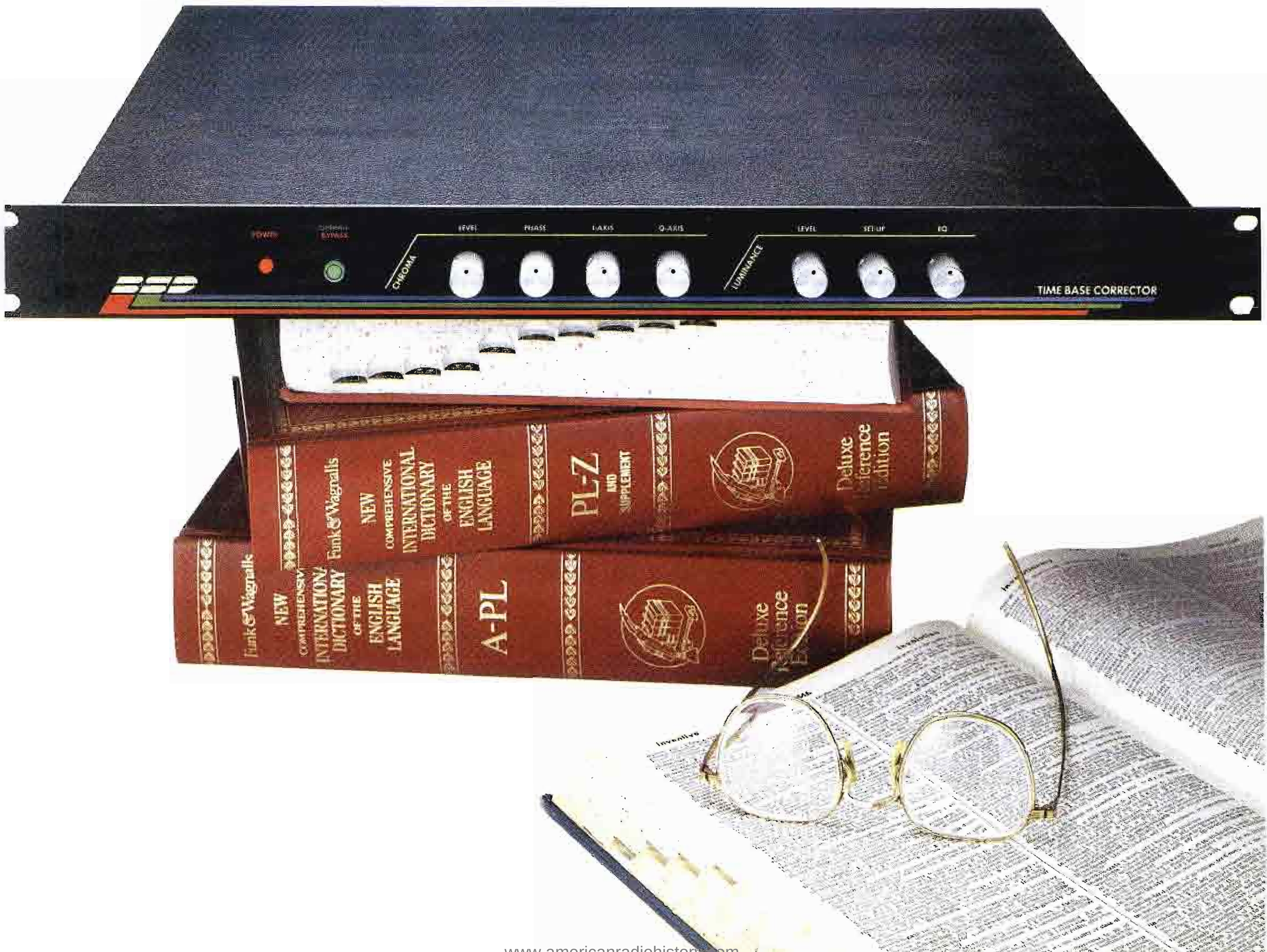

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Capabilities such as "After-the-fact" white balance, U-Matic, VHS and SVHS dub inputs and outputs, and pixel by pixel dropout compensation.

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- Unique dub feature, compatible with Y/688, Y/629 and Y/C (Super VHS) formats
- Expanded bandwidth resulting from an increased sampling rate delivers superior resolution
- Digital pixel by pixel dropout compensation
- Horizontal detail enhancement
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Quantizing	8 Bits
Differential Phase	1.5°
Differential Gain	1.5%
K Factor	1%
Residual Error	±10nSec Y ± 2nSec C

GENERAL

Inputs	Video	1Vpp Direct NTSC
	Dub	Y/C, Y/688, Y/629
	Genlock	4Vpp Comp Sync 2Vpp Subcarrier
	D.O.C.	1Vpp RF or TTL
Outputs	Video	1Vpp Comp Video
	Dub	Y/C, Y/688, Y/629
	Adv Sy	4Vpp Advanced Comp Sync
	VTR S/C	2Vpp Jittered 3.58MHz

USER CONTROLS

Chroma Level	±3dB
Chroma Phase	±30°
Chroma I Axis	±3dB
Chroma Q Axis	±3dB
Luminance Level	±3dB
Luminance Setup	±10 IRE
Luminance Eq	0dB to +6dB @ 2.6 MHz

MECHANICAL

Depth	12.8″	32.8cm
Width	19.0″	48.3cm
Height	1.75″	4.5cm
Weight	12 lbs.	5.0Kg

ELECTRICAL

Voltage	95–135 VAC
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Power	30 VA

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TYPE	MFGR	ABS MAX[1] SUPPLIES	NOISE[2]	SLEW	STABLE[3] GAIN	CURRENT[4] TYP/MAX	MIN[5] LOAD	COMMENTS
LM324	NSC	±16V	35	0.4	All	1.5/3.0	2k	Reference only, do not use.
TL074	TI	±18V	18	13	All	5.6/10	2k	Reference only. Generally too noisy.
5104	HAR	±20V	4.3	3	All	5.0/6.5	2k	Maximum differential input voltage only ±7V makes part unusable in many applications.
5114	HAR	±20V	4.3	20	6	5.0/6.5	2k	De-compensated 5104.
4156	RAY	±20V	9	1.6	All	5.0/7.0	2k	Most cost-effective noise upgrade part.
4741	NEC	±20V	9	1.6	All	5.0/7.0	2k	Second source for RC4156 (also by Harris).
MA374	ANA. SYS.	±24V	8	15	All	6.8/10	2k	Poor cost/performance ratio.
LM837	NSC	±18V	4.5	10	All	10/15	600	True quad 5532. Some applications may require local supply decoupling. Large current drain.
4574	NEC	±18V	5	6	All	8.5/12	2k	Quad 4570. Excellent cost/performance ratio. Large current drain.
OP470	PMI	±18V	3.2	2	All	9/11	2k	Quad OP27. Quietest quad. Large current drain. Medium cost/performance ratio.

See Table 1 for relevant footnotes.

Table 3. *Cross-references to quad op-amps. All specifications are for a 14-lead DIP package, at commercial temperature range.*

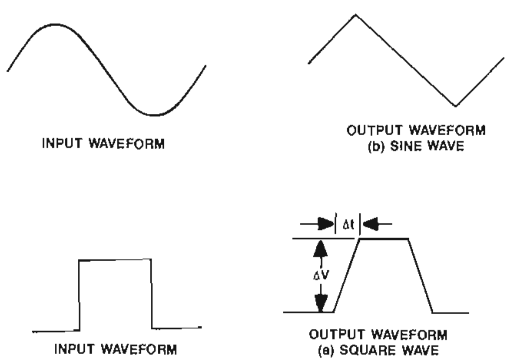

Figure 5. *Slew-rate distortion results in changes in the signal waveform.*

produce excessive distortion, premature clipping or protection circuit current-limiting. Noise problems, on the other hand, usually are caused by poor gain management somewhere in the audio system.

Aside from making sure that all the equipment is operating at the same nominal line level (−10dB or +4dBu), apply basic rules to optimum noise management in broadcast systems: Take as much gain as possible at the beginning of the signal path. Keep the signal level as high as possible in each unit, and avoid adding gain toward the end of the signal path. Keep the audio console levels as high as headroom will allow, from microphone stages to sub-bus stages to the output stages.

If you install a parametric equalizer into a channel-insert loop, keep the EQ gain at unity. Turning up the EQ gain will cause noise problems, due to additional gain taken at the mixer summing nodes. If you use a compressor/limiter for a concert or a mixdown, keep the output levels at maximum line level. Compressing the signal down and then bringing it back up with equalizer, crossover or tape-amp gain can result in excessive noise.

Try to keep equalizer, crossover and signal-processor level controls at unity-gain settings. Maintain the highest possible signal level all the way through the system, attenuating it only at the tape machine or exciter inputs as necessary.

Check each piece of signal-processing gear to find out whether it has input level controls, output level controls or both. Set the control(s) to maintain the highest signal level possible within each unit. If you're having noise problems, chances are you've attenuated the signal level somewhere along the line and turned up the gain someplace else downstream. This is gain mismatching.

Check every unit in the system. Avoid setting line-level controls above unity gain if at all possible. This way, you will ensure the kind of performance that is expected and possible from today's state-of-the-art equipment.

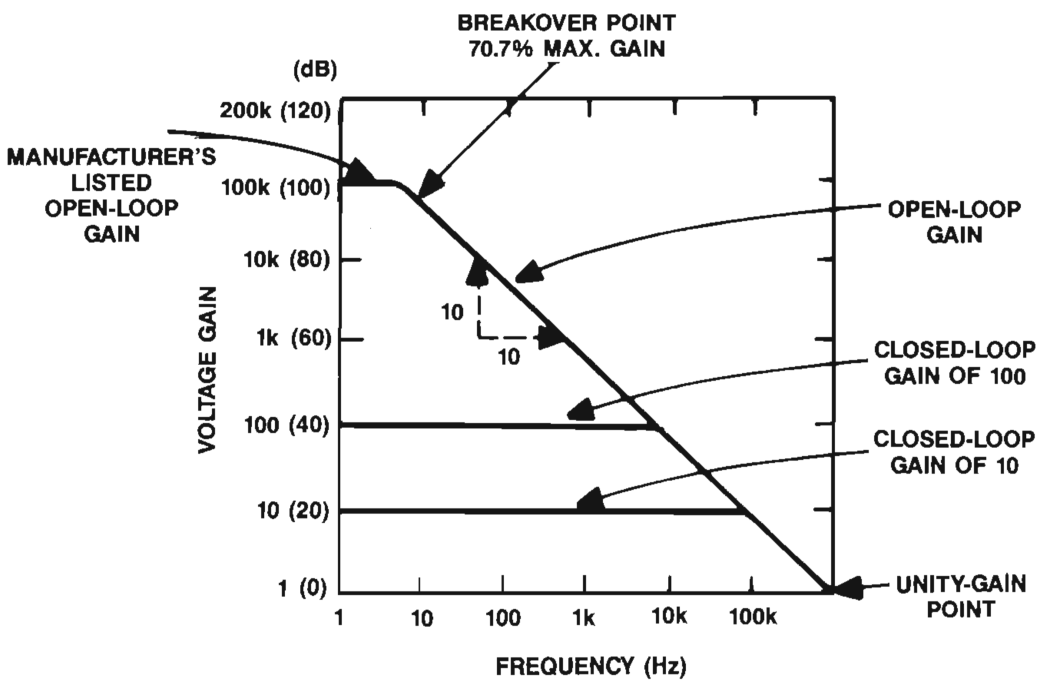

Figure 6. *Typical manufacturer's op-amp specification of gain vs. frequency.*

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Researching the future

By Jerry Whitaker, editorial director

Applied research for the broadcast industry is critical to its long-term survival.

It started about two years ago. It was the subject of much debate and concern. It led to predictions that the broadcast industry was about to go down the tubes. What was it? Oh, come on, you remember. The elimination (or so it seemed) of the broadcast industry's only two developmental laboratories dedicated to radio and TV technology.

The RCA Sarnoff Labs (Princeton, NJ) was the first to fall, with GE donating the lab to the Stanford Research Institute. That announcement was closely followed by the shutdown of the CBS Labs (Stamford, CT). These two institutions symbolized the commitment of the broadcast industry to its future. The labs were instrumental in numerous key developments. From color television to ENG, these organizations shaped broadcasting as we know it today.

Then there was the sentimental attachment. The apparent departure from the broadcast scene of the RCA Labs was many engineers' last connection with the grandfather of all broadcast equipment companies, RCA. More stations were put on the air—from microphone or camera to antenna—by RCA than by any other company. CBS Labs also goes back a long way. Most engineers' first experience with CBS Labs came in the form of a couple of 3½-inch-high beige packages called the Audimax and Volumax.

Despite the disturbing news of 1986 (the year of the corporate takeover), stations have not gone dark, broadcasting is still profitable and the future looks bright. Fortunately for this industry, the shakeouts at RCA (NBC) and CBS were more cosmetic than anything else. Development still goes on at those organizations and elsewhere, but with a different mindset.

Broadcast research

The broadcast industry is our home. It is our livelihood. It is motherhood and apple pie. But, I've got to tell you that in the world of research, it's small potatoes.

Still, the pace of research and development in broadcasting today is staggering. More new products are being introduced each year, and those new products are more sophisticated than ever before. The primary motivation for this development, however, is not the broadcast industry, but consumer and other commercial applications.

Spin-off technology from the computer industry has given radio and TV stations a whole new class of products at an affordable price. High-volume production from consumer markets has funded development from which broadcasting has benefited, but couldn't begin to support on its own. The need for solid-state controllers for smoke-stack industries has provided broadcasters with high-power transistors and MOSFETS.

Do you think that the volume of products in the broadcast industry could pay for development of an 80386 microprocessor chip? No way.

We could not go it alone. And, fortunately, we don't have to. There is plenty of research going on. And broadcast equipment manufacturers are scrambling just to keep up with it.

It was in this environment that NBC/RCA/GE and CBS decided that having dedicated development labs of their own just didn't make economic or technical sense.

To get an update on how the two networks involved, and the one that wasn't, view those decisions now with the benefit of hindsight, I spoke with the engineering chiefs of NBC, CBS and ABC. As you will see, this topic is one of the few on which all three essentially agree.

Continued on page 88

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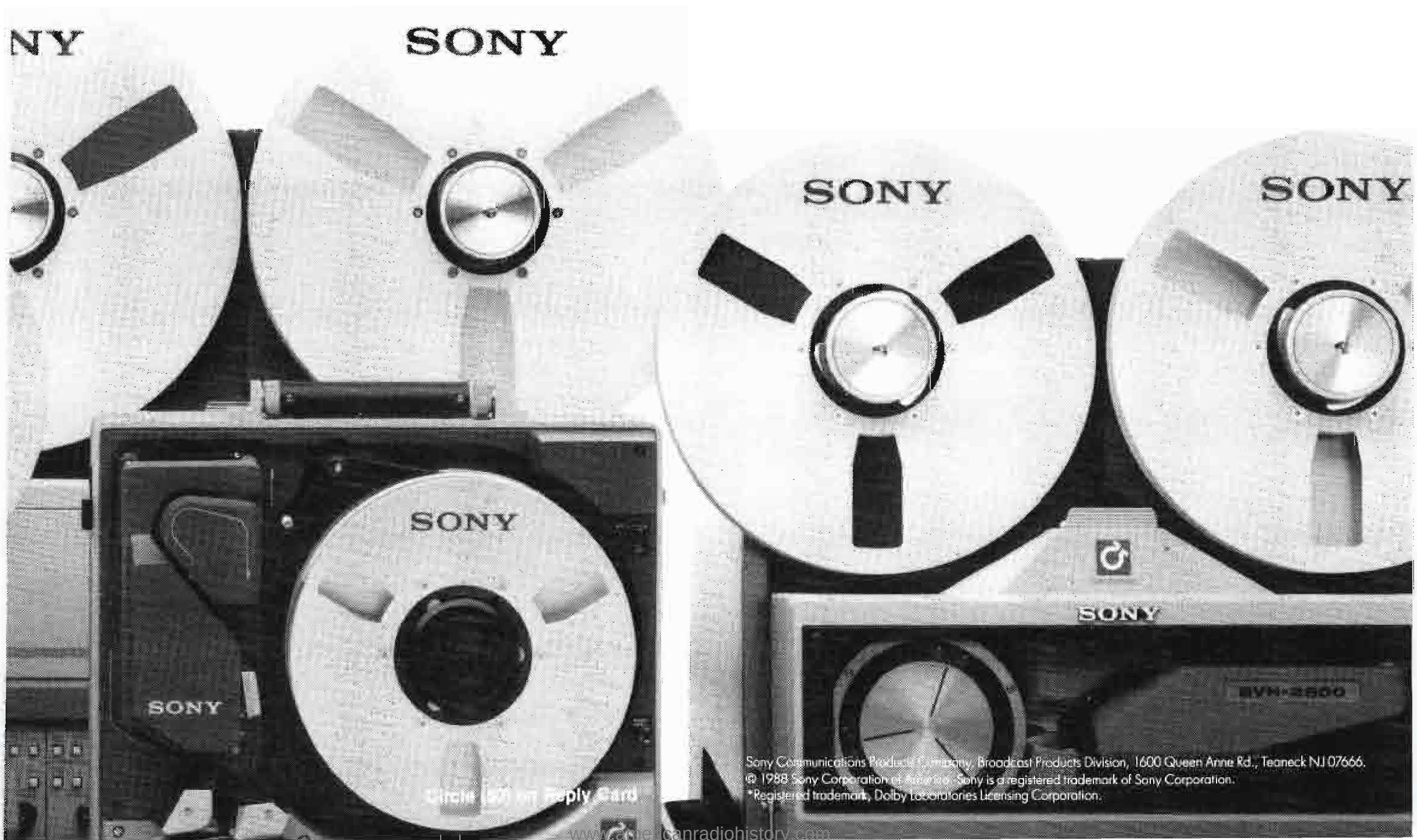

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Michael Sherlock
President
Operations and Technical Services
NBC-TV

Q: With the divestiture, I guess you could call it, of the Sarnoff Labs from GE/RCA . . .

A: Donation.

Q:. . . donation, and CBS Labs being closed, none of the three networks has a dedicated research arm as such. Do you see that as a problem for the industry overall?

A: Let me just argue with your question. All three networks do a certain amount of research because it behooves us, from a business point of view, to keep our hand into research. ABC has always done it differently from CBS and NBC. They have relied very heavily on equipment manufacturers to do research. CBS had a directly reporting laboratory. NBC had another way of doing it, namely using its parent's research lab.

You're right that CBS has gotten rid of its laboratory. I think the laboratory itself and the people working for it, basically, have broken up and gone away. NBC has been much more fortunate. The David Sarnoff Research Center has retained a lot of the people who were working on our projects, and we continue to fund those projects. So, it's merely done on an efficiency, buy-what-you-need basis, rather than an internal transfer basis.

And we look at that all the time. What is our return for our investment in that research, and we are pleased to continue with that arrangement. I think that we haven't lost a thing.

The way GE has set this up is to the great benefit of the company. We have all of those people available to us on a cost, pay-as-you-go basis.

Q: So you feel that the concern expressed about these changes was overblown?

A: I think that what I read in the press was overdone. Take a look at what we've been able to accomplish, and will continue to accomplish, with the David Sarnoff Research Laboratories relative to high-definition television. Clearly, that's what they're there for.

The Sarnoff Research Lab never evaluated any specific pieces of equipment for us; we did that. They are involved in development research, and we will continue to sponsor development research.

Q: To what extent is your organization involved in the assessment of new technologies?

A: We have a pretty extensive group of technology experts in our engineering

Continued on page 92

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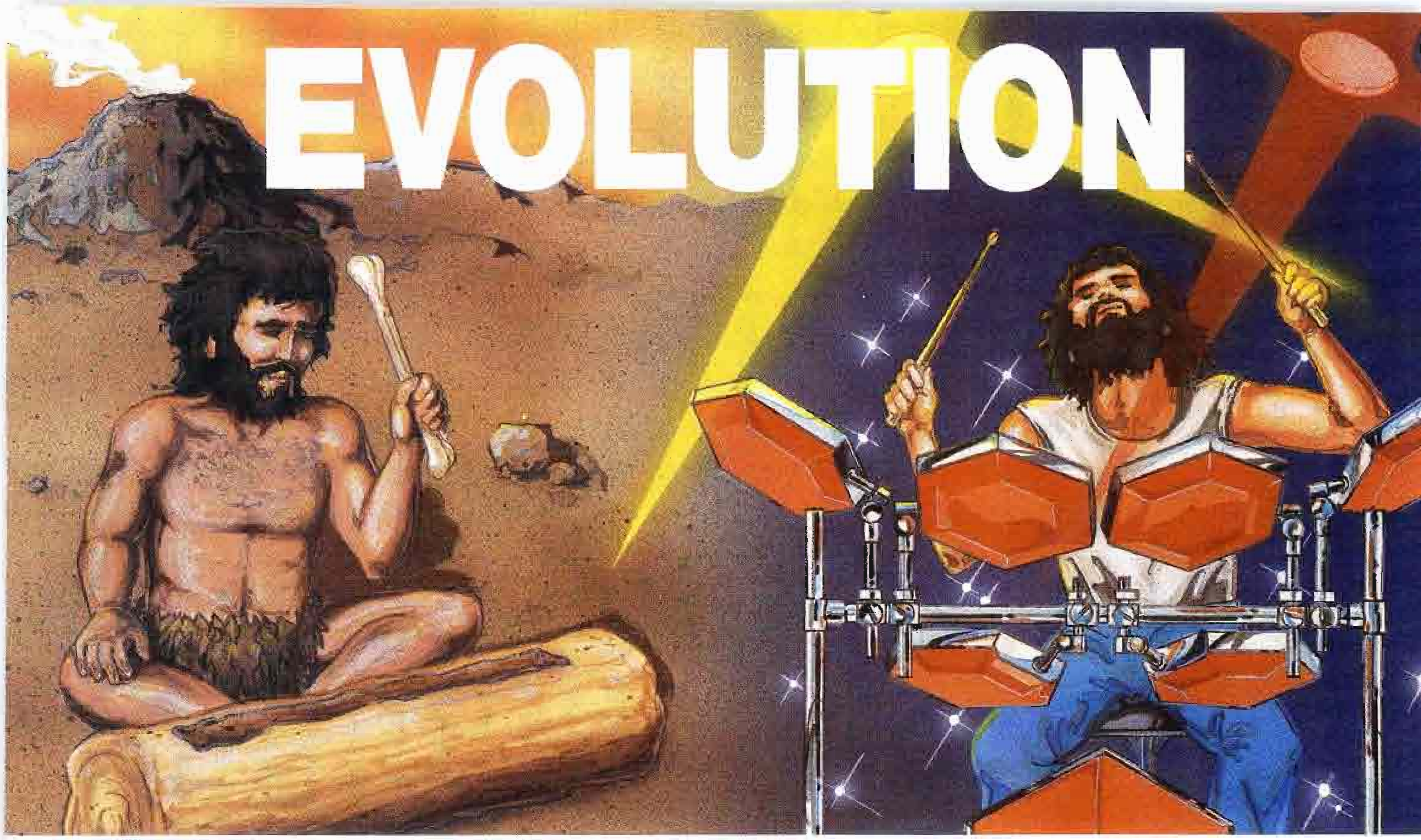

IN THE BEGINNING THERE WAS RHYTHM

Rhythm is the basis of life. It is the human heartbeat. It is waves lapping steadily on every shore. Perhaps rhythm was discovered by some caveman who tried to flush wild game out of a hollow log by pounding on it with a stick and was surprised by the booming sound pattern that echoed back. Hence, the first drum was born.

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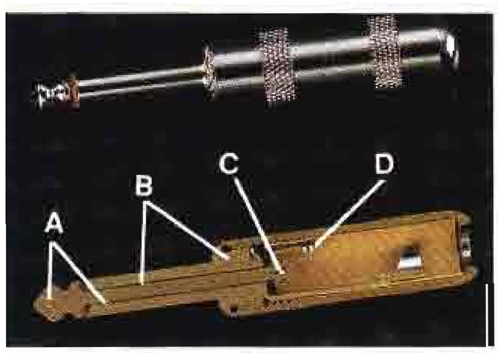

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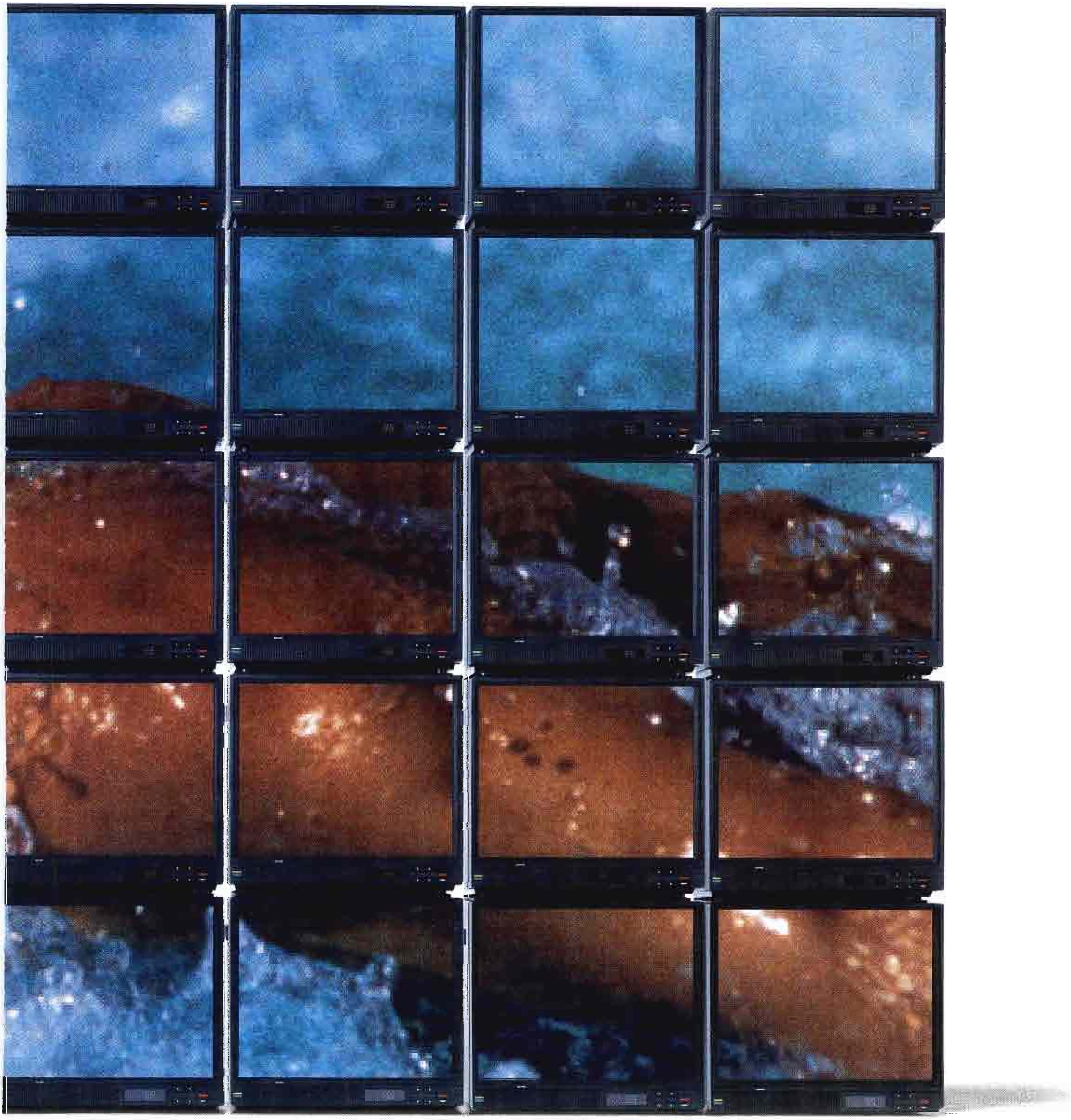

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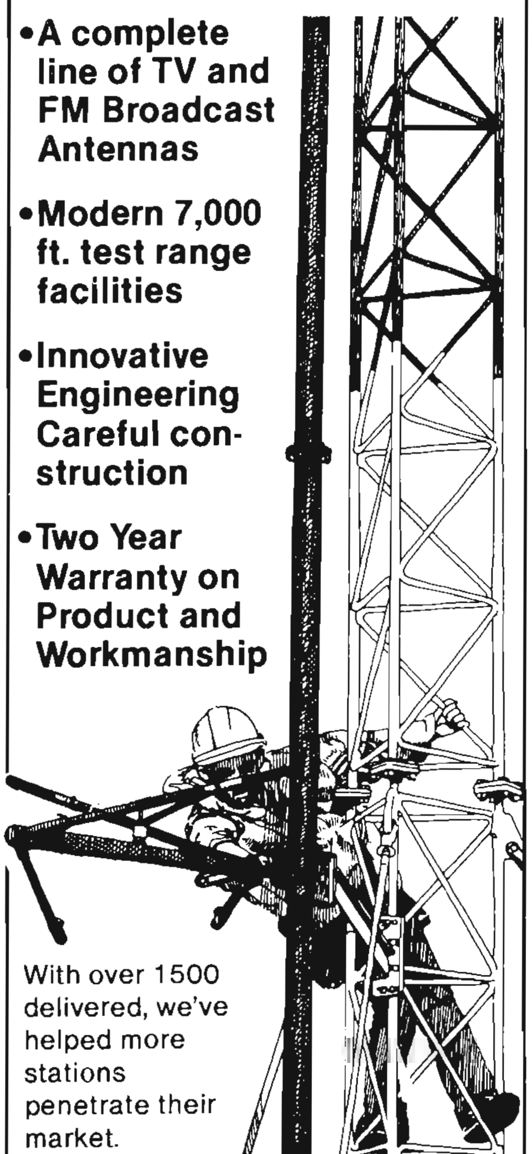

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Continued from page 88

department. And, throughout the whole organization of operators, there are a lot of people who are seeing a lot of new technology and evaluating it on a regular basis. That also applies to the sports and entertainment people.

When you work with the technology all the time, and you work with outside editors or producers, the word travels real fast. If somebody comes out with something new, you hear about it pretty quickly.

We do have, particularly in my engineering department in New York, a group of technology experts who do nothing but look at and get involved in new technology. They evaluate not only hardware, but also the future of a technology even before hardware is available.

Joseph Flaherty
Vice President and General Manager Engineering and Development CBS

Q: At this point, none of the big three networks has a dedicated research lab. Do you see that as a problem for you at CBS, or for the broadcast industry overall?

A: Well, actually, we do have a lab. When the CBS Technology Center was disbanded, the engineers working in the records area went to the records division. The ones working in television came here to New York, at least those who wanted to come. There were some who lived geographically in places where they didn't want to commute to New York, and others who were near or at retirement age. But the engineers who were charged with television development are still here, but now working in New York.

We never did research at Stamford. (I set aside the old military portion, which had nothing to do with us.) We did development. There's a big difference, and since CBS was not an equipment manufacturing company, we did not do basic research. We did development.

Sometimes a prototype was built at Stamford, and sometimes we just used the expertise at Stamford to write detailed specifications for a vendor.

We don't make equipment or sell equipment, unlike RCA at the time. And, it is impossible for us to give ongoing support to a product once we build it. So we try not to build more than a prototype in order to prove the feasibility of a concept. (**Editor's note:** CBS sold its broadcast equipment product line to Thomson-CSF during the early 1970s.)

There were three or four major projects under way within the last couple of years at Stamford. There were some satellite projects, particularly in the area of uplinking and downlinking signals and improving signal-to-noise ratios. There was high-definition development under way. Stamford built the first transmission system for HDTV and pioneered a great deal of work on digital technology.

Q: Do you think that the concern over the closing of the CBS Technology Center and the donation of the Sarnoff Labs to SRI was overplayed in the media?

A: Well, I don't know. I haven't really thought about the "macro picture" of it. At CBS, I think, it was handled pretty well. The budgets were transferred here, and the people were transferred. We haven't reduced, consciously, any of our work. We're still doing the work we did then. There are a few projects, in fact, that we have taken up since that time.

We are, after all, in the program business, not the hardware business.

Q: To what extent is your office involved in evaluation of new technologies?

A: Television and radio developmental work is done here in New York. Our development department has an arm that evaluates product or works to set new technologies in motion. We try to predict the availability of hardware and to engineer systems that enhance the quality of the product, speed of production, provide cost savings in production, and so on.

There are two types of evaluation in product decisions we make: a laboratory evaluation and a field evaluation with the actual operating crews. All of that input is fed back to the vendor for product improvement. Typically, in the first round,

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there will be 30 or 40 items on a check list of problems or concerns, usually no more than two or three serious ones. The vendors then work with us to improve their product.

Not many people are able to test a product as thoroughly as a large producer or television network. This feedback works to the advantage of the participating company and, in the final analysis, users of the product. That is also the method we used to purchase our new studio cameras.

The studio camera specifications were received by Hitachi about the time they were beginning a new design program. So, they built the camera to our specifications. The production version has a few minor variations for CBS, but it is essentially a mainline camera. Usually, that is what happens.

When specifications for the multicassette machine were issued, virtually no one had a new multicassette system. So, those who were interested were able to start from scratch and use our specs as a guideline. They may have their own ideas that we may or may not like. They are, of course, free to do as they wish, and we're free to buy as we wish.

Julius Barnathan
President
Broadcast Operations and Engineering
ABC

Q: At this point, none of the three networks has a dedicated engineering lab, in the formal sense. Does that concern you?

A: Well, we have a lab. We've had a lab for as long as anyone can remember. But it is what it is. It's not a profit-making operation. We're not looking for patents. It is a problem-solving lab that requires half a floor in this building. But it does basically what it's supposed to do: check out, monitor quality control, and evaluate facilities. We're not trying to reinvent the wheel. We go to manufacturers and ask them to help solve our problems, whether it is for super slow motion, large lenses, routing switchers, videotape recorders, audiotape recorders, graphics generators, you name it.

We have been involved in the start-up of some companies that today are giants. We don't believe in becoming a manufacturer of equipment. We never have. We feel we should be untied. And because we're in broadcasting, that should be our business.

Q: Do you find that companies are more willing, or less willing now to do special modifications for customers such as networks?

A: I would say that they are doing today as much as they have done in the past. What we try to do is to improve their product, not make it special for us. There are times, however, when we ask for more than would normally be required by a station. Generally speaking, what we do ask for, they normally include as part of their standard product. Very seldom do we ask for specialized changes, and those are for special reasons.

The best example of this is when we were working on the VPR-3. We needed the ability to sync-up one tape machine to another. That is a pure network reason because we always work in redundancy. We don't believe in making things nonstandard. But, generally speaking, what we ask for is something that we feel will be good for the user.

Q: To what extent is your office involved in evaluating new technologies?

A: We're involved in it all the time. It's a part of our function to evaluate all new equipment and to develop equipment that will help us do our job better.

Q: Do you have a dedicated staff for that?

A: A small one, yes, but dedicated. It's about six people, all together.

NAB Technologies

The National Association of Broadcasters (NAB), in an impressive show of support for the broadcast industry, has announced plans to establish a for-profit development center. The organization, to be known as NAB Technologies, is charged with developing the technical tools necessary to keep radio and TV broadcasters competitive with other entertainment mediums. They hope to turn a profit at the same time through licensing fees.

First on the agenda for NAB Technologies will be (for the radio side) FMX and (for television) enhanced or high-definition television of one form or another. The organization will be headed by Tom Keller, until recently, engineering vice president for the association. Keller is, in fact, co-inventor of the FMX system.

NAB is in the process of developing a budget for the spin-off organization and securing office space. At its January board of directors meeting, the association outlined a 2-year, $4 million proposed budget ($3 million for operating expenses and $1 million for capital expenditures).

NAB will seek to raise the needed funds through the contribution of money and other resources from the broadcast industry. At press time, ABC and NBC had pledged to support the project, and CBS was expected to follow suit. NAB already allocated $700,000 in start-up funds for NAB Technologies.

Testing 1, 2, 3

It is clear that there is no shortage of developmental work under way for the broadcast industry. Two articles in this issue, "Breaking New Ground: The MSDC Klystron" and "In the Chips," clearly demonstrate that much work is being done to keep radio and TV broadcasters competitive from an economic and technical standpoint with the numerous alternative information and entertainment media available to consumers today. Furthermore, the 100 or so pages of new product listings contained in the NAB preview section of this issue are indicative of the rapid pace of technology as applied to broadcasting.

Developmental work still is being done for broadcasting, only now with closer attention to the bottom-line return on investment.

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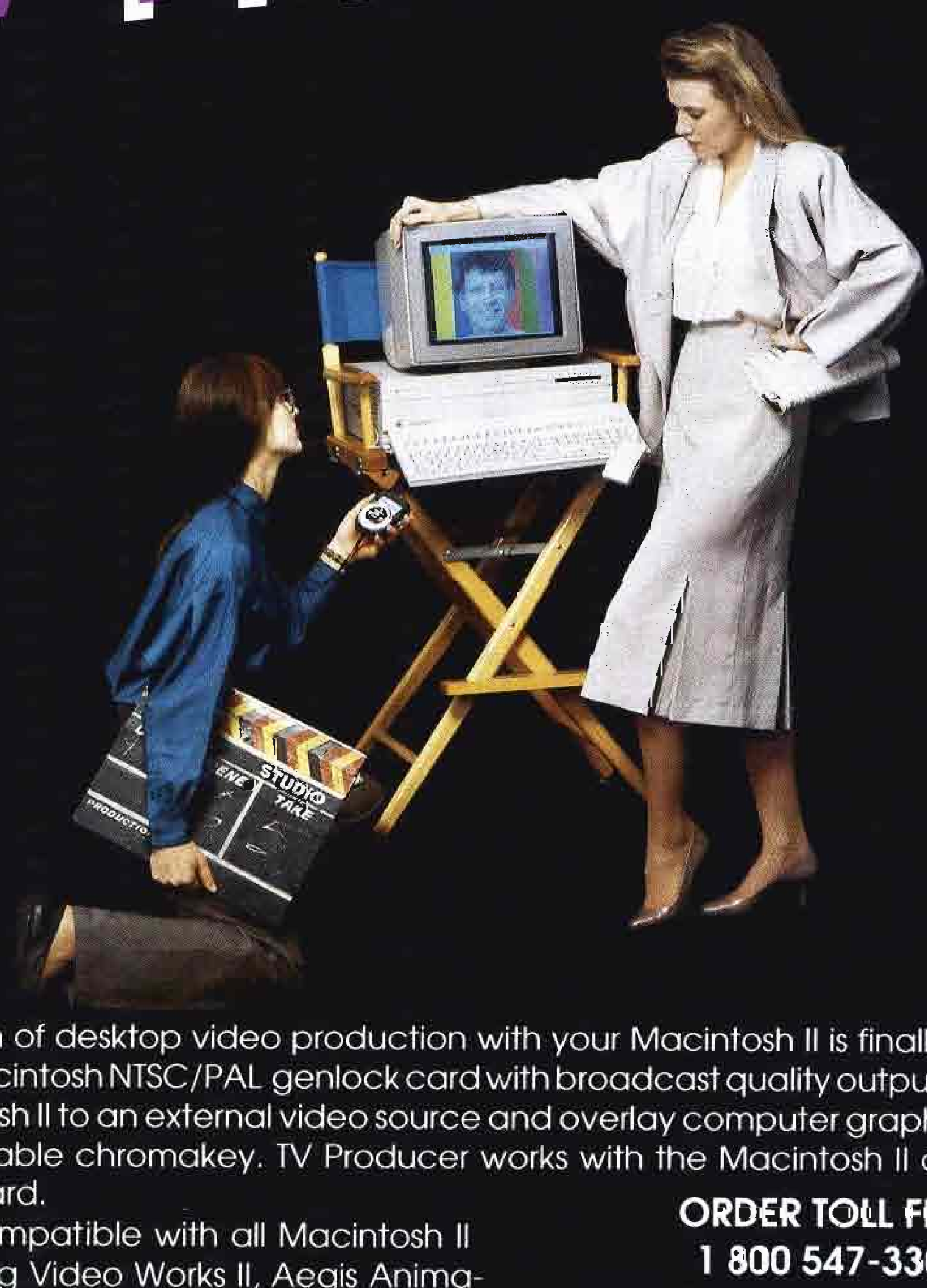

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Photo by Ben Weiss, KLSI-FM, Kansas City, MO

Facility planning special report

The construction of a radio or TV facility to meet present needs and future requirements demands detailed, long-range planning.

New technology and tough competition are causing many radio and TV stations to examine their technical plants for ways to improve efficiency and increase flexibility. Facility construction or renovation is a major undertaking that affects the entire engineering staff. It's not something to be taken lightly.

This special-emphasis section of **BE** looks at the process of building, or rebuilding, a technical center. Our examination of this topic includes the following articles:

It is impossible to predict with any accuracy what the requirements of a given facility will be three or five years from now, let alone 10 years — the average life of a studio or transmission complex between major renovations. Through careful planning, however, growing pains can be minimized.

Brad Dick

Brad Dick,
technical editor

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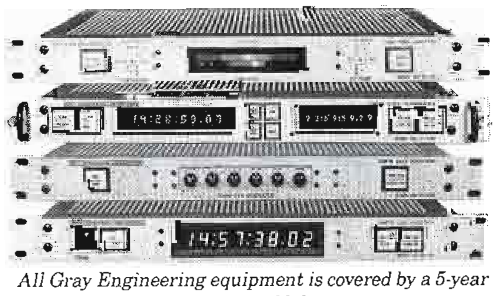

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To meet the requirements of FCC Docket 80-90 and provide increased coverage area, KLSI embarked on an ambitious community antenna project. The station's efforts are representative of much of the work that has been done in the past four years to meet the requirements of 80-90.

80-90 one year later

By Jerry Whitaker, editorial director

FCC Docket 80-90 has reshaped the face of FM broadcasting and cleared the way for hundreds of new FM stations.

The FM broadcast band has undergone dramatic change within the past four years. The driving force behind this activity has been the FCC's Docket 80-90 ruling.

A clock, set in motion by the commission on March 1, 1984, has been ticking away for FM broadcasters who did not meet the minimum facility requirements specified in the docket. The direction each affected station has taken since the race began four years ago will have long-term implications not only for the stations, but also for the FM band.

The 80-90 ruling established three new classes of stations. The existing classifications of A, B and C were expanded to include B1, C1 and C2. Each of the B and C classes carry minimum requirements. Under the provisions of the docket, facilities that do not meet the full B or C requirements will be reclassified to a lower (B1, C1 or C2) class.

The lower class brings with it lower spacing protections. The shift in station classes also opens the door for assignment of new stations to fill in the coverage gaps that the allocation scheme will identify.

The 80-90 order

In the Report and Order issued to implement Docket 80-90, the FCC specified a minimum transmitting antenna height above average terrain (HAAT) of 300m and a minimum effective radiated power (ERP) of 100kW for Class C facilities. Stations that did not meet those minimum requirements faced reclassification as C1 or C2 facilities. The minimum ERP for a C1 facility must exceed 50kW, and a C2 must exceed 3kW.

The order also specified that Class B facilities must have an ERP that exceeds 25kW to avoid reclassification as a Class B1 station. A Class B1 facility must have

Editor's note: Information for this article was provided by Robert D. Greenberg, supervisory engineer, audio services division, FCC Mass Media Bureau; and Ben Weiss, director of engineering, KLSI-FM, Kansas City, MO.

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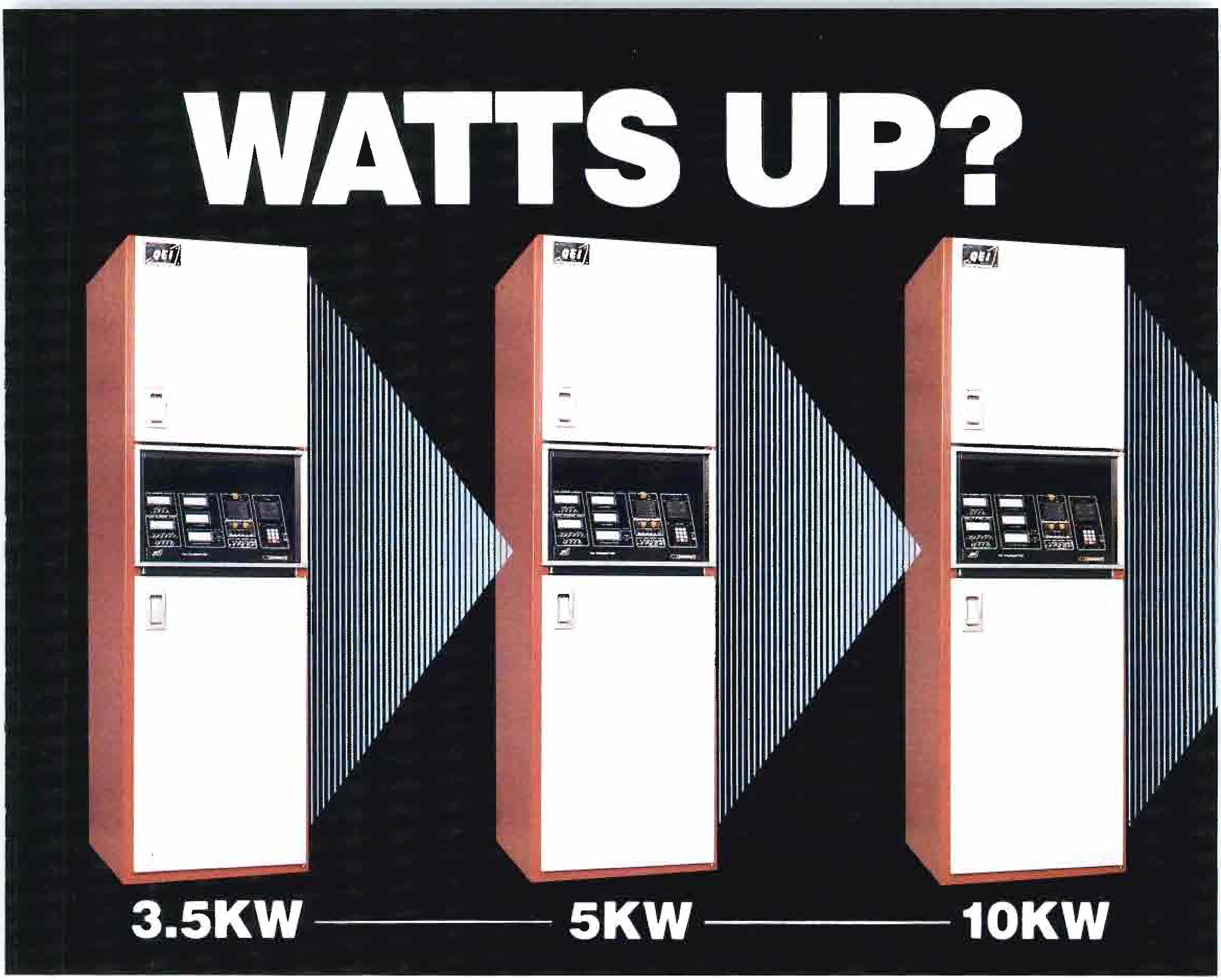

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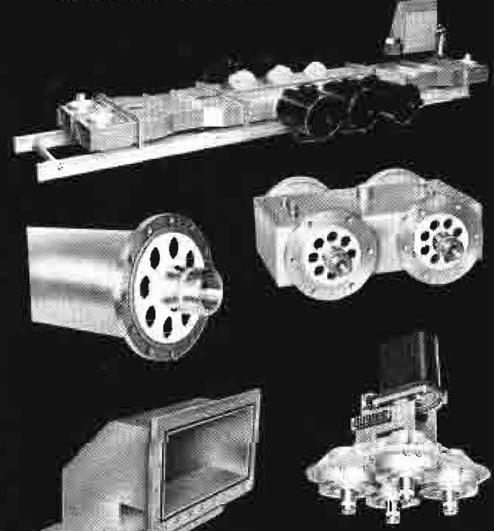

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a minimum ERP that exceeds 3kW. No minimum HAAT is specified for Class B, B1, C1 or C2 stations. The effective radiated powers referenced here assume that an overheight antenna (one that exceeds maximum HAAT for its class) is not used. See CFR 47, Part 73.211.

In order to provide existing licensees an opportunity to meet the new minimum requirements, the commission gave stations three years from the effective date of the Report and Order to submit their applications for facility upgrading. Those stations failing to do so, or any station whose application was rejected, would be reclassified.

The 80-90 notice was released on March 21, 1984. To avoid reclassification at a lower category, a station must have completed an application proposing minimum Class B or C facilities, which should have been received by the commission as of March 2, 1987.

When Docket 80-90 went into effect, the commission identified 203 Class B stations that faced reclassification under its provi-

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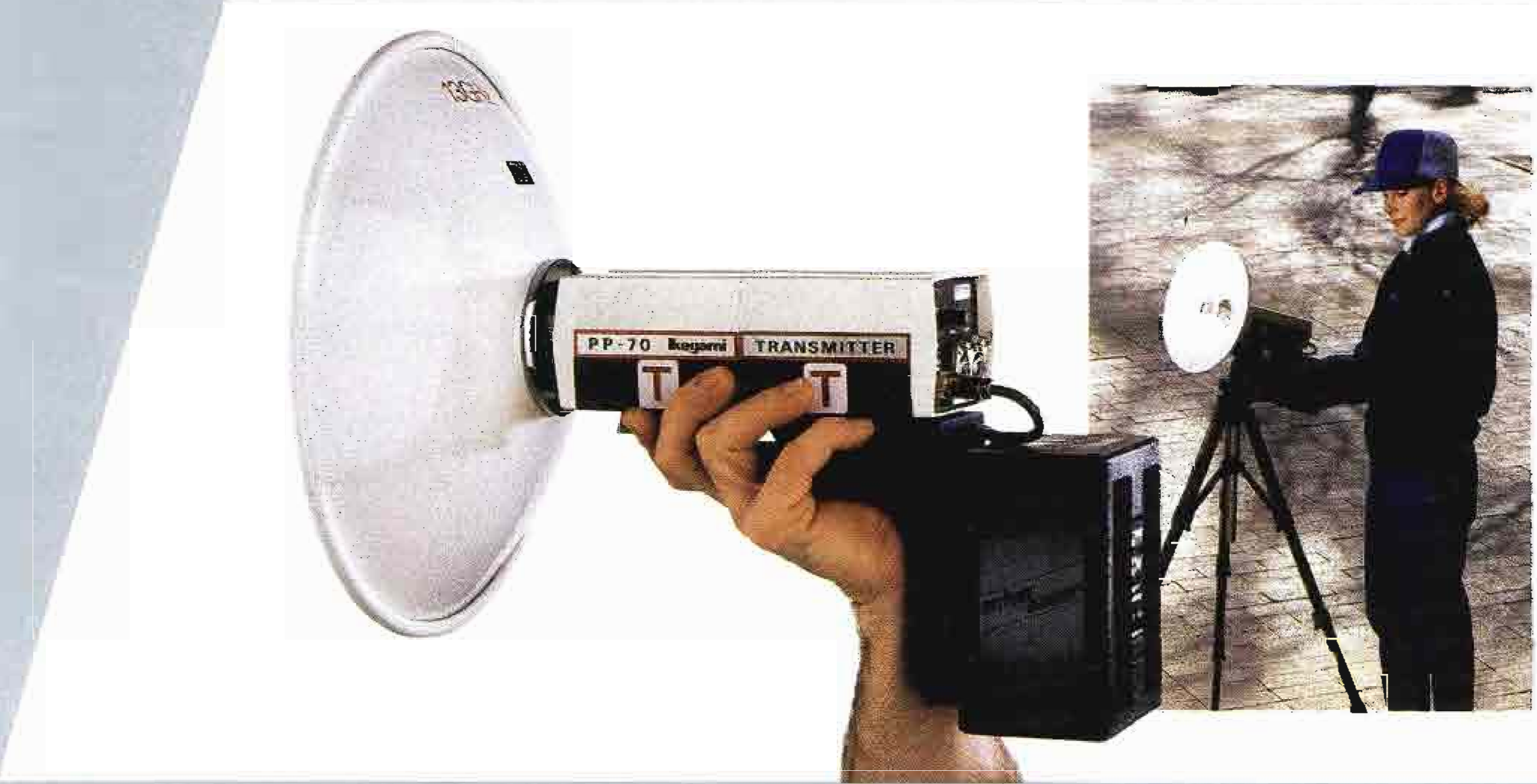

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sions. Of that number, more than half (116) were non-commercial educational stations. Class C facilities below minimum limits numbered 1,656, 395 of which were non-commercial stations.

The vast majority (60%) of the stations facing reclassification had facilities for which only the antenna HAAT was below minimum. Commission records show that 34% of the stations on its list faced reclassification because of facilities for which both the ERP and HAAT were below minimum levels. The balance of the stations (6%) had facilities with the required HAAT, but not ERP.

Upgrades/downgrades

The following example covers most of the situations that arose during the reclassification process. Consider the case of a Class C channel currently allotted to a city. The city and channel are listed in the Table of Allotments. A licensed station operates on the channel with facilities of 20kW and an antenna height of 100m. This station also has a construction permit to modify its facilities to increase power to 100kW but remain at 100m. The station filed an application by the close of business on March 2, 1987 (the cutoff date) to modify its construction permit to operate with facilities of 100kW and 400m.

The reclassification procedure affects the station and allotment in the following way:

- The license is reclassified to C2.
- The construction permit is reclassified to C1.
- The application remains classified as C.
- This channel is not reclassified in the Table of Allotments because the application requesting full C facilities was on file by the close of business on March 2, 1987.

Any other applicant will have to protect this station's licensed site as a C2, the site of its construction permit as a C1 and the proposed site in its application as a C.

The eventual grant of a license to this station for the facilities proposed in the application will retain the Class C channel in the Table of Allotments, and the station will continue to operate as a full Class C facility. However, if the application is later returned or dismissed, this channel will be reclassified to C1 in the Table of Allotments to reflect the class of the construction permit. Other applicants then will only have to protect this station's licensed site as a C2 and the site of its construction permit as a C1.

Subsequently, if the construction permit expires, the class of the channel in the Table of Allotments will be reclassified to C2 to reflect the class of the existing license. Other applicants then will only have to protect this station's licensed site as a C2.

There are a few exceptions to this general rule, which are handled on a case-by-case basis.

The scorecard

It is now one year after the deadline. How many stations took advantage of the commission's 3-year ultimatum? More than you might have expected.

According to documents released by the commission, a total of 524 commercial FM facilities have been reclassified at a lower level. A total of 963 commercial FM stations, however, have completed work to upgrade their facilities or have filed applications to upgrade.

It should be pointed out that many stations found themselves in a position in which it was impossible to upgrade their facilities. Some were boxed in by mileage separation limits, others by the inability to increase the antenna height on their present towers because of structural considerations, and still others by the unavailability of suitable land to construct new transmitting towers.

Although it is difficult to generalize as to which types of stations, and in what

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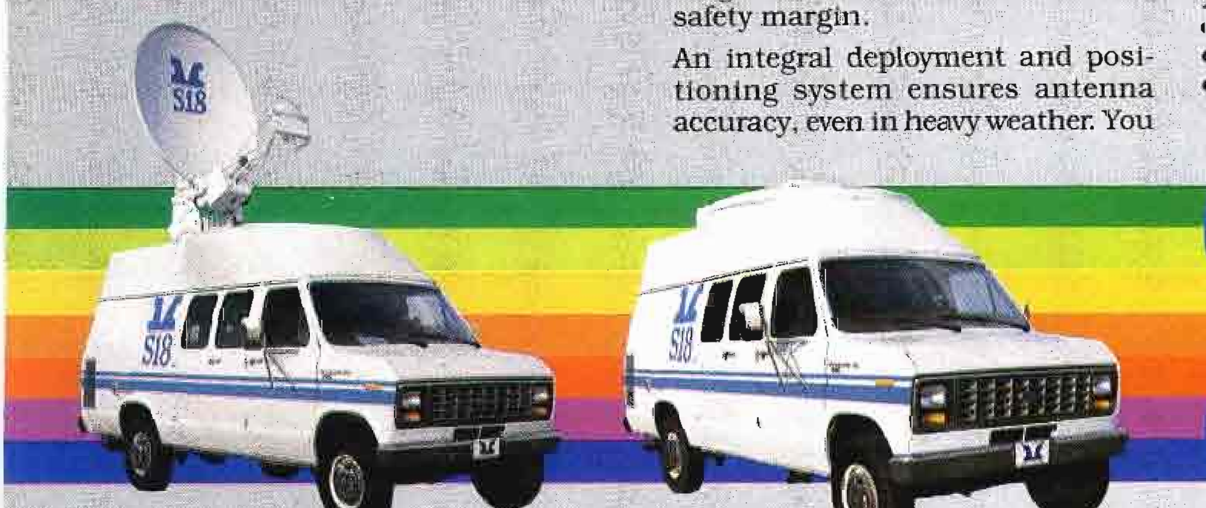

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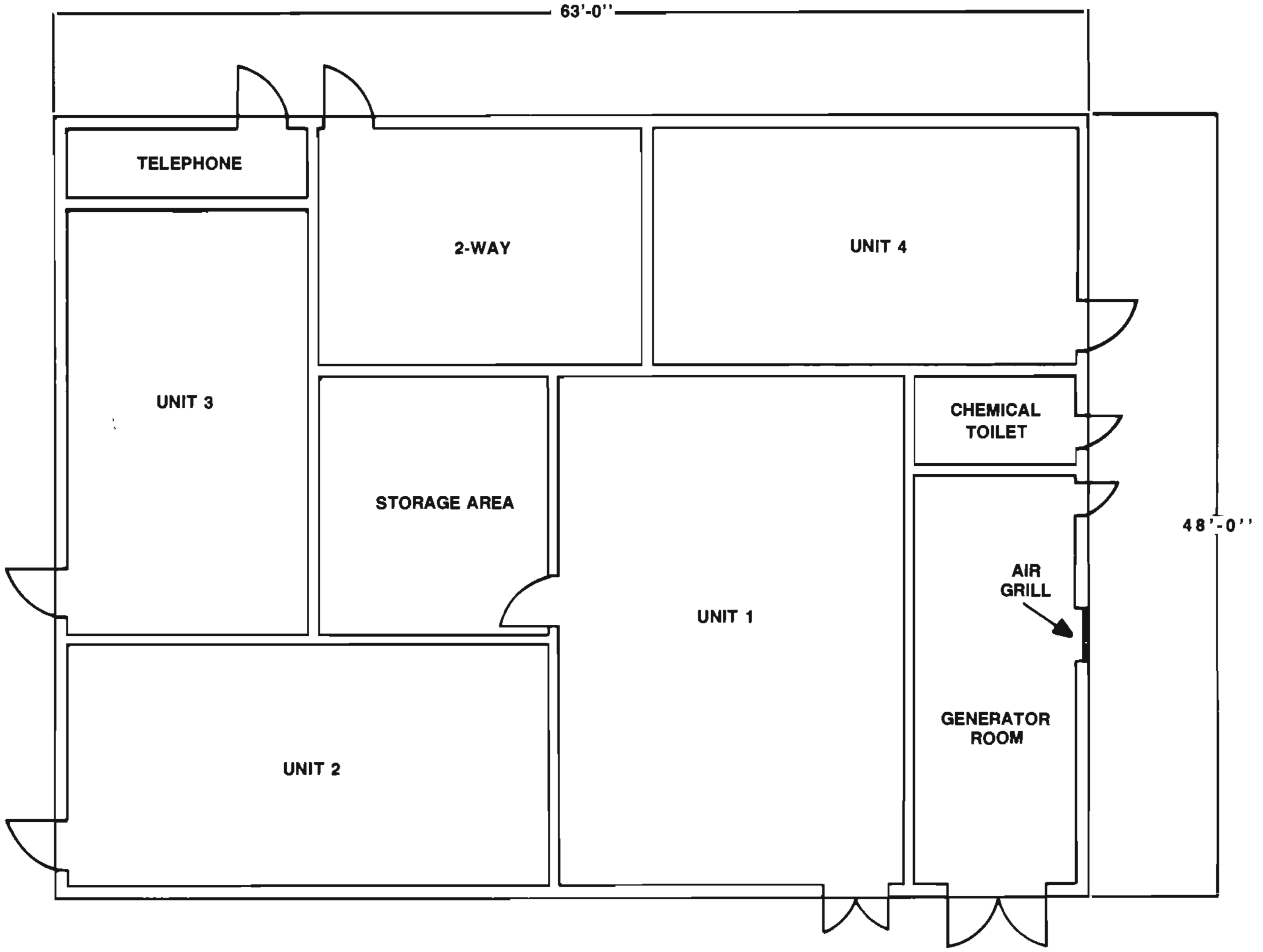

Figure 1. *Floor plan for the KLSI-FM transmitter facility. Four individual rooms are provided for FM transmitters, plus an enclosed generator room and 2-way radio equipment room. The building is constructed of precast concrete "double-T" sections.*

areas, decided not to upgrade, some observations can be made. First, most stations that did not upgrade are in small markets (below top 100), but there are exceptions. Commission documents show stations in top 30 cities such as Miami, Seattle, Kansas City, MO, and others have had their facilities reclassified at a lower level. Generally speaking, though, small-market broadcasters located in areas such as Marinette, WI, Corbin, KY, and Billings, MT, were the ones that decided (for whatever reason) not to upgrade.

Educational radio stations showed little interest in upgrading their facilities to avoid reclassification. Certainly, the economic incentives of improved coverage area and maintenance of mileage protection are not primary concerns for educational broadcasters.

Another factor, clearly, could be the ability (or inability, as the case may be) of educational stations to finance major facility improvement projects. A total of 277 educational stations have been downgraded, while only 95 have completed or filed for transmission facility improvements.

The figures given for both commercial and non-commercial stations are tentative, and they may not represent all upgrade and license modification actions taken by stations. The data presented here represents the latest available from the commission (as of Dec. 21, 1987). Also, the numbers given for upgraded facilities assume that the applications on file with the commission all will be approved and that the construction permits already issued will be completed by the licensees in a timely manner. Obviously, there will be some shifts in the totals after all is said and done.

One station's experience

KLSI-FM, Kansas City, MO, was faced not only with the 80-90 decision and its looming implications, but also with the fact that the station's transmission facility was being surrounded by newly constructed skyscraper office buildings.

The transmitting antenna was mounted atop a high-rise building in downtown Kansas City at an elevation of 485 feet. Because of the antenna's proximity to other high-rise buildings, the additional concern of electromagnetic radiation exposure limits had come into play. The existing site was well below the minimum height requirements for 80-90, and the highly competitive nature of the Kansas City radio market left the station little recourse but to pursue a new tower site.

The concept of a group effort to build a new community tower was attempted with other local broadcasters, but failed for a variety of reasons. Meetings were held on half a dozen occasions as early as February 1984 in an attempt to work out an agreement. All the stations involved were interested, but when it came to signing an agreement and putting up the needed money, cooperation fell through.

By the fall of 1985, it was clear that the community project was dead and that the

Continued on page 108

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Continued from page 104
80-90 deadline was fast approaching. On Nov. 22, the station filed a construction permit with the commission for its own community tower project.

Planning the new site

In the design of any project, those involved wish they had done some things differently, and this project was no exception. However, the overall result was quite satisfactory.

One key element in building a tall tower involves FAA approval. Land was explored for suitability as a transmitting location only after local FAA officials had been consulted. Although this may seem in somewhat reverse order, it was the most expedient way.

The more common approach, of course, is to go out and find a site, then ask for FAA approval. The station wanted, however, to avoid spending the time and money to locate a site only to have it rejected by the FAA. The agency previously had indicated an interest in grouping towers as much as possible to lessen air hazards in the Kansas City area. After some consideration, the FAA suggested to KLSI a couple of tower locations that would be acceptable to the agency and that were likely to be given rapid FAA approval.

With those recommendations in mind, KLSI started looking for land. The station's traffic helicopter proved valuable in the search. The idea, naturally, was to find a piece of land that was unoccupied and, hopefully, somewhat remote (or at least not accessible to the public). These requirements suggested the use of a helicopter or light plane for surveying work.

After a suitable site had been spotted by air, the station went back to the FAA to confirm that an application for a tower at that location would not meet with agency objections. Approval was granted in record time. The station then applied to the commission for a construction permit to build the new facility.

The site for the new tower was about 0.6 miles south of an existing TV transmitting tower. The TV tower is 2,049 feet above sea level, and the KLSI structure was to be 1,995 feet above sea level.

Site problems

After beginning the licensing process, the station discovered some unexpected problems with the site. The discovery that the land had been mined created concerns about the acceptability of the site for a tower. Had the station known the additional expense and time that it would take to plan construction around the mine below the site, it might have chosen a different location.

The extent of the problem did not become evident all at once. Instead, small problems surfaced at various stages of the work. As new expenses and delays were incurred, the station found itself too far into the project to move to another location. Because of the time and money it had invested in the site, it had reached points of no return; it would be too expensive to back out.

Instead, KLSI had to find solutions to the existing problems with the land.

Inside the mine

The site contained an abandoned underground limestone quarry. All the land that encompassed the approximately 47-acre area was undermined. While in the process of surveying the land on the surface, the station decided to find out what lay below. A survey crew was sent into the mine to locate the tower base and guy anchor points. The station wanted to be certain that those points would fall above solid ground. The survey crew found less-than-stable conditions where some of the guy wires were to land.

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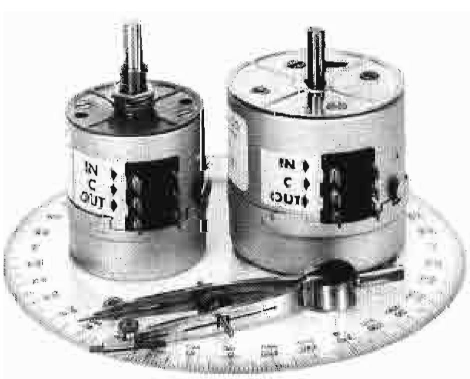

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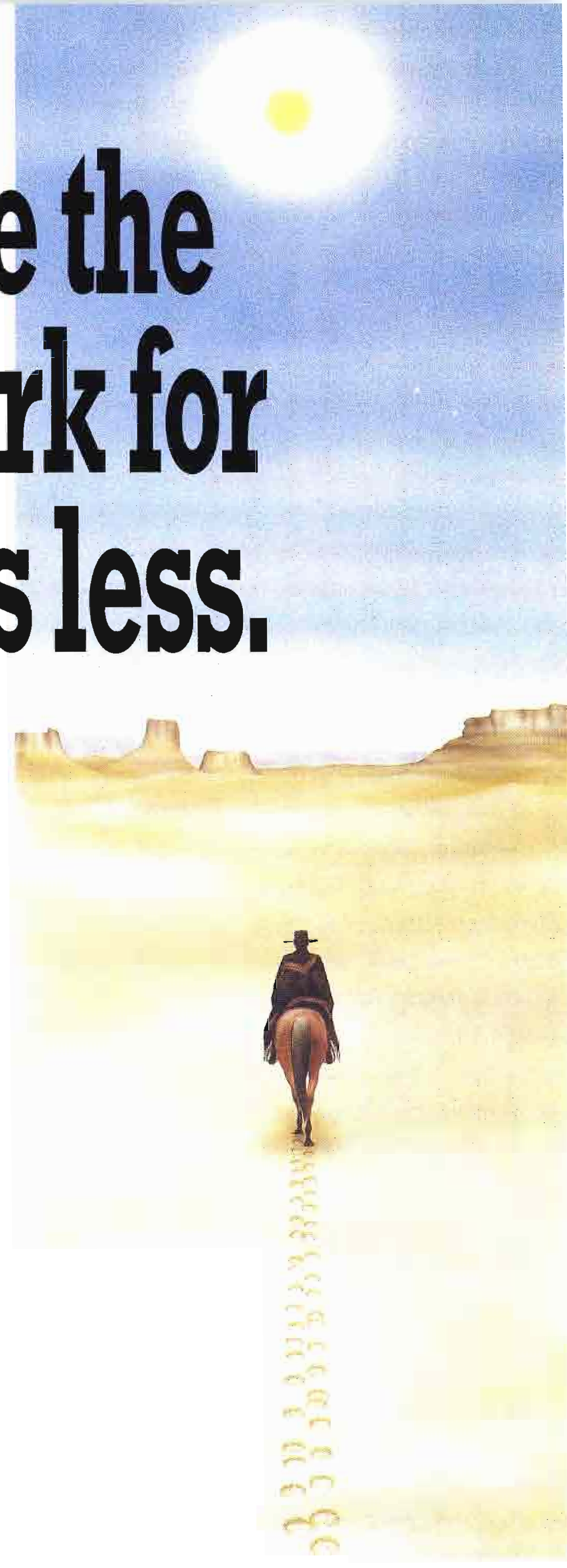

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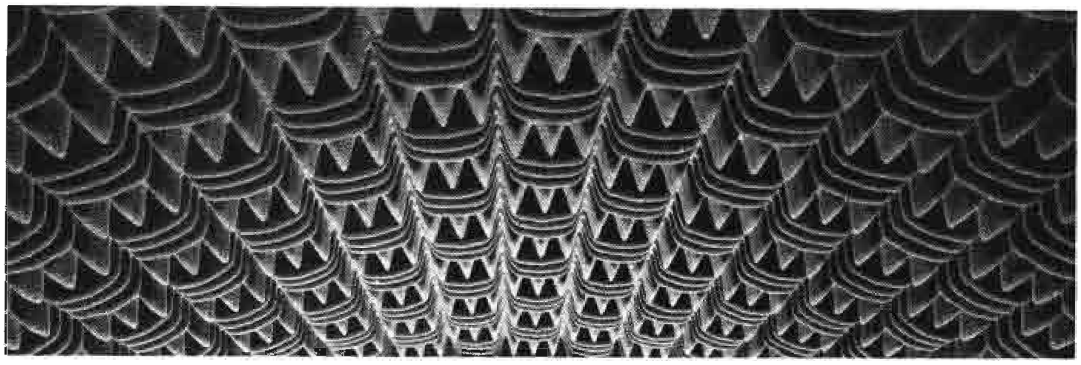

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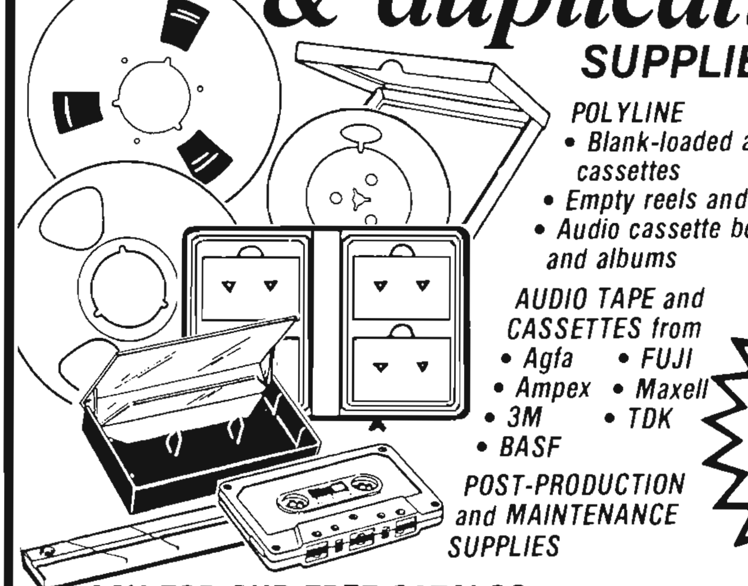

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what so they could fall in areas the experts thought would be less likely to present problems. Part of the trouble involved flooding inside the mine. Also, some areas of the mine had caved in and were unstable; those areas were avoided. The geologists actually went into the mine in a boat to complete the underground survey work.

Main story continues on page 114

The FCC's 80-90 decision has provided the impetus for FM broadcasters to improve their transmitting facilities. Many stations viewed the situation posed by the docket as a use-it-or-lose-it proposition.

Most stations faced with reclassification because of Docket 80-90 suffered from low transmitting antenna heights. This situation resulted in a great deal of interest in community antenna sites, such as the KLSI facility shown here.

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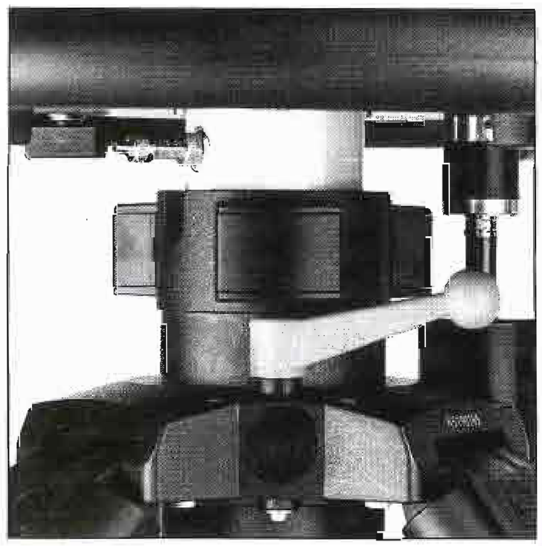

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The road to success

The construction phase of the KLSI project officially began on Aug. 22, 1986, with clearing of the site. Work continued through the winter and the bad weather that it brought. The facility was completed on March 5, 1987, when KLSI went on the air from the new site. The switchover from the old location to the new location occurred at 9 p.m.

One of the two transmitters used by the station was moved and temporarily installed. Once on the air from the new location, the second transmitter was moved, along with the combiner and other hardware. Both transmitters signed on the air from the new facility at 4:30 a.m. on Monday, March 9.

The road from groundbreaking to completion was punctuated with the usual number of delays and complications. However, once construction finally got under way, it went pretty much according to plan.

The first few weeks of the project involved clearing the land and finalizing drawings for the tower and building. A building permit was issued for the tower by the city of Kansas City, MO, on Sept. 26, 1986. (Photos by Ben Weiss.)

Nobody wants to put up a tower in the middle of December in the Midwest. However, KLSI didn't have a choice. The project was well under way, and it couldn't be interrupted by bad weather. Seven truckloads of steel were shipped to the tower site. Assembly of the sections on the ground began during week 15.

The first steel went up in the air on Jan. 10, 1987, in week 20 of the project. The base of the tower was placed, and over the course of the following six weeks, the structure slowly began to take shape. Bad weather and other problems kept the work "interesting."

The transmitter building began to take shape during week 19 of the project. Precast wall panels were trucked to the site and lifted into place by a crane. At this point in the project, the local utility company had placed the necessary power poles and lines for ac service.

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By week 10 of the project, the tower pier had been drilled and the rebar set in place. A 5-foot-diameter hole was drilled 56 feet down for the foundation of the structure.

Concrete was poured at the tower base during week 12. At the same time, drilling was under way for the guy anchor posts. Some of the posts were drilled to a depth of 80 feet to ensure a sound footing and to avoid problems with the underground limestone mine.

The top-mounted KLSI-FM antenna was hoisted up the tower on Feb. 7, 1987, week 24 of the project. At this point in the effort, electrical service for the transmitter building was well on the way to completion.

The tower was officially accepted on Feb. 27, 1987, 27 weeks after ground was first broken for the project. The tower inspection process was detailed and lengthy. All bolts were checked for tightness by a consultant for the station and by a consultant for the tower manufacturer.

The big day finally arrived during week 28. One of the two KLSI transmitters was moved to the new site and put into service. To everyone's relief, everything worked on the first try, just as it was supposed to. The second transmitter was moved to the facility the following day.

Ben Weiss, KLSI director of engineering, kept a detailed calendar of progress on the project. It contains the usual entries about schedules, who to meet and where. It also includes some entries that reflect the frustration and unpredictability of such a project. Here are some excerpts:

- *Monday, Oct. 20, 1986:* "Transmission on drilling machine breaks, halts progress."
- *Thursday, Nov. 13:* "No work. Too cold."
- *Monday, Nov. 24:* "Beautiful day. No work."
- *Sunday, Jan. 4, 1987:* "Tower crew rep should have showed up. Didn't."
- *Monday, Jan. 5:* "No crew. Were to set tower stub today."
- *Friday, Jan. 9:* "Crane arrives, gets stuck. No progress."
- *Thursday, Feb. 5:* "Snow and rain today. No work."
- *Monday, March 9:* "On air with both transmitters at 4:30 a.m. Everything looks good!"

For Weiss, the last entry made it all worthwhile.

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Main story continued from page 110

The area had been mined below the surface until 1959, but the actual age of the mine is unknown. The mine had been excavated in a *room and pillar* fashion. Underground areas were dug out with central pillars left for support and stability. The room size depended on the type of soil or rock found underground.

The mining of the KLSI property varied depending on the age of the mine's sections. Newer diggings offered greater stability through smaller rooms and larger pillars. Earlier excavations afforded less stability through larger rooms and smaller supporting pillars.

Because of the geological concerns, four of the six guy anchors were displaced from their previously planned locations. The guy anchors that fell within the mined areas were located above pillars. The concrete anchor points were drilled into the pillars themselves, to a depth of 75 to 80 feet. Pillars in more stable areas were drilled to a depth of 20 to 25 feet. The tower base itself sits above a large, solid pillar. The tower base concrete form extends through that pillar and into the solid mine floor.

Once the station realized that it would be unable to locate the guy anchor points at the locations recommended by the tower designer, the data was submitted to the manufacturer for evaluation. The original design called for traditional 120° spacing from the guy anchor points, plus spacing out from the tower at specified distances. Armed with this new data, the tower manufacturer did the final structural design.

Two of the four stations have closed-loop cooling systems in which no outside air is used to cool the transmitters. Exhaust air from each transmitter is dumped into the room and large air-conditioning units are used to keep the rooms cool. The heat exchangers for one of the transmitter rooms are shown.

Grounding is a major concern for the transmitting tower because of the frequency and severity of lightning storms in the Kansas City area. The ground system consists of radials spread out from the base of the tower in a manner similar to an AM antenna ground. The transmission line bridge from the building to the tower can be seen below the ice shield.

The tower design

The tower measures 1,024 feet from the base pier to the top of the structure. A 55-foot steel pole is mounted on top of the tower for the KLSI antenna. During design of the structure, the use of non-metallic guy wires was considered, at least within the aperture of the transmitting antennas. The tower manufacturer, however, designed the structure in a *cantilever* arrangement that eliminated guy wires within the aperture of the three transmitting antennas. With this approach, the top set of guy wires attach below any of the FM antennas.

The triangular tower has a 10-foot face. It was originally designed to hold four separate FM antennas, but the plan was modified to three when two of the stations planning to lease space on the structure decided to feed a common wideband antenna through a combiner. The choice of tower legs for support of each antenna was granted in the order that the lease agreements were signed. The incentive was to encourage tenants to sign quickly so they could pick the leg best oriented toward the city.

Only the facility owner, KLSI, has a standby antenna on the tower. Space and loading considerations will not permit other large FM transmitting antennas to be mounted on the structure. Two of the stations leasing space will maintain their old transmitting sites for backup.

KLSI uses a 5-bay transmitting antenna. One tenant is using a 10-bay, and two others are using an 8-bay broadband antenna through a combiner.

The tower was not designed to the more common EIA RS-222-D requirements. Instead, it was built to meet the tougher structural requirements of UBS (Uniform Building Code) and ANSI (American National Standards Institute), as specified by the city of Kansas City, MO. These stringent standards account for the large face and heavy steel used in construction. The tower is designed to withstand ½-inch ice at 75mph.

Continued on page 115

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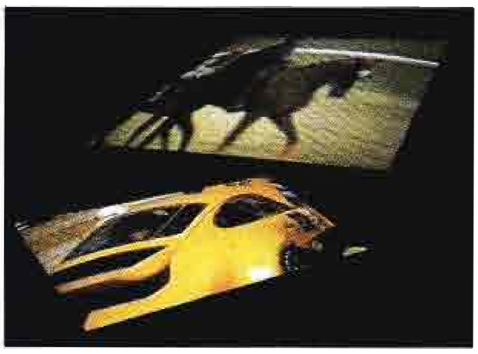

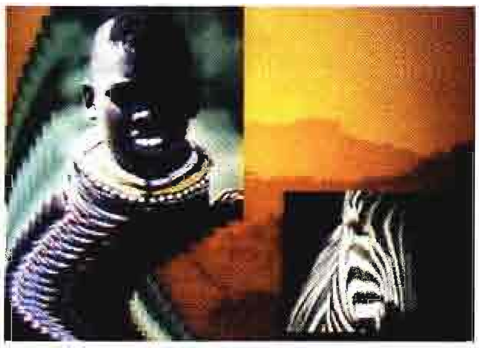
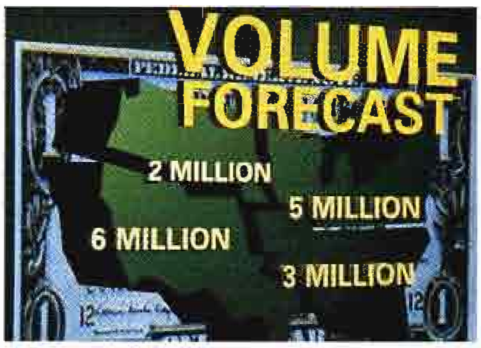


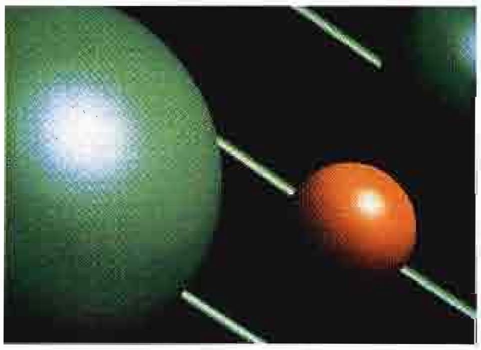





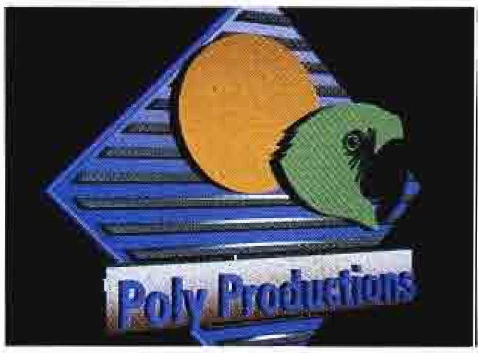


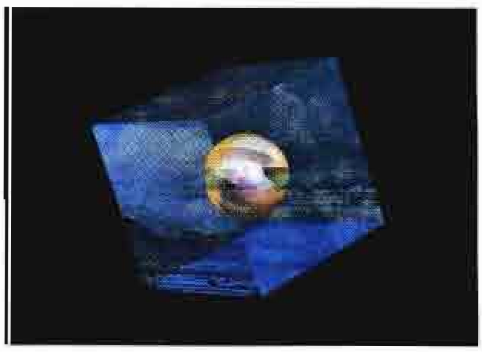


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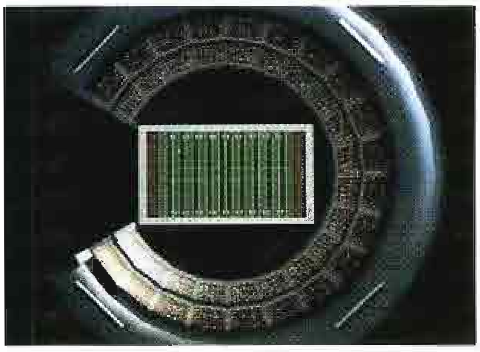
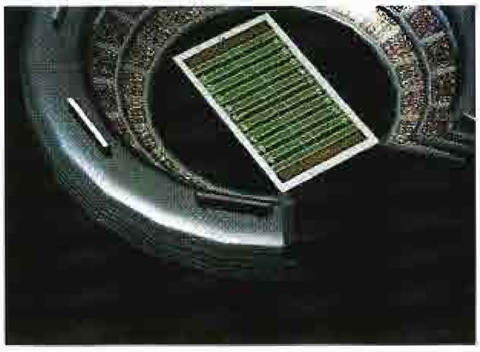

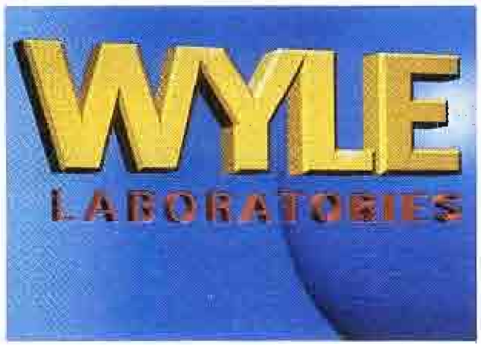


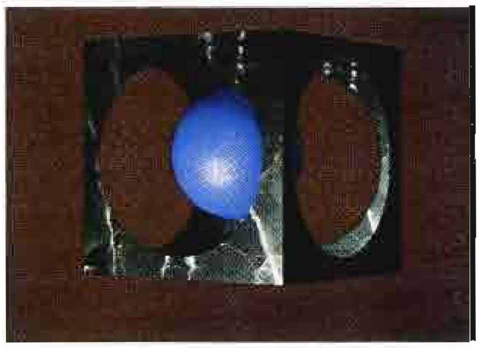



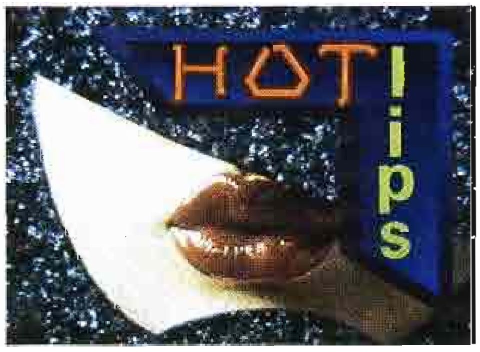





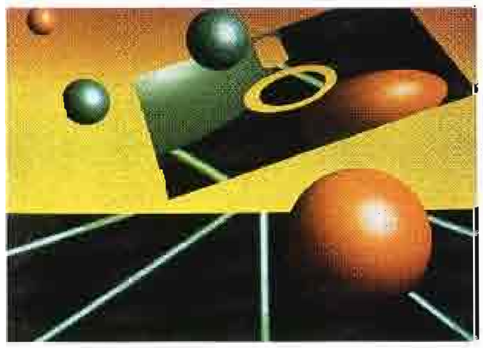

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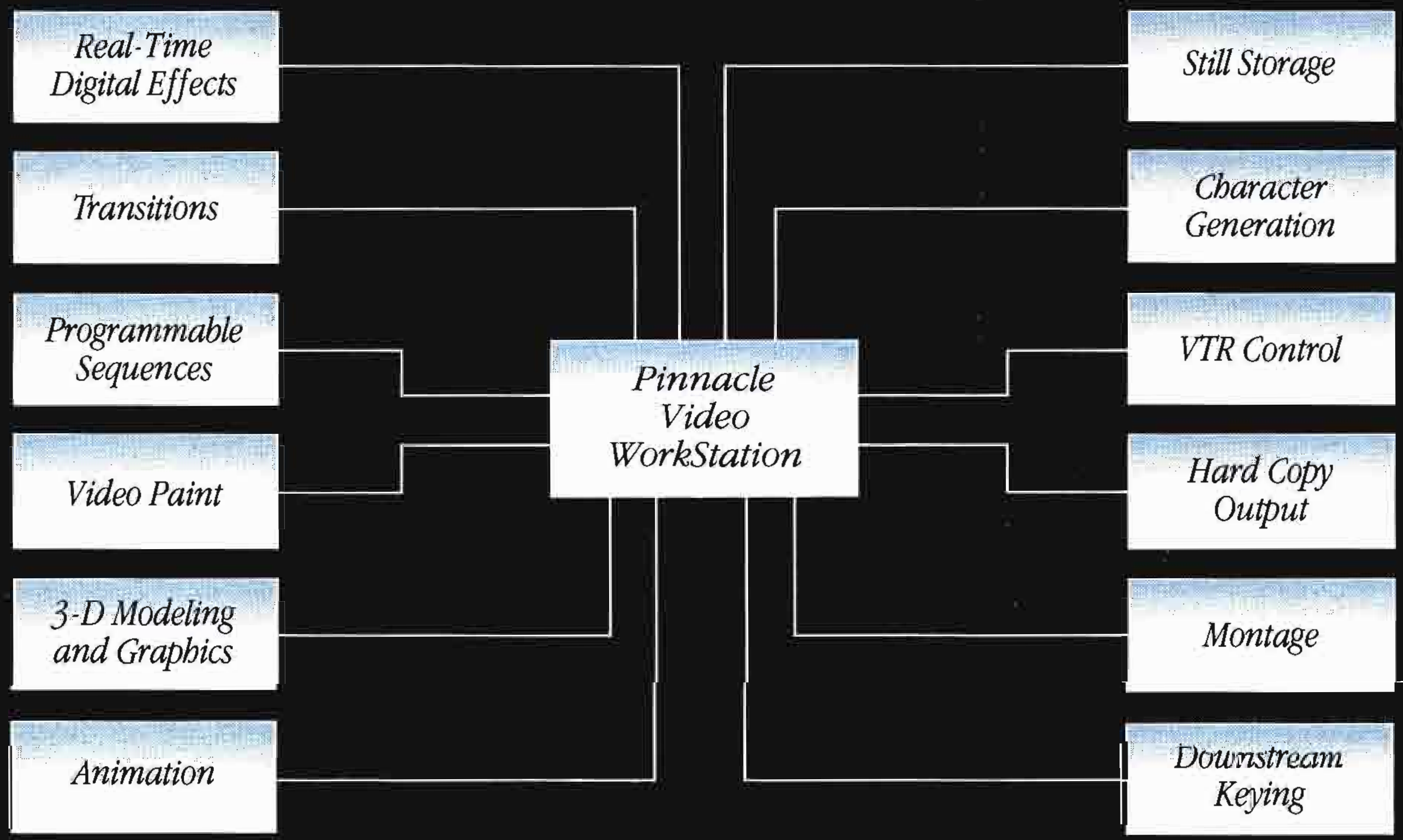

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Continued from page 114

Kansas City building codes also require a minimum setback from the property line of a tower to two-thirds of the tower height. This was the only aspect of the tower licensing procedure in which a variance was requested. The request for a waiver was granted because the area surrounding the tower is remote and sparsely populated. Furthermore, it was demonstrated to the city that if the tower fell straight, it would not hit any homes or other structures.

The station also submitted to the city engineer documentation on towers that had collapsed, showing that the two-thirds setback requirement was excessive. KLSI received case histories of tower failures from several tower manufacturers that showed that when most structures collapse, they do so in a small area surrounding the tower base. In fact, experience has shown that the taller the tower, the smaller the area of the tower collapse.

Auxiliary users

The tower is designed to accommodate 20 2-way antennas and separate feedlines. To facilitate sales of the 2-way spots, KLSI installed four broadband communications antennas and the connecting feedlines during construction of the facility. With the increased use of combined transmitters feeding a single communications antenna, it was believed that the four broadband units would serve the immediate needs of 2-way users.

The antennas installed on the tower initially included 800MHz- and 400MHz-band antennas at two different levels. Theoretically, 10 or more 2-way users can be accommodated by the antenna equipment installed at each level. Hardware options for communications users range from repeaters to trunking systems.

Transmitter building

KLSI has a large transmitter room, and each tenant has its own room, accessible from the outside of the building. The station had considered other designs for multiple-station operations where a common area was provided. It was decided, however, that security would be best served through individual, locked transmitter rooms.

Figure 1 shows the basic floor plan. The building measures 63′x48′ for 3,024 square feet of floor space. The "storage area" in the center of the building is accessible only through "unit 1," the transmitter room for KLSI. Note that all doors except those to the storage area are accessible from outside the building.

Each tenant was free to configure the rooms as necessary. Each arrangement of equipment is unique, including both mechanical and electrical layout. A room was also set aside in the building for telephone interface and auxiliary equipment. Another large room was set aside for 2-way operators. A bathroom was provided for use by any tenant.

Building design

The building is constructed of precast concrete "double-T" sections. The walls and roof are made of the same material. The double-T construction was chosen for its cost, speed of assembly and strength. A number of alternatives were examined, including poured-in-place walls, concrete blocks and metal construction. The station decided that the double-T method afforded the best cost-vs.-performance benefits. Because the site is unattended, security was another important factor in the selection of a construction method.

The double-T sections used for the roof and walls feature insulation cast into them to ease heating and cooling requirements during extreme temperatures. When the design of the transmitter building was finalized, the contractor cast the sections, complete with openings for doors, cables and air-exhaust vents. Because changes after the fact would be difficult, careful plan-

Security for the facility was an important design consideration because the site operates unattended in a remote area. Heavy-duty fencing surrounds the complex.

Standby power is provided only for KLSI, the landlord at the community site. Two other stations using the facility have kept their old transmitter sites for use in the event of a power failure or equipment problem.

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ning was a must.

After the wall and roof sections were cast and delivered to the site, they were set on previously poured footings and raised into place. The sections were then welded together at predesigned tie points. After the shell of the building was completed, the concrete floor was poured.

The possibility of damage from falling ice is an important consideration for a transmitter building in the East or Midwest. An ice bridge was installed to protect the transmission lines, and another was built over the utility company service drop surface-mounted transformer. Utility company switchgear and meter boxes also were protected with grated metal shields. Ice-protection shields are planned for all air-conditioning system components located outside the building.

Transient protection is a major concern because of the high level of lightning activity. This transient suppressor protects the KLSI section of the facility.

Protecting the building roof from falling ice was a major concern. Ice protection consists of a plywood deck placed above the roof double-T section and two layers of closed-cell foam insulation with a membrane seal on top. Above the membrane seal are 2-inch-thick interlocking patio blocks for added protection.

Construction work

The tower went up under the worst of conditions. The crew worked right through the winter. This was not by design, however. Delays experienced during the surveying stage forced construction of the tower and building itself to be moved back, and into winter. It took the geologists nearly six weeks to complete their underground study of the site to determine the best locations for the tower base and the antenna guy wires.

Drilling for the tower pier and guy anchor points began in late October 1986. The first section of the tower was installed during the first week in January 1987. The tower was completed by the third week in February.

Quality control was an important part of the KLSI project. When the city granted approval for the project, it was with the stipulation that an outside inspection firm


Cavity filters (shown in the background) are used on the output of each transmitter at the facility to prevent intermod problems. The combiner for the twin 25kW FM transmitters is shown in the foreground.

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monitor every aspect of tower construction. The city wanted the tower welding to be performed in a certified shop and required that all welding be observed by an outside inspection firm. The station retained Pittsburgh Testing Labs for this work.

An inspector was at the tower company plant while the structure was assembled. An inspector from the firm also was on site in Kansas City as the sections were bolted together. All bolts were checked with torque wrenches to be sure they were tightened to specifications. After the tower was completed, the inspector went from top to bottom checking the installation job.

For its own protection, the tower manufacturer then had another inspector check the tower for adherence to design specifications. The only problems experienced with the installation job involved wiring of the tower ac service and tower lighting system.

ac power

Utility company power enters the facility through a single pad-mounted transformer. The transformer secondary is a 208V 4-wire Wye. It is split off to feed each transmitter room through individual watt-hour meters for the tenants. A separately metered house circuit powers the tower lights and perimeter lighting, plus the telco room and 2-way radio room.

A standby generator was installed for exclusive use by KLSI. The other stations opted to forgo standby power. Two of the stations will maintain their old transmitting sites, eliminating the need for standby power.

Tower/building ground

The grounding system for the facility was designed by the tower manufacturer. It consists of four 6-inch copper straps crisscrossed at the base of the tower and attached to the structure at three points on the base.

Sixty ground radials encircle the tower base and are bonded to the copper straps. The ground system consists of a circle of No. 00 stranded-copper bare wire in a 10-foot radius around the tower base buried to a depth of about eight inches, to which is silver-soldered No. 10 solid-copper wire radials that run out in much the same fashion as an AM antenna system ground. At the end of every second radial, a 10-foot ground rod is driven into the earth and brazed or silvër-soldered to the radial.

A similar, but simplified, grounding scheme is used for each of the six guy anchor points.

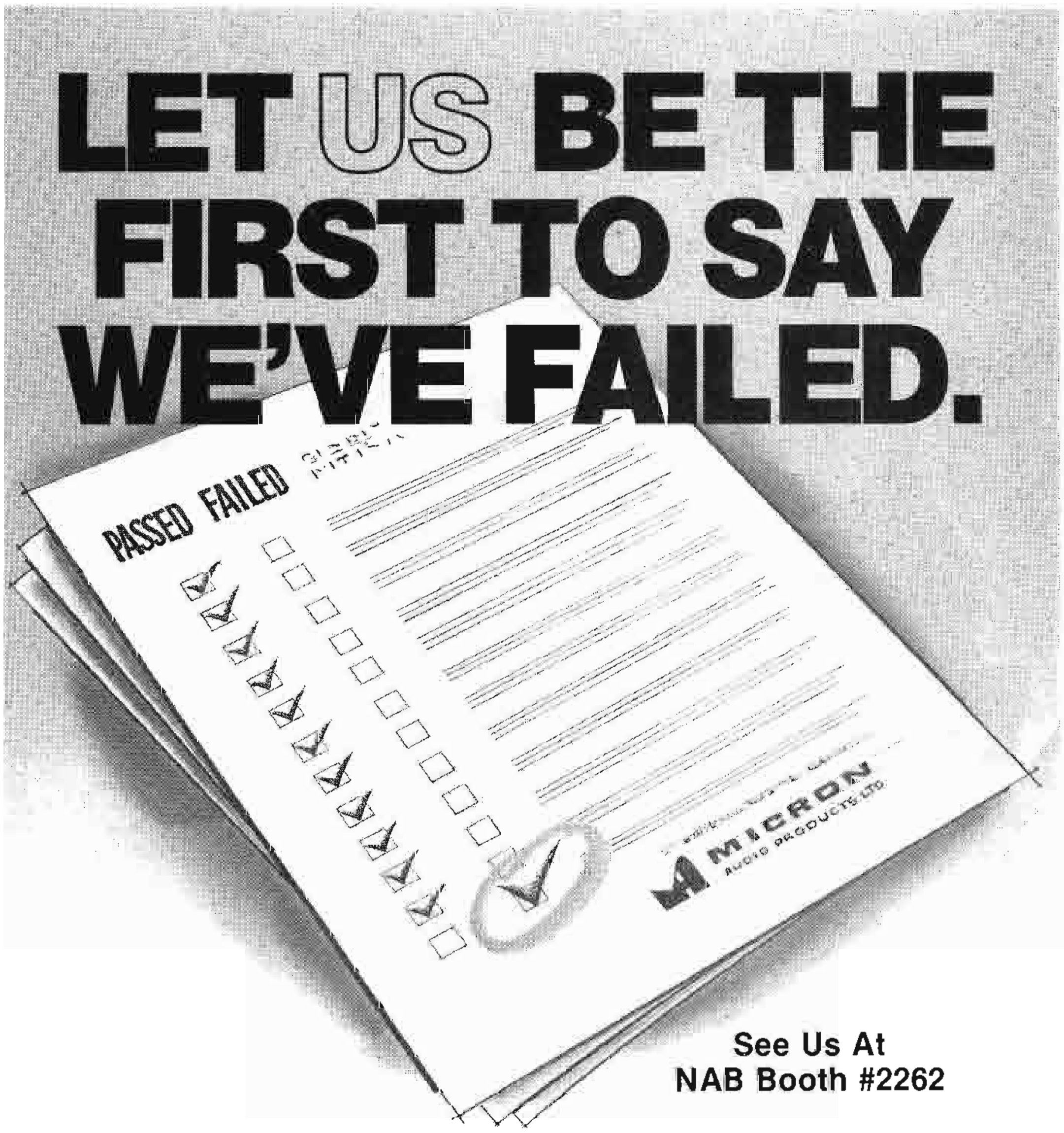
Transmitting facilities

KLSI operates with a transmitter output power of 45kW into a 5-bay antenna for an ERP of 100kW. Twin 25kW transmitters feed a combiner to develop the 45kW signal.

No pattern optimization was performed on the transmitting antennas installed on the tower. The KLSI antenna, mounted on a pole above the structure, was expected to produce predictable results. Additional pattern optimization could have, presumably, been accomplished, but it was determined the improvement would have been negligible.

Pattern optimization typically is performed by adding parasitic elements to the antenna. Antenna icing would have presented operational problems because the antennas were fitted with de-icers, but the parasitic would not have been. High VSWR conditions, it was feared, could result during icing conditions. De-icers were chosen instead of radomes because of the increased weight and windloading of radomes.

Antenna test range studies were used to mount the two lower antennas in an optimum position with regard to rotation about the legs of the tower.



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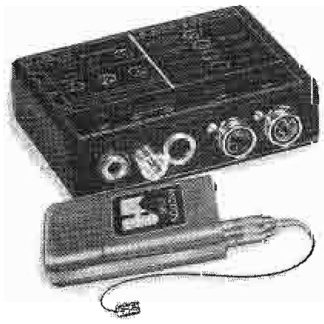

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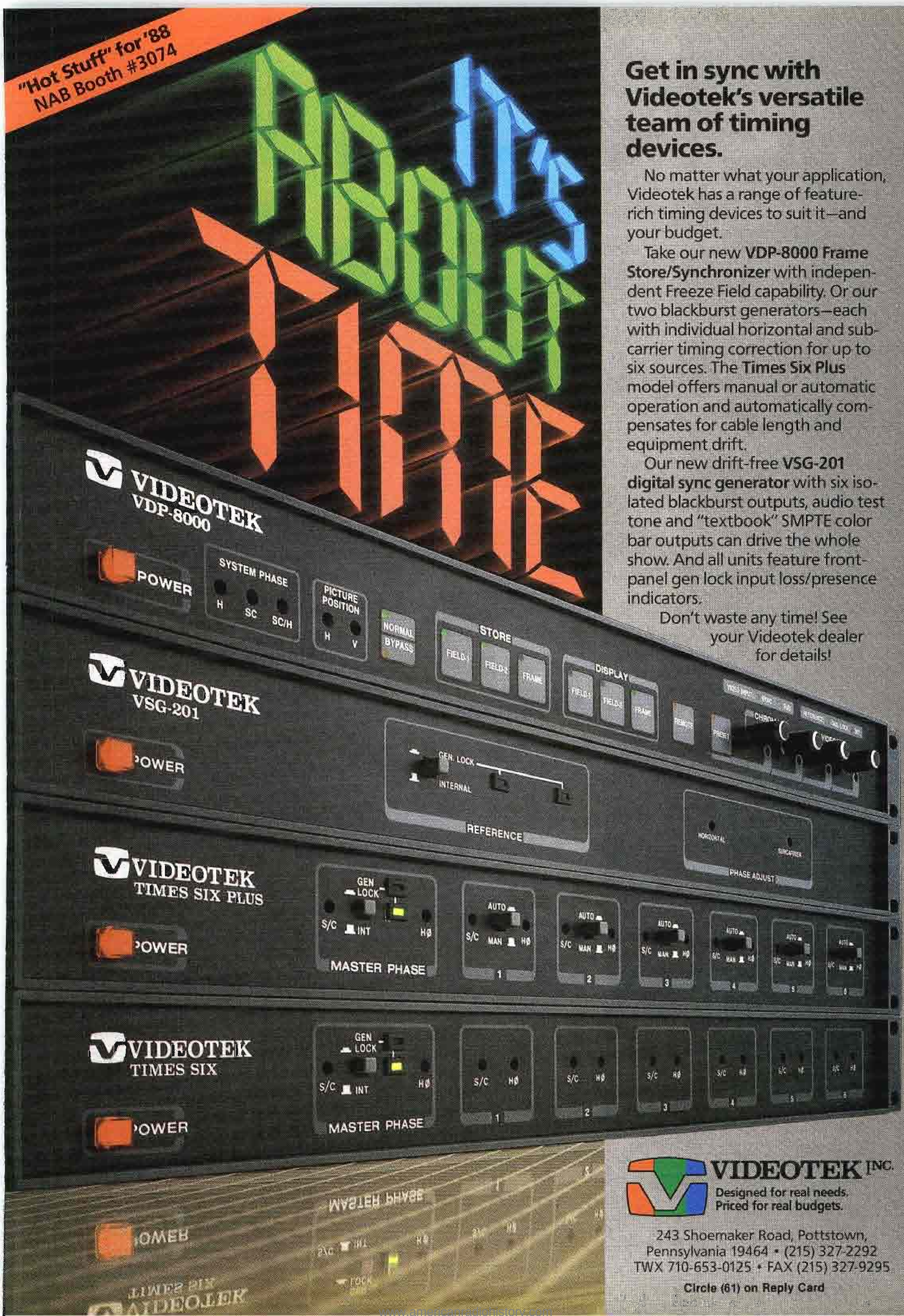

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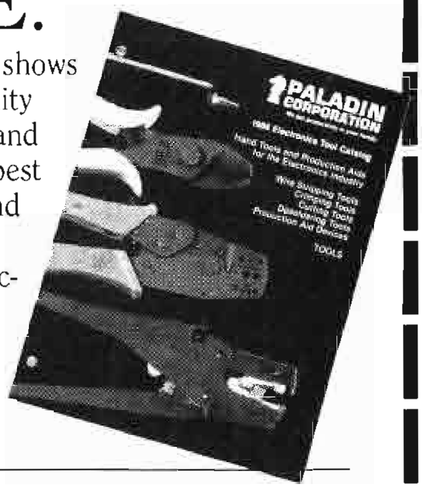

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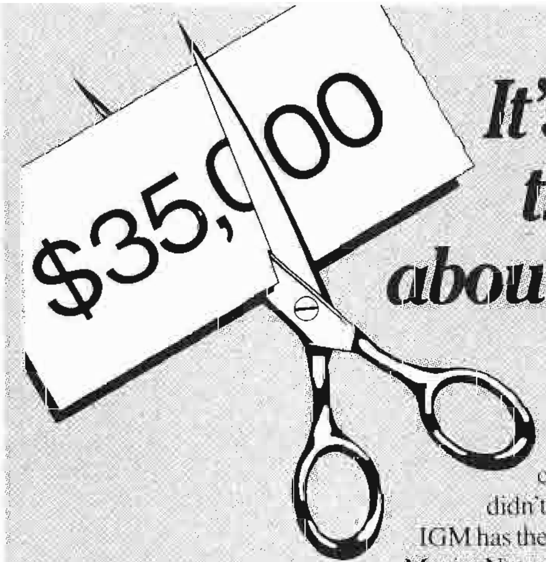

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The price tag

The total cost of the KLSI community transmitter site project came to about $1.75 million. The price ran over expectations because of the problems associated with the undermined area of the land.

The station hopes the project can be paid for through lease revenue within seven years. Paying tenants on the tower include the three FM stations and communications equipment customers.

Beyond 80-90

When Docket 80-90 was implemented, it was acknowledged that some refinements might be needed in the future to take care of unexpected complications. It soon became apparent to the commission that many feasible combinations of power and antenna height for a given coverage area did not fall within the limits of any of the six classes of stations established by 80-90.

This problem occurred because the minimum power requirements adopted in the docket do not make allowances for existing or proposed stations that have relatively high effective antenna heights. Such a station can operate below the minimum power for its class, yet have a range greater than the maximum that could be obtained by a station in the next lower class. This results in gaps in the range of allowable facilities.

To rectify the problem, the commission has amended its rules, in Docket 86-144, to provide a detailed explanation of the method it has used to classify stations since the effective date of Docket 80-90. This method looks first to the maximum and minimum ERP and HAAT limits in the rules, and then—for only those stations outside the limits—relies on a comparison of the station's *reference distance* with six *class contour distances* that are listed in the rules.

Exceptions to the minimum power requirements are allowed for stations with relatively high effective antenna heights and for stations whose reference distances exceed the class contour distance for the next lower class. With this action, the commission essentially ties most of the loose ends with regard to 80-90.

The commission's actions in implementing the docket, and radio stations' responses to it, have put a new face on the FM industry. Improvement projects such as the one documented here point the way to a new level of sophistication for FM broadcasters.

Docket 80-90 has forced the FM industry to embark on what has probably been the greatest concentrated facility renovation effort in the history of radio. When all is said and done, this author believes most broadcasters will agree that the rewards—for FM stations and for the general public—are worth the effort.

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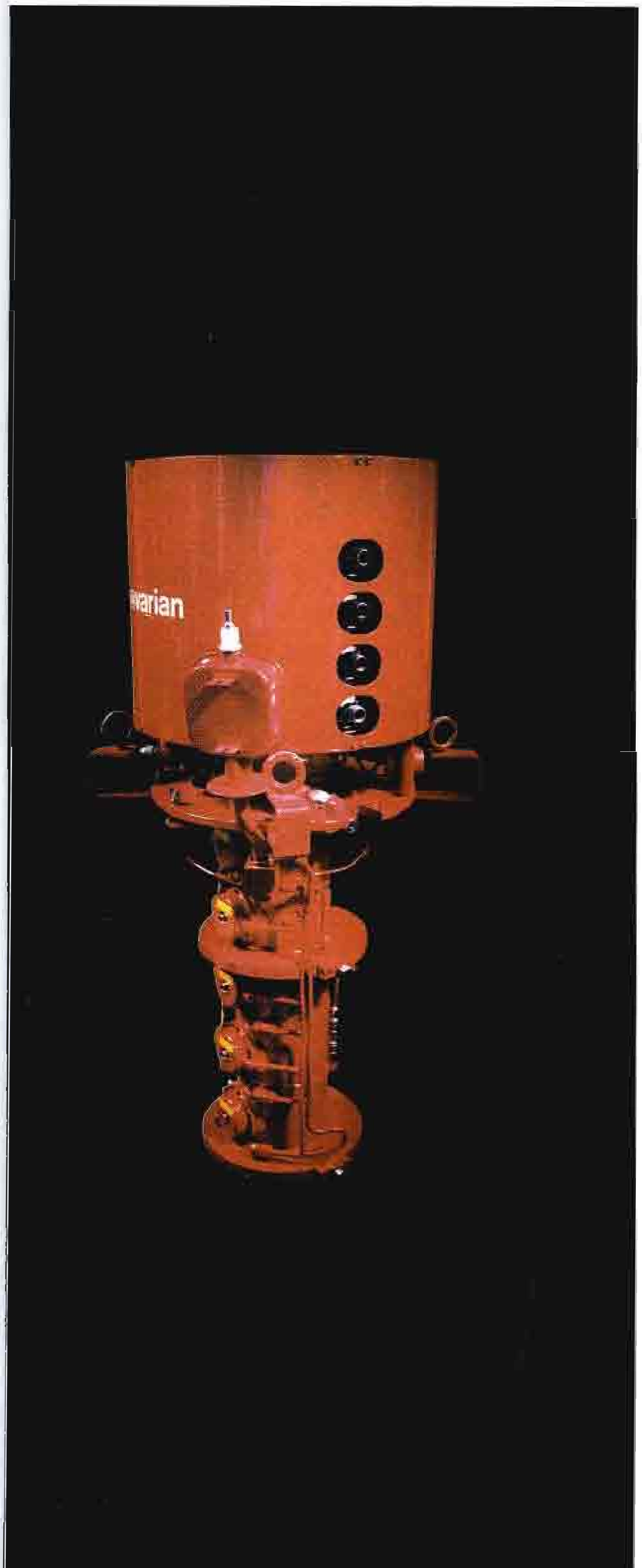

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The photo on the left is the new 60 KW VKP-7995 integral cavity MSDC klystron. This MSDC prototype was developed at the Varian Microwave Tube Division with support from NASA, PBS, NAB and various UHF-TV transmitter manufacturers. This new MSDC klystron will provide a figure of merit of up to 131 and will require approximately 50% of the power required by klystrons of equal power ratings with figures of merit of 65 to 70.

In addition to the integral cavity MSDC klystron, Varian will have its wideband external cavity MSDC klystron in full production by 1989.

Varian Microwave Tube Division
611 Hansen Way
Palo Alto, CA 94303
Telephone: (415) 424-5678

varian

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FROM VARIAN

ACE

ANNULAR CONTROL ELECTRODE

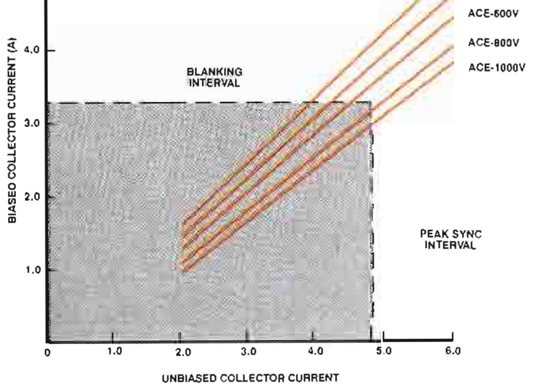
ACE Klystrons

Varian has incorporated an Annular Control Electrode ("ACE") to provide low voltage pulsing capability and efficiency enhancement in our "S" Series UHF-TV klystrons.* In conjunction with the improved linearity correction available from most original equipment manufacturers, these klystrons can provide the highest efficiency available in the world today, with a figure of merit approaching 85. The improved efficiency is coupled with the added reliability inherent in low voltage pulsing systems and the documented life of five cavity klystrons.

ACE Klystron Retrofits

These klystrons are now available from Varian for new transmitter applications and can be readily retrofitted into existing transmitters with kits available from OEMs. Contact Varian for recommendations on retrofits.

***VKP-7553S VKP-7554S and VKP-7555S**



ACE VOLTAGE CHARACTERISTICS AGAINST COLLECTOR CURRENT

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One of the four control rooms used by PBS to originate programming for more than 300 affiliates.

A new home for PBS

By Brad Dick, technical editor

New PBS network facilities are a model of efficiency and flexibility.

Few engineers can identify with the problem faced by PBS engineers on the night of Oct. 15, 1984. On that evening, a fire began on the upper floors of the L'Enfant Plaza building in Washington, DC. Because the building had no sprinkler system, the fire spread rapidly before firefighters could regain control. Hundreds of thousands of gallons of water were poured into the building from aerial ladder trucks and by firefighters who climbed the building's 10 stories with hoses and oxygen masks in an effort to subdue the flames.

Although there were no serious injuries, the network's offices on the fifth and sixth floors of the building were heavily damaged by smoke and water. Unfortunately, water runs downhill. The network's technical center, which was located underground at the second-garage level, was severely damaged by incoming water, smoke and toxic gases. The network was forced to move technical operations to another location.

Temporary operations began almost immediately with help from other public TV facilities. Within four days a videotape truck, loaned by ABC, and a rented mobile unit provided the majority of PBS feeds from the organization's uplink facility in Springfield, VA.

The design process

If there is an advantage to such an event, it is that the engineering staff had the opportunity to design new facilities that incorporate the latest technology and equipment.

After considerable investigation, a new office complex (Braddock Place) in Alexandria, VA, was selected as the location for the new facilities. Because the building selected was designed for standard office construction, it presented many challenges in the design of the technical facilities.

In view of its unfortunate experience at the L'Enfant Plaza location, PBS had no desire to locate its technical facilities below grade again, where cascading water could find its way. The network decided that the new technical facilities would be located above ground, and the building's third floor was selected as the most suitable. The area provided the needed space, and the support columns were spaced 20 feet apart, allowing sufficient flexibility in equipment positioning. The building's 10-foot ceiling height and expansive outside windows created many opportunities for improvements compared with the old facilities.

Interior spaces

The previous facility, completed in the late '70s, was advanced for its time, but incorporated mostly custom-designed hardware and systems. The new TV technical center was required to perform all of the functions of the previous facility, plus provide ample room for growth and technical enhancement. Because of cost considerations, these goals needed to be met through the use of as much standard off-the-shelf hardware as possible.

The new PBS technical facilities include: the television technical center, which is comprised of the technical operations area, equipment center, videotape editing suites, teleconferencing studio, technical maintenance and videotape library support areas; the computer services data-processing center; telephone switch room;

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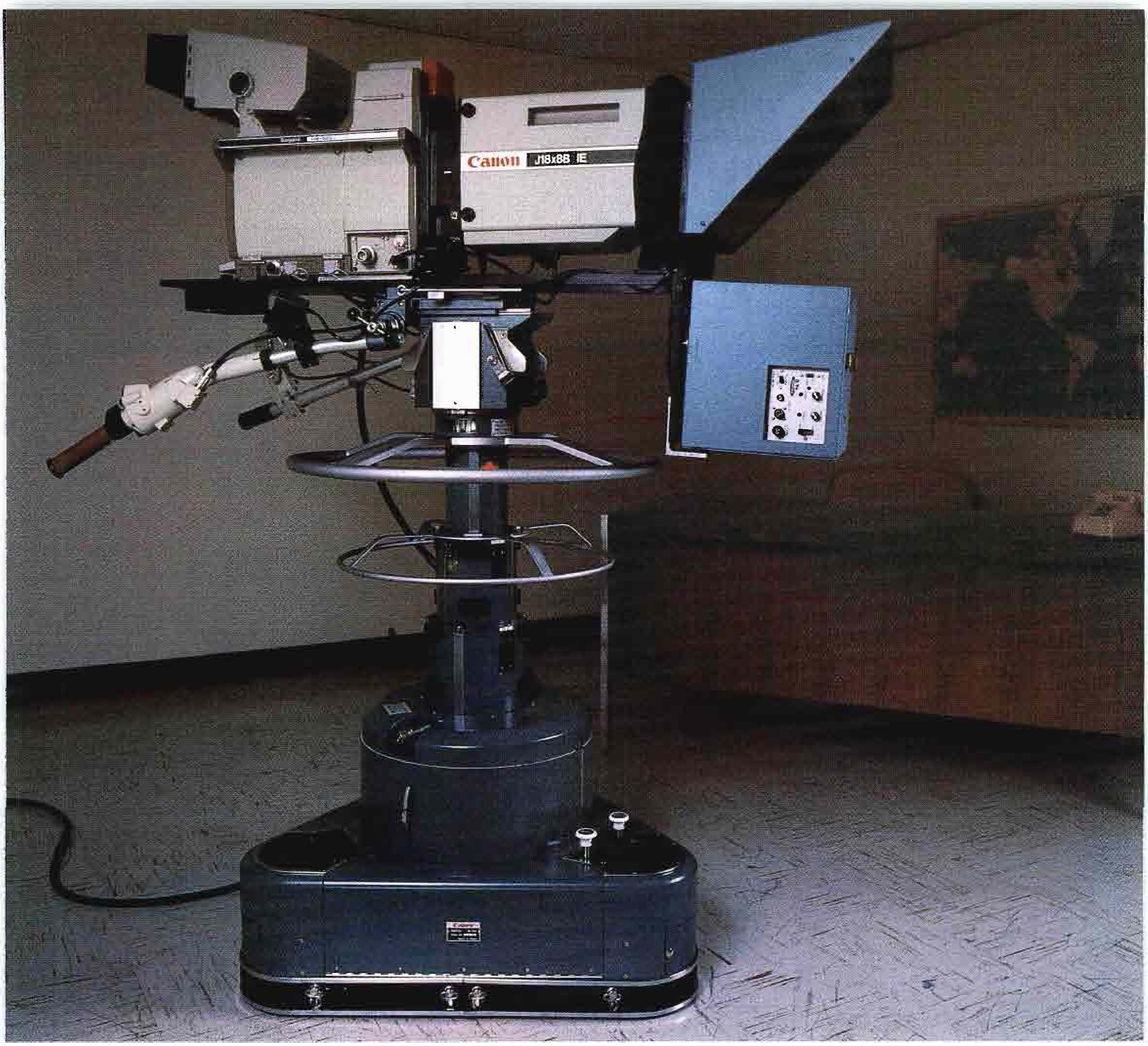

Canon Puts You on a Pedestal

Canon professional support equipment is right at home in the world's most sophisticated studios. Finely finished, rugged and sturdy, yet designed for fluidity of movement, the Canon MC-200 and MC-300 pedestals can handle any camera/lens combination—teleprompters, too!

Canon pedestals are counterbalanced with unique energy cassettes that make set-up a breeze and eliminate the frequent adjustments and servicing necessary with systems dependent on compressed gas. Their very short mounting height enhances low-angle shooting, and they offer the flexibility of 23-60 inch elevations.

Find out more about the quality and value in the entire line of Canon support equipment, including tripods and cam heads. All are sold, backed and serviced by the same people that made Canon the number one name in broadcast lenses. When we offer to put you on a pedestal, it's not a lot of hot air!

Canon

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Optics Division
Canon USA, Inc., Head Office: One Jericho Plaza, Jericho, NY 11753 (516) 933-6300. Dallas Office: 3200 Regent Blvd., Irving, TX 75063 (214) 830-9600
Chicago Office: 100 Park Blvd., Itasca, IL 60143 (312) 250-6200. West Coast Office: 123 Paularino Avenue East, Costa Mesa, CA 92626 (714) 979-6000
Canon Canada, Inc., 6390 Dixie Road, Mississauga, Ontario L5T1P7, Canada (416) 678-2730

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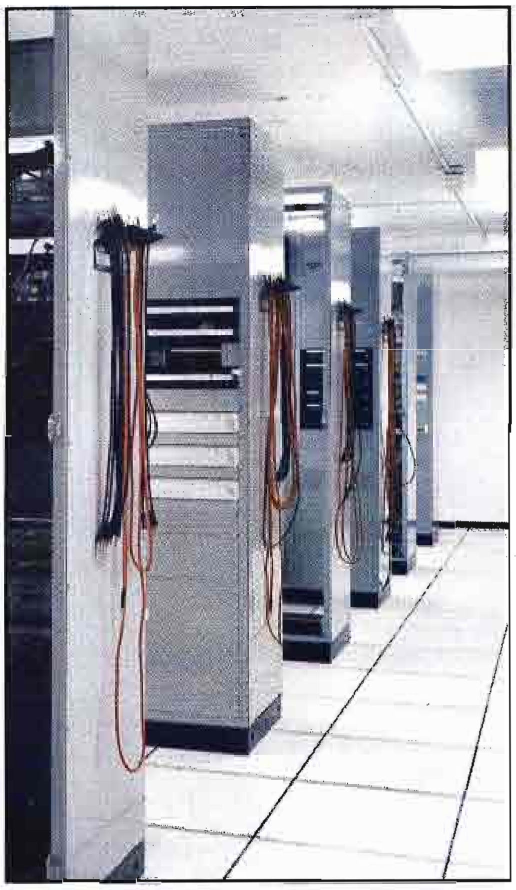
Shortly after the studio fire, network operations commenced from a videotape trailer, borrowed from ABC, and this Video Rentals truck.



The equipment center of the PBS technical facilities.

engineering development laboratory; and technical operations offices. The technical space occupies approximately 21,000 square feet.

Support areas include an electrical distribution/UPS room on the first-garage level, standby generator and TVRO satellite dish at ground level, HVAC equipment at the penthouse level and a microwave relay tower on the main roof.

Electrical power

The facility's design provides three tiers of electrical service for the technical floor: uninterrupted power, conditioned power and utility power. The main 480Vac technical service feeder is separate from the service provided to the rest of the building.

From the complex's transformers, the 480Vac service feeds directly to the third floor, where the power is transformed for distribution to the various load centers. This design substantially reduces the cable and installation costs. The design also reduces current losses from cable resistance.

Redundant public utility feeders to the site were considered, but were determined to be far too costly in comparison with local standby power protection. The technical center and computer room are protected by a 160kW uninterruptible power supply (UPS), which operates as a battery charger/inverter combination. If utility power fails, even for an instant, a battery bank connected in parallel with the rectifier-charger circuit maintains power to the output inverter.

Because the power system is fully regulated, the inverter ac output never changes despite interruptions of the primary input. If the input power is lost for more than 15 seconds, automatic sens-

Improve your favorite camera.

Load the new Sony ECM-672 shotgun on your camera and you'll swear your camera disappeared.

This microphone's unique floating capsule design shuts out vibration and handling noise. And its superior transformer shielding blocks electrical hum and hash from cameras. What you get is the crisp, disciplined sound that Sony shotgun mics are famous for. All in a compact, one-piece package.

It runs on a common AA battery for an uncommon 3000 hours. Or on phantom power. And comes with a windscreen that clamps on so it can't slide off.

Add the virtues of a built-in low cut filter and a modest price and there you have it. A great shotgun that won't shoot your budget to pieces.

To hear more about the ECM-672 and other broadcast quality shotguns, talk to your Sony Professional Audio representative. Or call Sony at 800-635-SONY.

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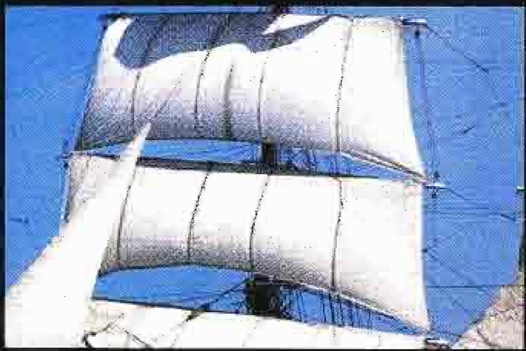
Only Canon Gives You

this...

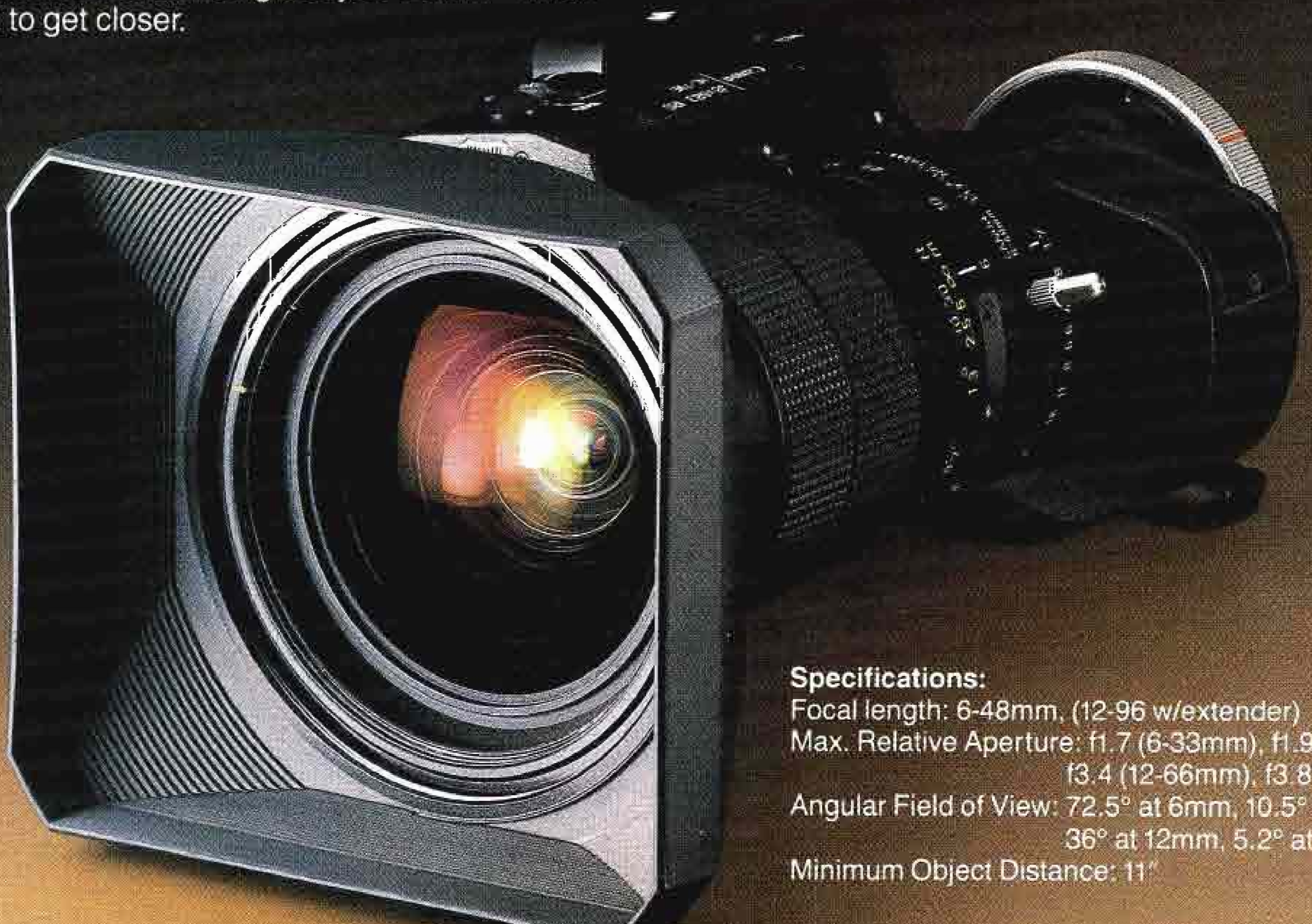


and this... and this!

J8 x 6 BIE: 6mm Wide, 96mm Telephoto, 11″ M.O.D.!

Once again, superior Canon optical technology gives you greater flexibility and capability than ever before. The incredible Canon J8 x 6 BIE lens provides the wide-angle coverage you need in tight situations and its built-in 2X extender gives you 96mm—when you need to get closer.

Better still, even with the 2X extender, you can get as close as you want, since your M.O.D. is an amazing eleven inches, even at 96mm! The Canon J8 x 6BIE, it gives you more.



Specifications:

Focal length: 6-48mm, (12-96 w/extender)
Max. Relative Aperture: f1.7 (6-33mm), f1.9 at 48mm
f3.4 (12-66mm), f3.8 at 96mm
Angular Field of View: 72.5° at 6mm, 10.5° at 48mm
36° at 12mm, 5.2° at 96mm
Minimum Object Distance: 11″

Canon

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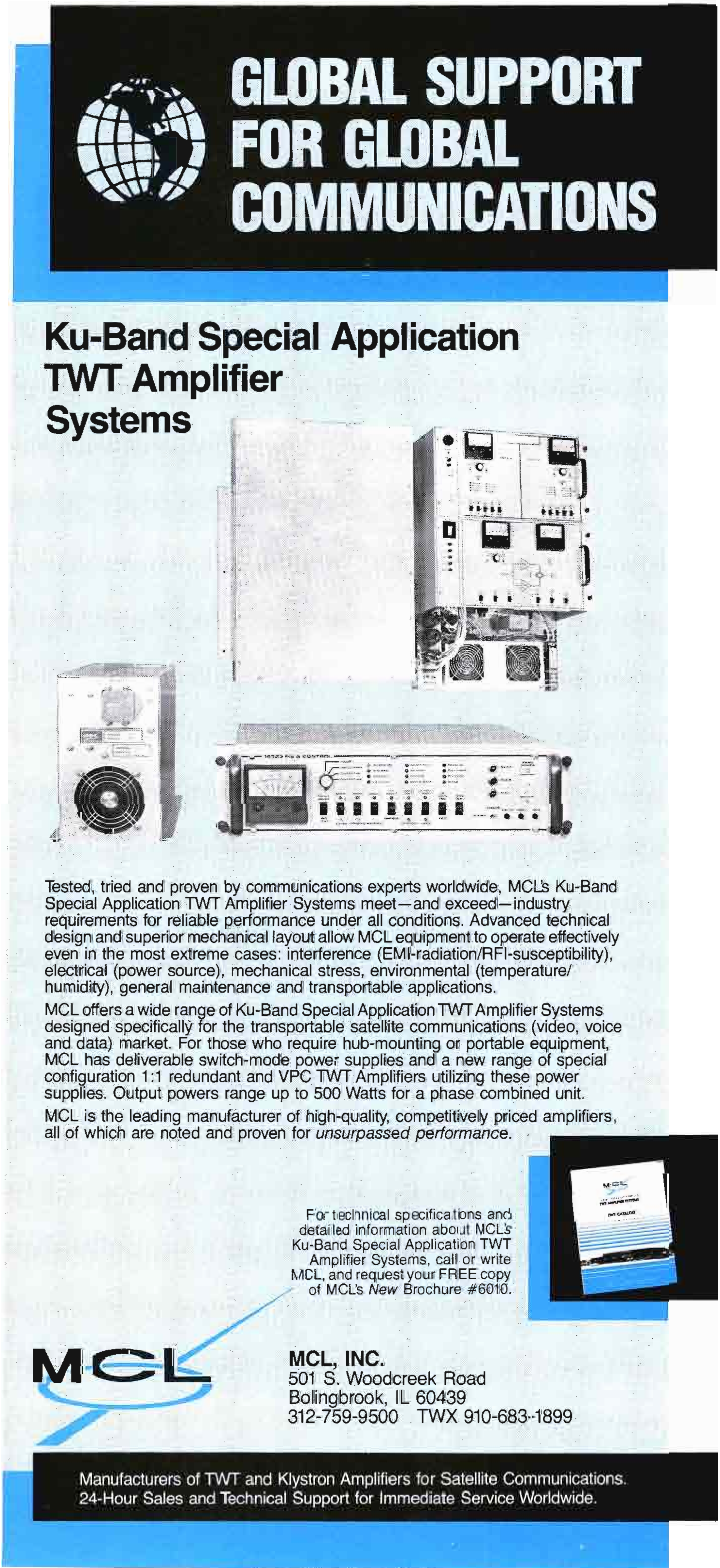

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The technical center is connected via common-carrier microwave to the Bren Mar uplink site, shown here.

ing circuitry in an 800A transfer switch starts the emergency generator. When the generator stabilizes to 60Hz, usually in a matter of seconds, the transfer switch connects the generator to the UPS input, which once again becomes the primary power source. The UPS battery bank can provide the full 160kW output for five minutes, or even longer if the load is less. The generator also provides power for critical air-conditioning and lighting.

The technical center power-distribution design incorporates an *isolated ground system*. All TV equipment and cable shields are connected to this ground and to no other. The ground system is wired in a multiple hub-and-spoke configuration and connected directly to the building service entrance ground.

HVAC

To provide precise temperature and humidity control, and to operate the HVAC system in the most efficient manner, it was necessary to minimize the effect of solar gain and outside temperatures transferred through the windows, which surround the third floor. Even though bronzed thermopane glazing was used throughout the building, low outside temperatures could cause moisture condensation from the 50% relative humidity environment within the building.

To solve the problem, the perimeter of the entire technical area was given a second insulated partition with a vapor barrier. The building's existing window blinds were left closed to maintain the outside appearance. The HVAC system also supports PBS's 2,000-square-foot computer center, the videotape library and the telephone switch room. Each technical area has its own redundant air-conditioning units, which precisely control temperature and humidity.

To reject heat from the conditioned area, a solution of pumped water and ethylene glycol is cooled to outside air temperature on the roof. In the cooler months, the solution temperature is low enough that the system can remove the equipment heat

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Datatek's D-4325 Video/Stereo Audio Switcher Features:

- Program line quality video and audio performance
- Two Video and two full performance audio outputs per channel
- HDTV (30 MHz) compatible; high audio output level capability
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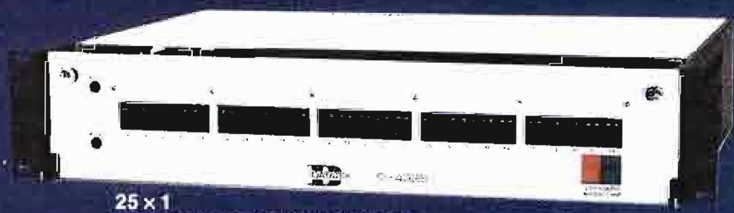
- Local or remote control panels provide unsurpassed flexibility—remote control over coax line
- RS-232/422 control standard
- Wire per crosspoint and binary parallel port control available
- All control arrangements are fully operable in parallel
- Expansion provisions are included



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Video/Stereo Audio Switcher

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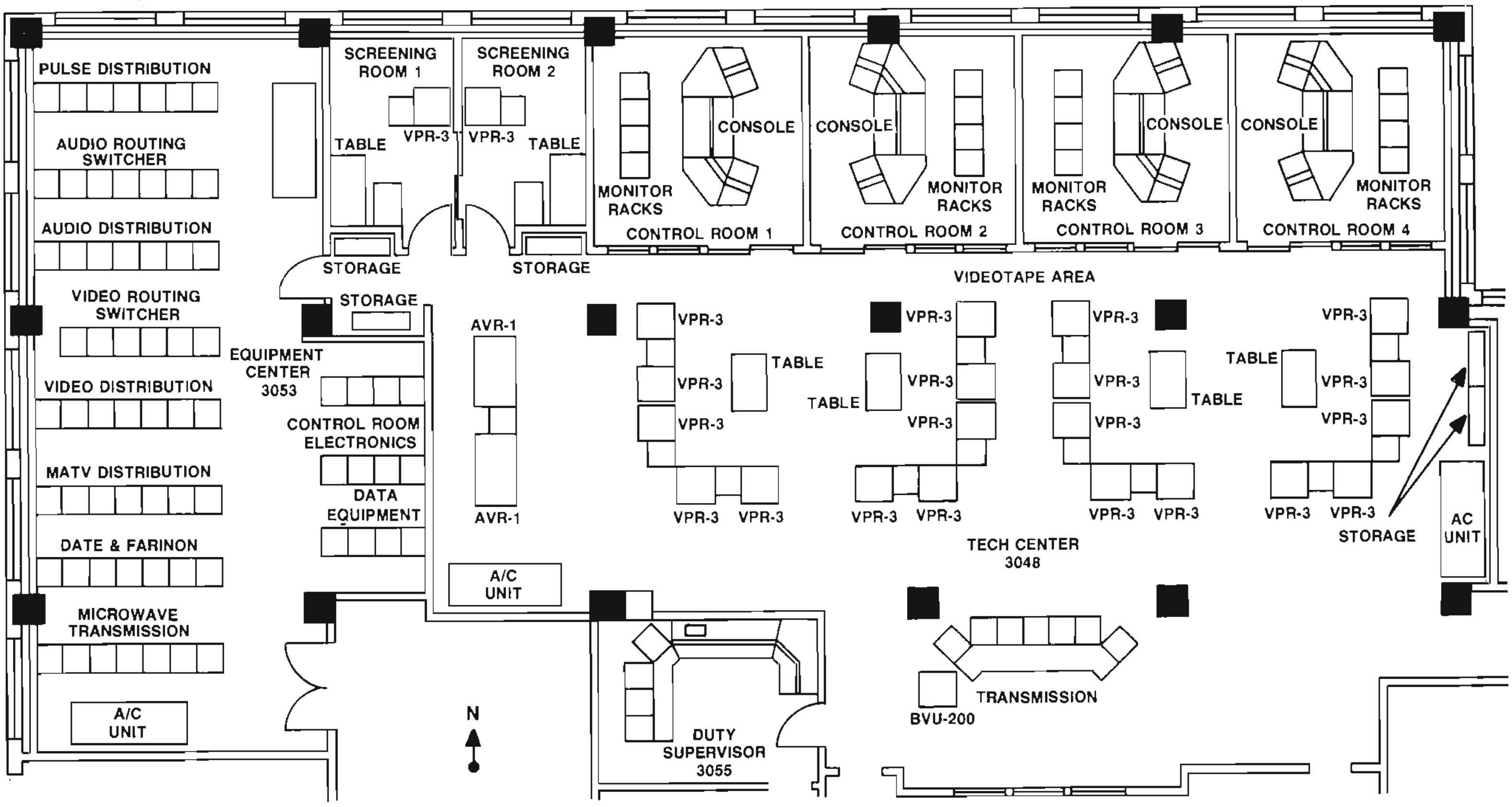


Figure 1. The Hartford N. Gunn Jr. Technical Center occupies more than 12,000 square feet in Alexandria, VA.

without the HVAC compressor. This process reduces operating costs dramatically. The HVAC system has a capacity of 170 tons.

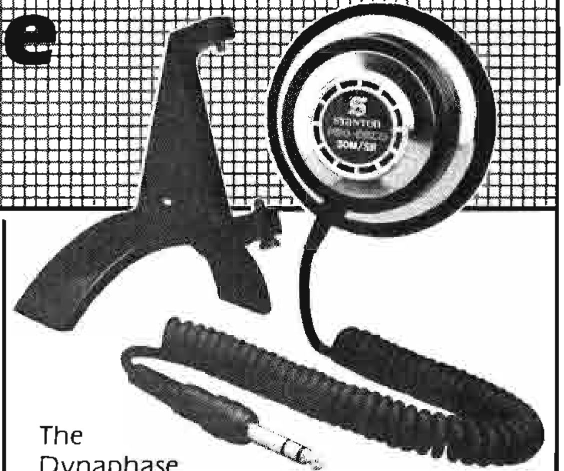
Interconnection

The PBS technical center is connected to the Bren Mar, VA, uplink site via

Continued on page 265

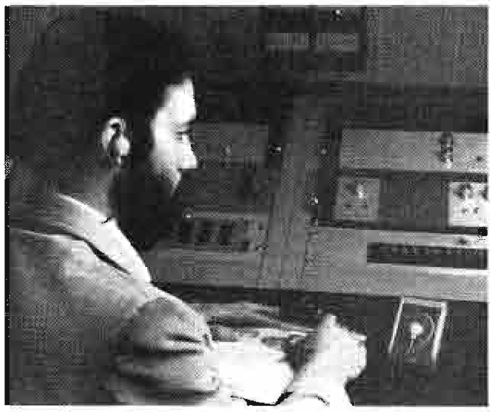
STANTON

The choice of the professionals...



310B
PROFESSIONAL
PHONO PREAMP/EQUALIZER
. . . Interfaces magnetic phono cartridges for optimum calibration of audio systems. Available with balanced or unbalanced output.

'680EL . . . Delivers sound excellence and stands up to backcueing, vibrations and mishandling.



PBR ANNOUNCER'S EARPHONE . . .
Ideal for on camera studio work and remote coverage.

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The Dynaphase 30M/SR is a shoulder rest single cup headphone that provides the ultimate in convenience, comfort and superb sound quality. Made to rest on either your left or right shoulder, or shoulder rest can be detached and used as a single cup hand-held monitor.

500AL . . . For heavy duty on-the-air use with wide tracking force range.

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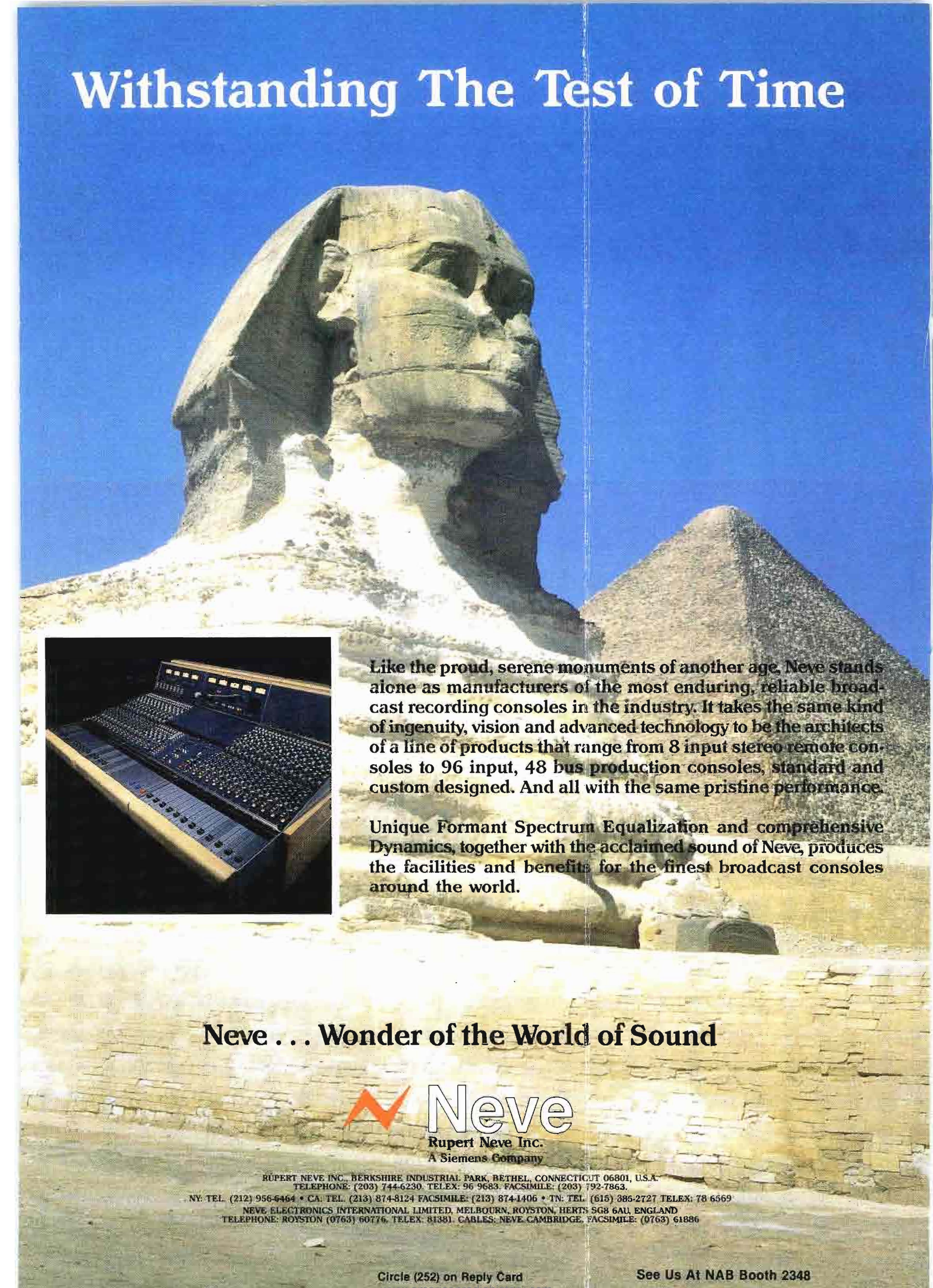

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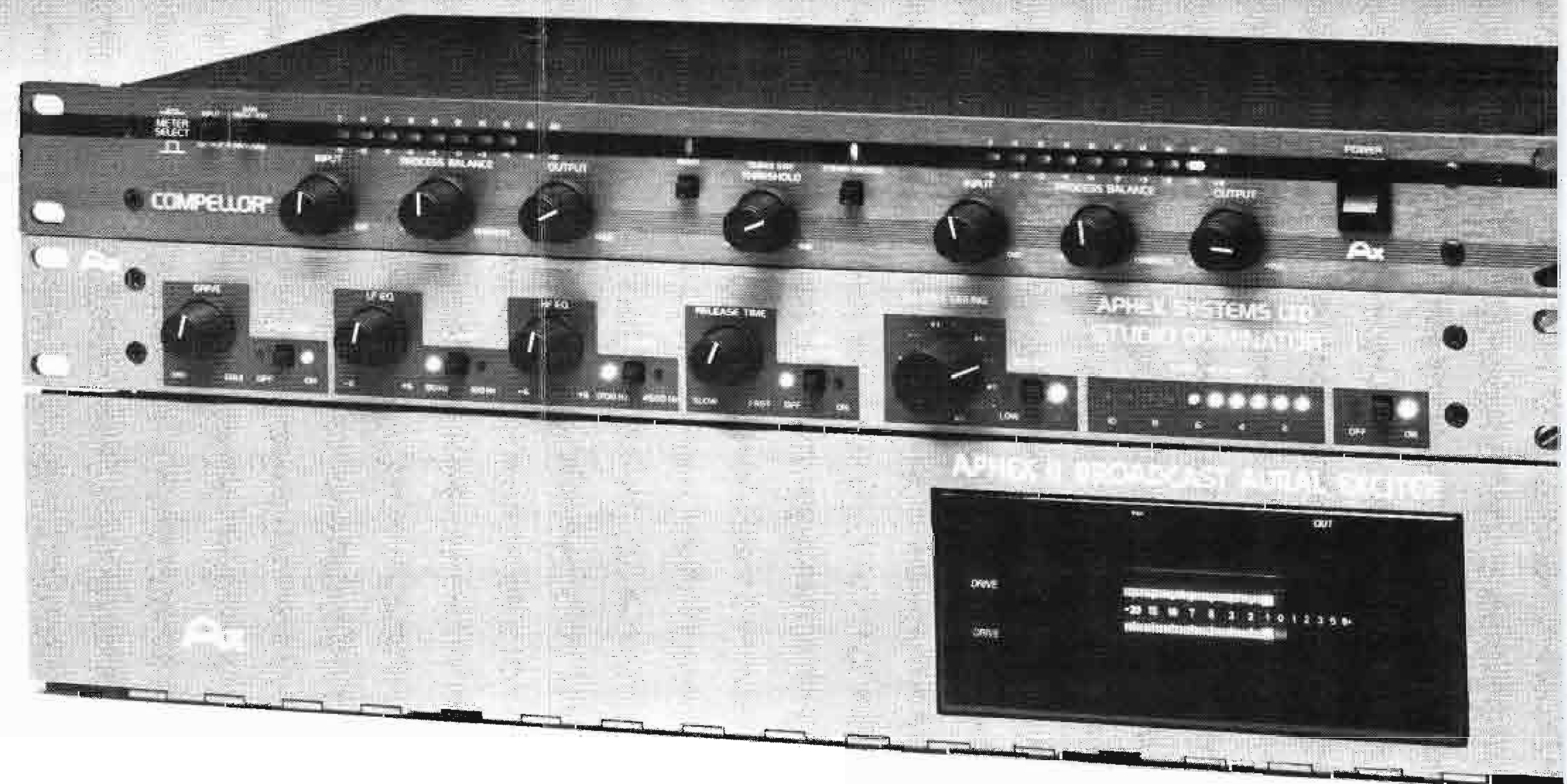
"FM radio has become a ratings war in which we are the casualties by being subjected to a poor excuse for clean accurate music."
Thomas J. Koch, *The Audiophile-File*

Aphex Makes You a Winner In the "No Win Modulation Wars"

KTWV-FM The Wave. WHYI Miami-Ft. Lauderdale Top 40. KKGO America's Jazz Station. WQXR New York's Premier Classical Station. All different, but all winners, because they have an overriding demand to deliver the best in audio quality. They know quality sound is essential to attract and keep loyal listeners.

That's why these premier stations have replaced their old FM processors with The Aphex Audiophile Air Chain, a combination of the Aphex Compellor™ and Dominator™, and/or Aural Exciter® to achieve *consistent high quality sound.* Once set up, this combination of Aphex products will maintain the same high quality regardless of program or who is controlling the board. Compared to other processors which need to be tuned for almost every song and achieve loudness by homogenizing or crunching to the point of pain.

AM, FM or TV…rock to Bach or talk, if you want to be a winner in the "no win modulation wars," call or write to arrange for a demo of the Aphex Audiophile Air Chain.



APHEX SYSTEMS LTD.

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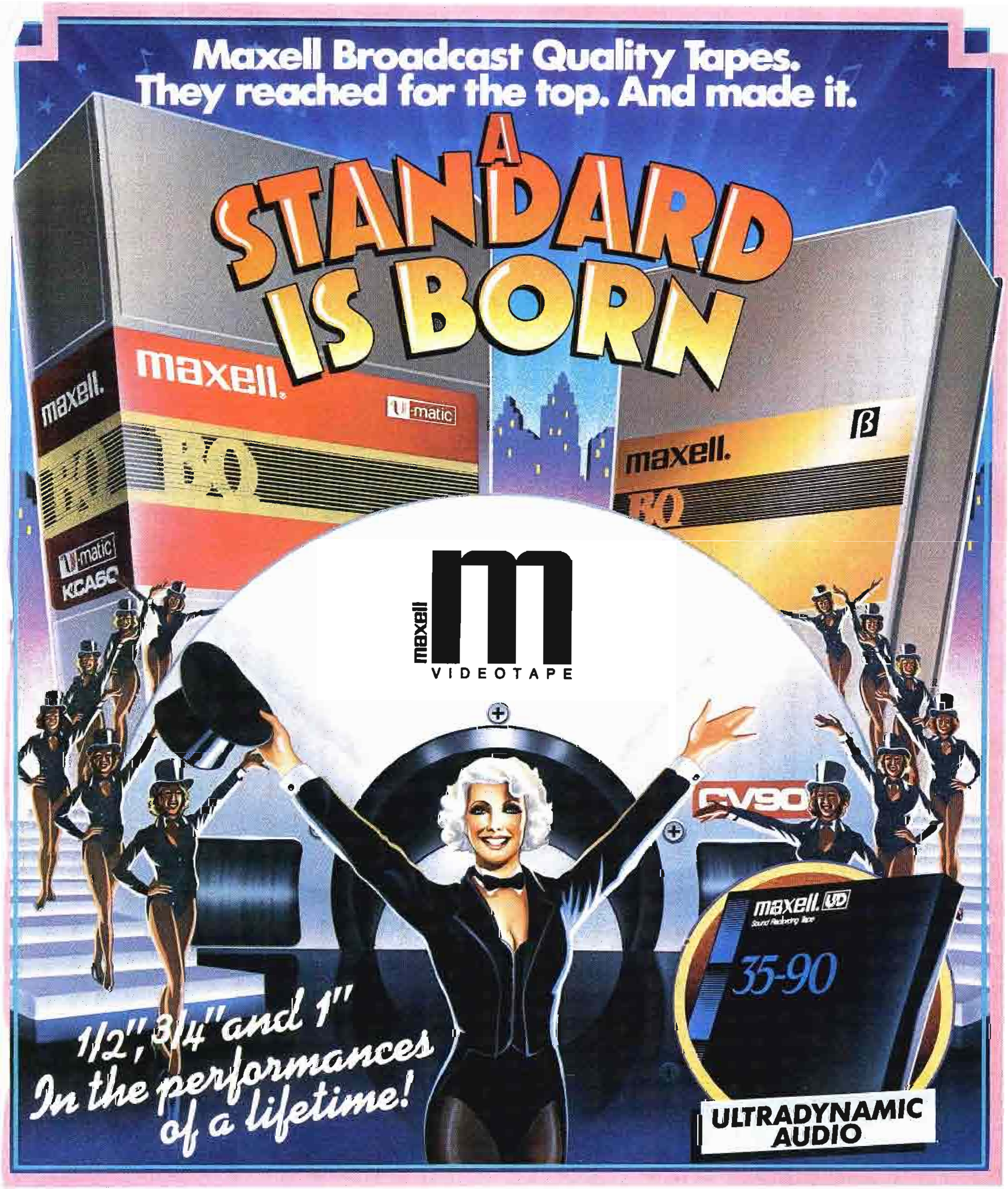

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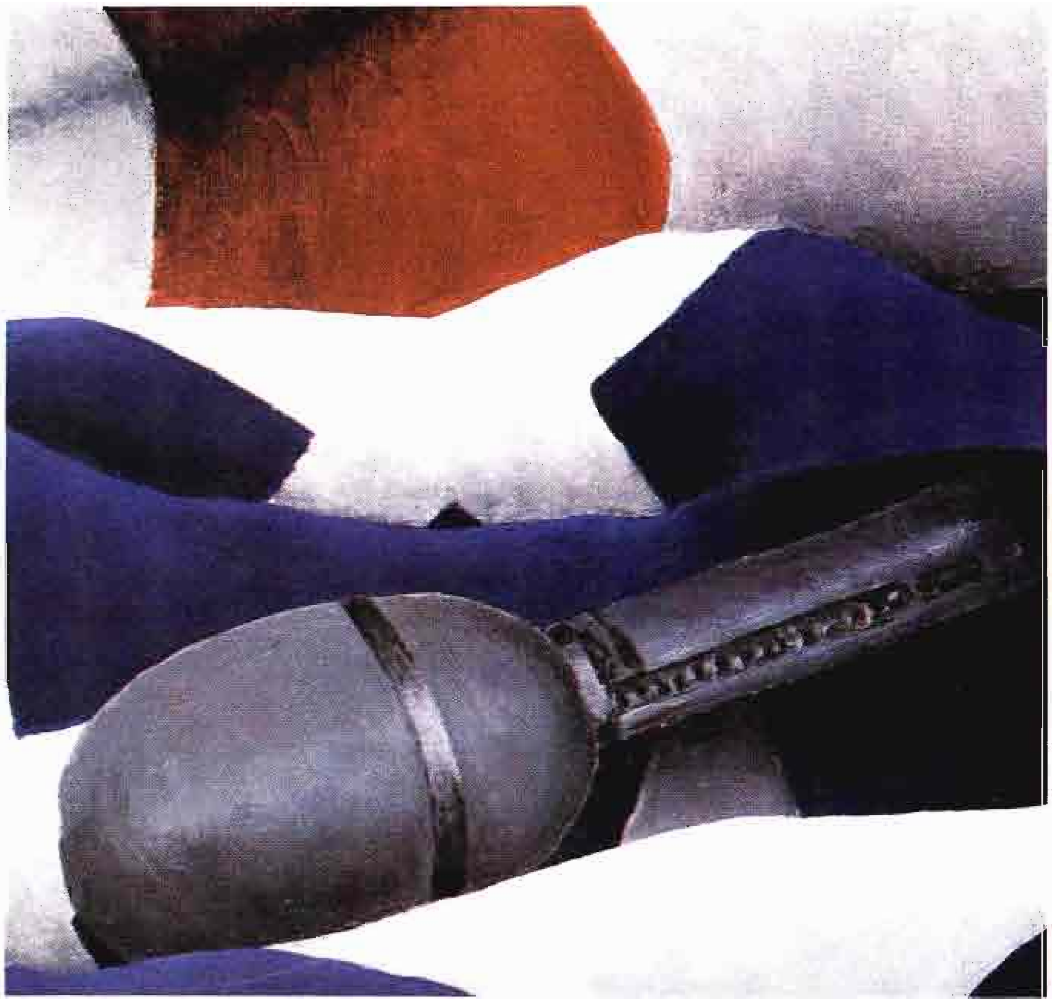
EXHIBITOR LISTINGS



After a 2-year hiatus, it's back to Las Vegas for NAB, which means more exhibit space and fewer transportation headaches between hotels and the convention center. NAB expects another record-breaking attendance, so make sure your airline and hotel reservations are in order.

The **BE** exhibitor guide consists of three parts. The first is a preliminary exhibitor map, inserted into your issue. The map plots the three main exhibition areas: the Las Vegas Convention Center, the Hilton Convention Annex and the parking lot between the two buildings. All Hilton exhibitor booth numbers in the listing begin with an *H*, to remind you that many interesting products will be found in that area. Exhibits in the parking lot area are denoted only by *PL*, because specific space numbers were not available.

Be aware that exhibitor booth assignments may change as late as April 8, but those changes will not be reflected on this map. Although you can tentatively chart your trip through the two indoor exhibit areas with this map, pick up a revised edition of the **BE** map when you register at the show. It will include any changes we have become aware of since its original printing date.

The second portion of the guide is the alphabetical "Exhibitor Listings," which begin on this page. All companies who told the **BE** staff that they planned to attend are included in this list with a generic notation of the products they expect to display. Their assigned exhibit numbers are included, as well as a reader service number, which can be used to request product information from these companies. A *see ad page* line alerts you to advertisements the company has placed in this issue of **BE**.

A code number, such as A1 or V4, that appears with an exhibitor's listing is to be used as a cross-reference to "New at NAB," part three of the exhibitor guide. "New at NAB" is a directory of products to be introduced at this year's convention and contains information provided by the manufacturers. Turn to page 199 to see what's new this year.

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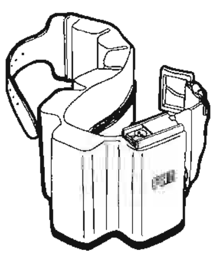
PAG COUNTDOWN TO A NEW PRODUCT AT NAB

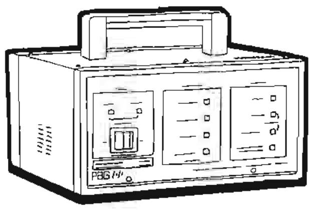
PAG has built a reputation as the leader in the design and development of microcomputer-controlled charging systems. Today: TV camera crews around the world rely upon PAG nickel-cadmium batteries and charging systems.

10



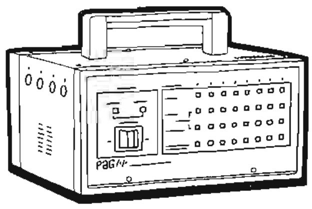
Pagbelts:
High quality, deep-moulded all leather battery belts.

9



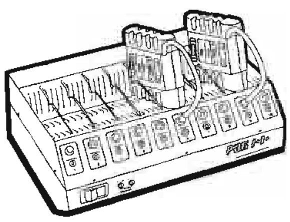
Speedcharge 6000:
Microcomputer-controlled fast-charger for nickel-cadmium batteries. Introduced in 1983.

8



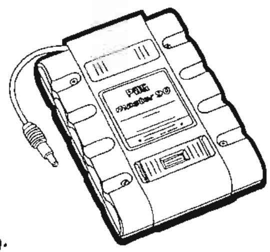
Sequencer 6000:
Combines with SC6000 to fast/slow charge and revitalize up to 8 nickel-cadmium batteries.

7



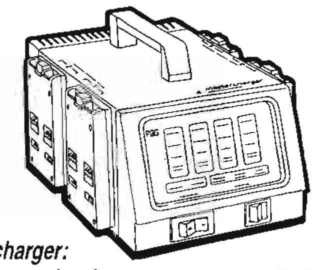
10/90 Multicharger:
A charger/balancer for up to 10 Master 90 or BP90 type batteries.

6



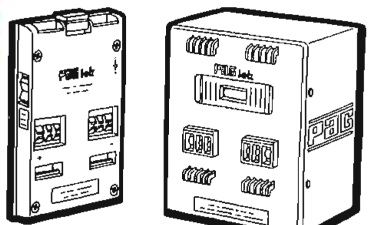
Master 90:
High performance nickel-cadmium battery for use with recorders and cameras.

5



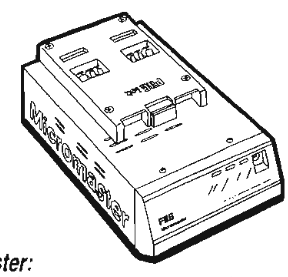
Mastercharger:
Fully automatic microcomputer-controlled 4 channel fast/slow charger.

4



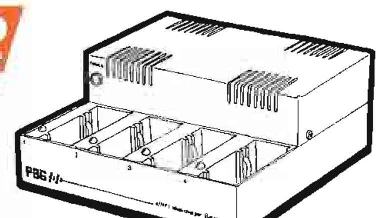
Paglok:
Advanced battery connector, for cameras, recorders and auxiliary equipment.

3



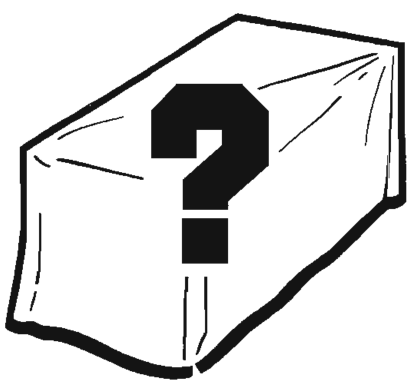
Micromaster:
Smallest microcomputer-controlled fast-charger; weighs only 2lb. AC line. 12V DC input model also available.

2



NP1 charger:
Charger/balancer specifically for use with up to 4 or 8 NP1 batteries.

1



Over the years PAG's research led design team have produced an unparalleled range of products, all of these have been "Stars of the Show": 1988 will be no exception.

To see the latest product unveiled – visit Frezzi/PAG at booth # 2438-2439

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Abbott & Company (4277)
Power connectors, grounding systems.
Circle (501)

Abekas Video (1439)
Digital video disk recording systems, still stores; graphic titling systems; digital effects equipment. (V5)
Circle (502) See ad page 63

ACCOM (H5825)
Circle (503)

Accu-Weather (4151)
Weather graphics equipment, data services, maps. (V5)
Circle (504)

Acoustic Systems (4280)
Acoustic treatments; prefab broadcast booths. (S3, S7)
Circle (505)

Acrodyne Industries (3833)
TV transmitters, translators; Marconi UHF TV transmitter, exciters, drivers. (R1, R5)
Circle (506) See ad page 301

Adams-Smith (1513)
Audio/videotape editing controllers; time code products; transport synchronizers. (A3, V2)
Circle (507)

ADC Telecommunications (3480)
Patch panels, designation labels, patch cords; cable management systems; connectors; hum-stop coils. (S2)
Circle (508) See ad page 323

Adelphon (4256, PL)
Broadcast/communications towers.
Circle (509)

ADM Technology (4369)
Audio mixing consoles; audio distribution equipment; editor-console interface.
Circle (510)

Adrienne Electronics (H5318)
A/V distribution routing switchers; machine control interface cards; time code readers (S1, S5)
Circle (511)

Advanced Designs (4278)
Doppler weather radar systems, display equipment.
Circle (512)

Advanced Micro-Dynamics (H5829)
RF distribution amplifiers; remote control systems. (S1)
Circle (513)

Advent Communications (PL)
Circle (1192)

AEG Bayly (719)
FM broadcast transmitters, exciters, SCA/stereo generation systems; RF coaxial switching; video color correction equipment. (R1, V7)
Circle (514) See ad page 309

Aerospatiale Helicopter (PL)
Circle (1911)

AF Associates (2869)
AVS standards converters, graphics systems; Marconi telecines; Radamac-EPO remote camera control equipment; turnkey facilities, mobile vehicles. (S1, V3, V5)
Circle (515) See ad page 267

Agfa-Gevaert (3880)
Recording media, all formats; R-DAT, digital audio.
Circle (516)

Aircraft Music (1613)
Production music libraries; CD, record, tape formats.
Circle (517)

AKG Acoustics (1245)
Wired, wireless microphones; phono cartridges; headphones; digital audio delays. (A4)
Circle (518) See ad page 179

Alamar USA (3180)
Program and business station automation software, hardware, accessories. (S1)
Circle (519)

Alden Electronics (4566)
Weather radar systems, data services. (V5)
Circle (520) See ad page 23

Alexander Batteries (2205)
Batteries, chargers, battery accessories. (V4)
Circle (521) See ad page 300

Alias Research (H5221)
Electronic graphics art systems.
Circle (522)

The Dorrough Loudness Meter

Dimensions: 8¼" x 2⅞" x 6½" Model 40-A

Simultaneous Display of Peak and Average on a Single Scale

Never before has a gain riding display been able to show what is taking place accoustically and electronically. Through its unique electronics, the 40-A allows the eye to see a one-half cycle excursion at 15kHz, thus helping to keep the audio peaks within the headroom of the equipment.

This meter correlates all types of program material and has led the way to open and clean programming throughout the system.

Specifications
Scale: 40 units in 1dB steps
Input Level: −30 to +20dBm
Input Impedance: 20k bal, 10k unbal.
Power: 120V/220-240V/50-60Hz

See Us at NAB Booths 458 & 460

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Gold Standard.

In finance, the gold standard means unquestioned security and reliability. In broadcast-quality satellite receivers, it means the Agile Omni Professional. From Standard Communications.

Based on intelligent microprocessors, the Omni Pro does most of the thinking for you. You choose the desired satellite signal, and the Omni Pro automatically sets the correct format of C or Ku band antenna inputs, full or half-transponder operation, center frequency, channel spacing, audio subcarrier frequencies and more. In essence, two knobs let you select audio/video performance without confusing conversion or reference tables, without complicated switches and controls, without hassle. But that's just the beginning.

Order the optional RS-232 computer remote control and you can change everything from the transponder bandwidth to the subcarrier frequency, for a whole network or any individual unit, either by phone modem or Earth station uplink.

For broadcast applications, Standard offers the Omni Pro with the Broadcast Performance Package, which includes proof of performance, EPROMs pre-programmed for all domestic satellite formats and channels, multiple IF bandwidths, additional audio subcarrier demodulators, and more.

To get the full story, call or write Standard's SATCOM Division.

And find out how little gold it takes to get on the Gold Standard.

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SATCOM Division

P.O. Box 92151
Los Angeles, CA 90009-2151
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In California (800) 824-7766
(213) 532-5300 Telex: 67-7173

Circle (76) on Reply Card

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Allen Avionics (2705)
Electronic signal filters; video/pulse delay devices; signal attenuators.
Circle (523)

Allen & Heath Brenell (5016)
Audio mixing consoles.
Circle (889)

Allied Broadcast Equipment (557)
Distributors: audio, RF equipment; CD players, digital audio disc recorders; remote equipment controllers; phonograph equipment. (A4)
Circle (524)

Allied Tower (859)
Broadcast/communication towers, services, accessories.
Circle (525)

Allsop (4141)
Tape, phono maintenance products.
Circle (526)

Alpha Audio (2256)
Acoustic treatments; audio editing controllers. (A3, S3)
Circle (527) See ad page 110

Alpha Video & Electronics (2980)
Sony VCR modifications; IFB systems. (A4)
Circle (528)

ALTA Group (H5917)
Digital video production systems, TBC/switcher/effects; dubbing format converters; signal distribution equipment. (V7)
Circle (529) See ad page 88

Altronic Research (1250)
RF dummy load and RF power test equipment (S6).
Circle (530)

Amber Electro Design (1201)
Audio test/measurement equipment; distortion analyzers. (S6)
Circle (531) See ad page 180

AMCO Engineering (2709)
Equipment racks, EMI-ratings, standard/custom designs.
Circle (532) See ad page 250

AMEK/TAC (145)
Audio mixing consoles; console control interfacing. (A1, S1)
Circle (533) See ad page 263

American Studio Equipment (H5012)
Grip, electrical equipment; special camera mounts, dollies.
Circle (534)

Amperex Electronic (2541)
Plumbicon camera tubes; CCDs; klystrons, power tetrodes. (R3, V1)
Circle (535) See ad page 42-43, 188-189

Ampex AVSD (3302)
Videotape recorders, still stores; TBC/synchronizer, signal processors; electronic graphic art systems; digital effects equipment; ENG cameras; video production, master control switchers; editor controllers. (V1, V2, V5, V6, V7)
Circle (536) See ad page 66A-H

Ampex MTD (3302)
Audio/video recording media, all formats. (S4)
Circle (537) See ad page 45, 47, 49, 51

AMS/Calrec (3372)
Audio delay-based effects systems; digital audio disk recording equipment; audio consoles; monitors, speakers. (A1, A3)
Circle (538)

Amtel Systems (2444)
Time code equipment; editing systems; transport synchronizers; distribution amplifiers, routing switchers; timer systems.
Circle (539)

AMX Corporation (H5910)
Remote controllers for A/V equipment, teleconferencing systems; distributor of audio, video and RF multiplex equipment. (S1, S5)
Circle (540)

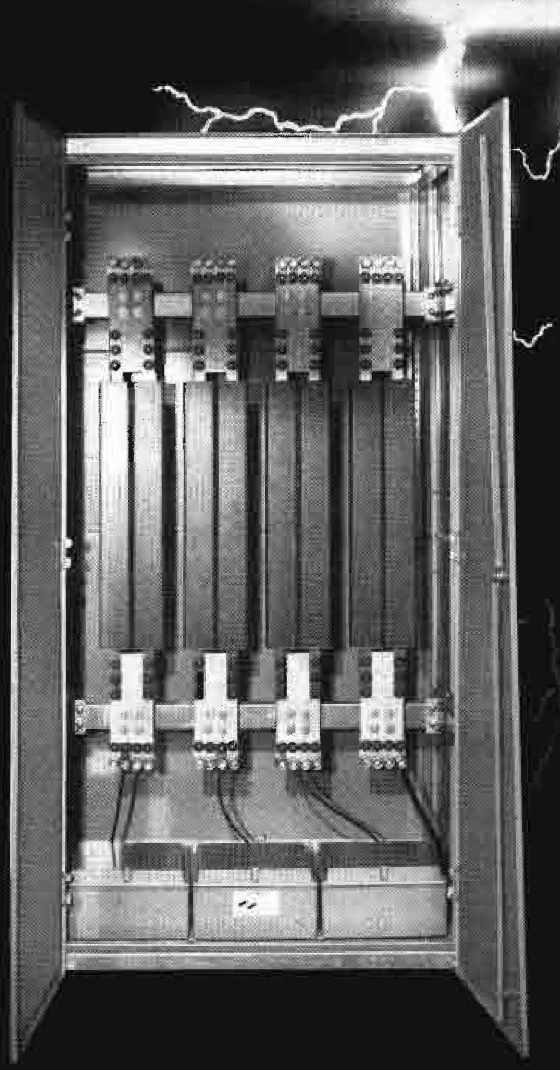
Andrew (1811)
RF transmission line, coaxial, waveguide products, pressurization products; broadcast, satellite, microwave antennas; equipment shelters; antenna guidance controllers; fiber optics products. (R1, R6)
Circle (541) See ad page 255

Angenieux (2634)
TV camera lens systems, accessories. (V1)
Circle (542)

Anritsu (H5002)
RF test equipment.
Circle (543)

ANT Telecommunications (170)
Noise reduction systems. (A2)
Circle (544)

Islatron®
before the "damage" is done...



Islatron power line protection safeguards both your income and your broadcast investment.

Islatron's patented Active Tracking® technology not only protects your station from lightning induced voltages, but also from the cumulative daily degradation of your equipment caused by electrical disturbances present on your distribution systems. This constant protection means longer equipment life and less maintenance.

I.E.E.E. studies indicate every location has at least 3 damaging disturbances per day. Remote control systems, satellite links, VCR's, switchers, carts, microprocessors and solid state equipment all need Islatron protection. Units are available for your lowest power requirements up to the largest FM and UHF transmitters. MTBF more than Ten Years, 5 Year Warranty.

Free: Get the facts on the exclusive Islatron Active Tracking system...before the damage is done. Visit NAB booth 4159.

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CONTROL CONCEPTS BROADCAST GROUP
P.O. BOX 1380
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(607) 724-2484

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BROADCAST AUDIO CORPORATION

SERIES IV

CUSTOM VERSION

- All new electronics and audio transformers, for superb audio quality — ideal for compact disks. New *plug-in* audio inputs.
- Transformer mic *and* active balanced line inputs on every mixer position. Optional transformer-less mic input.
- Optional 5-frequency EQ and Pan Pot on *any* mixer position.
- Optional Aux Send module for reverb and effects.
- New and improved slide fader with external cue detent switch.
- Prefader patchpoints and phantom power supply inputs on each mixer.
- Optional peak flashing indicator behind red area of VU meters.
- New control room monitor module with 3-frequency headphone EQ.
- Front panel digital up-timer.

Five models available with 6-16 mixers — call for brochure.

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Anton/Bauer (2239)
Batteries, chargers, evaluators; portable lighting equipment. (V4)
Circle (545)

Anvil Cases (1881)
Equipment cases. (S3)
Circle (546) See ad page 248

AP/Broadcast (2874)
News programming services.
Circle (547)

Aphex Systems (870)
Audio dynamics, spectral energy processors; FM stereo generators. (A2)
Circle (548) See ad page 132

Apollo Audio-Visual (H5826)
Circle (549)

Arben Design (4563)
Studio fixtures, cyc mounting equipment; facilities design. (S3)
Circle (550)

Arbitron Ratings (2369)
Audience research services.
Circle (551)

Arrakis Systems (465)
Audio mixing consoles, routing switchers, DAs; studio furnishings. (A4, S3)
Circle (552) See ad page 21, 61

Arriflex (2669)
Cine cameras, lenses, accessories; lighting accessories; time code devices. (V1, V3, V4)
Circle (553)

Artel Communications (2077)
Fiber optics products. (S2)
Circle (554)

ASACA ShibaSoku (2642)
Videotape/disc program automation systems; AF, video, RF test products; MTS TV demodulators; VTR test equipment; video monitors; HDTV equipment; magnetic/optical recording systems. (V2)
Circle (555)

Associated Computer Services (H5529)
Circle (556)

Associated Production Music (2216)
Production music services; music libraries. (S8)
Circle (557)

Aston Electronics (H5725)
Graphic titling systems. (V5)
Circle (558)

AT&T (3080)
Telephone services; electronic graphic art equipment. (V5)
Circle (559)

ATI/Audio Technologies (359)
Audio mixing systems, DAs, monitoring amps, dynamics processors; impedance interface equipment; mic, phono preamps. (A4, S6)
Circle (560) See ad page 133

Audico (1830)
Audio/videotape winders, cyclers, loaders; batteries. (V4)
Circle (561)

Audi-Cord (615)
Audio cartridge recording/playback systems.
Circle (562)

Audio Accessories (H5729)
Distributor of audio, video and test equipment.
Circle (563) See ad page 204

Audio Broadcast Group (1033, PL)
Audio monitor systems; studio design/installations; BE cart recorders.
Circle (564)

Audio Developments (2330)
Audio and edit mixing systems. (A1)
Circle (1181)

Audio Kinetics (259)
Time code systems; transport synchronizers; console automation.
Circle (565)

Audio Precision (1030)
PC-based audio system test software, hardware; audio distortion analyzers. (S6)
Circle (566) See ad page 325

Audio-Technica US (665)
Microphones; portable mic mixers; headphones; phono cartridges; audio accessories. (A1, A4)
Circle (567) See ad page 81

Audio-Video Engineering (1848)
Video hum-stop filters. (S6)
Circle (568) See ad page 276

Auditronics (453)
Audio mixing consoles.
Circle (569) See ad page 191

Aurora Systems (2377)
Electronic graphic art systems.
Circle (571)

Autogram (124)
Audio mixing consoles; timer systems. (A1)
Circle (572)

Automated Business Concepts (1651)
Software for management, accounting, sales, programming. (S1)
Circle (573)

AVCOM of VA (H5331)
Satellite/microwave receivers, downconverters. (R6)
Circle (574) See ad page 172

AVS div/AVESCO plc (2869)
Standards conversion, TBC/synchronizer equipment; electronic graphics systems. (V5)
Circle (575) See ad page 285

BAF Communications (H5429, PL)
Satellite relay vehicles, uplink trucks, flyaway systems; computer hardware. (S7)
Circle (576)

William Bal (2611)
Equipment cases.
Circle (577)

BAL Components Ltd (2601)
Video, pulse delay, filter products.
Circle (578)

Barco Industries (2983)
Video monitors, video decoders; TV demods, modulators; graphic art systems. (V8)
Circle (579) See ad page 219

Barrett Associates (156)
Satellite programming controllers; remote sensing systems; audio, RF product distributors.
Circle (580)

BASYS (3884)
Computerized newsroom systems, software, hardware. (S1)
Circle (581) See ad page 52-53

B&B Systems (2473)
Audio signal phase measurement, test systems; turnkey facilities design. (S6, S7)
Circle (582) See ad page 284

BCS (H6116)
Used broadcast equipment brokers.
Circle (583)

Beaveronics (1848)
Video switchers; studio timers, Favag clocks.
Circle (584)

Belar Electronics Lab (553)
AM, FM, TV modulation monitor systems; frequency monitors. (S6)
Circle (585) See ad page 168

Belden Wire/Cable (1224)
Audio, video wire, cable, coax, fiber optic material.
Circle (587) See ad page 183

Bencher (3987)
Animation, copy stands.
Circle (588)

Benchmark Media Systems (4287)
Audio DAs, preamps, meters, tone generators.
Circle (589) See ad page 162

Beyer Dynamic (1824)
Microphones; audio delay equipment, wireless mics. (A4)
Circle (590) See ad page 163

BFMA & BCA (3909)
Circle (591)

BHP/enVision Systems (H5619)
Video editing control systems. (V2)
Circle (592)

Birch Radio (3901)
Circle (593)

Bird Electronic (635)
RF load resistors, attenuators, wattmeters.
Circle (594)

Blimpy/Bend-A-Lite (N.A.)
Promotional signs, lighting products. (S8)
Circle (595)

BMI/Broadcast Music (E001)
Music licensing.
Circle (596)

BMS/Broadcast Microwave (4123)
ENG microwave transmitters, receivers, antennas; ENG tracking systems.
Circle (597)

Bogen Photo (4505)
Camera support products.
Circle (598)

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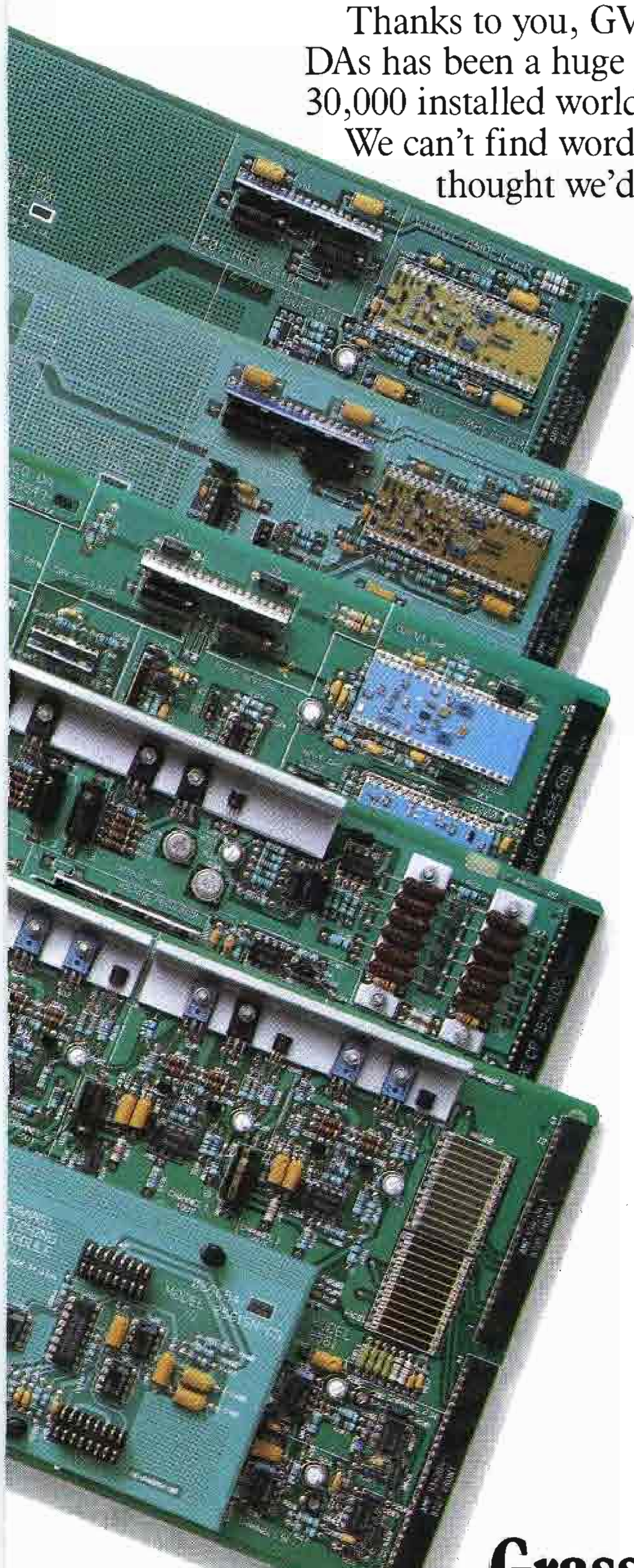
Now you'll pay even less for a GVG DA.

Thanks to you, GVG's family of high performance DAs has been a huge success. So far, there are over 30,000 installed world-wide.

We can't find words to express our gratitude, so we thought we'd use numbers, instead:



8501 Video DA
~~$175~~ old price — $160 new price

8502 Equalizing DA
~~$285~~ old price — $260 new price

8503 Precision DA
~~$395~~ old price — $375 new price

8551 Audio DA
~~$275~~ old price — $250 new price

8561 Stereo DA
~~$525~~ old price — $495 new price

Grass Valley Group DAs make extensive use of advanced hybrid circuit technology. And now, feature an all-time high performance-to-price ratio.

Grass Valley Group®

STRENGTH YOU CAN RELY ON

THE GRASS VALLEY GROUP, INC.® — P.O. Box 1114 — Grass Valley, CA 95945 USA — Telephone (916) 478-3000 — TRT: 160432
OFFICES: New York (201) 845-7988; District of Columbia (301) 622-6313; Atlanta (404) 493-1255; Chicago (219) 264-0931;
Minneapolis (612) 483-2594; Dallas/Fort Worth (817) 483-7447; Los Angeles (818) 999-2303; San Francisco (415) 968-6680 *A TEKTRONIX COMPANY*

Circle (79) on Reader Card

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Wouldn't it be great if somebody built a fully integrated station automation system that could handle all on-air operations, with off-the-shelf hardware, and backed by a ten-year warranty?

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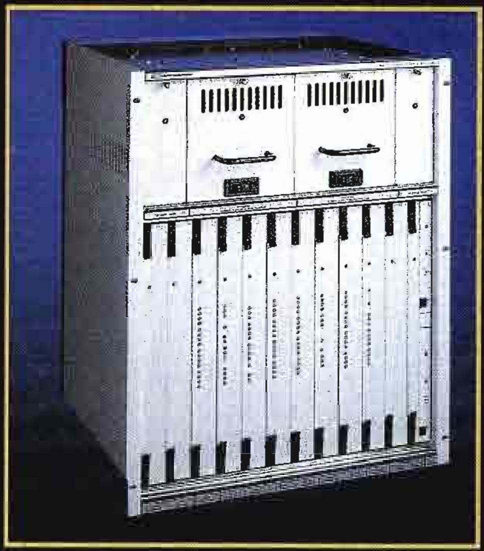
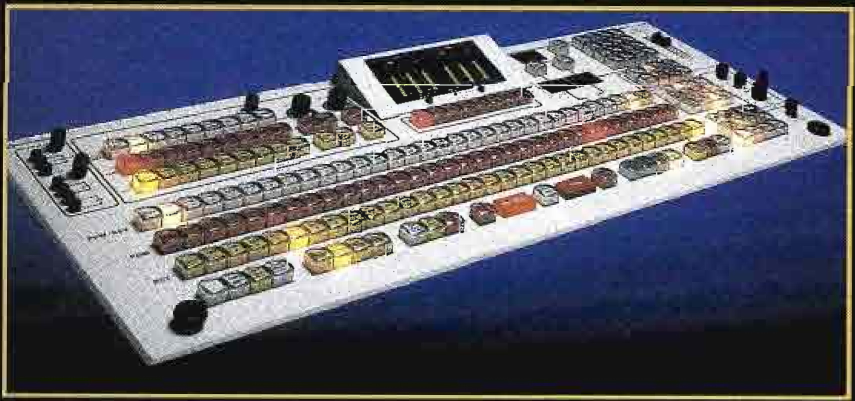
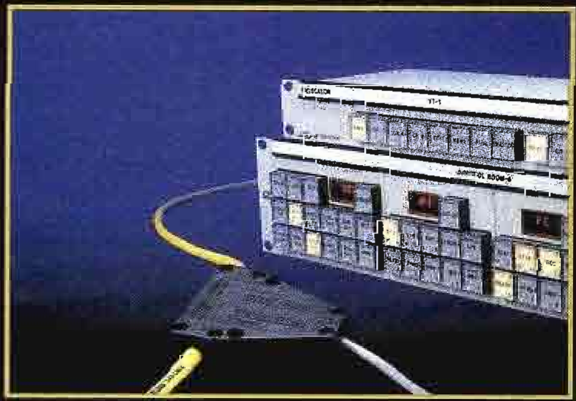
Somebody does.

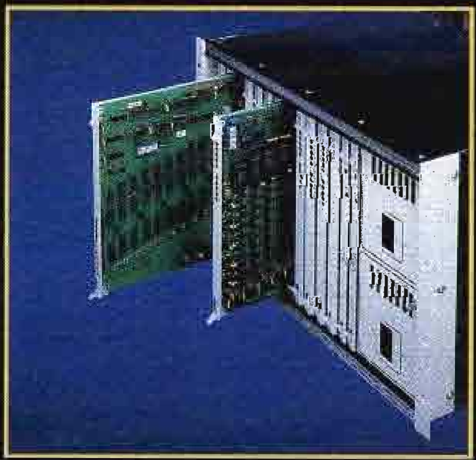
The SAS-2 from Utah Scientific—part of a growing line of integrated automation systems. Machine control, cart control, business service interface, off-line recording—complete systems from a single source. And all backed by the industry's only ten-year warranty.

See us at NAB—Dynatech Booth #3344.









US UTAH SCIENTIFIC

DYNATECH Broadcast Group

1685 West 2200 South, Salt Lake City, Utah 84119

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Circle (80) on Reply Card

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Bogner Broadcast Equipment (2666)
TV, communications antennas.
Circle (599) See ad page 317

Boonton Electronics (1128)
Modulation monitors for AM, FM, PM, TV.
Circle (600) See ad page 165

Bowen Broadcast Service (4507)
VTR modification kits; equipment maintenance software.
Circle (601)

Bradley Broadcast Sales (140)
Distributor: audio, RF products; telephone hybrids. (A2, A3, A4, S6)
Circle (602)

Bridal Fair (H5428)
Promotions
Circle (603)

Broadcast Audio (139)
Audio mixing consoles, monitors, preamplifiers; console timers; dynamics processor systems.
Circle (604) See ad page 155

Broadcast Automation (H5824)
Distributor: IGM automation systems; Otari, SMC, Studer audio recorders, players; CRL audio processors. (S1)
Circle (605)

Broadcast Electronics (303)
FM radio transmitters, stereo exciters, subcarrier generators; audio mixing consoles; radio program automation; remote control equipment; phono turntables, preamps; audio cart recorders; digital recorders. (A1, A3)
Circle (607)

Broadcast Management Plus (2166)
Programming, sales analysis software. (S1)
Circle (608)

Broadcast Programming (415)
Radio music formats on reel-to-reel tape; jingles.
Circle (609)

Broadcast Video Systems (2226)
Video/pulse delay, DA products; color correctors, video encoders, keyers; Electronic Visuals vector, waveform monitors; safe area, slate generators; video switchers; VBI equipment. (S1, S6, V5, V6, V7)
Circle (610) See ad page 172, 332

Broadcasters General Store (H6021)
Miwltronics telephone interface systems; audio equipment.
Circle (611)

Bryston Limited (1305)
Audio monitors.
Circle (612)

BSM Broadcast Systems (1233)
Audio, video DAs, routing switchers.
Circle (613) See page 82A-B

BSW/Broadcast Supply West (365)
Distributor: audio products; phono equipment; audio DAs, processors, recorders, mixing consoles; cart storage racks; studio furniture; timers; tape; microwave equipment; exciters, RF generators.
Circle (614)

BTS Broadcast TV Systems (2920)
TV cameras; video recorders; production, master control, routing switchers; A/V DAs; video monitors; graphic art, titling systems; station automation equipment. (S5, S6, V1, V2, V5, V7)
Circle (615) See ad page 201, 203, 205

Cablewave Systems (2614)
Coaxial, waveguide transmission line; tower, antenna products, services.
Circle (616)

Calaway Engineering (3344)
Editing controller systems. (V2)
Circle (718)

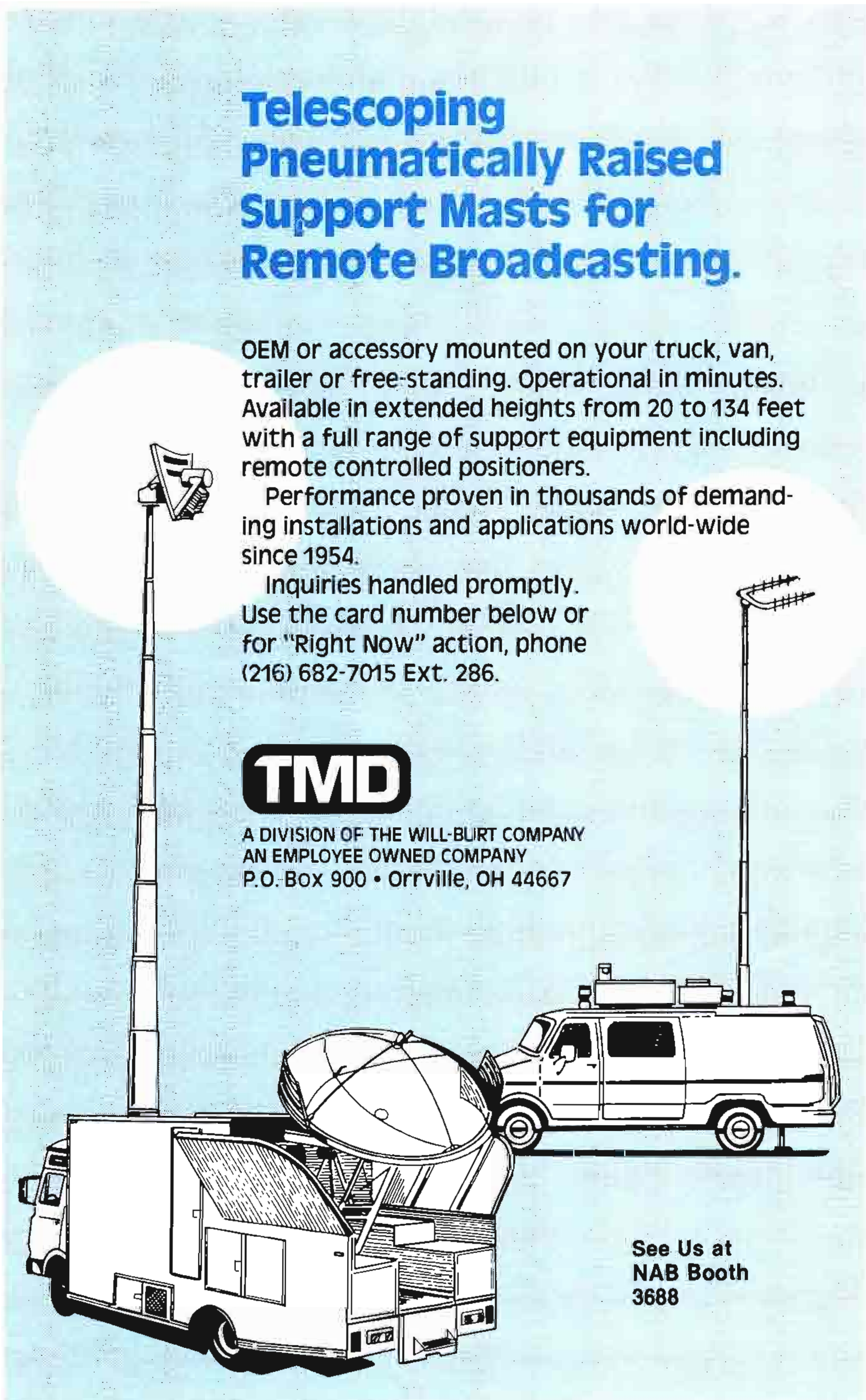
Cal Switch (H5008)
Jack/patch panels, connectors, wire, cable, fuses, electronic hardware.
Circle (617)

CAL/Cox Associates (2226)
Color correction systems.
Circle (618)

Calzone Case (1852)
ATA-rated equipment transportation cases. (S3)
Circle (619)

Cam-Lok (H5931)
Power, multiconductor control connectors; power interlock systems. (S2)
Circle (620)

Cambridge Products (2788)
Audio, video connectors; patch cord assemblies.
Circle (621)



Circle (81) on Reply Card

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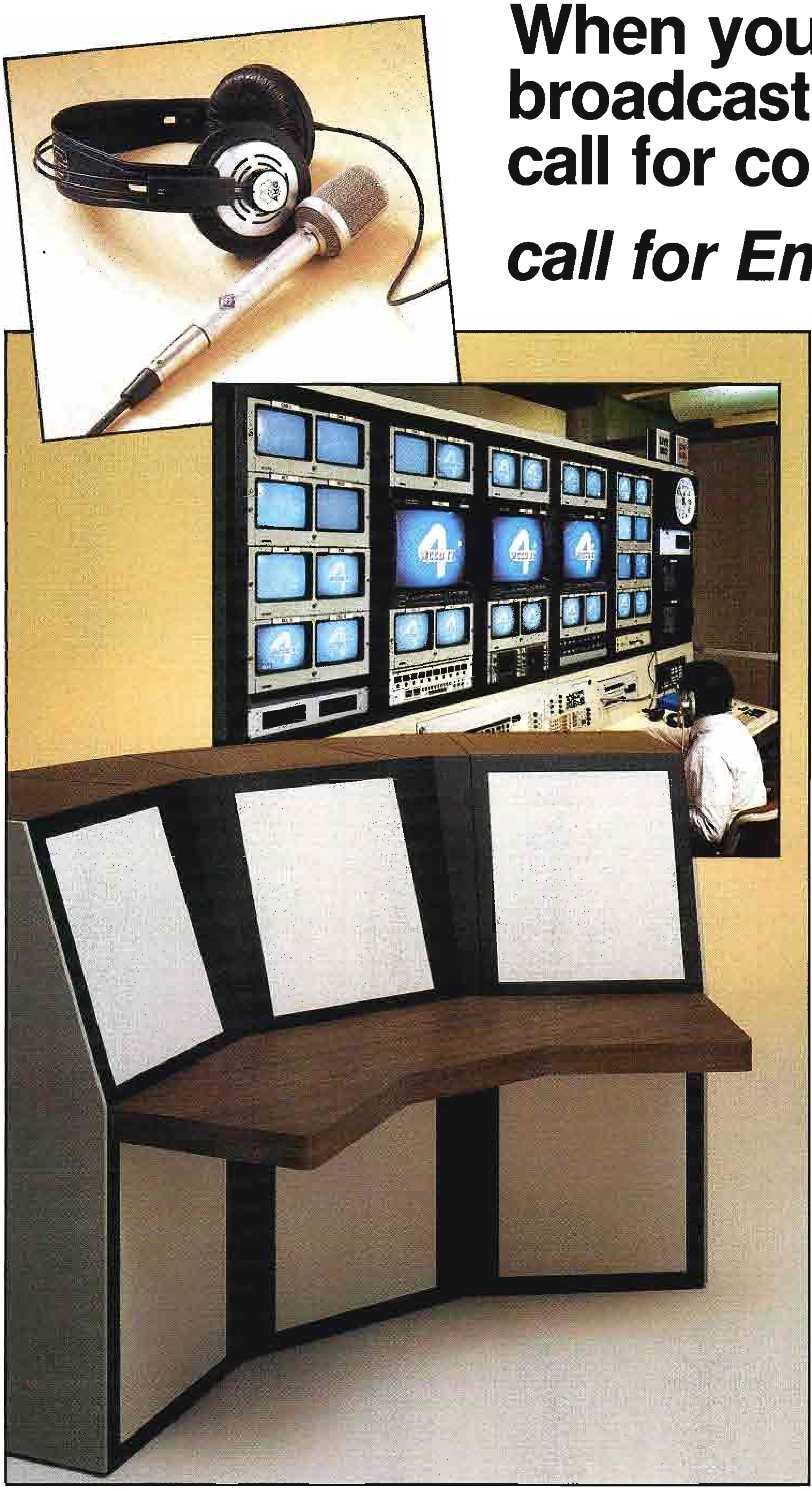

When your broadcast specs call for consoles,

call for Emcor

You know what the station needs in its control room; now you want the right enclosures. Emcor's modular design allows you to customize a console to fit your needs. Choose from slope front, vertical and low silhouette enclosures and much more — just what you need to mount your control panels, switchers and preview monitors. In all, there are 6 distinct product lines and more than 9,000 standard items, including a full range of accessories such as drawers, equipment shelves, slide out shelves and hundreds of console writing top configurations.

Emcor enclosures are attractive as well as rugged. Consider your appearance options — decorative trim in a variety of styles, 16 standard paint colors in a smooth or textured finish, and 14 standard laminates from which to choose. Also, our ACS Digital Color Computer allows us to match any color you desire.

If you need it extra fast, Instant Emcor, our off-the-shelf stock program, has a large variety of our most popular items ready to ship in just 5 working days. If you have a custom requirement, count on Emcor to provide you with the best design engineering and manufacturing services available anywhere.

No matter what your requirement, Emcor has what broadcasters want!

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EMCOR

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Chester Cable (4261)
Wire, cable products. (S2)
Circle (639)

Christie Electric (2217)
Batteries, chargers, analyzers. (V4)
Circle (640) See ad page 251

Chyron (3556)
Electronic graphic arts, titling systems. (V5)
Circle (641) See ad page 65

Cine 60 (2712)
Batteries, accessories; lighting equipment.
Circle (642)

Cinema Products (4143)
Film, video camera accessories, remote control products.
Circle (643)

Cinemills (2475)
Lighting equipment, filters, gobos.
Circle (644)

Cipher Digital (3369)
Time code systems; transport synchronizers; audio editing equipment. (A3, V2)
Circle (645) See ad page 80

Circuit Studios (3135)
Motion control, video animation system. (V5)
Circle (1180)

Clear-Com Intercoms (2515)
Wired, wireless intercom systems. (A4)
Circle (646) See ad page 73

CMC Technology (2853)
Replacement type C video heads; recorder head refurbishing. (S4)
Circle (647)

CMX (3556)
Videotape editing controllers; software utilities.
Circle (648)

Coaxial Dynamics (1112)
Power terminations, loads; RF test systems, wattmeters. (S6)
Circle (649)

Coherent Communications (H5518)
Time code equipment; wireless mics, audio/video transmitters; audio mixers, mic supplies.
Circle (650)

ColorGraphics Systems (3344)
Electronic graphics/art equipment; weather graphics, data services; New England Technology Group videodisc systems. (V5)
Circle (719)

Colorado Video (2609)
Still-store, slow-scan, video noise reduction systems. (V2, S1)
Circle (651)

Columbine Systems (3274)
Music, newsroom, traffic management software. (S1)
Circle (652)

Comad Communications (H5104)
FM, TV transmitters, antennas.
Circle (653)

Comark Communications/Thomson (3333)
FM, TV transmitters, translators; transmission line products. (R1)
Circle (654) See ad page 41, 100

Comlux (4338)
Video fiber optic equipment. (S2)
Circle (655)

Communication Microwave (4257)
ITFS, OFS, MMDS microwave transmitters; power amplifiers, devices. (R2)
Circle (656)

Communications Graphics (855)
Promotional, presentation packages.
Circle (657)

Comprehensive Video Supply (3174)
Distributors: audio, video, lighting equipment; production management software.
Circle (658) See ad page 218

Comprompter (3887)
PC-based newsroom systems; prompters.
Circle (659)

Compu-Cable USA (H5925)
Electronic titling systems.
Circle (660)

Compu-Prompt (4540)
Computer-based prompters.
Circle (661)

CompuSonics (H5521)
Digital audio disc recorders; optical disk audio editor. (A3)
Circle (662) See ad page 261

Computer Concepts (759)
Broadcast business software systems.
Circle (663)

Computer Prompting (2167)
Computer-based prompting, captioning systems. (V5)
Circle (664)

Computer Prompting Services (H5228)
Circle (1202)

Comrex (753)
Telephone bandwidth extenders; telephone hybrids; Vortex Communications A/V, support products.
Circle (665) See ad page 312

Comsat International (2387)
Global TV Intelsat relay service. (S8)
Circle (666)

Comtech Antenna (1202)
Earth station antennas.
Circle (668)

ComTek Communications (4524)
TV signal monitoring receivers; wireless mics. (A4)
Circle (669)

Concept Productions (833)
Production, programmed music products.
Circle (670)

Conifer (2559)
ITFS, MMDS antennas, receivers. (R2)
Circle (671)

Connectronics (270)
Audio multicore cable, connectors; Bandive/SECK audio mixers. (S2)
Circle (672)

Connolly Systems (H5133)
Remote control systems.
Circle (673)

Conrac (3135)
Color, monochrome video monitor products.
Circle (674)

Control Concepts (4159)
Power line filters, conditioners. (S6)
Circle (675) See ad page 154

Conus Communications (1509)
Satellite program, news information distribution.
Circle (676)

Convergence (1867)
Videotape editing controllers.
Circle (677)

Cool Light (2253)
Lighting products, accessories.
Circle (678)

Corporate Communications (2080)
Film-to-video transfer, signal correction equipment.
Circle (679)

Cortana (H6007)
Circle (1201)

Countryman Associates (629)
Microphones; audio accessories.
Circle (680)

CRL Systems (133)
Audio signal dynamics processors; AM, FM, TV stereo/subcarrier generators, exciters, processors.
Circle (681) See ad page 162

Crosspoint Latch (2374)
Video production, master control switchers; TBCs, encoders; production systems. (V5)
Circle (682) See ad page 344

Crown International (843)
Audio monitor amplifiers, test equipment.
Circle (683)

CSI (239)
AM, FM transmitter systems.
Circle (684)

Cubicomp (4310)
Electronic graphics/art systems. (V2, V5)
Circle (685)

Current Technology (H6110)
Power line conditioners, surge protection. (S6)
Circle (686) See ad page 256

Cycle-Sat (H5433)
Satellite signal relay services, addressable decoder controlled. (S1)
Circle (687) See ad page 240-241

Peter W. Dahl (865)
Audio, power transformers, inductors. (S6)
Circle (688)

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Boonton's Family of High Performance Audio Instruments

BOONTON

For your most demanding requirements, Boonton has just the instrument to generate or characterize audio signals with unbeatable accuracy. Whether you're working on the bench or with an ATE system, they provide fast, low cost solutions to all your audio testing needs.

1110 Audio Oscillator

- High power output to +30.5 dBm
- 10 Hz – 150 kHz with ultra-low distortion (typically 0.001%)
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1120 Audio Analyzer

- All-in-one source and analyzer, 10 Hz–140 kHz
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- AC/DC voltage
- Distortion in %THD or SINAD
- Signal-to-noise

1130 Distortion Analyzer

- Distortion, 10 Hz–140 kHz, with 3 mV sensitivity
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- Programmable notch filter
- Standard and optional filters
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All Boonton audio instruments feature non-volatile storage for up to 99 complete panel set ups. IEEE 488 interfaces are standard. Call your local representative today for a convincing demonstration.

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Signal Generators ■ Modulation Analyzers ■ RF Power Meters ■ RF Millivoltmeters ■ Capacitance Meters and Bridges ■ Audio Test Instruments

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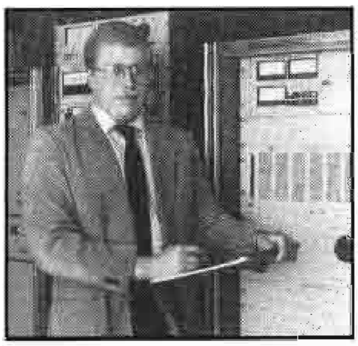
"With the new Continental solid-state transmitter we have had zero down time despite inclement weather."

"At what must be the world's most hostile transmitter site, we have had zero down time despite inclement weather and antenna icing conditions. The transmitter remained on the air, with a minimum of power foldback."

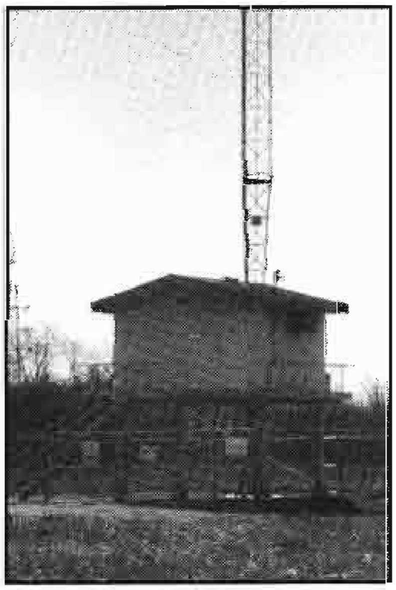


W.C. Alexander
Director of Engineering
Crawford Broadcasting Company

"We are very pleased with the superior sound and performance of the solid-state 1 kW Continental transmitter."

"The new transmitter has a "cleaner" sound, better than any other stereo station on the AM band in this market by a wide margin."

"The reliability has surpassed that of its predecessor, in fact, we have installed our sixth new Continental transmitter."



A Continental 1 kW AM transmitter installation for KPBC in Dallas.

For information on any of Continental Electronics' family of reliable transmitters, contact:

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Telephone: 214-381-7161 FAX: 214-381-4949

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Bill Daniels **(2556)**
Product literature services, catalogs.
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Data Center Management **(H5015)**
Electronic newsroom computer systems. (S1)
Circle (690)

Datacount **(H5525)**
Station data management software.
Circle (691)

Data Security **(N.A.)**
Tape degausser systems. (S4)
Circle (692)

Datatek **(2356)**
Audio, video DAs, routing switchers, control panels, machine controllers, interface modules. (S5)
Circle (693) See ad page 129

Dataworld **(165)**
Industry databases, computation programs, allocation, interference, population studies; 24-hour database access.
Circle (694)

Datum **(4147)**
Time code systems, source ID readers, encoders.
Circle (695)

dbx **(1225)**
Audio dynamics, MTS signal processors. (A2)
Circle (696)

Delta Electronics **(134)**
RF test instruments; remote control systems; coaxial transfer switches; power, modulation controllers; AM stereo processors. (S6)
Circle (697)

Desisti Lighting/Desmar **(2345)**
Lighting instruments, mounting equipment, lamps; dimmers; studio rigging fixtures.
Circle (698)

DeWolfe Music Library **(1844)**
Production music, effects libraries.
Circle (699)

Dielectric Communications **(4334)**
Transmission lines, waveguides; CP, panel antennas; RF switching, combining products; RF test loads, dehydrators, microwave absorption material.
Circle (700) See ad page 206-207

Digital Arts **(H5810)**
Electronic graphic systems.
Circle (701)

Digital Audio Research **(H5419)**
Digital audio disc recording/editing workstation.
Circle (702)

Digital Creations **(H5929)**
Circle (703)

Digital Equipment/DEC **(H5205)**
Computer hardware.
Circle (704)

Digital F/X **(5227)**
Digital video effects, production systems. (V5)
Circle (705)

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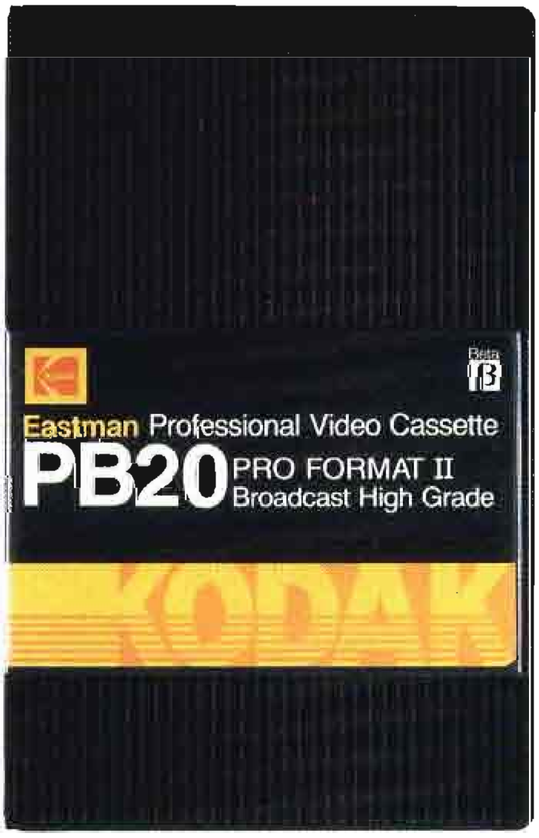
'GROWING PAINS' GOES TO HAWAII WITH



When George Spiro Dibie, Emmy-winning director of photography for "Growing Pains," recently went to Maui to shoot a special hour-long episode, he specified Eastman Pro Format II broadcast video cassettes.

"Pro Format II video cassettes lived up to our best expectations," he says. "Every subtle nuance that we captured with our CCD (charge-coupled device) cameras was faithfully recorded.

"Our images are gorgeous. We are particularly happy with the color saturation. The reflections of the sun in the blue ocean sparkle. We were able to record true skin tones in the moonlight while still holding rich blacks.

"The image quality of the ½-inch tape, which we shot in widely varied lighting circumstances, was comparable to the 1-inch tape shot in the studio. There were no problems, even when we intercut original 1-inch tape from the studio with second-generation 1-inch dupes of the original footage shot in Hawaii.

"Eastman tape is consistent and reliable. When faced with shooting video tape in challenging locations, this is the way to do it."

Find out how Eastman Pro Format II video cassettes can give you the image quality you need. Call toll free, 1 800 445-6325, Ext 802, for information.

Eastman
Professional Video Tape

Kodak

©Eastman Kodak Company, 1987

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Digital Processing Systems (4342)
TBC, synchronizer systems; B-MAC codec products.
Circle (706)

Digital Services/DSC (3556)
Digital video effects, still stores, graphic/art, animation equipment. (V2)
Circle (707)

Dimension Music (H5333)
Sound effects.
Circle (709)

Di-Tech (2180)
Audio, video DAs, routing switchers; control panels. (S5)
Circle (710) See ad page IBC

DKW Systems (N.A.)
Broadcast programming, business automation. (S1)
Circle (711) See ad page 202

Dolby (2380)
Audio noise reduction, spectral enhancement processors.
Circle (712)

Dorrough Electronics (458)
Audio dynamics processors, mixers, level meters. (A1)
Circle (713) See ad page 152, 304

Dubner Computer Systems (2928)
Electronic graphic art, titler systems; video still stores. (V2, V5)
Circle (714)

DX Communications (1345)
Satellite receiver systems. (R4)
Circle (715)

Dynair Electronics (3730)
Routing switchers, routing controllers; fiber optic products; DAs. (S2, S5)
Circle (716)

Dynamic Technology (1647)
Distribution, routing systems.
Circle (717)

Dynatech Broadcast Group (3344)
see:
- *ColorGraphics, LEA*
- *Quanta, Utah Scientific*

Dynatech NewStar (3344)
Automated newsroom equipment. (S1)
Circle (721)

Eastman Kodak (1835)
Videotape media; motion picture film.
Circle (724) See ad page 167

ECHOlab (1866)
Video production switchers. (V6)
Circle (725)

Econco Broadcast Service (771)
Broadcast power tube rebuilding services. (S3)
Circle (726)

Editron USA (H5327)
Audio, video, film editing, transport synchronizers.
Circle (728)

EEG Enterprises (2247)
On-screen text, captioning systems; vertical interval data encoders/decoders.
Circle (729)

EELA Audio (159)
Audio mixers, reporter recorders, telephone hybrids.
Circle (730)

EEV (3384)
Leddicon, vidicon camera tubes, CCD; RF power tubes, klystrons. (V1, R3)
Circle (731) See ad page 185

EG&G/Electro-Optics (2220)
Tower lights, controls; beacons.
Circle (732)

Eidophor/Gretag (H6112)
Video projector systems.
Circle (733)

Elcom-Bauer (631)
AM, FM transmitters, exciters.
Circle (734)

Elcon Associates (H5828)
Videotape conditioners, cleaners, evaluators.
Circle (735)

Electro Controls (4184)
Lighting controllers, dimmers.
Circle (736)

Electro Impulse Laboratory (413)
RF test loads, calorimeters; RF attenuators, wattmeters. (S6)
Circle (737)

You can measure...
with the best monitor and the most accurate test set.
The FMM-2/FMS-2 series monitors provide an even greater degree of precision measurement than ever before... **You can measure** S/N below **90 dB, You can measure** crosstalk below **85 dB, You can measure** separations of better than **70 dB, You can measure** frequency response to better than **0.25 dB, You can measure** distortions to lower than **0.01%**, and much more... Our uncluttered panels and autoranging voltmeters make these measurements a dream.
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ELECTRONICS LABORATORY, INC.
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Call or write for more information on Belar AM, FM, Stereo, SCA and TV monitors.

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UHF TV MAGNETS **"Buy Now" at major dollar savings! 23% off emergency, 15% off regular prices.**

For a limited time, our special plan-ahead "Buy Now" program offers dramatic savings of up to 23%.

Varian leads the way...again.

SPECIAL OFFER. For a limited time, Varian rewards your "Buy Now" purchase of a spare magnet with big dollar savings on the most advanced UHF TV magnet. ***FREE STORAGE.*** We'll store your magnet up to one year; free when you "Buy Now". ***LONGER WARRANTY.*** As a further incentive, we're extending our magnet warranty from 12 to 18 months when you "Buy Now". ***FINANCING.*** Choose the plan that fits your cash flow. Don't get caught without a spare. Plan ahead now. Check the chart for the UHF TV magnet you need, then call us for the final clincher—our "Buy Now" prices.

Tube Frequency	Tube Power	Tube Model No.	Magnet Model No.
470-566 MHz	30KW	VA-890H	VA-1590H
	30KW	VA-946H	VA-1950H
	60KW	VKP-7553S	VA-1950H
566-698 MHz	30KW	VA-891H	VA-1591H
	30KW	VA-947H	VA-1951H
	60KW	VKP-7554S	VA-1951H
694-850 MHz	30KW	VA-948H	VA-1952H
	60KW	VKP-7555S	VA-1952H

VARIAN MICROWAVE EQUIPMENT DIVISION **varian**
3200 Patrick Henry Drive, Santa Clara, CA 95054, (408) 496-6273

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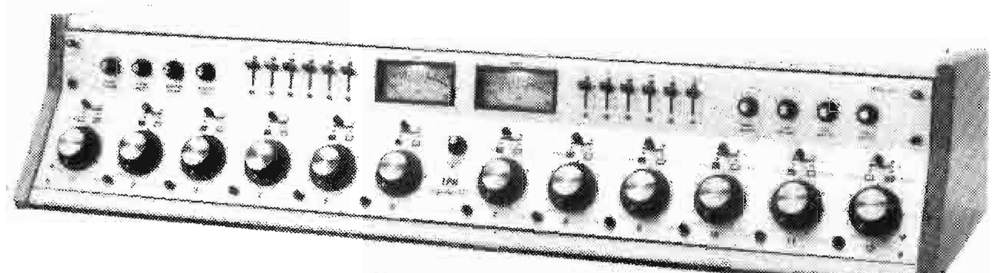
Others have lots of hype, we have lots of proof!

LPB Signature© Consoles



12 mixer dual stereo S-24 shown

Consoles of proven reliability with over 2,000 units sold since 1972! Ask any user! Identical functioning 6, 8, 10 & 12 mixer dual stereo and 6, 8 & 10 mixer dual mono Signature III consoles priced from $2,895.00. Leasing available.

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Electro-Voice (730)
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Circle (738)

Electronic Research (1325)
FM antennas; diplexers, notch filters.
Circle (739)

Electronic Visuals (2226)
TV waveform, vector monitors.
Circle (740)

Elicon (N.A.)
Animation, controlled-motion camera supports. (V1)
Circle (741)

EMCEE (3053)
UHF TV, MDS, ITFS transmission systems.
Circle (742)

EMCOR Products/Crenlo (4246)
Equipment racks, enclosures.
Circle (743) See ad page 161

Emergency Alert Receiver (1352)
Special purpose, emergency receivers.
Circle (744)

Energy-Onyx (1850)
FM broadcast transmitters. (R1)
Circle (745)

Enterprise Electronics (2460)
Weather radar systems.
Circle (746)

Enterprise Systems (4020)
Station business and management systems. (S1)
Circle (747)

Environmental Satellite Data (4271)
Weather graphics equipment, work stations; weather database, data processing systems for radio, TV.
Circle (748)

ESE (1800)
Time code systems, timers, clocks; telephone hybrids; DAs; audio signal level indicators. (S1, S5)
Circle (749) See ad page 311

Eventide (871)
Digital audio delay systems, programmable effects processors; time modification systems. (A2)
Circle (750)

Evertz Microsystems (2087)
Time code equipment; VTR emulation modules; transport synchronizers.
Circle (751)

Excalibur Industries (2882)
Equipment transport cases.
Circle (752)

Fairlight Instruments (H5315)
Videographic synthesizer/computer.
Circle (753)

Faroudja Laboratories (4535)
Video encoders, decoders; video noise reduction equipment; component transcoding systems; component detail processors. (V7)
Circle (754) See ad page 235

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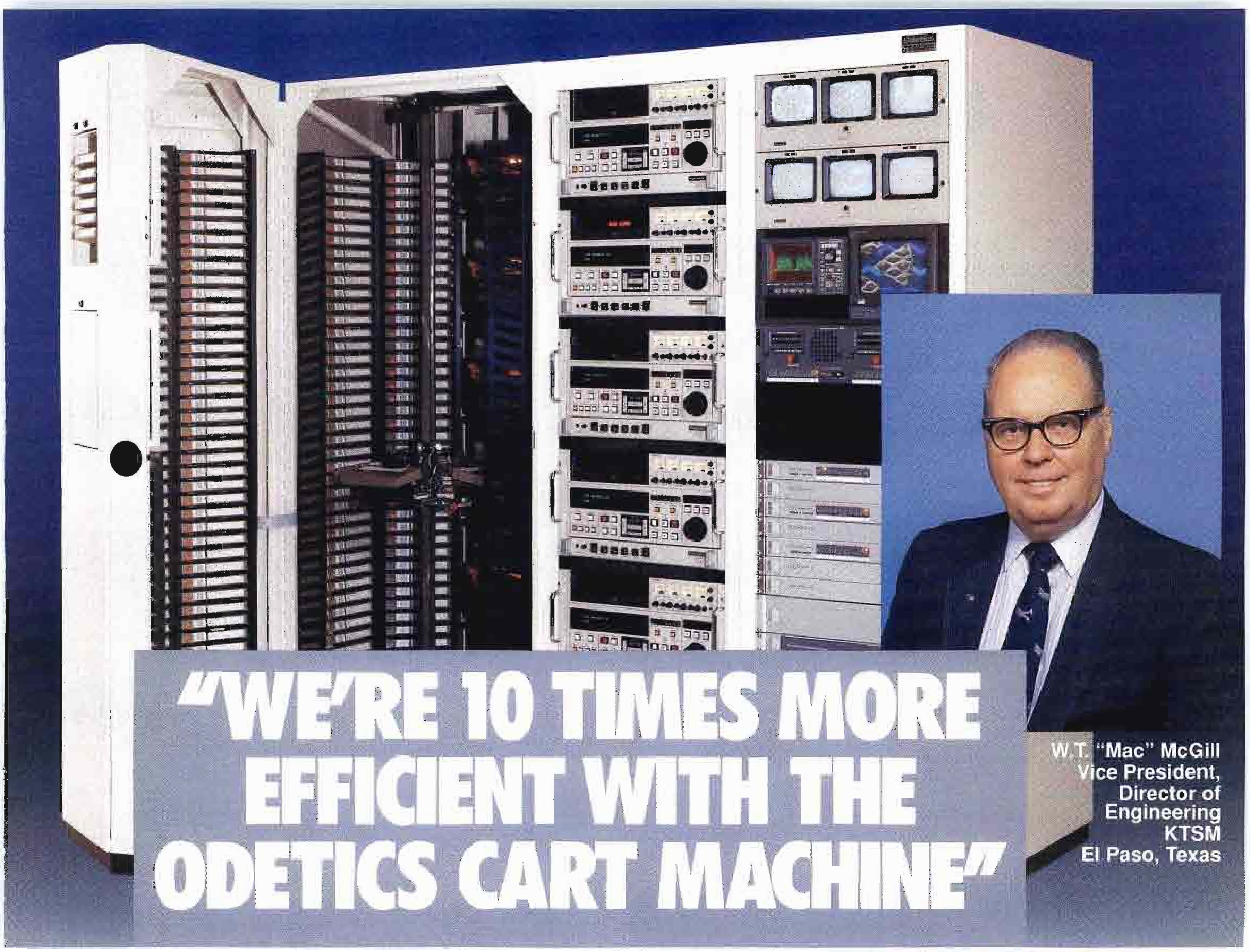

After years of working with manually operated cart machines, the engineering staff at KTSM is breathing a sigh of relief. Now they rely on The Odetics Cart Machine.

Mac McGill says that The Cart Machine has been responsible for a dramatic reduction in errors — spots airing at the wrong time or not at all.

"With our old cart machines, between the time the traffic department's logs were printed and the airing of the carts, we could count on numerous errors every week," he explains. "Now the logs are automatically downloaded to the Cart Machine from the traffic computer. From there, The Cart Machine handles just about everything else. As a result, we've seen a significant reduction in lost spots."

The Odetics Cart Machine can automatically manage, record and play-to-air all forms of spots and programs — including events as short as one second.

An average day's play list at KTSM consists of 380 to 400 individual cart events, including repeats. Mac cite's the Cart Machine's extraordinary storage capacity — which includes a 65,000 cart database and 1,600 event look-ahead feature.

"The Cart Machine requires a minimum amount of space, yet it has a library of 280 cassettes. That allows us to store almost an entire day's worth of events."

The Odetics Cart Machine can automatically preplan spot play lists hours, or even days, in advance of airing. In fact, every weekend KTSM operates with four days of play lists loaded into their Cart Machine.

And, now that KTSM is broadcasting 24 hours a day, six days a week, The Cart Machine lets them broadcast with just one operator during the early morning hours.

The Cart Machine is available in your choice of small formats.

Call us now to find out how your station can enjoy the efficiency of the Odetics Cart Machine.

The Cart Machine from Odetics

1515 South Manchester Avenue
Anaheim, California 92802-2907

Call toll free 800-243-2001

See Us at NAB
Booth 5813 (Hilton Center)

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Farrtronics (4538)
Audio distribution switchers, equipment.
Circle (755)

FCC (4560)
Circle (1213)

Feldmar Watch (4580)
Timers, clock systems.
Circle (756)

Ferno Washington (H5624)
A/V on-location equipment carts; battery, lighting accessories. (S3)
Circle (757)

FGV Panther (H5927)
Camera pedestals, cranes, support systems.
Circle (758)

Fiberbilt Cases (4004)
Equipment cases.
Circle (759)

Fidelipac (515)
Audio cartridge recorders, cartridge media. (A3, S4)
Circle (760)

Fife-Pearce Electronic (H5933)
Electro-Matic tape eraser/degausser systems. (S4)
Circle (761)

Film House (815)
TV commercials promoting radio stations.
Circle (762)

FirstCom Broadcast Services (829)
Music, sound effects libraries.
Circle (763)

Flash Technology (4125)
Tower obstruction lighting, beacons.
Circle (764)

FloriCal Systems (N.A)
Videotape delay systems, software.
Circle (765)

Focal Press (1450)
Circle (766)

FOR-A (3169)
Digital audio recorders; video production switchers, TBCs, color correctors; Time code equipment; component video products; graphic/titling systems. (A1, A3, V1, V2, V5, V6, V7, V8)
Circle (767) See ad page 225

Fort Worth Towers (3066)
Broadcast, communications towers, services; communications equipment buildings. (S7)
Circle (768)

Fortel (3576)
TBCs, synchronizers; noise reduction systems.
Circle (769)

Fostex (4251)
Audio mixing consoles, EQ systems, tape recorders; audio delay, dynamics processors. (A3, V2)
Circle (770) See ad page 297

Frezzolini Electronics (2438)
Batteries, chargers, analyzers; portable lighting. (V4)
Circle (771)

Fuji Photo Film USA (4307)
Standard, metallic videotape in all formats. (S4)
Circle (772) See ad page 220-221

Fujinon Optics (4301)
TV camera lens systems, accessories. (V1)
Circle (773) See ad page 249

Future Productions (H5830)
Videotape duplication systems, services; camera control units. (V1, V2, S5)
Circle (774)

Garner Industries (4007)
Audio/videotape erasers, degaussers.
Circle (775)

GE American Communications (2629, PL)
Domestic satellite program distribution services. (S8)
Circle (776)

General Electric (1051)
Stage, studio lamps.
Circle (777)

General Electric/Comband (H5615)
ITFS, MMDS downconverters, reception equipment. (R2)
Circle (778)

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Electronic graphics systems. (V5)
Circle (1203)

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- ✓ **MASTERKEY™** – stand alone composite linear keyer
- ✓ **DIGIVIEW** – test system for 601 digital signals
- ✓ **COX 204** – new generation NTSC encoder
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- ✓ Plus our full range of component and composite video terminal equipment, delay lines and filters.

broadcast video systems ltd.

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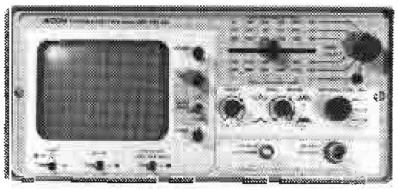
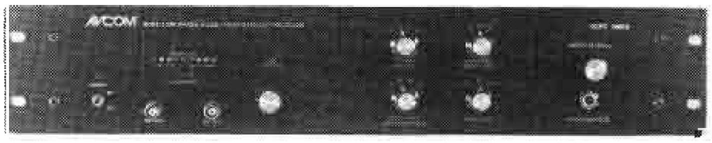
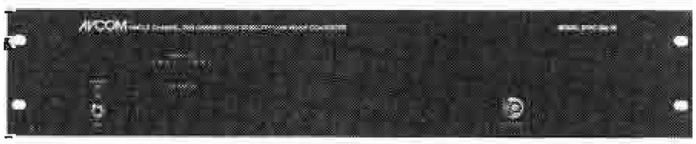


NEW!!
SATELLITE EQUIPMENT

The PSA-35A Portable Spectrum Analyzer accurately measures wideband signals commonly used in the American and International satellite communication industries. The PSA-35A covers frequencies from less than 10 to over 1750 MHz, and from 3.7 to 4.2 GHz; switch-selectable sensitivity of 2 dB/div or 10 dB/div; and on-screen dynamic range of greater than 65 dB. The portable, battery or line-operated PSA-35A is the perfect test instrument for service and troubleshooting, dish and antenna alignment, and optimizing signal reception. **$1965**



AVCOM's Single Channel Per Carrier Receiver, model SCPC-2000E, receives FM SCPC signals from satellites operating in the 3.7 to 4.2 GHz band. The SCPC-2000E is a complete receiver that can tune up to 4 specific crystal-controlled audio or data channels from a given transponder, and is available in wideband or narrowband models. A phase-locked cavity oscillator referenced to an ovenized crystal oscillator provides exceptional stability. The SCPC-2000E may be used with the AVCOM SS-1000 Slave for simultaneous reception of additional channels. **$1875**



The highly stable SCPC-500-70 Single Channel Per Carrier Downconverter converts SCPC signals from a transponder in the 3.7 to 4.2 GHz range to a center frequency of 70 MHz. A sophisticated phase-locked cavity oscillator referenced to an ovenized crystal oscillator enhances frequency stability. No other equipment at a comparable price can match the SCPC-500-70 Downconverter. **$1322**

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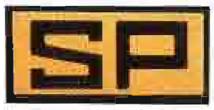
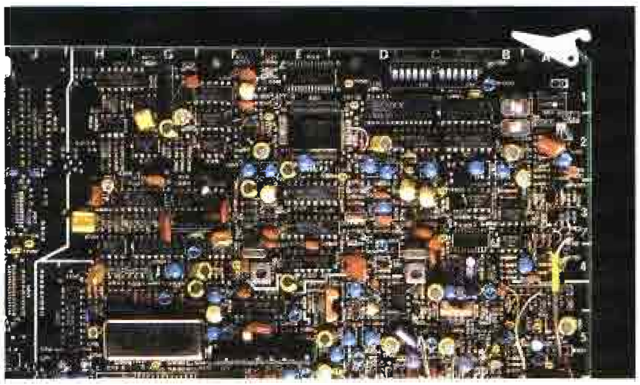
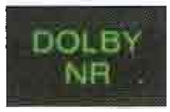
This is what makes the new Sony editing VTR so good.



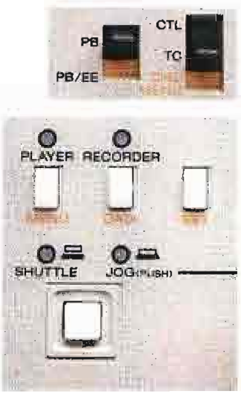
SP Technology



Plug-in Time Base Corrector



Dolby* C Noise Reduction



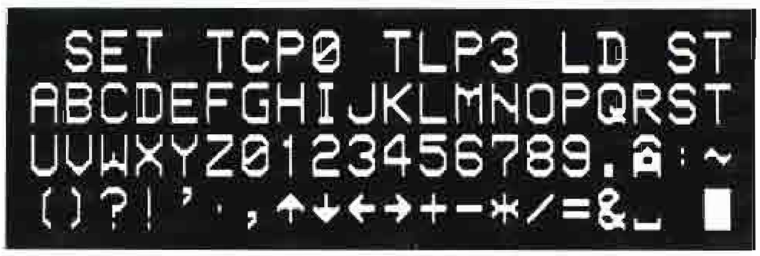
Front-panel Presets

TBC Remote Control

Expanded Dial Operation

Plug-in Time Code

Status Display



Built-in Character Generator

Self-Diagnostics

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This is what makes it great.

U-matic

It's rare to find an editing VTR that comes with everything you want, yet still goes with everything you have.

Enter the BVU-950.

Not only is it compatible with the entire U-matic line of players and recorders, it can be used with other broadcast equipment as well through an RS-422 interface.

Either way, the picture quality is superior. SP technology means you get 340 lines of resolution on every original.

It also means you don't have to compromise on copies. With SP, your third generation tapes will look as good as first generation conventional U-matic.

And sound even better. Because every word is heard through a Dolby* C Noise Reduction system.

The BVU-950 is also the first U-matic editor to offer a plug-in time base corrector and plug-in time code generator.

These easy-to-install cards conserve power as well as space. And there are no cable connections to make.

They also make the VTR simpler to operate. With a single jog dial, you can now display time codes and user bits, set preroll times, and customize operating routines.

You can even record titles using a built-in character generator.

And if there's ever a break

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Introducing the BVU-950.

in the action, the BVU-950 can tell you why—using its own self-diagnostic routine.

To learn more about this remarkable addition to the U-matic line, please write to Sony, P.O. Box 6185, Department BVU-1, Union, NJ 07083.

And find out how to get what you want without giving up what you have.

SONY®

Professional Video

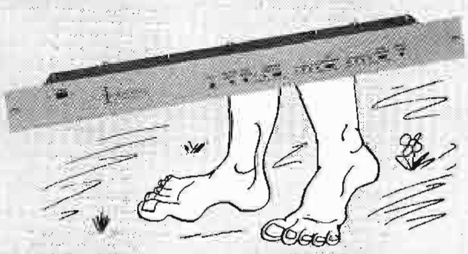
Circle (98) on Reply Card

www.americanradiohistory.com

ERASE IT!

Circle (99) on Reply Card

NRSC WINNER



...even "barefoot!"

Inovonics' "NRSC Box" works **with** your existing AM processing chain **or without!**

The *built-in* Feedforward/PWM Limiter (defeatable) features a "floating platform" function to yield high **average** modulation in addition to tight **peak** control for superb stand-alone performance.

Easy to install,* simply connect the unit in-line with the audio feed to your transmitter for total modulation control, "adaptive" (protected) preemphasis, and overshoot-controlled lowpass filtering to the NRSC spec.

And the best part: all this for a paltry $520.

Call for full info or see your distributor for a demo.

See us at NAB Booth #770

*Typical installation/setup time:
Chief or Asst. Engineer — 5 min.
Corporate V.P. of Engineering — 10 min.

Inovonics Inc.
1305 Fair Ave., Santa Cruz, CA 95060
(408) 458-0552

Circle (100) on Reply Card

Gentner Electronics (265)
Telephone bandwidth extenders, hybrids; audio routing switchers. (A2, A4, S1, S2)
Circle (779) See ad page 30, 316

Gentner RF Products (265)
Transmitter remote control hardware, software. (S1)
Circle (780)

Giant Boom Box (PL)
Portable studios. (S7)
Circle (781)

G&M Power Products (4534)
Batteries, chargers; battery belts; lighting products.
Circle (782)

GML America (2551)
TBCs, frame synchronizers; special effects, video production systems. (V5, V7)
Circle (783)

Alan Gordon Enterprises (2538)
Animation equipment; distributor for mics, audio accessories, camera support equipment; rental house; studio furnishings, effects devices. (A4, V1, S3)
Circle (784)

Gorman Redlich (1200)
EBS encoders, decoders; NOAA weather receivers.
Circle (785)

Gotham Audio (2330)
Neumann microphones; audio noise reduction products; EMT dynamics processors; CD players; audio recorders; K&H speakers.
Circle (786)

Graham-Patten Systems (4530)
Audio editing mixers, programmable EQ equipment; video keying processors; utility, remote controllable audio/video DAs; equipment controllers; A/V transmission multiplex processing for microwave. (A2, A3)
Circle (787) See ad page 270

Grass Valley Group (2928)
Routing, production, master control switchers; automation systems; DS3 products; DAs; analog, digital, component video products; digital effects, editing systems; fiber-optic products; impedance conversion modules. (V6, V7, S5, S6)
Circle (788) See ad page IFC, 9, 157, 294

Gray Communications Consultants (2242)
Distributor: audio, video equipment; cameras, video recorders; graphic/titling systems; switchers, TBCs; video displays; ENG microwave; signal distribution equipment; test/monitoring products; production vehicles. (S7)
Circle (789)

Gray Engineering Labs (4174)
Time code products; safe title generators; video-assisted film editing equipment.
Circle (790) See ad page 97, 182

Great American Market (2684)
Lighting equipment, effects, pattern projectors, lamps. (V4)
Circle (791)

L. Greenburg Elec. Teleprompt. (5119)
Circle (1214)

Grumman (3253)
Commercial insertion equipment linked to traffic, billing.
Circle (792)

James L. Grunder (1433)
CEL TBCs, synchronizers, video effects equipment; editing systems, video monitors, test products; standards conversion systems. (S5, V2, V5, V7)
Circle (793)

GTE Spacenet (1333)
Satellite program transmission, distribution services for news, voice, data; signal turnaround, bandwidth conversions.
Circle (794)

Hallikainen & Friends (308)
Remote control, logging systems; audio mixers; digital metering kits.
Circle (795)

Harris Broadcast (503)
Radio, TV, STL, ENG, uplink transmitters, antennas; audio mixers, dynamics processors; stereo, subcarrier generators, exciters; remote control, automation systems; audio phase correction products. (R1)
Circle (796) See ad page 58-59, 257

Harris Video Systems (503)
TBCs, synchronizers; digital effects systems; Aurora electronic graphic/art systems; video interfaces. (V7)
Circle (797)

Harrison Systems (125)
Audio mixing, editing consoles; automation systems; audio routing switchers. (A1, S5).
Circle (798)

HEDCO (1820)
Audio, video DAs, routing switcher systems; sync generators. (A2, S1, S5, S6, V7)
Circle (799) See ad page 108

Karl Heitz (2263)
Camera support products, pan/tilt heads; mic poles. (V1)
Circle (800)

Hipotronics (4546)
Automatic voltage regulation equipment. (R3, S6)
Circle (801)

Hitachi Denshi (3324)
TV cameras; video recorders, encoders; HDTV equipment. (V1, V7, V8)
Circle (802) See ad page 3

HM Electronics (4238)
Wireless microphone systems; intercom systems; speaker, headset stations. (A4)
Circle (803) See ad page 177

Hoffend & Sons (2188)
Studio rigging systems, controllers.
Circle (804)

Holaday Industries (1114)
Test equipment; magnetic, electric field, non-ionizing radiation measurement units. (S6)
Circle (805)

Hotronic (2571)
TBCs, frame synchronizers. (V7)
Circle (806) See ad page 224

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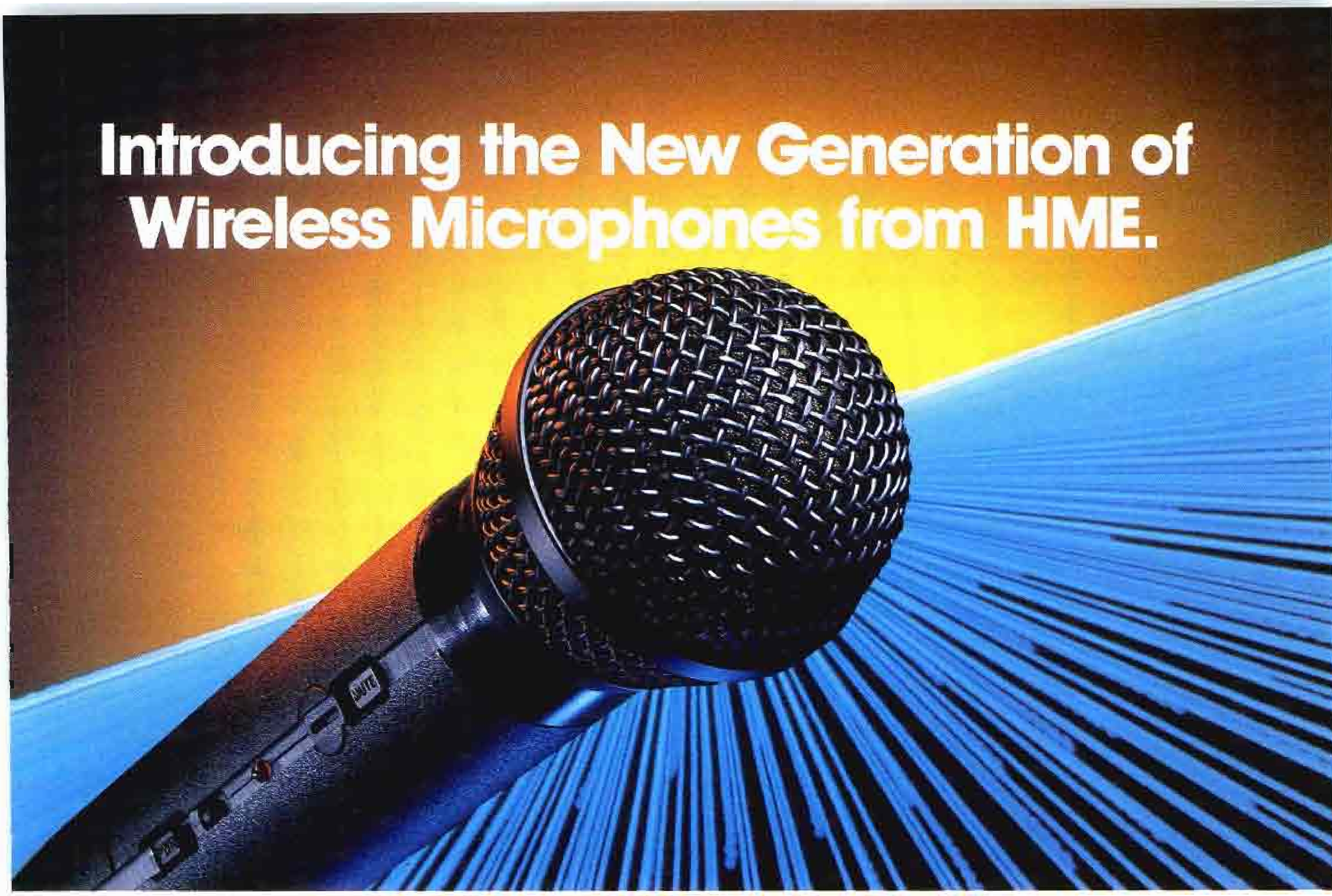

All New RF Link. All New Switching Diversity. All New Packaging. And *Unbeatable* Sound.

HME's new Series 50 is so advanced that anything else is a compromise.

Here's just a few highlights:

A completely new RF link greatly improves the capture ratio for dropout-free performance under the most demanding conditions. Our new state-of-the-art noise-free switching diversity system has broken the price/performance barrier.

There's a new, rugged ABS body on the hand-held models, along with an advanced internal antenna with superb radiation characteristics. The new dual-frequency body pacs give you top performance under physical as well as electrical abuse.

HME's new NRX II™ noise reduction system has to be heard to be believed. It's the only noise reduction system designed *expressly* for wireless microphones. And it's available only in HME's New Generation Series 50, both hand-held and body pac.

See your HME dealer for the final shock:

You'll find HME's Series 50 price *below* every other professional system. That's because we're sure every thinking professional will standardize on it.

And why not. There's nothing even close.

HM ELECTRONICS, INC.
6675 Mesa Ridge Road
San Diego, CA 92121
(619) 535-6060

HME's New Series 50 Wireless Microphone—with NRX II™

No Equal. Nothing Close.

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Howe Technologies/HoweTech (153)
Audio mixing consoles, phase correction equipment; audio amplifiers; turnkey studio designs, construction. (A2)
Circle (807)

HSN/Home Shopping Network (H5515)
Merchandise sales via TV.
Circle (808)

Hubbard Communications (1139)
Program distribution services; uplink redundancy switching; feedline pressurizers.
Circle (809) See ad page 167

IEEE/Broadcast Tech. Soc. (3903)
Professional service organization.
Circle (810)

IGM Communications (619)
Radio automation systems; automated audio cart playback equipment. (A4, S1)
Circle (811) See ad page 120

Ikegami Electronics (2320)
TV cameras; color, monochrome video monitors; video switchers; audio mixers; HDTV products; ENG microwave systems; video projectors; telecines. (R2, S5, V1, V2, V6, V7)
Circle (812) See ad page 252-253

ILC Technology (H5230)
Daymax HMI lamps. (V4)
Circle (813)

Image Video Ltd (3584)
Master control, video production switchers; digital audio recording/editing system; audio/video routing switchers. (A3, V6, S5).
Circle (814)

IMC/International Music (H5728)
Akai audio recorders; RSD Soundmaster audio mixers; Fane speakers, cabinets; Ross Systems PA equipment. (A2, A3, S2)
Circle (815)

IMS/Integrated Media Systems (H5232)
Signal distribution equipment. (A3)
Circle (816)

Industrial Acoustics (1026)
Acoustic, sound-proofing materials, broadcast booths.
Circle (817)

Information Display (H6112)
Turnkey studio systems; U.S. sales, service for Eidophor projection systems.
Circle (818)

Inovonics (770)
FM stereo generators, multiband audio dynamics processors; magnetic film recorder components; CRT audio level displays. (A2, A3, R5)
Circle (819) See ad page 176

Interactive Motion Control (4263)
Computer-controlled animation, camera support systems. (V2)
Circle (820)

Intergroup Technologies (2359)
Video production, master control, A/V routing switchers; video switcher effects systems. (V6, S5)
Circle (821) See ad page 234

ITC/3M (2305)
Audio reel, cartridge recorders; recording tape; cartridge analyzers; digital audio recorders.
Circle (822)

ITE/Innovative TV Equipment (2623)
Pan/tilt heads, tripods, pedestals. (V1)
Circle (823)

Itelco (3187)
AM, FM, TV transmitters, transposers.
Circle (824)

Intelligent Light (5127)
Circle (1215)

ITS (1113)
TV transmitters, transposers; microwave systems; exciters, generators. (R1)
Circle (825)

Jampro (531)
FM, TV transmitting antennas. (R1)
Circle (826) See ad page 92

JBL Professional (4377)
Studio monitors, speakers; EQ systems. (A4)
Circle (827) See ad page 5

Jefferson Pilot Data (1821)
Newsroom, business, music rotation software.
Circle (828)

Jensen Tools (4016)
Electronic tool kits; hand tools, tool cases; fiber optics maintenance equipment, VCR alignment tools. (S6)
Circle (829)

J-Lab (1019)
Video recording interface products. (S2, S5, V1, V2, V7)
Circle (830)

Johnson Electronics (1300)
SCA, EBS receivers; audio amplifiers.
Circle (831)

J&R Film/Moviola (2711)
Film-to-tape transfer equipment, transport synchronizers; editing accessories. (V3)
Circle (832)

JVC (2656)
TV cameras, lenses; electronic graphics, titling equipment; video monitors, recorders; routing switchers; TBCs; tape duplicators; recording media. (V1, V2)
Circle (833) See ad page 19, 28-29

Kahn Communications (739)
Audio dynamics processors; telephone bandwidth extenders; AM stereo equipment.
Circle (834)

Kalamusic (H5625)
Syndicated programming services.
Circle (835)

Kangaroo Video Products (2214)
Protective video equipment cases, covers. (S3)
Circle (836)

Kavouras (4520)
Weather radar display systems, maps.
Circle (837)

Kay Industries (728)
Power line conditioners, electrical power phase converters.
Circle (838)

Keltec Florida (H5531)
Satellite uplink, HPA electronics; TWT amplifiers.
Circle (839)

Keylite PSI (4509)
Lighting instruments, dimmers, controllers; lighting accessories.
Circle (840)

Key Video (1205)
Audio, video routing switchers.
Circle (1175)

K&H Products (3374)
Camera support products. (S3)
Circle (841) See ad page 212

Kinemetrics/Truetime (4015)
Precision timers, synchronized clock systems. (S1)
Circle (842)

Kings Electronics (4010)
RF, video, coaxial, triaxial connectors.
Circle (843)

Kintek (1611)
Stereo converters, processors; polarity/phase identification, correction equipment. (A2, S6)
Circle (844)

Kintronic Labs (1040)
AM DA phasors, tuners; RF patch panels, switching products; HV insulators; tower transformers, lighting chokes, variable inductors. (R1, S3, S6)
Circle (845)

Kliegl (3720)
Lighting instruments, lamps, dimmers, controllers.
Circle (846)

Kline Iron & Steel (1013)
Broadcast, communications towers, services, accessories.
Circle (847)

Knox Video Products (2551)
Electronic graphic titlers. (V5)
Circle (848)

Laird Telemedia (3962)
TV film multiplexers; electronic graphic titlers, paint systems. (V5)
Circle (849)

Lake Systems (1039)
Automated VCR playback systems, software; facility design, construction; custom equipment consoles. (S3)
Circle (850)

Landy Associates (2677)
Distributor: video equipment; cameras, editing systems; graphics equipment; computer software. (V4, V5)
Circle (851)

Lang Video Communications (4173)
Video equipment distributor; cameras, editors, graphics, computer systems.
Circle (852)

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GET IT IN STEREO.

In the field or on the run, the **AKG C 522 ENG**, mics it just like you hear it — in stereo. Wherever you are, whatever you're recording, from courthouse interview, press conference, rock concert, to forest fire, the C 522's clarity, rugged performance, and convenience are exactly what you need to add a true-life dimension.

Inside its sturdy housing are two matched cardioid condenser capsules, elastic-mounted for low noise and pre-configured to give you a smooth, one-handed XY-stereo field. It's a workhorse mic, with the little extras a working pro needs, like a built-in rechargeable battery, low-power warning LED, integrated on/off switch and boom mount shock suspension.

Get it live in stereo with the **AKG C 522.**

Reporter: Denise O'Brien.
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AKG® acoustics
77 Selleck Street
Stamford, CT 06902

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LDL Communications (2175)
FM, TV transmitters, MTS stereo equipment; TV antennas; towers, tower services. (R1)
Circle (853)

Leader-Brac Industries (H6121)
Audiotape splice/edit accessories.
Circle (854)

Leader Instruments (3472)
Sync, video, test signal generators; waveform, vector monitors; oscilloscopes; video level meters. (S6, V8)
Circle (855) See ad page 93

LEA Dynatech (3344)
Lightning protection, deterrent products; power surge protection devices. (S6)
Circle (720) See ad page 329

Lectrosonics (H6106)
Wireless microphone systems.
Circle (856) See ad page 290

Lee Colortran (3580)
Lighting instruments, lamps, dimmers, controllers; accessories; lighting ballasts; color corrections gels. (V4)
Circle (857)

Lee Filters (3580)
Light coloring gels.
Circle (858)

Leitch Video (2169)
Still stores; tone, sync, VBI test generators, inserters; SC/H test monitors, DAs, timing systems; video frame synchronizers. (S5, S6, V5, V8)
Circle (859) See ad page 85

LEMO USA (4022)
Audio, video connectors; coax, triax, multicore, mixed coax/multipin connectors.
Circle (860)

Lenco (3956)
Audio, video DAs; audio monitor amps; sync generators; video monitors; TBCs, video encoders. (S5, V7)
Circle (861) See ad page 71

Lexicon (1209)
Audio delay/effects processors; digital audio editing systems; time modification equipment. (A2)
Circle (862) See ad page 192

Lighting Methods (3184)
Lighting dimmers, dimmer controllers.
Circle (863)

Lightning Eliminators (1025)
Lightning dissipation arrays, ground rods, warning systems; power conditioning consultation.
Circle (864)

Lipsner-Smith (2466)
Motion picture film cleaning systems. (V3)
Circle (865)

Listec Video (4314)
Computer video prompting systems, display monitors. (V5)
Circle (866) See ad page 294

Logitek (825)
Audio mixers; audio monitors; impedance interfaces.
Circle (867)

Lowel Light (2569)
Lighting instruments, lamps.
Circle (868) See ad page 184

LPB (639)
Audio mixing consoles; low power AM transmitters.
Circle (869) See ad page 170

LTM (4135)
Lighting instruments; fiber optic lighting systems; mic poles; lighting dimmers. (V4)
Circle (870)

Lucasey Mfg. (5528)
Circle (1211)

Luxor (H5812)
Satellite receivers.
Circle (871)

L-W International (4005)
Telecine systems.
Circle (872)

Lyon Lamb Video Animation (2251)
Video animation controllers, equipment. (V2)
Circle (873)

M/A-Com MAC (3633)
STL, ENG systems.
Circle (874) See ad page 305

Magni Systems (H5109)
PC-based test signal, monitoring systems; waveform, vector monitors; component digital products. (S6)
Circle (875) See ad page 121

Magnum Tower (714)
Triangular, self-supporting, knock-down masts, towers.
Circle (876)

Manhattan Production Music (1635)
Programmed music service.
Circle (877)

MARCOM (103)
Distributor: Rood FM, TV stereo generators, metered receivers, telephone frequency extenders; TFT BTSC mod kits; Ian Hill AM transmitters. (R1, S6)
Circle (878)

Marconi Communications Systems (2869, 3833)
Radio, TV, exciters, transmitters; klystron pulsers; telecines. (R1, V3, V7)
Circle (879) See ad page 105

Marconi Instruments (2518)
TV test signal generators; automated test systems, analyzers. (S6)
Circle (880) See ad page 328A-B

Marti Electronics (525)
RPU, radio STL antennas, electronics; subcarrier equipment. (R5)
Circle (881)

MATCO (4487)
Sequencers, routing switchers, DAs, dubbing controllers, commercial insertion systems.
Circle (882)

Matthews Studio Equipment (4374)
Camera pedestals, cranes, tracks; grip equipment; lighting products. (V4)
Circle (883)

Matthey Electronics (2601)
Video, pulse delay lines, filters; HDTV products.
Circle (884)

Maxell (2383)
Recording media, all formats; audio, video cables; batteries. (S4)
Circle (885) See ad page 149, Map

Maze Broadcast (H5818)
Used equipment broker: audio, RF.
Circle (886)

McCurdy Radio Industries (1849)
Audio mixing consoles; phono products; studio furniture; intercom systems. (S5, S6)
Circle (887) See ad page 231

MCL (PL)
TWT power amplifiers, transmitters for satellite communications. (R6)
Circle (888) See ad page 128

McMartin Industries (512)
Audio monitor, control products; FM exciters, SCA products.
Circle (890)

Media Computing (4275)
Election, news graphics, newsroom software. (S1)
Circle (891)

Media Concepts (5117)
Circle (1204)

Media General Broadcast (3251)
Production music, sales libraries, promos, IDs, music formats.
Circle (892)

Merlin Engineering (4338)
Equipment reconditioning, rebuilding, VTR modification kits; Snell & Wilcox standards converters; Comlux fiber optic products. (S2)
Circle (893)

Micro Communications (4166)
FM, TV antennas, waveguides, feed lines; RF transfer switching components; diplexers, combiners, multiplexers, filters. (R1)
Circle (894)

Micro Controls (202)
STL systems; subcarrier paging systems; FM exciters. (R2, R5)
Circle (895)

Microdyne (2415)
Satellite antennas, mounts; uplink, downlink electronics. (R6)
Circle (896) See ad page 277

Micron Audio Products (2262)
Wireless microphone systems. (A4)
Circle (897) See ad page 118

Microsonics (4262)
Video filters, delay lines.
Circle (898)

Microtime (2638)
TBCs, frame synchronizers; digital video effects equipment; component format interchange systems; electronic graphic/art equipment. (V5, V7)
Circle (899) See ad page 243

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Complete Solutions

We'll Help You Take On *Any* Technical Project

OMEGA INTERNATIONAL

From Concept to Completion

- Custom Studio and RF System Designs
- Complete Turnkey Installations
- Project Management
- Feasibility Studies
- RFR (Non-ionizing radiation) Studies
- Unique FM Synchronous Repeaters (Boosters)

OMEGA INTERNATIONAL

can help you do the impossible. We can also help you with the routine. If it's a technical project, **OMEGA** has the expertise, the tools and equipment, and the time to design and construct a complete station when you need it yesterday, or to simply offer some labor when you need an extra pair of hands.

WE WORK FOR YOU.

As an independent, totally services-oriented company, **OMEGA INTERNATIONAL** is only interested in how to serve our customer. We are not an equipment manufacturer or supplier, so our designs and constructed systems offer you unlimited choices. What's best for you is our only concern. Call us. Without obligation or pressure, we'll discuss your project or idea.

OMEGA INTERNATIONAL

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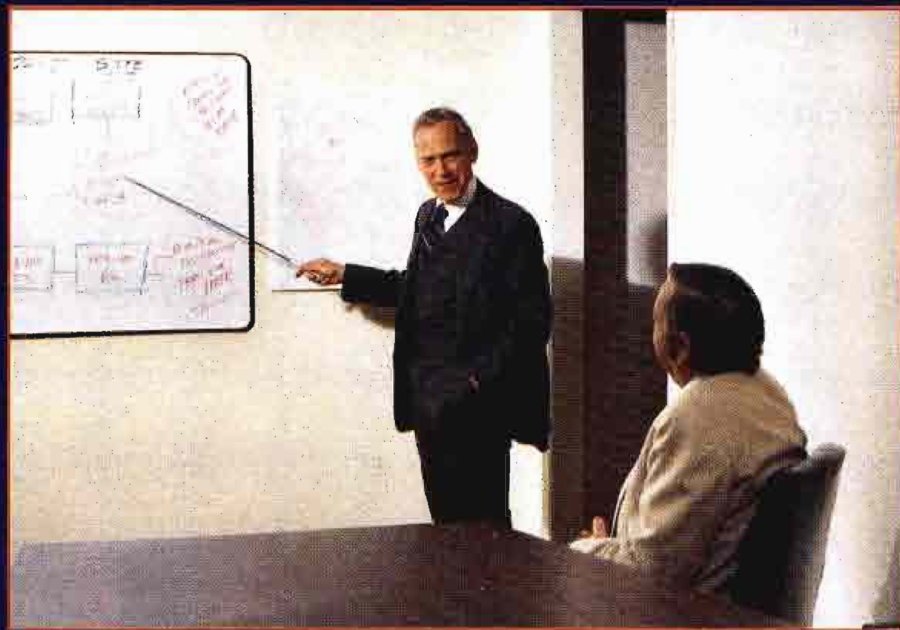
THE ORIGINAL

AT OMEGA INTERNATIONAL

we go out of our way to find creative solutions. Our approach to technical problem solving has led us to develop ideas which serve the Broadcast and Telecommunications industries in new ways. For example, our FM Synchronous Repeater allows you to fill in the holes in your coverage area under new F.C.C. rules, with a system much too powerful to be called a "Booster."

We have also devised a program to help you meet new F.C.C. rules requiring many stations to measure Radio Frequency Radiation, without it costing you a fortune.

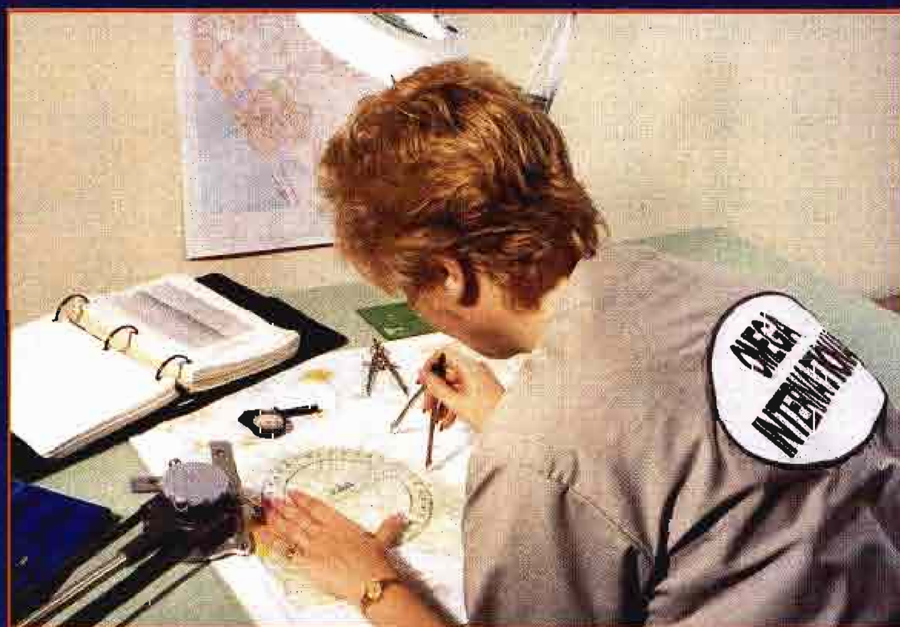


THE LEADER

THE DEPTH OF EXPERIENCE

which is present in **OMEGA INTERNATIONAL'S** engineering department, when combined with that enjoyed by your staff, can provide some very satisfying results. Our in-house facilities and engineering allow you to get major systemization and construction completed without disrupting your station's day-to-day operations, too.

Independence. Expertise. Performance. The time has come for **OMEGA INTERNATIONAL.**



- **Performance: On Time and Within Budget**
- **Full In-house Engineering and Technical Facilities**
- **Experienced and Qualified**
- **Next Door or Worldwide**
- **Independent. Service is our ONLY business!**

CALL THE ORIGINAL. . .CALL THE LEADER in Systems Engineering

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Microwave Radio (2935)
ENG microwave electronics, antennas. (R2)
Circle (900)

Midwest Communications (4342, PL)
Production vehicle, facilities designs, turnkey construction.
Circle (901) See ad page 1, 101, 103

Miller Fluid Heads (2364)
Camera support products, pan/tilt heads, tripods. (V1)
Circle (902) See ad page 116

Minolta/Industrial Meters (2573)
Light metering, colorimetry monitoring systems. (S6)
Circle (903)

Mitchell Camera (5726)
Camera pan/tilt heads, cradles.
Circle (908)

Mitsubishi Pro Audio (1519)
Audio mixers, recorders. (A1, A3)
Circle (904)

Miwltronics (H6021)
Telephone hybrid accessories.
Circle (905)

3M/Magnetic Media (2305)
Videocassette recording media, all formats. (S4)
Circle (906) See ad page 90-91

3M/Broadcast Related Products (2305)
Electronic graphics, titling systems; routing, master control switchers; machine control systems. (S1, S5, V5)
Circle (907) See ad page 223

Modulation Sciences (4544)
MTS, SAP, PRO generators, test demods, FM SCA systems; RF, stereo audio processors. (R4)
Circle (909)

Modulite/Bardwell-McAlister (2789)
Lighting products, systems, accessories.
Circle (910)

Mole-Richardson (4107)
Lighting instruments, lamps.
Circle (911)

Montage Group (1009)
Videotape editing systems. (V2)
Circle (912)

Morton Hi-Tek Furnishing (H5424)
Studio furnishings, equipment racks, cases; production facility design/consulting. (S3, S7)
Circle (913)

Moseley Associates (2315)
Remote control systems; STLs; RF generators, exciters; audio processors. (R2, S1, S5)
Circle (914) See ad page 13

Motorola C-Quam/AM Stereo (117)
AM stereo generators, exciters, modulation monitors, receivers. (R4, R5)
Circle (915)

MPO Videotronics (4188)
Integrated videodisc, tape presentation systems.
Circle (916)

Multi-Track Magnetics (2456)
Magnetic film sound recording systems.
Circle (917)

Musco Mobile Lighting (PL)
Self-contained, remote lighting systems, vehicles. (V4)
Circle (918)

Nady Systems (4009)
Wireless microphone systems. (A4)
Circle (920)

Nagra Magnetic Recorders (2714)
Audio recording systems. (A3)
Circle (921)

Nalpak Video Sales (4526)
Equipment cases, production carts; test equipment. (S3, S6)
Circle (923) See ad page 210

Narda Microwave (1428)
STL, ENG microwave electronics. (S6)
Circle (924) See ad page 299

Nautel (765)
AM radio transmitters. (R1)
Circle (925) See ad page 326

NEC America/Broadcast (2747)
Digital effects systems, TBCs, synchronizers; CCD cameras; routing switchers; digital recorders. (V1, V2)
Circle (926) See ad page 320-321

L. E. Nelson (2260)
Studio, stage lamps, lighting accessories. (V4)
Circle (927)

Neotek (H5530)
Reinforcement, production audio mixing consoles. (A1)
Circle (928)

Network Production Music (353)
Music, sound effects libraries. (S8)
Circle (929)

Neutrik USA (4587)
Connectors. (S2)
Circle (1219)

Rupert Neve (2348)
Audio mixing consoles; audio processing, EQ products; digital transfer equipment. (A2)
Circle (930) See ad page 131

New England Digital (4551)
Digital audio disk recording, editing equipment. (A3)
Circle (931)

A. C. Nielsen (2289)
Audience research, viewership statistics.
Circle (932)

Nikon (5128)
Circle (1216)

Norpak Corporation (3087)
Teletext, NABTS data delivery equipment. (V5, S1)
Circle (933)

Nortronics (2618)
Audio recording heads, accessories.
Circle (934) See ad page 274

Nova Systems (2210)
Video TBCs, synchronizers. (V7)
Circle (935) See ad page 331

NPR Satellite Services (H5533)
Program distribution, subcarrier paging services.
Circle (936) See ad page 237

Nurad (4101)
ENG, STL microwave electronics, antennas; remote control systems. (R2)
Circle (937)

Nytone Electronics (2442)
TV slide projection systems. (8)
Circle (938)

O'Connor Engineering Lab (2674)
Camera support systems, pan/tilt heads, tripods, pedestals, dollies. (V1)
Circle (939) See ad page 170

Odetics (H5813)
TV videocassette program automation systems, traffic interface, software. (S1, V2)
Circle (940) See ad page 171

OKI Electric Industry (2988)
Video standards conversion systems.
Circle (941)

Olesen (2647)
Lighting instruments, related products.
Circle (942)

Omicron Video (1870)
Utility routing, component video, production switchers; analog/digital component DAs. (V6, S5)
Circle (943) See ad page 190

Omnimusic (118)
Production music libraries. (S8)
Circle (944)

Optical Disc Corporation (H5321)
Optical disc recording equipment. (V2)
Circle (945)

Orban Associates (725)
Audio dynamics processors, stereo generators, synthesizers; programmable mic processors, de-essers; EQ products. (A2, R4)
Circle (946) See ad page 7, 17

Orion Research (1641)
Audio mixing consoles, distribution routing switchers. (A1)
Circle (947)

Osram/Siemens (H6107)
Stage, theatre, studio lamps.
Circle (948)

Otari (312)
Audio recording systems, tape duplication equipment. (A3)
Circle (949) See ad page 15, 307

Pacific Radio Electronics (H6119)
Circle (950)

Pacific Recorders/Engineering (339)
Audio mixing consoles; audio cart recorders; signal processing, distribution and control equipment; equipment enclosures. (A3)
Circle (951)

Paco Electronics USA (1452)
Batteries, chargers. (V4)
Circle (952) See ad page 278

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NEW

SMPTE-EBU Time Code Analyzer

Model TCA-143

If your edit problems are SMPTE Time Code related, Gray Engineering's new Time Code Analyzer pinpoints the error, displays code faults and corrects for phase and amplitude error.

Code Conditions at a Glance

- Phase Error/Display
- Sync Word Error
- Bit Count Error
- Sequential Count Error
- Color Sync Frame
- Code Level
- Flag Bits
- Video Sync Loss
- Code Loss

When a time code error occurs, a front panel light is illuminated, and an audible alarm is activated.

3 Output Modes

:BY-PASS–(E to E)
:RESTORE (restores amplitude and reshapes) (DUB)
:REPHASE (rephases, restores amplitude and reshapes)

List Price $2595.00
5-Year Warranty— Parts & Labor

GRAY ENGINEERING LABORATORIES INCORPORATED

NAB Booth 4174/4175

504-P W. Chapman Avenue • Orange, CA 92668 714-997-4151

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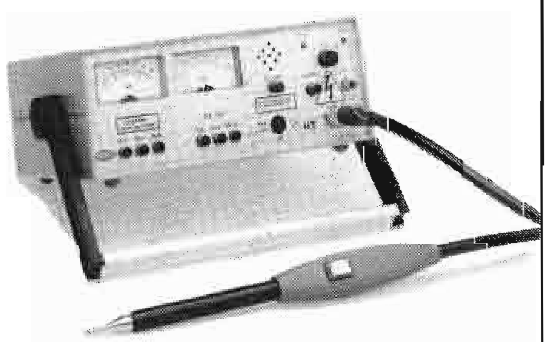
Circle (105) on Reply Card

15KV of Portable Broadcast Maintenance.



The JP15 Non-Destructive DC Insulation Tester.

Station maintenance engineers have found the JP Hi-pot testers to be useful tools for checking the co-ax cable running up antenna towers. Poor insulation within the cable, or malfunctioning tower insulators are easily identified with the 15KV output range of the JP15.

The JP15 operates on AC or DC power. DC current is supplied by either standard dry cell batteries or rechargeable NI-CD batteries stored in the bolt-on battery pack.

The unit is compact and weighs only 9½ lbs. It features minimal discharge energy for protection, and continuously variable output voltage. Test voltage is applied by a probe with a High Tension switch for one-handed operation.

In addition to antenna maintenance, the JP15 is ideal for other applications such as checking transient suppressors. Call us today for more information.

RE • INSTRUMENTS re

Electronics for Test and Communication

RE INSTRUMENTS CORPORATION
31029 Center Ridge Road, Westlake, Ohio 44145
Telephone (216) 871-7617 Telefax (216) 871-4303

Circle (106) on Reply Card

PAG Ltd (2438)
Batteries, chargers.
Circle (953) See ad page 151

Paltex (2301)
Videotape editing controller systems; audio mixing consoles; videotape degaussers. (A1, S4, V2)
Circle (954) See ad page 78-79

Panasonic Broadcast Systems (2938)
Video cameras, recorders; TBCs, signal processing; video playback automation.
Circle (955) See ad page 68-69, 272-273, Map

Panasonic Industrial/PIC (2938)
Video cameras, recorders, editing systems; video projectors. (V1, V2, V8)
Circle (922) See ad page 291, 293

Panasonic/RAMSA (2938)
Audio mixing consoles, recording systems, source/monitoring equipment. (A4)
Circle (956) See ad page 227

Patch Bay Designation (4178)
Patch panel labels.
Circle (957) See ad page 208

Peerless Sales (2417)
Utility equipment carts.
Circle (958)

Penn Fabrication (H5115)
Circle (959)

Penny & Giles (1020)
Audio faders; AF/RF attenuators.
Circle (960) See ad page 335, 336

PEP (2701)
Batteries, chargers.
Circle (961)

Perrott Engineering Labs (2230)
Batteries, chargers; protective covers; color correction filters.
Circle (962) See ad page 332

PESA Electronica (3280)
Video monitors, production titlers; automatic TV monitoring systems; FM/TV transmitters, translators; satellite receivers, intercom systems. (V5)
Circle (963) See ad page 239

Philips TM&I/Pro TV (3177)
TV sync, test generators; picture, waveform, vector, SC/H phase monitors; video, VBI test equipment; TV IF, stereo modulators; demodulators; color analyzers. (S6, R5)
Circle (965)

Photographic Equip. Service (H6113)
Circle (966)

Photokina (4561)
Circle (1212)

Photron (2440)
Sync generators, video encoders, interfaces; computer products.
Circle (967)

Pinnacle Systems (H6027)
Electronic graphic art, digital effects, still store systems; desktop video workstations. (V2, V5)
Circle (968) See ad page 114A-D

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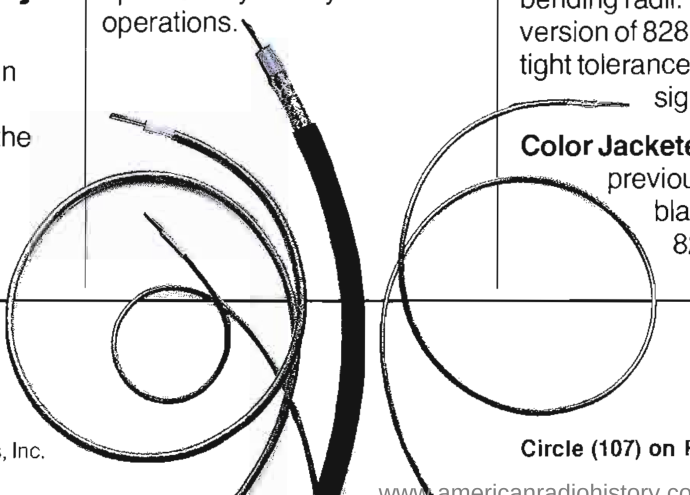
A BELDEN® BROADCAST CABLE MEANS NEVER HAVING TO SAY YOU'RE SORRY

Signal disruption during a live broadcast is a major and costly embarrassment.

With close to 30 million seconds of air time in a year, it only takes a few seconds to realize why you need Belden quality.

That's why the broadcast industry depends on Belden cable to cover large events such as the Olympics and the Indy 500. Events where a cable has to keep working while being subjected to extremes of weather, terrain and traffic. Events where there is no second chance.

And, because broadcasters need a cable they can install permanently without worry of failure, Belden is also relied upon for day-to-day studio operations.



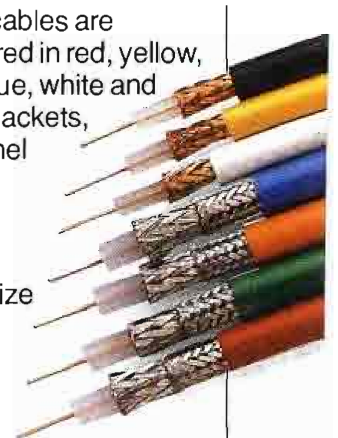
The broadcast industry knows that Belden is accepted worldwide as the standard for reliable, top-quality cable. More importantly, broadcasters know Belden has earned this reputation by designing durability into cables, so users won't have reason to be sorry.

New ways to avoid apologizing.

Dependable Belden performance is now available in six new broadcast cables:

Conformable™ and Flexible Coax—9307, 9308 and 1168A are innovative conformable replacements for semi-rigid coax in applications calling for improved flexibility, high temperature rating or tight bending radii. 1163A, a flexible version of 8281, is designed to tight tolerances for excellent signal return loss.

Color Jacketed Coax—previously available in black only, Belden's 8241, 8281 and 1163A video cables are also now offered in red, yellow, green, light blue, white and orange outer jackets, making channel coding much easier.



If you've ever had to apologize for inferior cable performance, find out why *There is no equal* to Belden. For ordering information call your local Belden distributor. Or contact:

BELDEN Wire and Cable
P.O. Box 1980
Richmond, IN 47375

1-800-BELDEN-4

(in Indiana, call 317/983-5200)

There is no equal.™

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Circle (107) on Reply Card

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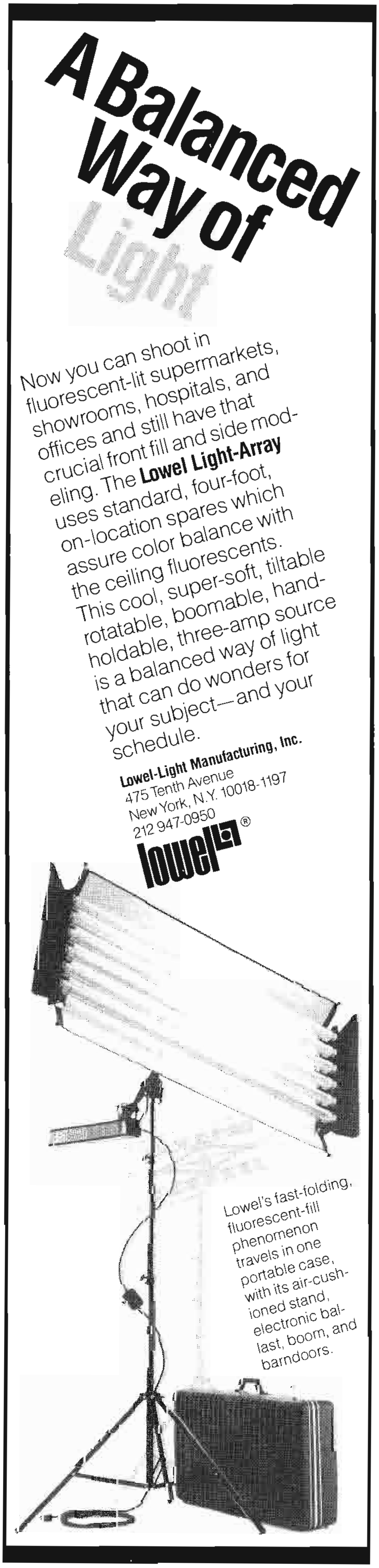

Circle (108) on Reply Card

Pinzone Communications (1119)
Audio multiplex system; videocart refurbishment; satellite receivers, downconverters; AM antennas. (R1, R2, R6, S1)
Circle (969)

Plasmec Systems Ltd. (5526)
Circle (1209)

Polar Video (3576)
Video switchers, safe area generators, keyers, faders.
Circle (970)

Polaroid (4576)
Instant photo video printer, print/slide materials. (V3)
Circle (971)

Porta-Pattern (2877)
Video test charts, transparencies, films, illuminators.
Circle (972)

Potomac Instruments (1108)
AM DA antenna analyzers; audio test systems; remote control products; RF signal meters; modulation, power controllers; AM monitor receivers; signal generators, detectors.
Circle (973) See ad page 244

Pro Battery (4483)
Batteries, replacement inserts, chargers. (V4)
Circle (974)

Progressive Computer Products (5320)
Circle (1210)

QEI (247)
FM transmitters, exciters, modulation monitors; remote transmitter control systems. (R1)
Circle (975) See ad page 99

QSI Systems (2462)
VBI/SID generators, encoders, decoders; blackburst generators.
Circle (976)

Q-TV (4117)
Video prompting and newsroom script preparation systems.
Circle (977)

Quality Video Supply (4387)
Mono/color video signal combiners. (S6, V3, V6, V7)
Circle (978)

Quanta (3344)
Electronic graphic titlers, art systems; Calaway editing control systems. (V2, V5)
Circle (722) See ad page 32

Quantel (3638)
Electronic graphic art systems, caption generators; standards conversion systems; digital still libraries, optical disk memory; digital video production studio systems. (V2, V5)
Circle (979) See ad page 198

Quantum Audio Labs (2301)
Audio mixing consoles; videotape degaussers. (S4)
Circle (980)

Quickset (4120)
Camera support products; pan/tilt heads, tripods. (V1)
Circle (981) See ad page 230

Radiation Systems/Mark Antenna (1550, PL)
Microwave antennas; waveguide, feedline. (R2)
Circle (982) See ad page 320

Radio Systems (159)
Audio mixing consoles; SCA receivers; phono preamps, audio DAs, monitor amps; meters; cart machines; cabinetry.
Circle (983) See Map

RAKS (H5633)
Videocassette recording media.
Circle (984)

RAM Broadcast (170)
Distributor: audio, radio, video products; audio phase monitors, video monitors, routing switchers; cabinetry/furniture; consultants. (A1, S6)
Circle (985)

Rank Cintel (2334)
Telecine systems; digital still image library, color correction, electronic graphic art systems; automation equipment; standards/format converters; comb filter decoders; audio recording systems. (V3, V5)
Circle (986) See ad page 193, 314

RCA/Burle Industries (2620)
Camera tubes; RF power amplifier devices.
Circle (987)

R-Columbia Products (2267)
Intercom systems; camera headsets, headphones. (A4)
Circle (988) See ad page 186

Reach Electronics (4180)
Communications, SCA paging equipment. (S1)
Circle (989)

Recortec (H5430)
Tape conditioning equipment; VHS recorder adaptations. (V2)
Circle (990)

Rees Associates (4240)
Studio, facilities designs.
Circle (991)

Register Data Systems (659)
Automated station business software, equipment.
Circle (993)

Religious Broadcasters Assn. (4559)
Circle (1178)

Retex International (H6033)
Circle (994)

RF Technology (4243)
ENG microwave equipment; Faraday filters; wireless microphones; auto-tracking antennas. (A4, R2, S6)
Circle (995)

Richardson Electronics (2561)
RF power amplifier tubes; camera tubes. (R3)
Circle (996)

Rockwell International (2451)
Weather radar equipment; STL/ICR microwave systems.
Circle (998)

ROH/Anchor Audio (2234)
Audio monitors, DAs, sound systems; intercom, party-line, IFB systems; test equipment. (A4, S5)
Circle (999) See ad page 210

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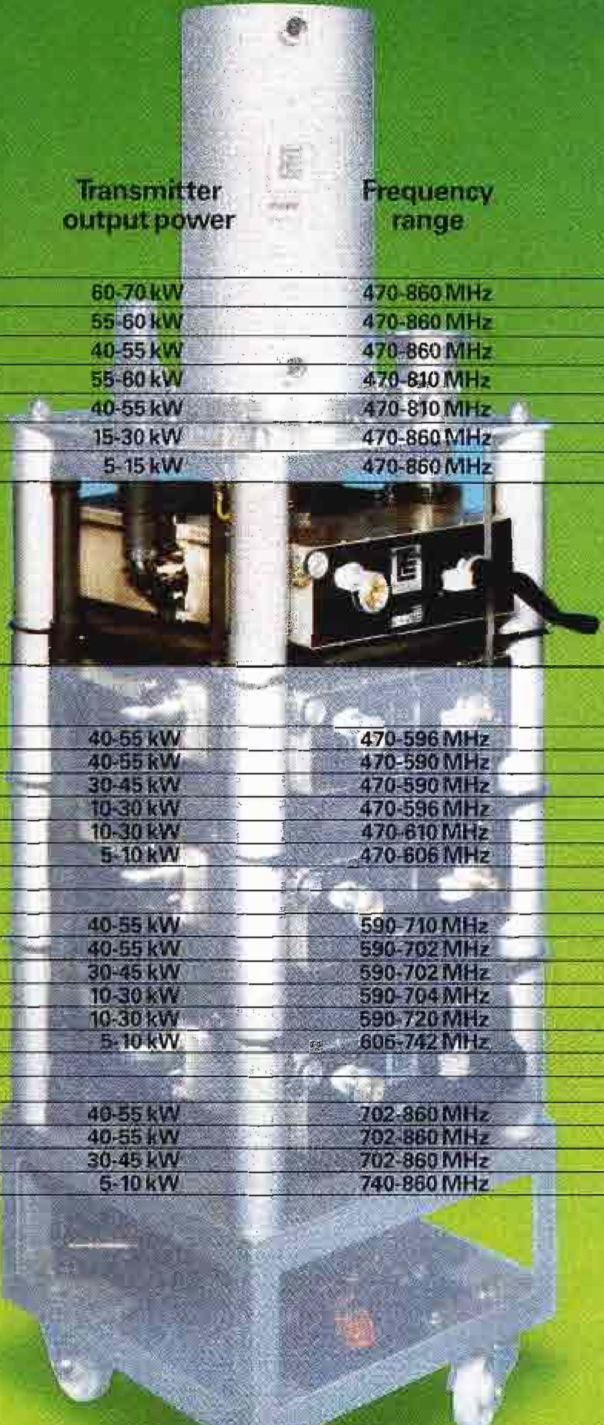
EEV KLYSTRONS
SO MUCH MORE TO OFFER

The most comprehensive range of External Cavity UHF TV Klystrons



	Transmitter output power	Frequency range	Typical Sync efficiency
WIDEBAND SERIES			
K3773BCD	60-70 kW	470-860 MHz	44% to 48%
K3673BCD	55-60 kW	470-860 MHz	44% to 48%
K3573BCD	40-55 kW	470-860 MHz	43% to 46%
K3672BCD	55-60 kW	470-810 MHz	44% to 48%
K3572BCD	40-55 kW	470-810 MHz	43% to 46%
K3271BCD	15-30 kW	470-860 MHz	42% to 47%
K3270BCD	5-15 kW	470-860 MHz	42% to 47%
STANDARD SERIES			
Low Band			
K3276HBCD	40-55 kW	470-596 MHz	38% to 43%
K3382BCD	40-55 kW	470-590 MHz	38% to 42%
K3217HBCD	30-45 kW	470-590 MHz	40% to 42%
K3230BCD	10-30 kW	470-596 MHz	40% to 42%
K376L	10-30 kW	470-610 MHz	34% to 40%
K370/W series	5-10 kW	470-606 MHz	29% to 35%
Mid Band			
K3277HBCD	40-55 kW	590-710 MHz	38% to 43%
K3383BCD	40-55 kW	590-702 MHz	38% to 42%
K3218HBCD	30-45 kW	590-702 MHz	40% to 42%
K3231BCD	10-30 kW	590-704 MHz	40% to 42%
K377L	10-30 kW	590-720 MHz	38% to 45%
K371/W series	5-10 kW	606-742 MHz	32% to 35%
High Band			
K3278HBCD	40-55 kW	702-860 MHz	38% to 43%
K3384BCD	40-55 kW	702-860 MHz	38% to 42%
K3219HBCD	30-45 kW	702-860 MHz	40% to 42%
K372/W series	5-10 kW	740-860 MHz	32% to 35%

AVAILABLE TODAY **EEV Klystrons**

See Us At NAB Booth #3384

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USA: EEV Inc, 4 Westchester Plaza, Elmsford, NY 10523 Telephone: (914) 592 6050 Telex: 6818096 Fax: (914) 682 8922
CANADA: EEV Canada Ltd, 67 Westmore Drive, Rexdale, Ontario M9V 3Y6 Telephone: (416) 745 9494 Telex: 06 989363 Fax: (416) 745 0618
UK: EEV, Waterhouse Lane, Chelmsford, Essex CM1 2QU, England Telephone: (0245) 493493 Telex: 99103 Fax: (0245) 492492

Subsidiary of the General Electric Company plc of England GEC

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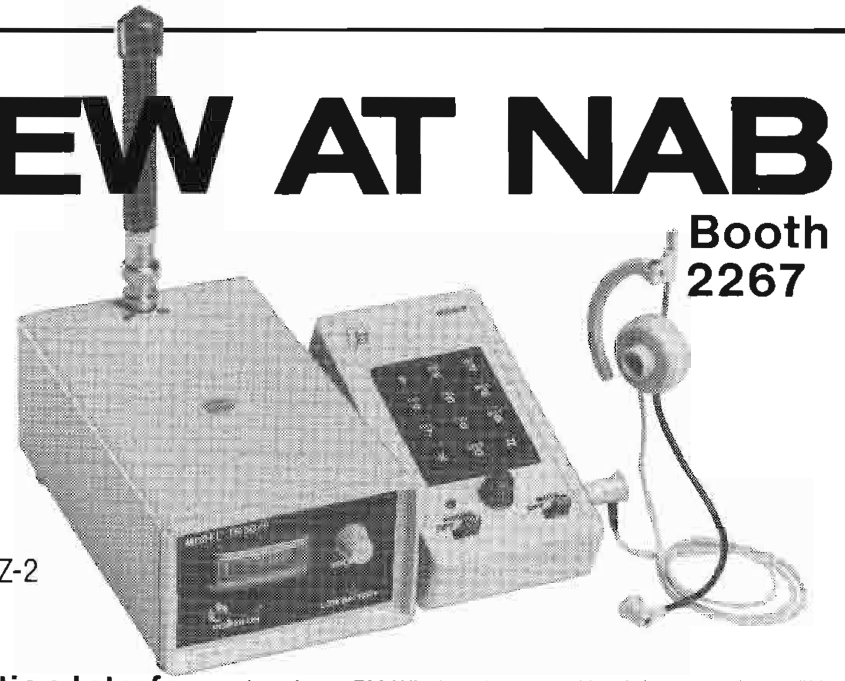
NEW AT NAB

Booth 2267



Request Catalog CZ-2

Base Station Interface - Interfaces FM Wireless Intercom Headphones with any "Hard-Wired" system such as Clear Com, RTS, Telex, etc. Full or partial duplex. AC line (120v) or battery operation. Uses license-free frequencies.

ENG/IFB/Telephone - "Hands-free" telephone with exclusive features for ENG and "dial-up" IFB work. Small size 2" x 4" x 1" with a clip for attaching to the user's belt. New model has selectable tone or pulse dialing.

Ultra-Lightweight Cameraman's Headphone - Amplified headphone weighs less than 2 ounces and is available in single or double ear models. Boosts volume of carbon mic systems up to 5 times. Compatible with all types of TV cameras.

5-Channel FM Wireless Intercom Headphone - Self contained FM transmitter, receiver, battery supply, and microprocessor. Range is 150 yards (¼ mile in open terrain) using any one of 5 selectable license-free frequencies.

R-COLUMBIA PRODUCTS CO., INC.

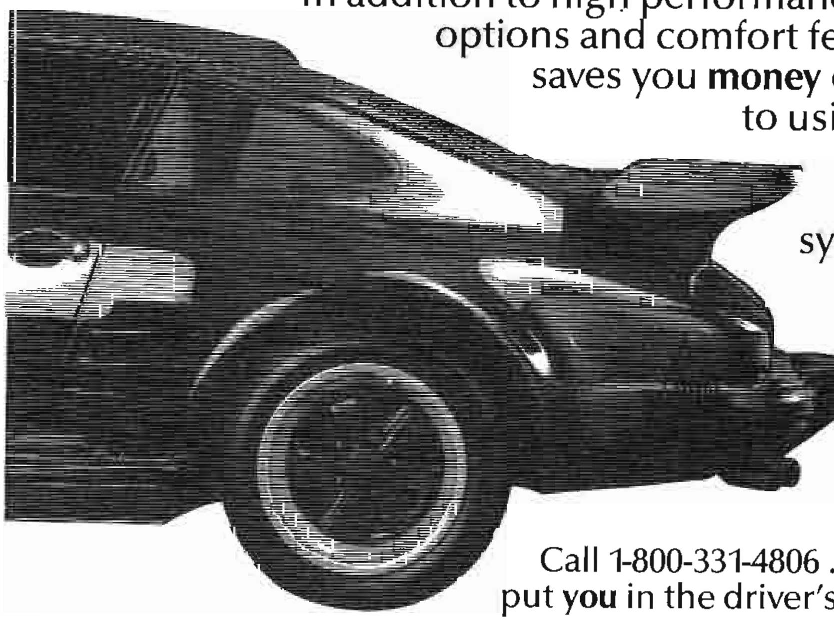
2008 St. Johns Ave., Highland Park, IL. 60035-2499 • (312) 432-7915 TWX: 910-692-2160

Circle (110) on Reply Card

TURBOCHARGE YOUR DELIVERY SYSTEM!

More than 2500 radio stations are cruising to Westar V and the SCS Radio Network Services. Drive your audio market with a quality system that gets you connected. FAST!

In addition to high performance, standard options and comfort features, SCS saves you **money** compared to using any other signal transportation system.



RADIO SCS NETWORK SERVICES

Call 1-800-331-4806 . . . We want to put **you** in the driver's seat!

Circle (111) on Reply Card

Rohde & Schwarz/Polarad (2706)
Audio, video, RF test equipment, signal generators, monitors; FM, TV demodulators. (R4, S6)
Circle (1000) See ad page 315

ROHN (4013)
Communications antenna support structures, towers; equipment shelters, lightning protection devices.
Circle (1001)

Rosco Laboratories (2547)
Chroma-key paints, background fabrics; effects equipment; lighting gels, projectors; stage plugs.
Circle (1002)

Roscor Corporation (3151)
News, production vehicles. (S7)
Circle (1003)

Ross Video (3377)
Video production switchers, keyers. (V6)
Circle (1004) See ad page 303

RPG Diffusor Systems (1125)
Studio acoustic treatment materials. (S3)
Circle (1005)

R/Scan (H5007)
Lightning detection equipment.
Circle (1006)

RTI/Research Technology (2566)
Videotape evaluators, cleaners; film editing systems. (S4, V3)
Circle (1007)

RTNDA (2703)
Circle (1179)

RTS Systems (4330)
Intercom systems; audio tone generators. (A4)
Circle (1008) See ad page 62, 64

Sachtler (3147)
Camera support products; pan/tilt heads, tripods, pedestals. (V1)
Circle (1009) See ad page 111

Saki Magnetics (671)
Recording heads, refurbishing services.
Circle (1010)

Samson Products (4273)
Wireless microphone systems.
Circle (1011)

Sanken Microphone (H6120)
Microphones.
Circle (1012)

Satellite Music Network (H6015)
Syndicated programming services.
Circle (1013)

SBE (3911)
Professional organization; certification program.
Circle (1014)

Schafer World Communications (539)
Automated CD players.
Circle (1015)

Schmid Telecommunication (1046)
Automated audio test systems.
Circle (1016)

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WE'VE MADE A TON OF IMPROVEMENTS ON THE WORLD'S MOST POPULAR SNG® VEHICLE

Over a ton, in fact. Because our new SNG® 230 has a 2100-lb. greater weight capacity. With the same height (10'), size and economy of our most popular SNG® vehicle.

And we didn't stop there. Our new cutaway feature allows easy access from the cab to the work area. There's plenty of storage space: 155 cubic feet. A GVW of 16,900 lbs. Even a generator compartment that accommodates up to 20 KW.

The newest addition to the HUBCOM fleet has been improved from the inside out. And it's destined to become an industry standard in satellite news gathering transmission.

There's lots more we could tell you about the 230. (Like its highly advanced technology and equipment.) And a lot more we could say about HUBCOM. (The fact we've got more SNG®'s on the road than anyone else, for example.)

But with a whole ton of improvements to consider, now's the time to call your HUBCOM representative. So you can start weighing the differences for yourself.

HUBCOM

HUBBARD COMMUNICATIONS, INC.

The last word in technology from the first name in the industry

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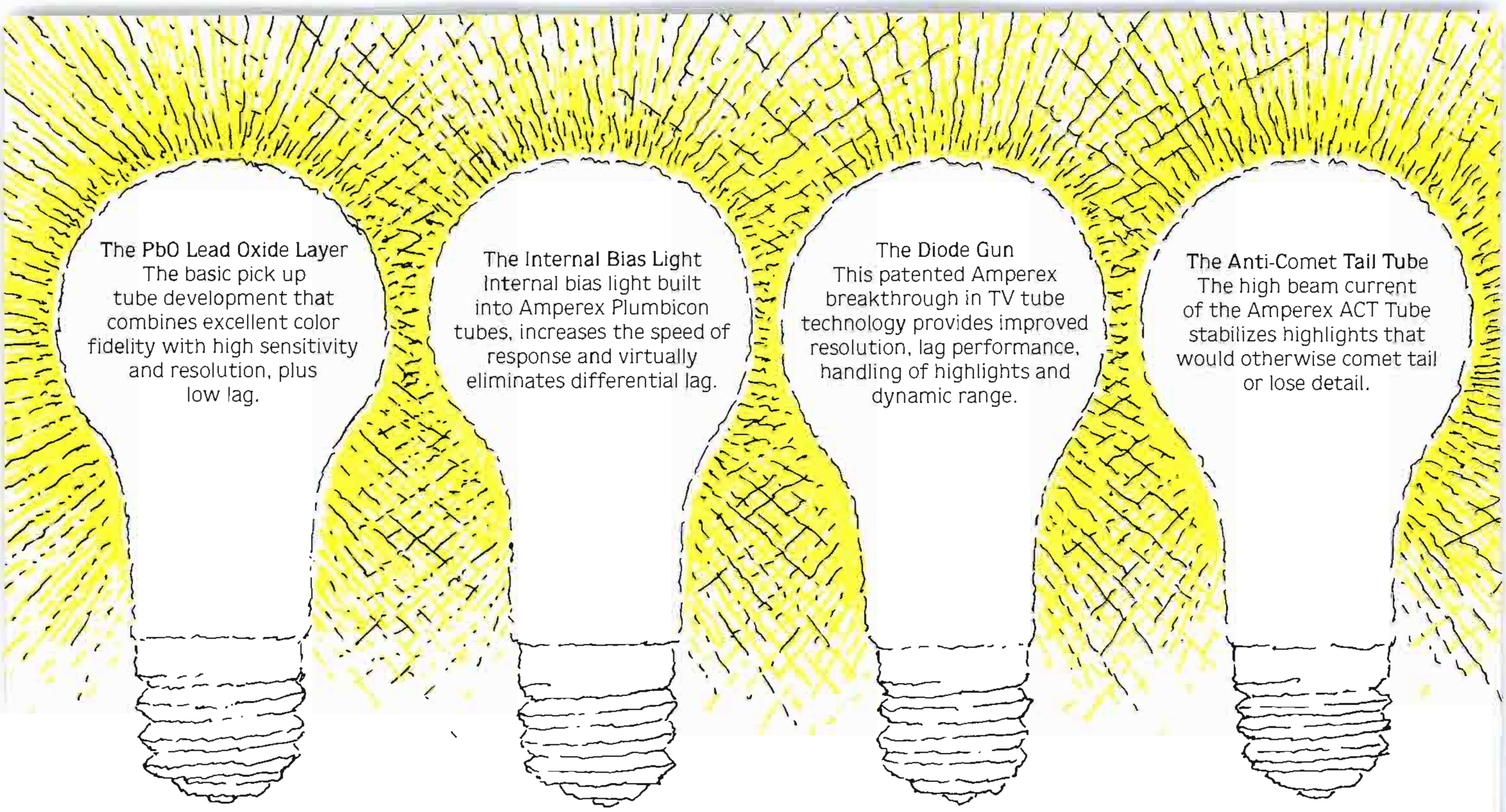
See Us At NAB Booth #1139



Eight brilliant ideas in TV

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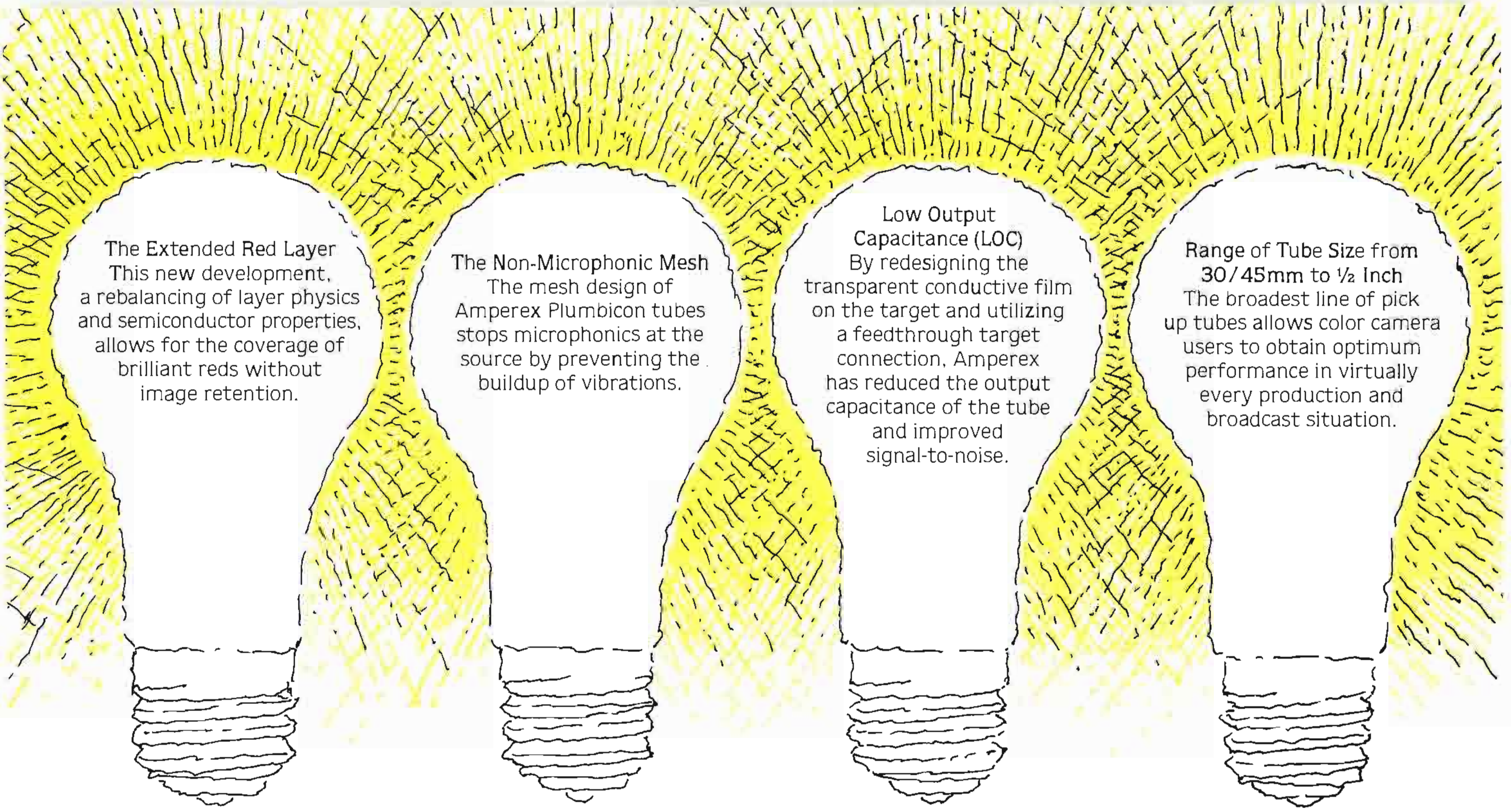

technology and what they mean to you.

The current high state-of-the-art of TV color cameras owes a great deal to the ideas and insights generated by Amperex and Philips. In fact, our corporate family has developed more innovations and refinements in pick up tube technology than anyone else.

Behind each flash of brilliance is a deep understanding of the broadcasting industry. We know, for example, how competitive pressures have created a need for cameras that deliver increasingly better performance in a variety of difficult situations.

We've responded...with one innovation after another until today, we offer the broadest line of extended performance Plumbicon® TV Camera Tubes. No matter what cameras you use—domestic or imported—we have the tube that can optimize their performance. Which makes the specifying of Amperex Plumbicon tubes a pretty bright idea in itself.

Made in Rhode Island, U.S.A. Delivered to you in twenty-four hours or less.

For more information call or write Imaging Products Group, Amperex Electronic Corporation, Slatersville, Rhode Island 02876. (401) 762-3800. A North American Philips Company. Outside the U.S.A. contact: Philips Electronic Components and Materials Division, 5600 MD Eindhoven, The Netherlands.

Visit us at NAB, Booths #2541-2545.

Amperex®

Amperex Imaging Products
. . . we see things your way.

Circle (113) on Reply Card

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Schneider Optics (4110)
TV camera lens systems, accessories. (V1)
Circle (1017) See ad page 55

Schwem Technology (4584)
TV camera lens stabilizers, wide-angle lenses. (V1)
Circle (1018)

Scientific Atlanta (2343)
Satellite system antennas, electronics.
Circle (1019)

Selco/Sifam (863)
Equipment knobs, fuseholders, meters.
Circle (1020)

Sennheiser Electric (152)
Audio mixers; condenser, dynamic, wireless microphones; headsets. (A4)
Circle (1021) See ad page 327

SESCOM (2206)
Impedance interfaces; AF amplifier modules; audio dynamics processors, test products, monitors. (A4, S6)
Circle (1022) See ad page 328

SG Communications (1027)
Tower, antenna installation, services.
Circle (1023)

Sharp Electronics/Broadcast (4316)
TV cameras, video monitors, displays; VCRs; digital audio recorders; video printers. (A3, V1, V2, V8)
Circle (1024)

Shima Seiki (5704)
Circle (1206)

Shively Labs (109)
Single, multistation FM antennas, directional couplers, combiners.
Circle (1025) See ad page 337

Shook Electronics (PL)
Mobile video production vehicles. (S7)
Circle (1026)

Shure Brothers (203)
Mics, wireless mics; audio mixers, DAs, monitor amps; phono products; audio dynamics processors. (A1, A4)
Circle (1027) See ad page 250

Sierra Video Systems (H5315)
Distribution routing products; video signal processing equipment; signal generators. (S5, S6, V7)
Circle (1028)

Sigma Electronics (2075)
Blackburst, bar generators; video processors, DAs.
Circle (1029) See ad page 226

Singer Products (715)
Distributor: audio, radio, video equipment.
Circle (1030)

Skotel (4149)
Time code systems.
Circle (1031)

SMPTE (3913)
Professional organization; standards coordination.
Circle (1032)

Circle (147) on Reply Card

Want more information on advertised products? Use the Reader Service Card.

Snell & Wilcox Electronic (4338)
TBC/synchronizer, standards conversion equipment.
Circle (1033)

Solid State Logic (1409)
Audio mixing consoles, console automation. (A1, A2)
Circle (1034) See ad page 251

H. A. Solutec (4541)
Stereo phase, test indicators; A/V DAs; commercial insertion equipment. (S1, S5, S6)
Circle (1035)

Sono-Mag (419)
Radio program automation; multicartridge carousel systems.
Circle (1036)

Sony Broadcast (2902)
TV cameras, video recorders, monitors; editing controllers; cassette automation systems; wireless mics. (A1, A2, A3, S1, S4, V1, V2, V8)
Circle (1037) See ad page 24-25

Sony Magnetic Products (2902)
Recording media, all formats. (S4)
Circle (1038)

Sony Professional Audio (2902)
Audio mixers; analog, digital audio recorders; microphones; signal processors; microphones. (A1, A2, A3)
Circle (1039) See ad page 126, 288-289

Sony Professional Video (2902)
Video recorders, monitors, editor controllers. (V1, V2, V8)
Circle (1040) See ad page 86-87, 173-175

Sound Ideas (2605)
Sound effects, music libraries.
Circle (1041)

Sound Technology (2479)
Audio system, distortion test, analyzer equipment; MTS switcher; audio filters. (S6)
Circle (1042) See ad page 197

Soundcraft (4377)
Audio mixing consoles. (A1)
Circle (1043)

Soundmaster International (H5010)
Audio editing controller; machine synchronizers.
Circle (1044)

Soundtracs (1245)
Audio mixing consoles, console automation. (A1)
Circle (1045)

Sprague Magnetics (255)
Audio recording heads, refurbishing.
Circle (1046)

Stainless (2553)
Broadcast/communications towers, accessories; services.
Circle (1047) See ad page 260

Standard Communications (1048)
Satellite receiving electronics. (R6)
Circle (1048) See ad page 153

Stanton Magnetics (849)
Phono cartridges, styli, preamps; headphones,

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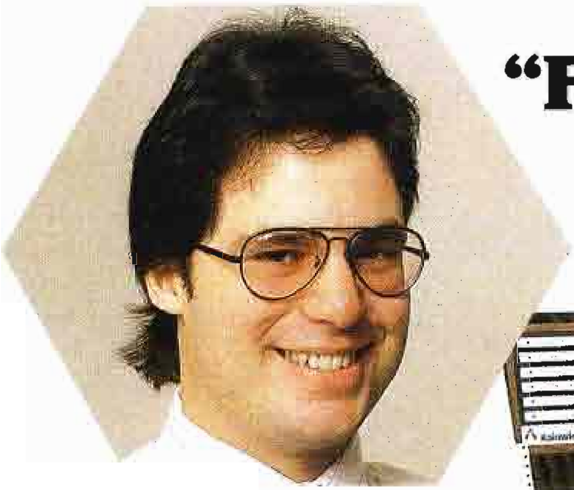
"Features and specs sold us on Auditronics 200 consoles."



Robert Lankton, Chief Engineer
WDUV/WBRD in Bradenton, Florida

"Their performance and reliability keep us sold."

"We wanted a console flexible enough to use in master control, production and news. We shopped for features and specs, but we also looked for ease-of-use and reliability. We got just what we wanted in our four Auditronics 200s."

Features

"I insisted on outboard power supplies and no monitor amps in the console for noise reasons. I was impressed with Auditronics' VCA technology, which at the time was not available elsewhere. We wanted the self-contained clock and timer. We needed the switching logic to interface between the A and B inputs, (a neat concept most other consoles don't offer). And we needed a lot of extra line inputs to support our satellite feeds. We needed a first-rate telephone interface. Auditronics beat its competitor hands-down on this. And, of course, modular design was a must for serviceability. We got it all in the Auditronics 200."

Specifications

"We go for the widest dynamic range we can get because much of our programming originates on CD. So the 200's 3dB better S/N is really important. Everything on the Auditronics 200 tests out better than the specs they publish, and you can't ask for more than that."

Ease of Operation

"I found the 200 logically laid out and very easy to train our people to use. The jocks like them and can easily understand them, which is very important to management."

Reliability

"We're just ecstatic about the Auditronics consoles. They've run 24-hours, 7-days since turn-on without a failure. What's more, they've held their specs, which I check every month to audiophile standards."

"Would I buy Auditronics again?"

"At WDUV/WBRD everybody is happy with both the Auditronics consoles and the support we've received from the company. We look forward to doing business with them again." If you'd like to know more about why Rob Lankton swears by Auditronics consoles, call 1-800-638-0977 or contact

auditronics, inc.
3750 Old Getwell Road, Memphis, TN 38118
901-362-1350

Circle (116) on Reply Card

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audio accessories. (A3, A4)
Circle (1049) See ad page 130

Stantron Unit/Zero **(1804)**
Equipment, dubbing, duplication racks, enclosures. (S3)
Circle (1050) See ad page 236

Star Case **(2487)**
Equipment transport cases. (S3)
Circle (1051)

Status Cabinetry **(H5731)**
Studio furnishings.
Circle (1052)

Steadi-Film **(H5113)**
Telecine gate stabilizers; motion controllers; cuing devices; telecine lenses. (V1, V2, V3)
Circle (1053)

Steenbeck **(2480)**
Videotape, film editing systems. (V2, V3)
Circle (1054)

Storeel **(2653)**
Videocassette, CD storage systems; utility tape carts; (S3)
Circle (1055)

Straight Wire Audio/A+DR **(352)**
Distributor: Audio+Design/Recording audio processors; CD players; cart machine, phono preamps, stereo matrix systems.
Circle (1056)

Strand Lighting **(2351)**
Lighting instruments, dimmers, controllers, accessories.
Circle (1057)

Strata Marketing **(1419)**
Radio station business, accounting software.
Circle (1058)

Studer ReVox America **(545)**
Audio mixing consoles; audio recorders; CD players; machine synchronizers; monitor amps, speakers; telephone hybrids. (A3)
Circle (1059) See ad page 11, 104

Studio Technologies **(1633)**
Stereo simulation, identification systems; mic preamps.
Circle (1060)

Sunspot **(371)**
Radio broadcast business software.
Circle (1061)

Swintek Enterprises **(1302)**
Wireless microphones, intercoms, headphones, video accessories. (S4)
Circle (1062)

Switchcraft **(130)**
Audio, video, connectors; patch panel accessories. (S2)
Circle (1063) See ad page 89

SWR **(4001)**
FM/TV antennas, transmission line products. (R1)
Circle (1064)

Sylvania Lighting **(2606)**
Studio, stage lamps.
Circle (1065)

Symbolics/Graphics **(H6003)**
Electronic graphics art equipment. (V5)
Circle (1066)

Symetrix **(672)**
Audio dynamics processors; telephone interface systems. (A2)
Circle (1067)

System Associates **(4154)**
Reconditioned, used equipment brokers; distributor: video equipment.
Circle (1068)

Systemation **(1151)**
Radio automation hardware. (A3)
Circle (1069)

Taber **(2718)**
Audio recording heads; tape degaussers, cleaners, conditioners; tape.
Circle (1070)

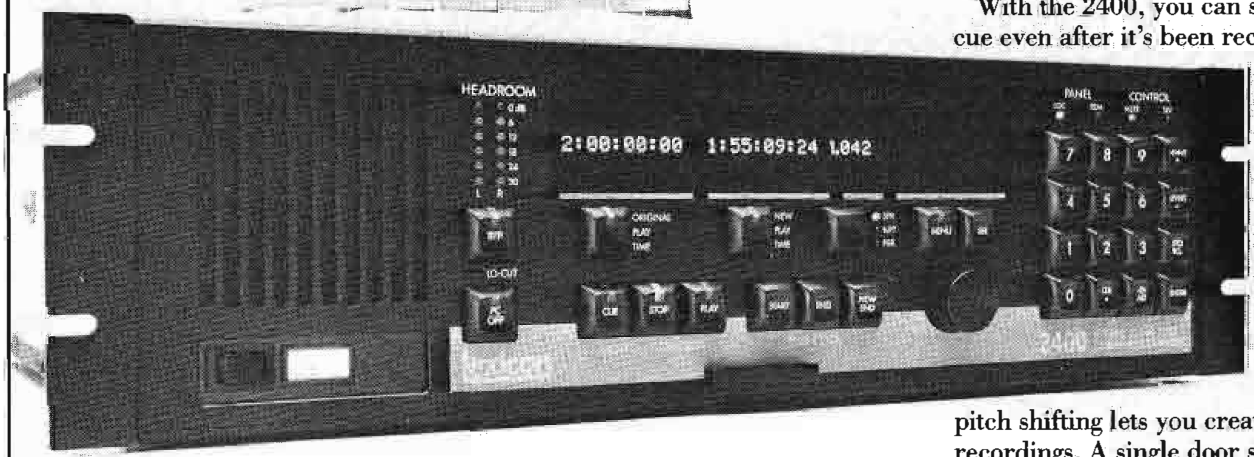
Tamron Industries **(3380)**
ENG camera lenses, video image processors.
Circle (1072)

Tannoy North America **(H6109)**
Audio speaker/monitor systems.
Circle (1073)

Tapscan **(620)**
Music scheduling/inventory software.
Circle (1074)

TASCAM **(2183)**
Audio mixing consoles, recorders, processing systems. (A3)
Circle (1075) See ad page 72, 74, 232

TIME COMPRESSION & EXPANSION VS. CUT AND PASTE EDITING



The Model 2400 has proven its effectiveness in fitting films, commercials and other programming to broadcast time slots: it also provides you new creative possibilities in editing and post-production.

See Us At NAB Booth #1209

Fitting the best voice-over take to the right time
You could try to do this by physically editing the tape to shorten or lengthen pauses. But why spend the painstaking hours, when the Model 2400 does the whole thing in one pass? It will read timecode from any variable speed ATR or VTR, correcting pitch and EQ automatically. Operation is via straightforward front panel menus and dedicated function keys.

Tailoring the length of music beds
With the 2400, you can shorten or extend a bed to hit the cue even after it's been recorded. Lexicon's breakthrough in audio processing produces superior audio quality an order of magnitude beyond previous devices. Advanced DSP architecture processes off-speed audio in phase-coherent stereo, without the artifacts normally associated with pitch shifting.

Expanding your sound effects library
The Model 2400's flawless pitch shifting lets you create new sound effects from existing recordings. A single door slam or tire squeal can now match dozens of visuals.

The Model 2400 is a fast, simple, non-disruptive method of fitting sound to image. Wouldn't a tool like that make your editing suite a better place to work? Find out just how much better: call Lexicon for a demo of the Model 2400 Stereo Audio Time Compressor/Expander.

lexicon

Lexicon Inc., 100 Beaver Street,
Waltham, MA 02154 (617) 891-6790

Circle (55) on Reply Card

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If film is dead, I must be in heaven

ADS 1-C

The Rank Quality CCD Digital Telecine

They tell me that television stations don't use film anymore. They say that film is dead.

So I don't tell them about my ADS 1 telecine from Rank Cintel. Why should I share the secret of my success?

My ADS 1 CCD telecine lets me run film like a tape machine. I edit electronically — no blades. I transfer film 24 hours a day — no breakdowns. And it saves me money. I'm the only Rank house in town.

The station manager likes it too. It's entirely self sufficient. Its varispeed function gives us two and a half minutes of extra ad time per hour.

I appreciate it too: The ADS 1 automatically color corrects. Its electronic dirt concealment hides film defects. It's the improved CCD imager that really makes a difference.

So let them say all they want about film. Let them run their old TK28/29's. Our station looks better because our film-to-tape transfers are better.

And I'm sitting back getting all the credit while the ADS 1 does all the work.

"The ADS 1 is part of our systems approach toward automation. We are looking at very substantial and significant gains in station productivity with this equipment."

Hal Protter, Vice President
Gaylord Broadcasting

"Provides all the technology and convenience needed to produce top quality images for our audience."

Andy Murphy, Erv Vanags
WMSN-TV, Madison, Wisconsin

"It has given our station that technical edge we have been looking for..."

Bob Olsen, Chief Engineer
KSCH-TV, Rancho Cordova, California

Take the hassle out of film broadcasting — call us at (914) 268-8911 - 2 - 3

Rank Cintel, Inc. Head Office
704 Executive Blvd.
Valley Cottage, New York 10989
Tel: (914) 268-8911
Fax: (914) 268-5939

Rank Cintel Inc.

Midwest Sales Office
33 West Higgins Rd.
South Barrington, IL 60010
Tel: (312) 426-2450
Fax: (312) 426-8693

West Coast Sales Office
13340 Saticoy, Unit F
North Hollywood, CA 91605
Tel: 818-765-7265
Fax: 818-765-3315

Circle (122) on Reply Card

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TDK Electronics (4161)
Phono products; recording media.
Circle (1076)

TEAC (2183)
Optical disc recorders.
Circle (1077)

Teatronics (4514)
Lighting dimmers, controllers. (V4)
Circle (1078)

TECCOM (2982)
Circle (1079)

Technov Industries (2484)
Editing controllers; blackburst, sync generators; A/V DAs. (V7)
Circle (1080)

TEKNO (H5802)
Lighting instruments, lamps, accessories; cycloramas, painted canvas backgrounds; rail systems; power inverters. (V4)
Circle (1081)

Tekskil Industries (1625)
Computer prompting systems.
Circle (1082)

Tektronix (3320)
Audio/video/RF test equipment; waveform, vector, picture monitors; TBC/synchronizers; audio delay systems; modulation monitors; spectrum analyzers. (S6)
Circle (1083) See ad page 105-107

Telemet (3722)
Audio/video distribution routing switchers, DAs; video encoders, decoders; TV demodulators; fiber optic products; sync/test generators. (R4, S6)
Circle (1084) See ad page 102

Telemetrics (4177)
Remote controlled camera mount products. (V1)
Circle (1085) See ad page 38

Telepak San Diego (4569)
Battery belts; equipment cases. (S3)
Circle (1086)

Telescript (4138)
Computer prompting systems.
Circle (1087)

Telesource Communications (4160)
Circle (1207)

Television Engineering Corp (1856)
Mobile production vehicles; facilities designs; equipment distributors.(S7)
Circle (1088)

Television Equipment Associates (2601)
Matthey video delays, filters; Racal headsets; Elcon tape evaluators. (A4, S6)
Circle (1089) See ad page 332

Television Labs (5721)
Circle (606)

Telex Communications (4113)
Wireless microphones, intercom systems; mics. (A4)
Circle (1090) See ad page 308

Telmak Pty. Ltd. (5908)
Circle (1190)

Tennaplex Systems (1814)
FM, TV antennas, multisignal combiners; RF field strength meters; transmission line products. (R1, S6)
Circle (1091) See ad page 212

Tentel (4017)
VTR/VCR alignment tools. (S6)
Circle (1092) See ad page 208

Texar (H5415)
Audio signal dynamics controllers.
Circle (1093) See ad page 275

TFT (1109)
Remote pickup systems; STLs; transmitter remote control systems; EBS equipment; modulation monitors; distortion analyzers. (R2, R4, S6)
Circle (1094) See ad page 287

Theatre Service/Supply (2580)
Studio draperies, tracks, fixtures; lighting grids, hardware; scenic supplies. (V4)
Circle (1095)

Theatre Vision/TVI (4549)
Studio fixtures, dimmers, power distribution equipment; cycs, tracks, chromakey fabrics.
Circle (1096)

Thermodyne International (1319)
Protective equipment transport containers.
Circle (1097) See ad page 246

Thomas Engineering (2066)
Structural materials, studio-related.
Circle (1098)

Thomson Electron Tubes/Devices (1219)
RF power tubes; solid-state devices; camera tubes, CCDs. (R3)
Circle (1099)

Thomson-DTE (3333)
Digital slide scanners, digital video component production switchers. (V2, V6)
Circle (1100) See ad page 279

Thomson Video Equipement (3333)
TV cameras; digital video switching, effects systems; CCD slide scanners; video recorders; electronic graphics systems.
Circle (1101) See ad page 195

Thomson-LGT (3333)
FM, TV transmitters, translators/transposers. (R1, R6)
Circle (1102) See ad page 245

Tiffen Mfg (2223)
Photo-optical filters. (V1)
Circle (1103)

TimeLine (1629)
Time code products; machine control, deck synchronizers. (V2)
Circle (1104)

Times Square Lighting (2472)
Lighting instruments, lighting control systems.
Circle (1105)

Titus Technological Labs (557)
On-air lights; multichannel audio controllers; automation equipment; test, monitoring products.
Circle (1106)

TMD div/Will-Burt (3687)
Pneumatic portable antenna support systems. (R7)
Circle (1107) See ad page 160

Toko America (N.A.)
Video frame memory systems. (V7)
Circle (1177)

Torpey Controls & Engineering (1205)
Station clock systems, timers; Key Video switcher systems.
Circle (1108)

Toshiba America (4320, PL)
Special purpose cameras; audio, video delay systems; satellite electronics. (V1)
Circle (1109) See ad page 269

Total Spectrum Mfg (2069)
Camera mounting systems, remote controllers; ENG accessories. (V1)
Circle (1110) See ad page 31

Townsend Broadcast Systems (4356)
Videocassette automation systems; TV transmitters, antennas. (S1)
Circle (1111) See ad page 213

TransImage International Ltd (3587)
TBC time-sharing systems, associated A/V signal control devices.
Circle (1112)

Transmission Structures (839)
Broadcast/communications towers, services.
Circle (1113)

Trident Audio (1008)
Audio mixing consoles.
Circle (1114)

Trimm (H5432)
Patch panels, connectors; terminal blocks.
Circle (1115)

Trompeter (4156)
Patch panels, cords; connectors; cable assemblies.
Circle (1116)

TTC/Television Technology (1801)
TV transmitters, translators. (R1, R3, R5)
Circle (1117) See ad page 75

Twentier Systems (5805)
Electronic newsroom systems.
Circle (1205)

TWR Lighting (H5524)
Tower obstruction lights, controllers. (R7)
Circle (1119)

Ultimatte Corporation (4380)
Video compositing systems. (V7)
Circle (1120)

Union Connector (2584)
Electrical distribution, power controllers for studio lighting systems. (S2)
Circle (1121)

Uni-Set (1834)
Studio fixtures, furniture.
Circle (1122)

United Ad Label (H5626)
Promotion materials.
Circle (1123)

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ENTER
THE 4.2.2. WORLD

"LE STUDIO NUMERIQUE"®
WE DEVELOPED IT FIRST.
WE MADE IT FIRST.
AND NOW WE DELIVER IT.

Our latest success: "Le studio numérique®". The world's first fully operational Serial Component Digital switcher. The digital switcher that's available now.

Digital - for impeccable production quality. Even with multiple generations Thomson is making you an offer you can't refuse with their Digital switcher "Le studio numérique®".

Component Digital - avoid unnecessary coding and decoding; the Component Digital switcher is your only choice.

Serial Component Digital - picture source and other peripheral devices are easily connected. All you need is standard coaxial cable.

The Serial Component Digital Switcher. Get the picture? You will with Thomson- - every time.

THE ALL DIGITAL STUDIO

®"LE STUDIO NUMERIQUE" is a registered trade mark of Thomson.

POLARIS Code 5596

See us at NAB Booth #3333
Circle (123) on Reply Card

THOMSON VIDEO EQUIPEMENT

THOMSON VIDEO EQUIPEMENT 17, rue du Petit Albi - BP 8244 - 95801 CERGY-PONTOISE CEDEX FRANCE - Phone (33-1) 34.20.70.00 - Telex 204.780 F - Fax (33-1) 34.20.70.47
USA-THOMSON-CSF BROADCAST INC. - 30 Commerce Road STAMFORD CONNECTICUT 06902 - Phone (203) 324.13.20 - Telex 6819035 - Fax (203) 324.97.60

United Media (4363)
Videotape editing controllers; editing switchers; time code products. (V2)
Circle (1124)

United Ropeworks (USA) (724)
Tower guying materials, accessories.
Circle (1125) See ad page 216

UPI/United Press (1309)
News programming services.
Circle (1126)

UREI (4377)
Studio monitors, power amps; audio mixing consoles; audio dynamics processors.
Circle (1127)

Ushio America (5325)
Circle (1208)

U.S. Tape & Label (625)
Self-adhesive labels, promotional materials.
Circle (1128)

Utah Scientific (3344)
Master control, distribution routing switchers, control panels; VTA Technologies video signal processors, color correction systems.
Circle (723) See ad page 158-159

Utility Tower (733)
Broadcast/communications towers, services.
Circle (1129)

Valentino Production Music (2612)
Production music/effects libraries.
Circle (1130)

Valley International (104)
Audio dynamics processors; noise reduction units.
Circle (1131)

Valmont Industries (H5833)
AM antennas; antenna support equipment.
Circle (1132)

Varian Associates (3725)
Grid power tubes; klystrons, Klystrodes; TWT, microwave devices. (R3)
Circle (1133) See ad page 39, 122-123, 169, 217

Varian Continental TVT (324)
AM, FM, TV transmitters; exciters, RF generators; microwave systems. (R2)
Circle (1134) See ad page 166

VEAM/Litton (H5532)
Power connectors; fiber optic products.
Circle (1135)

Vector Technology (1509)
AM DA phasing, matching systems; toroidal transformers; FM broadcast transmitters. (R1)
Circle (1136)

VG Electronics Ltd (503)
Radio data encoders; teletext systems (V5, S1)
Circle (1137)

Video Accessory (2617)
Sync/color bar generators; video DAs. (S5, S6, V7)
Circle (1138) See ad page 338

Video Associates Labs (2704)
Videograph titling keyers. (V7)
Circle (1139)

Video Brokers (H5627, PL)
Circle (1140)

Video Design Pro (H6114)
Computer aided design software. (S1)
Circle (1142)

Video Financial (4571)
Equipment leasing, financing plans. (S7)
Circle (1143)

Video Int'l Development (2577)
TBC, synchronizers, standards converter systems. (V7)
Circle (1144) See ad page 319

VideoLab (H5004)
Retrofits for VCRs; shuttle, balanced audio, time code modules. (V2)
Circle (1145)

Videomedia (3966)
Videotape editing controllers; machine synchronizers. (V2)
Circle (1146)

Video Services Unlimited (6118)
Camera support equipment.
Circle (1071)

Videotek (3074)
DAs, routing/production switchers; waveform, vector monitors; video monitors; SC/H phase indicators; demods; sync/blackburst generators; frame store/synchronizers. (V6, V7, S5)
Circle (1147) See ad page 117, 119

Viking Cases (4145)
Equipment transport enclosures.
Circle (1148)

Vinten Equipment (1425)
Camera support products; pan/tilt heads, tripods, pedestals; combo packages; remote camera controllers. (V1)
Circle (1149) See ad page 282-283

Vital Industries (3247)
Video switchers, digital effects equipment.
Circle (1150)

Voodoo Technology (4338)
Time code systems.
Circle (1182)

Vortex Communications (753)
Distribution routing switchers, DAs; sync generators, ID signal generators. (V7, S5)
Circle (1151)

Ward-Beck Systems (3876)
Audio mixing consoles; audio distribution products; intercoms; audio metering systems. (A1, A4)
Circle (1153) See ad page BC

WATCO Inc (H5006)
Ku-band satellite transmitters, combiners/redundancy switching, remote control equipment. (R6)
Circle (1154)

WaveFrame (H5821)
Digital audio workstation, hard disk recorder, editor.
Circle (1155)

Wavefront Technologies (H5235)
Electronic videographics, animation equipment.
Circle (1156)

WeatherBank (1012)
Weather information computer systems.
Circle (1157)

Wegener Communications (1133)
Microwave SCPC decoders, encoders; network controllers; digital audio transmission systems. (R4)
Circle (1158)

Westlake Audio (H6019)
Audio monitors, speaker enclosures; audio product distributor.
Circle (1159)

Wheatstone Broadcast Group (110)
Audio mixing consoles. (A1)
Circle (1160)

Wheelit (2583)
Production utility carts, computer furniture. (S3)
Circle (1161)

Whirlwind (4169)
Audio cables, assemblies, connectors; direct boxes; cable test units. (A1, A4)
Circle (1162)

H. Wilson (5000)
Furniture, cabinetry for audio, video, computer equipment.
Circle (1163)

Winsted Corporation (2680)
Modular equipment racks, control room fixtures. (S3)
Circle (1164) See ad page 56, 67

Wireworks Corporation (1810)
Audio/video cable, wire, wiring harnesses.
Circle (1165)

Wold Communications (2448)
Satellite time brokers, program distribution.
Circle (1166)

Wolf Coach (4327)
Mobile TV production vehicles.
Circle (1167)

World Tower (1301)
Communications/broadcast towers.
Circle (1168)

WSI (4171)
Weather graphic database, satellite imagery; sports information package. (V5)
Circle (1169)

Yamaha Music (H5213)
Audio mixers, speaker systems; audio delay, effects systems. (A1, A2, A4)
Circle (1170) See ad page 258-259

Yamashita Engineering/YEM (H5913)
TBCs, synchronizers, sync generators; video encoders. (V7)
Circle (1171)

Zenith Electronics (H5630)
Captioning, on-screen text data decoders. (V5)
Circle (1172)

Zonal Ltd/MAG-ZON (1621)
Recording media, various formats. (S4)
Circle (1173)

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THE NEW 3000 SERIES AUDIO TEST SYSTEMS FROM SOUND TECHNOLOGY

GP-IB RS-232C · FSK · CENTRONICS® Parallel Port

There's a new TOP GUN in audio testing . . . the Sound Technology 3000 series. The 3000 series is singularly THE most flexible audio test system available. And, with its exclusive on-board FSK automation, the 3000 series becomes THE most practical audio test system to automate! Here are a few of the features:

ULTIMATE FLEXIBILITY

- The 3000 series can be configured as a separate oscillator and analyzer for remote work OR in one main-frame as an audio test system.
- The 3000 series is portable. Use the 3000A manually for troubleshooting OR use the built-in automation for quick and comprehensive checkouts.
- Obtain tabular or graphic hardcopy directly from the Analyzer to a standard dot matrix printer!

PRACTICAL AUTOMATION

- Automate benchtop testing using the 3000's built-in automation OR use ST's IBM®/compatible bundled software with the 3000's industry standard GPIB and RS-232 interfaces!
- Automate remote tests using built-in FSK automation: no need for modems, computers or phone lines!
- Simple automated playback testing: record FSK automation on audio tracks of ATR's and VTR's. Analyzer then automatically tracks overall playback performance. Excellent for testing multiple playback-only machines!

With the ST3000 series you have ultimate flexibility with no compromises. For instance, true-floating transformerless balanced outputs allow for the world's finest squarewave output. And no one offers a greater selection of waveforms. Finally, our specifications are the finest one can encounter.

Contact us now for full technical and applications information. Learn firsthand why the ST3000 series is the TOP GUN IN AUDIO TESTING!

SOUND TECHNOLOGY
1400 Dell Avenue
Campbell, California 95008
(408) 378-6540 Telex: 357445

Put The Best To Test!

In Canada, contact the Pringle Division at (416) 222-2447

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Circle (254) on Reply Card

See Harry at NAB.
Hear the *big* news.

QUANTEL

Quantel Inc., 655 Washington Boulevard, Stamford, Connecticut 06901, USA. Tel: (203) 348-4104 Fax: (203) 356-9021

Circle (255) on Reply Card

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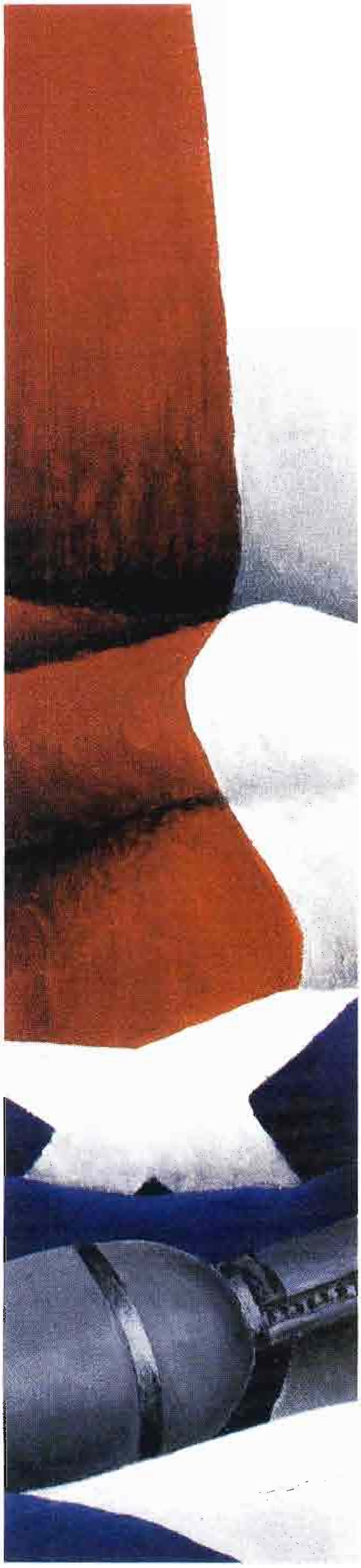

NEW AT NAB

The following pages contain a listing of new products that manufacturers have told us they plan to debut at NAB '88. These products include items that have been brought to market since the 1987 show, as well as enhanced versions or production models of prototype equipment displayed at previous exhibitions. We've included some general information about the products, as provided to our staff by the manufacturers.

"New at NAB" is broken down into four general categories: *audio, RF/tower, support* and *video* products. Each is further subdivided as appropriate, and each of the subcategories has been assigned a code number, such as A1 or V4. (These code numbers are cross-referenced in the "Exhibitor Listings," which begin on page 150.)

For easy reference, see the following outline. It tells you what products can be found in each category and indicates the page where that product category begins. By using this system, you should be able to find helpful information about the introductions that interest you most.

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Audio Products
A1: Mixers

AMEK/TAC (145)
SCORPION: audio production console with stereo line input modules.
CLASSIC: large-scale broadcast audio production mixer.
Interface: serial video control interface for BC-II and Classic audio consoles.
Circle (533)

AMS/Calrec (3372)
Assignable 88: latest version of the Calrec digitally assignable TV broadcast, production console.
Circle (538)

Audio Developments (2330)
AD 110: digital edit mixer.
AD 145-E: edit mixer in 4-, 6- or 8-input configurations.
AD 150: mic/line module.
AD 066-10: mic splitter.
AD 062-7: editing mixer; 8-16 input system.
Circle (1181)

Audio-Technica (665)
AT4462: portable stereo ENG/EFP mic mixer.
Circle (567)

Autogram (124)
Updated modules: for IC-10, AC-6, AC-8 on-air audio mixers.
Circle (572)

Broadcast Electronics (303)
Mixtrak-90: modular audio mixer for on-air work; 12, 18-input models; stereo capability; sequencing allows operator to setup entire station break for automatic performance, including equipment starts.
Circle (607)

Dorrough Electronics (458)
Model 700: on-air console; dual channel system; 7-position with 15 line, 3 mic inputs; loudness meter option.
Circle (713)

FOR-A (3169)
AS-740: audio-follow mixer; operates with FA-740 TBC/EC-740 editing controller.
Circle (767)

Gentner Electronics (265)
Versa Mixer: 4 mic/line portable or rack-mount mixer; integral 4-output headset amp; each mic has its own output, each headset has its own input or master input.
Circle (779)

Harrison Systems (125)
AIR-790: on-air radio mixing console.
PRO-790: audio production, edit suite console.
Circle (798)

Mitsubishi Pro Audio (1419)
Westar 8300: film re-recording console.
Circle (904)

Neotek (H5530)
Essence: audio console; increases efficiency, productivity of multitrack effects, layup, ADR, Foley recording, post production assembly, synthesizer sampling and assembly.
Circle (928)

Orion Research (1641)
Newsmaker: audio console with Remem Recall memory system; universal input modules; upgrade software based on AMU system with additional features for TV applications.
Circle (947)

Panasonic/RAMSA (2938)
WR-T820B: 8-bus recording console.
WV-8119: surround module for WR-842B post production audio console.
Circle (956)

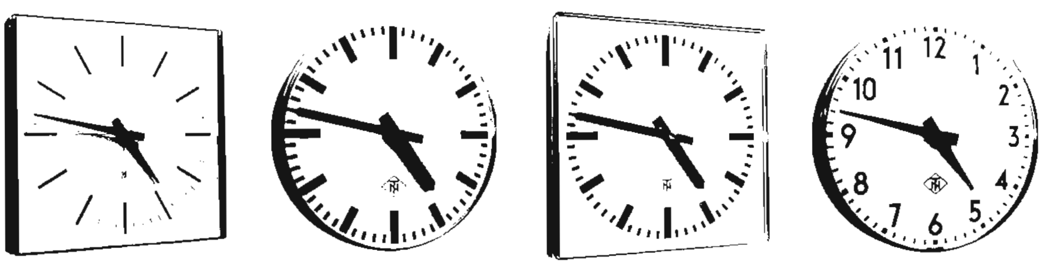
RAM Broadcast Systems (170)
SX-18: stereo on-air console.
Circle (985)

Shure Brothers (203)
FP51: portable gated compressor-mixer.
Circle (1027)

Solid State Logic (1409)
G series: fully integrated working environment based on SSL Master Studio System.
G series computer: computer hardware with on-board memory, high capacity disk cartridges; optional remote keyboard.
Circle (1034)

Sony Professional Audio (2902)
MXP-3036 enhancements: software upgrade, wild fader option; vacuum fluorescent light meters.
Circle (1039)

Soundcraft (4377)
TS-12 automation: new automation system, exclusive for TS-12 console.
SAC-200: stereo on-air, post-production console.
#200BV/E: 8-input model of series 200B console; for applications with video editor.



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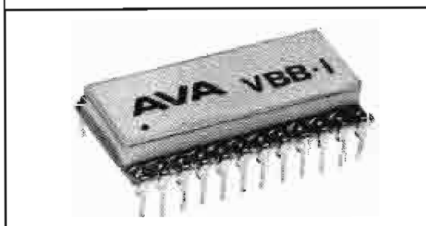

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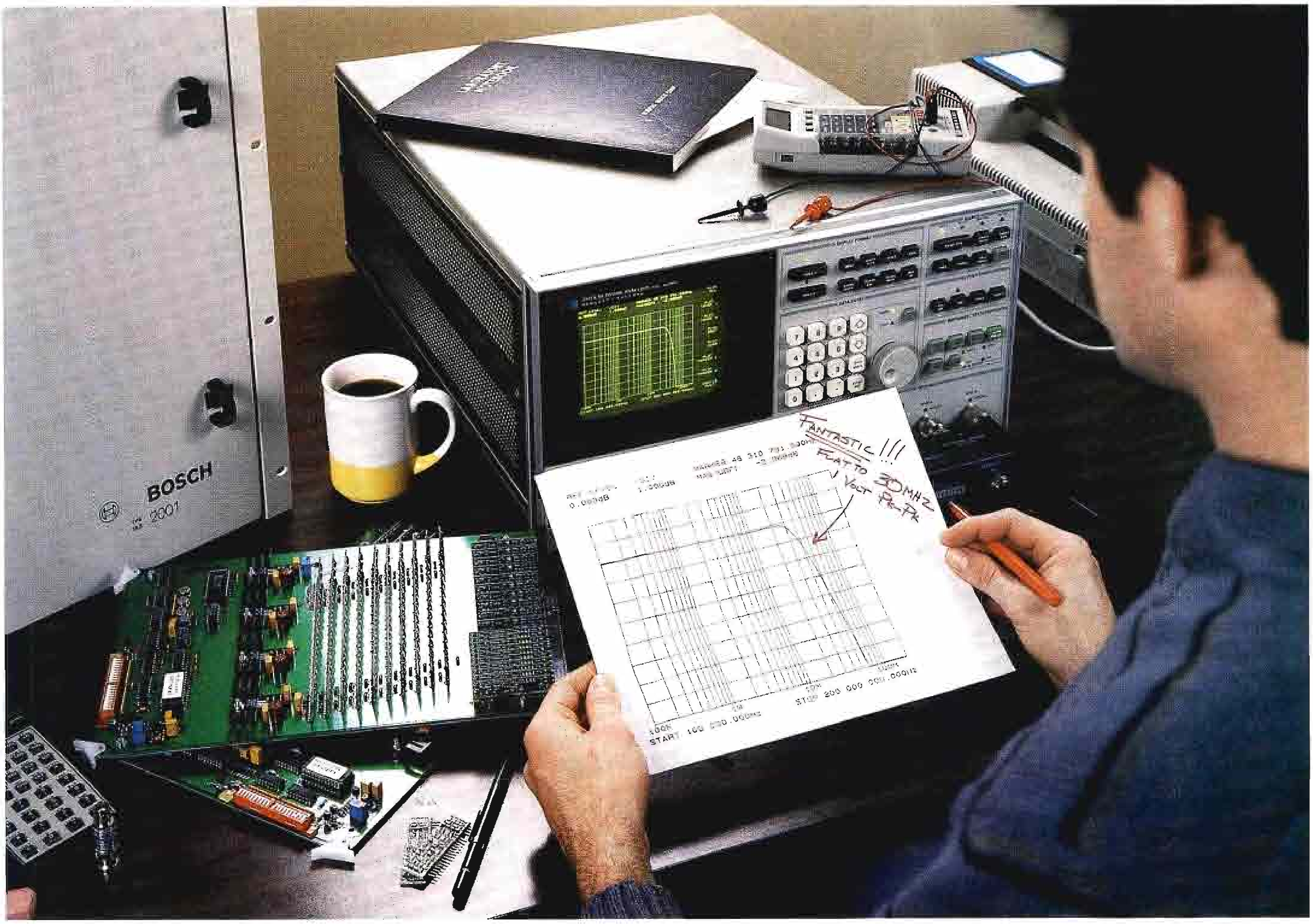

(Chart/image on analyzer is actual output from the 2001 switcher.)

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The new Bosch TVS/TAS-2001 Video/Audio Routing Switcher demonstrates a video bandwidth of more than 30 MHz — measured with a **full-amplitude** (1 V P-P) sine wave or video signal.

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#6000 console: split bus architecture; monitor for 24-bus, expands to 32-track.
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Systemation (1511)
X7-DR: RDAT with Systemation control.
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Ward-Beck Systems (3876)
RP2200: radio production console; in-line EQ, multitrack interfacing to existing WBS radio consoles.
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Wheatstone Broadcast Group (110)
Model A20: mid-market radio on-air console; 10-input system.
TV500: master control console.
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Whirlwind (4169)
US-M-8: 8-channel stereo rack mixer.
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Yamaha Music (H5213)
Stereo series consoles: MC802, MC1202, MC1602 with 8, 12, 16 inputs, respectively; 3 aux sends, headphone cue system.
Monaural powered mixers: EM1400, EM1600, EM1800 for 4, 6, 8 inputs, respectively; 150W 4Ω, two aux sends, integral reverb.
Sound Reinforcement Handbook: 400 pages answer often-asked questions; illustrated.
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ANT Telecommunications (170)
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Bradley Broadcast Sales (140)
Telos 100: second generation digital telephone interface.
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BSW Broadcast Supply West (365)
Orban 222A: spatial enhancer audio processor.
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CRL Systems (133)
BAP-2000: broadcast audio processor; mono FM limiter with applications for LPTV; sync filter for TV use includes jumper to remove filter from circuit for radio use; input AGC circuit.
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dbx (2620)
Model 1531P: graphic equalizer.
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H3000 Ultra-Harmonizer: pitch change and audio effects processor.
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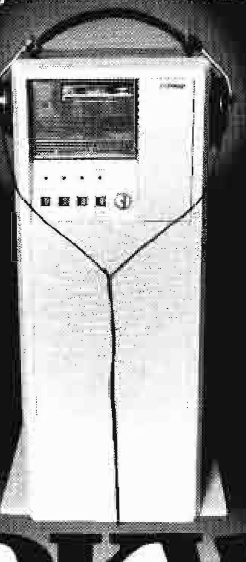

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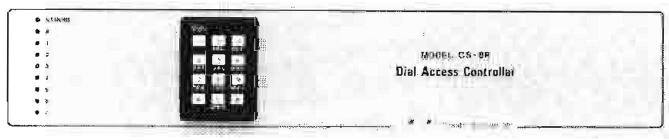

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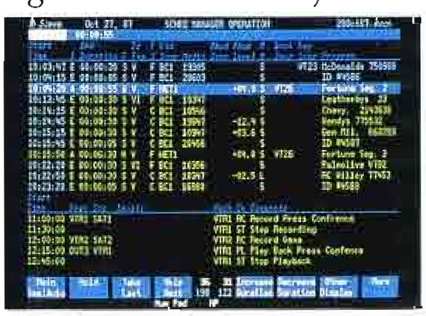
Television Automation System

Others were interested in full-function machine control — like multi-roll of A/V splits and backup machines using the Bosch TCS-1 Machine Control System. Or, interface to the Bosch BTA-2300 Television Automation System, which can control *every* function of the MCS-2000, right down to the clip levels of the keyer.

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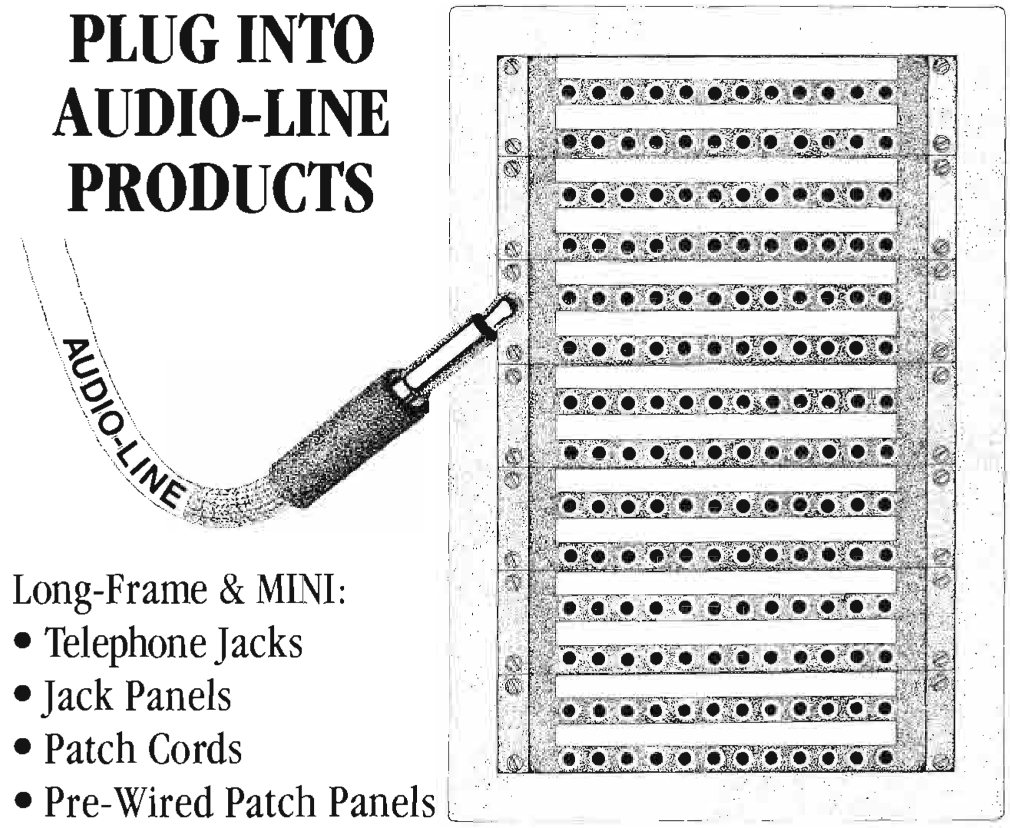

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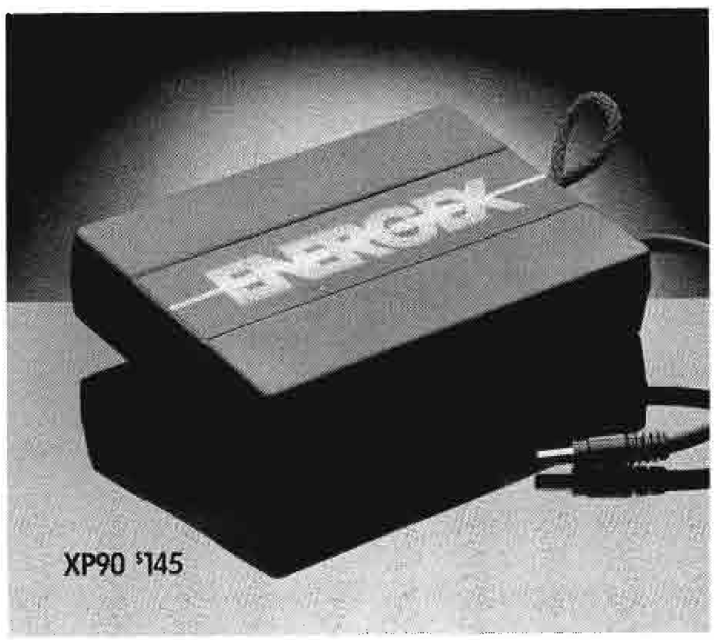

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HEDCO **(1820)**
HPA-100: audio power amplifier; part of HEDLine series.
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Howe Technologies **(153)**
2300A PhaseChaser: detects, corrects interchannel time delays in stereo program material; maintains mono compatibility, improves stereo imaging; auto fill-in capability, polarity reversal correction.
Circle (807)

IMC/International Music **(H5728)**
SMK007: battery-backed sampler-expander, holds 10 samples in non-volatile memory.
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Inovonics **(770)**
#222: NRSC processor; complies with AM improvement program.
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Kintek **(1611)**
KT-904 mono-stereo converters: -S for TV broadcast; *-Post* for post-production; *-Plus2* includes Monogard, correlation monitor.
Circle (844)

Lexicon **(1209)**
LXP-1: digital multiple effects processing module.
MRC controller: MIDI remote control unit; provides analog-style control of DX-7 synthesizers, enhanced control of LXP-1 and totally programmable generic MIDI control functions.
SME sampling memory expander: for 480L system, stores phase-locked stereo sample to 10.9s or 21.8s sample at 48kHz sampling.
Circle (862)

Rupert Neve **(2348)**
Neve Prism: rack-mount units derived from Series V consoles; powered from existing console; Formant Spectrum EQ, mic amp/dynamics modules.
Circle (930)

Orban Associates **(725)**
9105A Optimod-SW: audio processing for international shortwave AM and SSB broadcast; 3-4dB greater loudness than standard system to compensate for noise and interference.
#642B parametric filter: switchable 4-band dual channel or 8-band mono parametric EQ/not filtering; 12dB/octave Automatic Sliding Besselworth LP filter, 18dB/octave HP filter and vernier-tuned notching.
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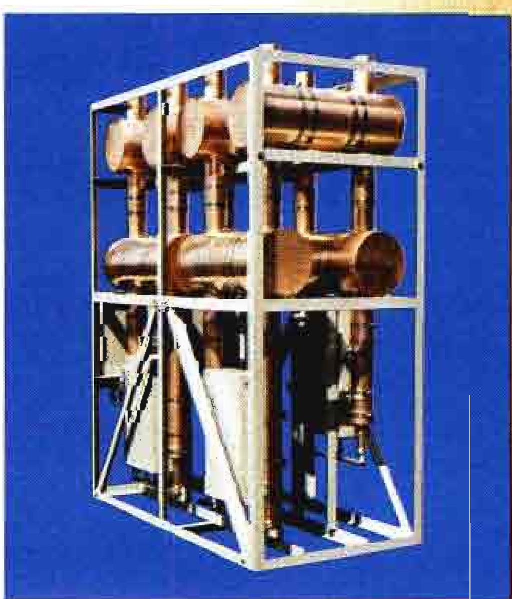

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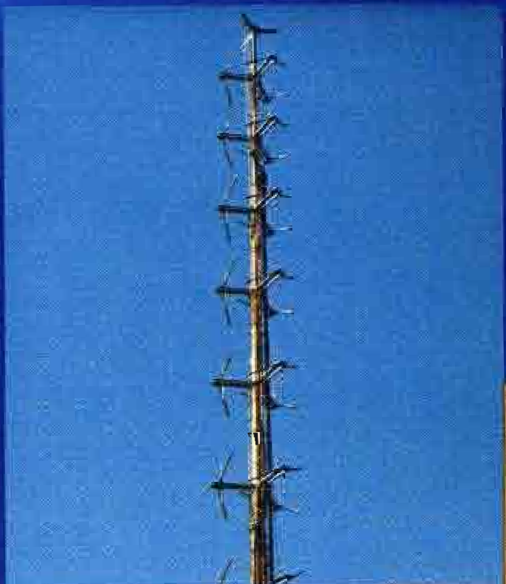

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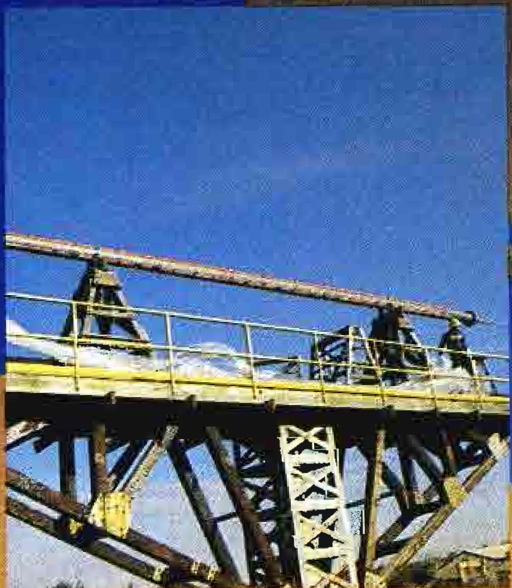

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ACC-204 composite isolation transformer: improves S/N, prevents ground loops between stereo generator; installs at exciter, presents generator composite output with balanced floating load.
#787A mic processor: programmable parametric EQ, compressor, de-esser, noise/compressor gate; 99 control setups; MIDI, RS-232 control interfaces available.
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Solid State Logic **(1409)**
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Sony Broadcast **(2902)**
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Sony Professional Audio **(2902)**
DAL-1000: digital audio limiter.
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ISS system: modular, integrated simulator system and mono-stereo recognition for MTS broadcasting.
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Symetrix **(672)**
SX-201: parametric EQ/preamplifier.
Hybrid: new automatic telephone interface product.
SX-203: single-line telephone interface.
Circle (1067)

Systemation **(1511)**
X7-D: 8mm Sony digital random access player.
Circle (1069)

UREI **(4377)**
#7110 compressor/limiter: complete user control over threshold, attack, release time and output level; single rack-space unit.
Circle (1127)

Yamaha Music **(H5213)**
REV5: studio digital reverb system, includes multiple effects and programmability.
FMC1 digital format converter: stereo system accepts SDIF-2, CD/DAT or AES/EBU signal for direct digital input/output to Yamaha digital audio products.
REX50: compact digital multiple effects processor.
DEQ7: programmable digital EQ system.
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A3: Recording

- Analog, digital
- Audio editing systems
- Deck synchronizers
- Recording accessories

Adams-Smith **(1513)**
2600 A/V enhancement: audio-for-video editor; *C:Sound* graphics simplify audio editing.
Circle (507)

Alpha Audio **(2258)**
BOSS accessory: programmable keyboard.
Circle (527)

AMS/Calrec **(3372)**
AMS Audiofile update: new software includes cut/paste, scrub edit and other features; interface to video editing controllers.
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Arrakis Systems **(465)**
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Circle (552)

Bradley Broadcast Sales **(140)**
SoundSpace: digital multitrack recording/editing system.
Circle (602)

Broadcast Electronics **(303)**
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BSW Broadcast Supply West **(365)**
Sony PCM2500: pro R-DAT recorder.
Otari MX55: reel-to-reel recorder.
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CompuSonics **(H5521)**
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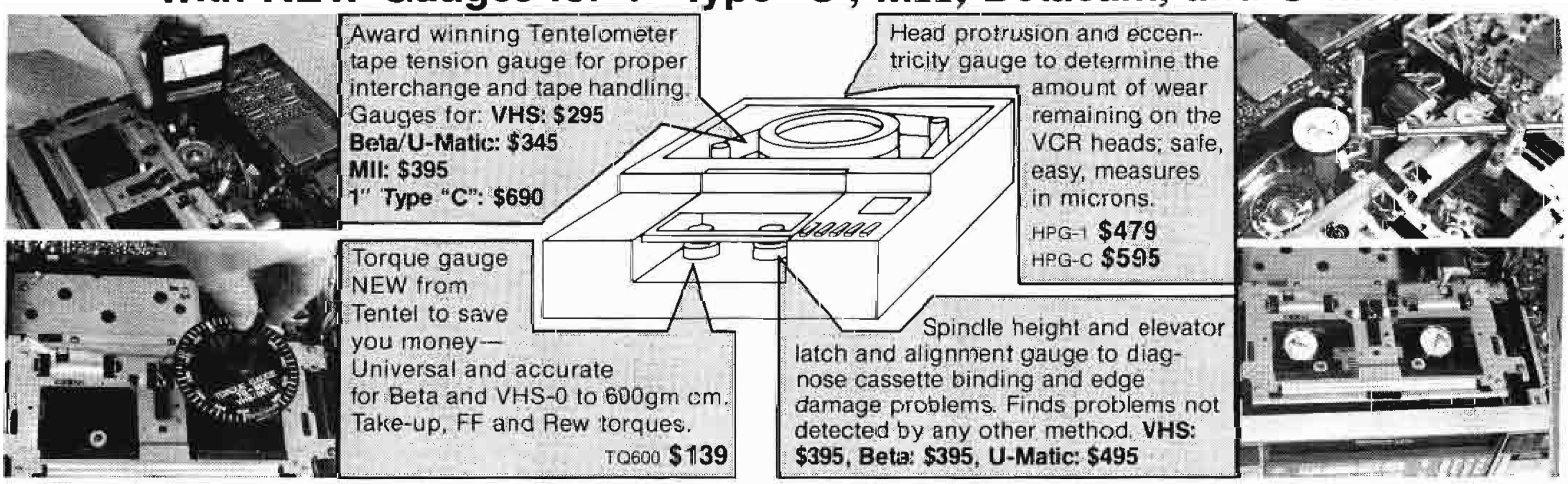

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Fidelipac (515)
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Circle (760)

FOR-A (3169)
Sirius-100: digital audio memory; multiple feature storage system.
Circle (767)

Fostex (4251)
R-DAT: digital audio recorder/player; locks to video with SMPTE code for editing.
Circle (770)

Graham-Patten Systems (4530)
Fader memory: dynamic event memory system for Graham-Patten ESAM edit suite audio mixers.
Circle (787)

IMC/International Music (H5728)
DR1200: 12-track digital recorder; PCM design, 44.1kHz/48kHz sampling; 17-minute record time on Video 8 cartridge; 16-bit resolution.
SC51 interface: allows interface of S900 sampler to most hard-disk drives.
Circle (815)

IMS/Integrated Media Systems (H5232)
Dyaxis: disk-based digital audio recording, editing system; Apple Macintosh with Maxmix software; disk capacity options include 72, 160, 320, 640Mbyte or >640Mbytes in 320Mbyte increments.
Circle (816)

Inovonics (770)
#390: magnetic film recording electronics
Circle (819)

ITC/3M (2305)
Digital cart machine.
Analog audio recorders: Model 99B; Delta, Omega cart machines.
Circle (822)

Mitsubishi Pro Audio (1419)
X-86HS: 2-channel high sampling rate digital audio recorder.
X-86C: 2-channel, dual-format digital audio recorder.
Circle (904)

Nagra Magnetic Recorders (2714)
T-Audio enhancement: control keyboard with dedicated keys for efficient entry of numeric codes or time code data.
Circle (921)

New England Digital (H5227)
Synclavier enhancement: 96 stereo sampling, synthesis voices, 64MBytes on-line RAM-about 10 minutes at 50kHz sampling; 200-track sequencing, optical disk storage.
Direct-to-Disk: multitrack hard disk recorder; 16-bit, 100kHz fidelity; record time greater than 3 hours; non-destructive editing of ADR, effects layback, voiceovers; 4, 8, 16 tracks.
Circle (931)

Otari (312)
T-700 TMD: high-speed video duplicator using Thermal Magnetic Duplication; duplication at speeds to 150x normal play speed; tape bin loop design.
MX-55 recorder: ¼ " compact audio recorder; two multiple speed models; for recording, post production; dc quartz PLL capstan motor; 7-digit tape timer; 4-memory locator.
MTR-100 series: multitrack audio recorders; full auto record/reproduce alignment; accepts noise reduction modules; 24-track.
Circle (949)

Pacific Recorders & Engineering (339)
Spectral recording: circuitry for cartridge format improves audio performance of existing machines and media.
Circle (951)

Sharp/Pro Products (4316)
RDAT-10D: digital audio cassette deck; commercial, professional grade.
Circle (1024)

Sony Professional Audio (2902)
RM-KIT3310, DMU-30: software upgrade for PCM-3324 digital audio recorder and digital remote meter.
Circle (1039)

Stanton Magnetics (849)
Disco Starter: Stanton kit; everything the DJ needs to get started.
DP5107AL: styli 3-pak.
Circle (1049)

Studer Revox America (545)
C270: compact 2-channel ¼ " audio recorder.
A807 VUK: floor console model of ¼ " recorder.
A820-8: 8-channel 1" A820 series multi-channel recorder.
Circle (1059)

TASCAM (2183)
ES-50: transport synchronizer with *ES-51* controller.
ATR-80: multitrack recorder; 2" tape format, 24-track.
ATR-6016: multitrack recorder; 1" 16-track

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format.
#238 Syncassette: cassette recorder; 8-track system.
MTS-30: MIDI tape synchronizer.
Circle (1075)

WaveFrame (H5821)
AudioFrame: digital audio workstation; produces finished tracks within digital domain.
Circle (1155)

A4: Sources, monitoring

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- Headphones, headsets
- Intercoms
- Speakers
- Wired, wireless mics

AKG Acoustics (1145)
C-522 MS: handheld or boom ENG mic: M-S stereo, electret.
C-522 X-Y: handheld or boom ENG mic; X-Y stereo, electret.
C-522 MS: handheld or boom ENG mic; MS-S stereo, electret.
C-562: natural response, shock-isolated boundary mic with windscreen.
C-414BULS: ultra-linear, 4-pattern FET condenser mic; large diaphragm design.
Circle (518)

Allied Broadcast (557)
Denon DN950F: CD cart machine.
Audiometrics AMCDS 1000A: 100-disc CD multiplay system.
Circle (524)

Alpha Video & Electronics (2980)
News Connection: telephone IFB system allows reporters to page a director from any remote location for confidential handset-to-handset communications; director has access to five lines simultaneously with audio cues to one or all locations.
Circle (528)

ATI/Audio Technologies (359)
Micro-Matchers series: connector-mounted amplifiers; fully shielded; derive uni-/bipolar operating power from equipment; *BLI-100* balanced line level to IHF phono jack input; *BLO-100* boosts IHF output to +4dBm for balanced, unbalanced lines; *BSO-100* sums left/right IHF levels to balanced L+R line; *BMI-100* balanced low noise mic to IHF input amp; *SHB-100/MHB-100* stereo/mono headphone boost amp for low-impedance headphones.
Circle (560)

Audio-Technica (665)
Model AT4071: externally polarized, transformerless line-gradient mic; lightweight, low-noise, high output.
Model AT4073: short version of AT4071; slightly wider acceptance angle.
Model AT4031: cardioid studio/field production capacitor mic.
Model AT8506: 48V 4-mic phantom power supply; ac powered.
Circle (567)

Beyer Dynamic (1824)
MCE86 mic: short shotgun unit.
M58 mic: for ENG/EFP sports, news interview use.
MCE10 mic: miniature hypercardioid.
MPC60: cardioid, hypercardioid acoustical boundary mic.
MPC40: omnidirectional acoustical boundary mic.
MCE81 mic: shock-mounted supercardioid.
Circle (590)

Bradley Broadcast Sales (140)
PGM-6.5: Tannoy reference monitor.
Circle (602)

Cetec Vega (1127)
"Q"PLUS: production models of wireless intercom system; full duplex, programmable interface.
R-33 ProPlus: miniature wireless mic receiver for ENG, other applications.
Ranger systems: wireless mic systems; *-2* provides true-diversity.
R-32: diversity receiver for Pro 2 wireless mic system.
Circle (637)

Clear-Com Intercoms (4526)
WBS/STR wireless: intercom system consisting of *WBS-6* base station, *WTR-1* portable transceivers, and a series of accessories; full duplex, dynamic compander for wide AF response, low noise and good dynamic range.
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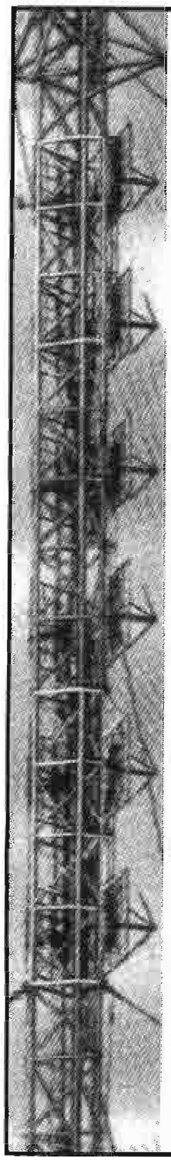
Circle (646)



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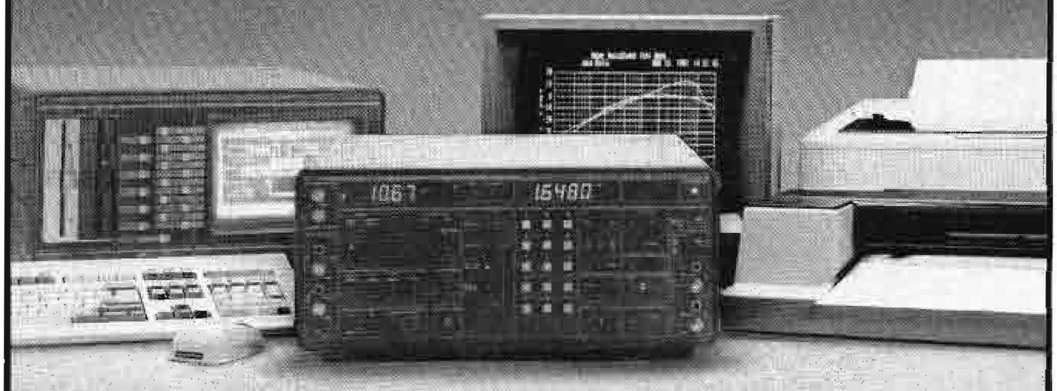

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ComTek (4524)
Phase Right +1: active, dual summation, gated antenna system.
MR-180: miniature wireless mic receiver; for use with cameras.
Circle (669)

Gentner Electronics (265)
Headset amplifier: 6-output stereo; direct, master input capability.
Remote power amp: single rack-unit; remote output level control.
Circle (779)

Alan Gordon Enterprises (2538)
Sonic 312/307: Sonic mic booms, boom holders.
Circle (784)

HM Electronics (4238)
System 55: wireless handheld mic.
System 50: wireless body-pac mic.
Circle (803)

IGM Communications (619)
CD-240: multidisc CD player.
Circle (811)

Image Video (3584)
AES-2000: digital audio editing system.
Circle (814)

JBL Professional (4377)
Control 5: addition to Control series of studio monitors.
Circle (827)

Lectrosonics (H6106)
QUAD mini: miniature 4-channel wireless mic system for field or ENG production.
PRO 4-channel: wireless mic system for studio, ENG.
PRO mini: miniature wireless mic system for field production; XLR receiver output.
HT-185: hand-held wireless mic transmitter.
Circle (856)

Micron Audio (2262)
CNS-500 series: wireless mic systems; hand-held, pocket type transmitters; portable and modular space diversity receivers.
Circle (897)

Nady Systems (4009)
Nady 1200VHF: wireless mic, diversity receiving.
Nady 101VHF: wireless mic, non-diversity.
Nady 201VHF: wireless mic system, diversity receiving.
Circle (920)

Peerless Sales (4553)
040-815-02 Radial Cube: speaker mount.
Circle (958)

R-Columbia Products (2267)
TR-50/B: wireless-to-wired base station interface for TV camera intercoms.
52/XT: headphone/mic for use with telephones.
TR-55: selectable 5-channel FM wireless intercom headphone.
52/700: amplified camera operator headphone; ultra light-weight.
6058/PT: ENG/IFB "hands free" telephone.
Circle (988)

RF Technology (4243)
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Circle (995)

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ROH **(2235)**
#303PS: portable party-line power supply; phantom power 12-15 PL headset stations, belt-packs etc.; user programmable; universal operation.
Circle (999)

RTS Systems **(4330)**
BP317: portable single-channel headset user station; TW intercom system component.
DC848: data concentrator; for 848A intercom systems.
BP325: portable 2-channel programmable headset user station; TW intercom system component.
CC62/CPK62: intercom user station mini circuit card/assembly; TW intercom system component.
#848A: 24-channel programmable matrix intercom station; series 800 system component.
CIF612: camera-iso interface; TW intercom system component.
#2524: dual 8x1 audio summing amplifier; series 2500 component.
Circle (1008)

Sennheiser Electric **(152)**
MKH 30 P48U3: figure-8 condenser mic; symmetrical capsule design, for M-S recording.
MKE 4032: stage vocal mic; all metal body, double-screen basket.
HD450/HD480: Open-aire monitor headphones.
Circle (1021)

SESCOM **(2206)**
Mixers: mini-console type systems for audio, video production studios.
Rack products: line-level active combiner and monitor amp with speaker.
Mic-line drivers.
Circle (1022)

Shure Brothers **(203)**
SM84: supercardioid condenser lavalier mic.
PDP1000: professional compact disc player for broadcast use.
SM15: headworn condenser mic.
Circle (1027)

Stanton Magnetics **(849)**
SRS-215, -225, -245, -265: professional headphones.
ST-PRO, ST-4: professional headphones.
Circle (1049)

Swintek Enterprises **(1302)**
Mark 200D/P: full duplex radio headset with integral antenna.
Mark 200/L/7: full duplex, 2-channel wireless intercom; usable with RTS, Ward Beck, Telex, Swintek hard-wired systems.
Mark QOC/2: 20 channel radio mic receiver for video camera.
Mark SM55 OMN: radio hand-held mic for ENG field use.
Mark ENG/2: 0.5W remote, field broadcast mic.
Circle (1062)

Symetrix **(672)**
SX-204: headphone amplifier.
SX-202: dual mic preamplifier.
Circle (1067)

Telex Communications **(4113)**
HT-400: 2-channel wireless mic/transmitter.
FMR-4: 4-channel wireless receiver.
LM-300: unidirectional lapel mic system.
Circle (1090)

Ward-Beck Systems **(3876)**
MicroCOM-II: second generation μprocessor-controlled TV plant intercom; bidirectional data transfer on single audio pair, assignable key functions, alpha/numeric readouts, central salvo reprogramming.
Circle (1153)

Whirlwind **(4169)**
PHMAS: headphone amplifier system.
US-A: 40W stereo amplifier.
Circle (1162)

Yamaha Music **(H5213)**
S110H/S115H: Club series speakers; 10" or 15" with horn tweeter; 200W program power capability.
SM10H/SM15H: 10" or 15" Club series speaker with horn tweeter; slant-front floor monitor; 150W or 200W program power capability.
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MZ203Be: dynamic vocal mic; wide response with laminated beryllium diaphragm.
MZ106S: dynamic mic; high quality with Off/On switch.
MZ205Be: dynamic mic; compact for high transient sources, tight spaces; laminated beryllium diaphragm.
S115MT: Club series speaker includes 1-15", 1-6.5" mid-range, 1-3.2" bullet tweeter with 200W program capability.
Circle (1170)

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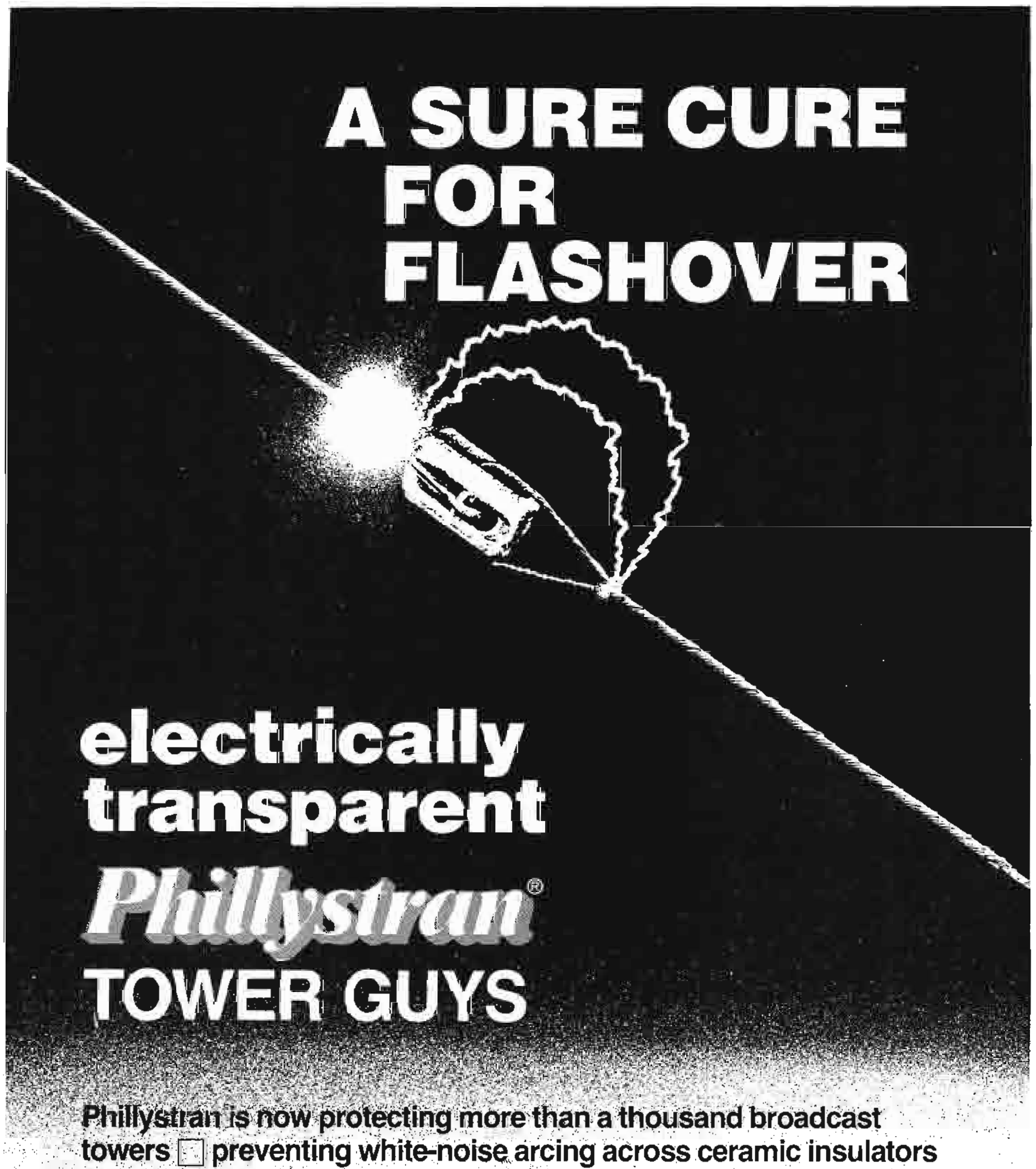

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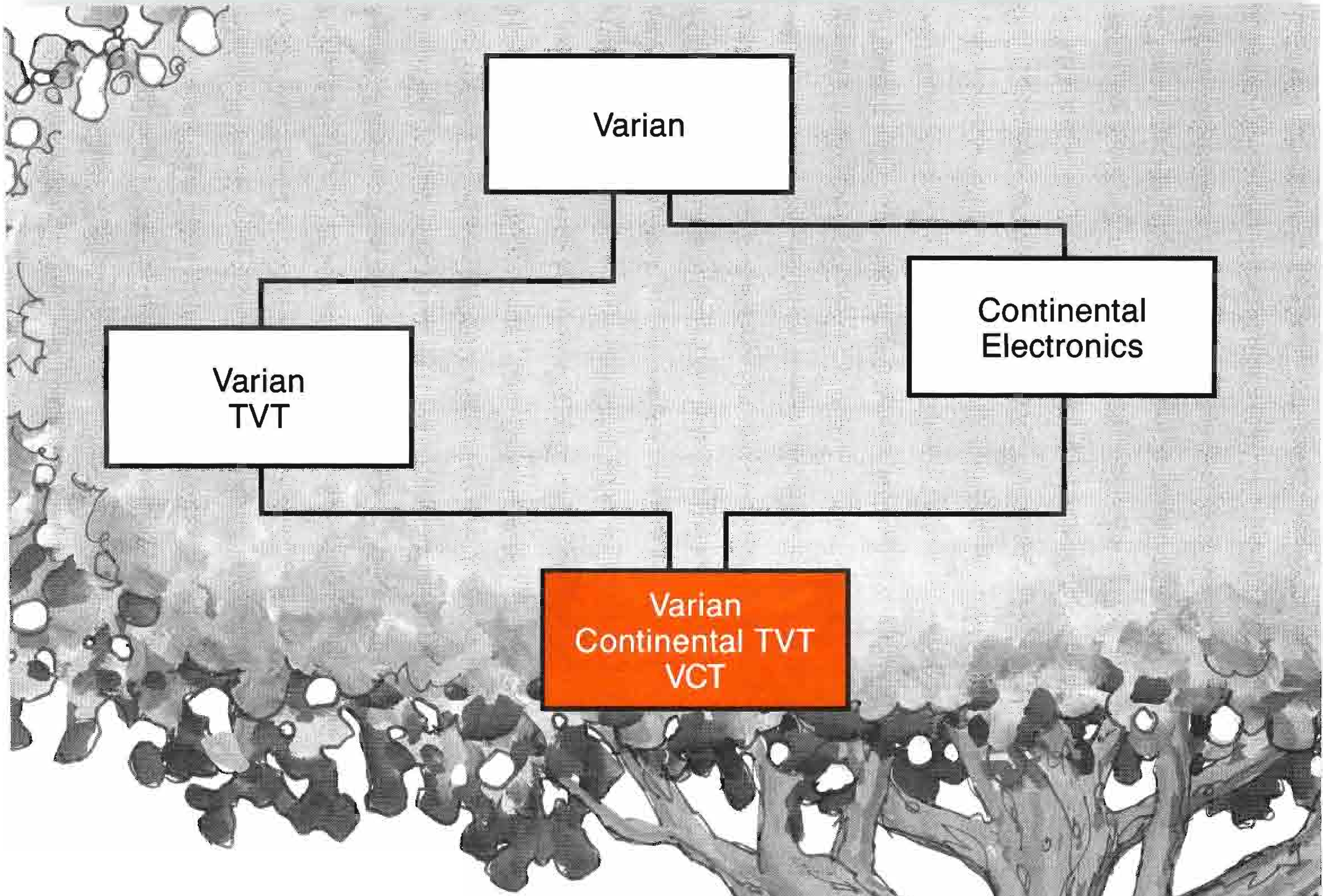

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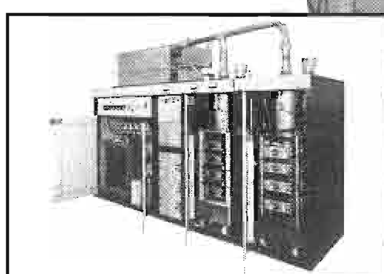

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Acrodyne Industries **(3833)**
Marconi B7548: 60kW UHF TV transmitter.
FL/30KL: 30kW VHF CCIR Band-I TV transmitter.
Circle (506)

AEG Bayly **(719)**
RDSC 3237: radio data system encoder.
Circle (514)

Andrew **(1811)**
HJ12-50: 2-¼" air dielectric Heliax for class B 25kW FM.
Ground straps: applicable to all Heliax products.
Video presentation: design, test capabilities to customize radiation patterns in anechoic chamber.
Pressurization equipment.
ACX series: rigid line, eliminates sliding contacts and resultant copper shavings; 3-1/8" through 5-1/8", 50Ω, 75Ω.
ACW series: high power circular waveguide.
Circle (541)

Comark Communications **(3333)**
CTT-U-120SK: 120kW UHF Klystrode transmitter.
CCT-U-25MX: 25kW UHF multiplex klystron transmitter.
Circle (654)

Energy-Onyx **(1850)**
40kW FM transmitter: based on tetrode PA stage; full modulation with 800W drive.
Transmitter controller: for 1.5kW to 40kW systems; maintains output with varying line voltage; auto, manual modes; fold-back VSWR; full interlock status without transmitter energized.
Solid-state FM series: 20W-500W range.
Circle (745)

Harris/Broadcast **(503)**
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DX-25: digital, solid-state 25kW AM transmitter; improved efficiency and audio performance.
SX-5A: single-phase 5kW AM transmitter.
Circle (796)

ITS **(1113)**
ITS-220: 100W UHF transmitter for LPTV.
Circle (825)

Jampro Antennas **(531)**
UHF shunt corner reflector: high gain antenna for wide range of power levels; flexibility to produce various patterns.
JTC: spiral CP TV antenna; high degree of pattern circularity, axial ratio.
JSCP "C" series: Modified version of current Penetrator FM antenna, improved power handling, reduced cost.
JSM, JSH "EP" slot TV antenna: elliptical polarization; new application of existing technology for better market saturation.
JSDP FM antennas: cavity antenna; virtual unity gain; for single and multiple frequency applications.
JBBP series 1, 2: balanced, omnidirectional circular polarized FM antenna; more symmetrical pattern, less frequency sensitive, improved axial ratio; can be top-mounted.
Circle (826)

Kintronic Labs **(1040)**
RF contactor: switch for low power AM signals.
Circle (845)

LDL Communications **(2175)**
TTC-50LH: Larcan 50kW VHF TV transmitter.
TTS-6M: Larcan 6kW solid-state VHF TV transmitter.
TTS-22M: Larcan 22kW solid-state VHF TV transmitter
TC-TP: circular-polarized, top-mount VHF TV antennas.
Circle (853)

Marcom **(103)**
A125T, A1000T, A5000T: Pulse Power pulse-modulated AM transmitters; 125W, 1kW and 5kW ratings; 20% reserve above each level; 160% modulation capability; AM stereo compatible; full metering, VSWR protection; by Ian Hill.
Circle (878)

Marconi Communications Systems **(3833)**
B7500 series (UHF): high performance 60/120kW TV transmitters.
B8880 series: range of feeder components.
Circle (879)

Micro Communications **(4155)**
#90000: UHF high-power waveguide antenna; improved efficiency, reliability with higher power capacity.
#55000: VHF switchless combiner; hot-switching for visual and aural transmitters without lost air-time.
#55090: 180kW switchless combiner; system for operation of three visual transmitters.
TTL circuitry: μP-controller for MCI motor-driven equipment; requires momentary closures for operation.
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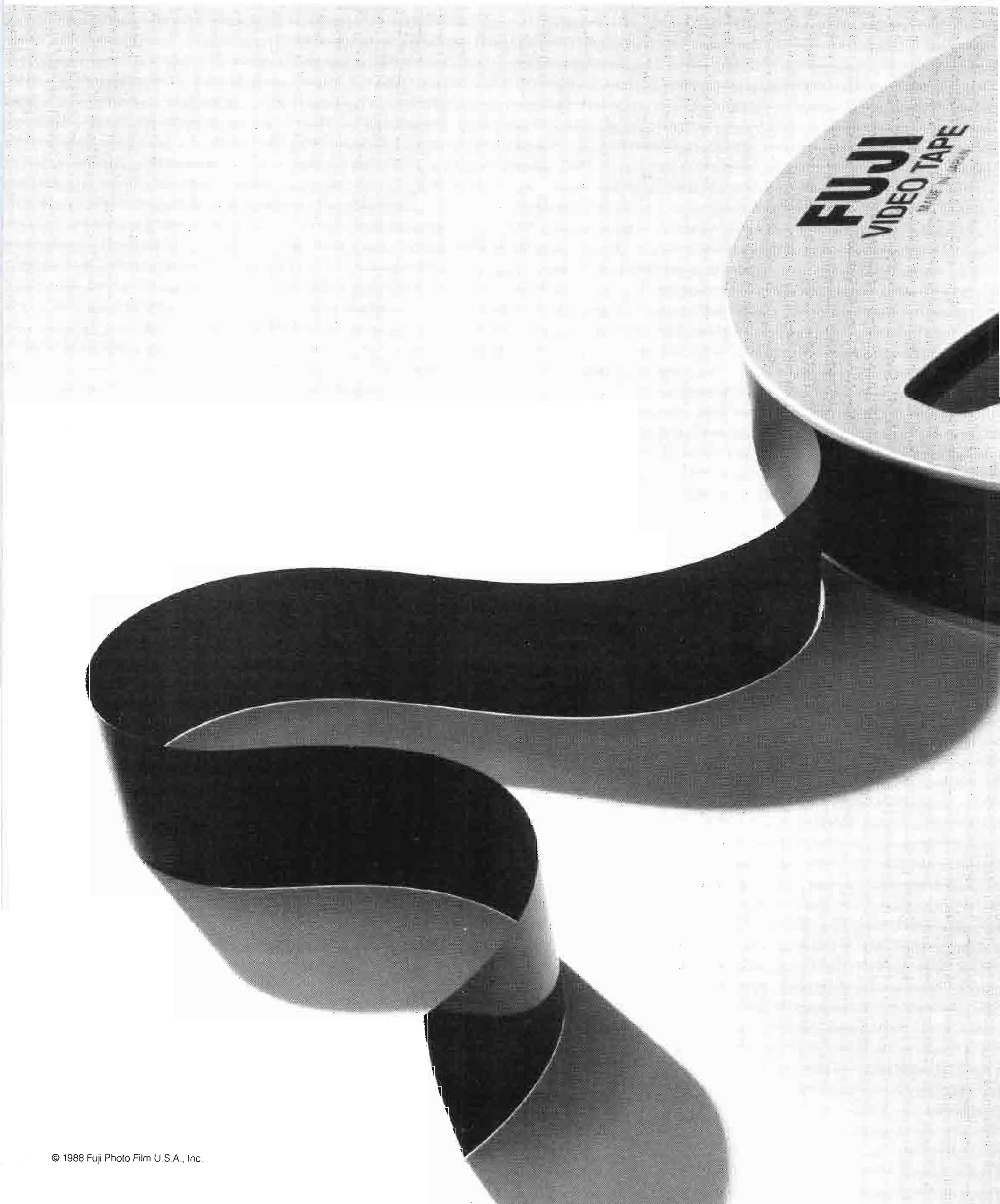

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Nautel **(765)**
AMPFET ND10: 10kW solid-state AM transmitter; 10% greater headroom than previous AMPFET 10 system; <5% square wave tilt, IMD <1%, IQM >35dB; efficient design includes main/standby exciters; modular redundancy with eight 1.25kW subsystems.
Circle (925)

Pinzone Communications **(1119)**
Corum antenna: anti-skywave, anti-fading AM broadcast antenna; low profile, pattern nearly equal to 190° tower (835 ft at 620kHz).
Circle (969)

QEI **(247)**
FMQ series: FM transmitters; field upgradable from 3.5kW to 5kW, 10kW; 30kW model available.
Circle (975)

SWR **(4001)**
WR1150, -1400, -1500, -1800: rectangular waveguide for UHF TV applications; "R" flange.
Circle (1064)

Tennaplex Systems **(1814)**
Hardware: Spinner coaxial, waveguide accessories.
OMEGA: full-band multi-station FM antenna.
Panel antennas: triangular mast-mount for VHF TV, FM radio.
ALPHA: high-power, multi-station combiner.
Circle (1091)

Thomson-LGT **(3333)**
EUHF 100S: 100W UHF transmitter; dual exciter; fully solid-state.
RAMSES: 2kW FM transmitter; compact design; compatible with paging systems.
EUHF-1000S: 1kW UHF transmitter; fully solid-state, combined amplification.
EVHF 20,000: 20kW VHF transmitter; single tube for combined amplification; BTS stereo sound compatibility.
Circle (1102)

TMD/Will-Burt **(3588)**
#7-42-357/367: telescoping mast; black anodized finish; 42-ft height.
Circle (1107)

TTC/Television Technology **(1801)**
XL300MU: 300W UHF TV transmitter.
FM-300J: 300W solid-state FM transmitter; regulated beam power supply.
Circle (117)

TWR Lighting **(H5325)**
L-866: FAA-spec medium intensity strobe light.
Circle (1119)

Valmont Industries **(H5833)**
AM Unipole/monopole: improves AM coverage, audio reception; no guys, base insulators needed.
Circle (1132)

Varian Continental TVT **(324)**
Demonstration: production model *314-F* operating 1kW solid-state FM transmitter; improved audio, control circuitry.
Demonstration: 35kW FM *816R-5* operating with main and SCA channels; solid-state driver.
Circle (1134)

Vector Technology **(H5421)**
Toroidal transformer: impedance matcher device aids wideband signal matching for phasor.
40kW FM: 1-tube, 1-cabinet FM broadcast transmitter.
FMT-3: 3.5kW FM transmitter; 3CX3000A7 grounded-grid amplifier >70% efficienct; PLL exciter, *Auto-Matic* power control, integral remote, VSWR overload, power foldback modules.
Circle (1136)

R2: Microwave

- Antennas, electronics
- ITFS, OFS, STL
- MDS, MMDS

Communication Microwave **(4257)**
Solid-state transmitters: models for 50W, 100W rating.
Circle (656)

Conifer **(2559)**
QL-3030: integrated dual MMDS block downconverter; separate inputs with common output; Interdigital Filter.
PT-2528: 4' ITFS receive antenna; 1-piece perforated aluminum reflector; matched feed assembly; mounts to 2" to 4- ½ " OD mast.
QL-3010: integrated dual-band MMDS block downconverter; common input, common output; for MDS channels 1, 2 and all ITFS/OFS channels; Interdigital Filter improves image, out-of-band rejection; SMD technology.
CIT series: ITFS downconverter; optional Interdigital Filter improves RF selectivity; high-Q response improves rejection of image, out-of-band signals.
Circle (671)

GE/Comband **(H5615)**
Proband/Comband: addressable scrambling

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and bandwidth compression system for MDS/MMDS, ITFS, OFS.
Circle (778)

Graham-Patten Systems **(4530)**
VAMP STL system: provides dual channel PCM audio and a subcarrier over video.
Circle (787)

Ikegami **(2320)**
PP-80: ENG microwave equipment; high-power 2GHz, 7GHz; complements lower power PP-70 series.
Circle (812)

Micro Controls **(202)**
TSL 2001: 450MHz transmitter-to-studio link.
Circle (895)

Microwave Radio **(2935)**
Model 2T2: ProStar portable microwave transmitter.
Model 2A20: ProStar ENG antenna.
Circle (900)

Midwest Communications **(4342, PL)**
Portable microwave: by Ikegami.
Circle (901)

Moseley Associates **(2315)**
PCL-600A: increased metering functions for PCL-600 STL system.
Circle (914)

Nurad **(4101)**
70CP1S, 70CP2S: 7GHz parabolic antennas; compact design.
20PT1-10: 2GHz portable ENG transmitter.
130CP1S, 130CP2S: 13GHZ compact parabolic antennas.
230HP2L: 23GHz parabolic antenna.
Circle (937)

Pinzone Communications **(1119)**
VIMCAS upgrade: multichannel audio system, compensates for link errors, line tilt; 3° phase stability at 14kHz; places stereo audio on video-only, mono microwave paths.
Model 2100: 2GHz ENG receiver; fully agile over band, RS-232 option; integral low noise pre-amp; remote switchable 20MHz, 10MHz IF.
Circle (969)

Radiation Systems/Mark Antenna (1550)
P-21A72CG-2: compact grid-type antenna.
Hardware series: waveguide, coax, hangers, accessories.
Circle (982)

RF Technology **(4243)**
RF-CD: automatic tracking antenna for wireless camera; 1.7-13GHz.
RF-FLP: colinear omnidirectional antennas for helicopter, central receiver, wireless camera receivers.
RF-200LC: ultraportable receiver; use with UPL transmitters in 1.7-2.7GHz range.
RF-203B: ultraportable transmitter; 1.7-2.7GHz, frequency agile; two audio channels, mic/line switching; 500mW output.
RF-SCP: low-profile antennas for boat, racecar, backpack wireless camera.
Circle (995)

TFT **(1109)**
Model 8888: remote pickup unit, rated 2.5W, 40W.
Model 8700: 450MHz TSL transmitter-studio link.
Circle (1094)

R3: Amplifiers, power devices

Amperex Electronic **(2541)**
YK1270: air-cooled klystron.
YL1750: UHF tetrode.
#9021: tetrodes for UHF/VHF TV, FM.
Circle (535)

Econco Broadcast Service **(771)**
4CX3500A: rebuilt tetrode power tube.
Circle (726)

EEV **(3384)**
K3936L24: air-cooled C-band uplink klystron.
K3773BCD: 70kW wideband UHF TV klystron.
K3153: 15kW air-cooled UHF TV klystron.
Circle (731)

Hipotronics **(4546)**
DC beam: power supplies.
Circle (801)

Keltec Florida **(5531)**
R50-125C: low power C-band TWT amplifier.
H60-300Ku: hub-mount TWT amplifier.
R90: high power TWT amplifier.
R60-300Ku: medium power Ku-band TWT amplifier.
Circle (839)

MCL **(PL)**
#10906: 300W Ku-band hub-mounted TWT amplifier.
#10890: 500W Ku-band phase-combined hub-mount ABSAT TWT amplifier.
Circle (888)

Circle (156) on Reply Card

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FOR-A's FA-800 AUTOCOR™ Frame Synchronizer and TBC with automatic level control is a super way to produce synchronized inputs from a number of different remote sources—Camera, VTR, Satellite and Microwave.

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Richardson Electronics **(2561)**
Siemens YD1381, YD1275: planar triodes for TV translators.
Circle (996)

Thomson Electron Tubes/Devices **(1219)**
TH-3694: 450W TWT for 18GHz DBS uplink stations; forced-air cooling; current control anode counteracts tube aging.
TH-2426: 2kW 14GHz klystron; 37dB minimum gain, instantaneous bandwidth greater than 85MHz; forced-air cooling, permanent magnet beam confinement.
Circle (1099)

Varian Associates **(3725)**
VKP-7990: external cavity klystron, multistage depressed collector.
X2254: air-cooled Klystrode, rated 15kW.
YU-148: 10kW FM power amplifier tube.
VKP-7995: integral cavity klystron, multistage depressed collector.
Circle (1133)

R4: Receiving

- Demods
- Modulation monitors
- Receivers

Catel Telecommunications **(1252)**
Synthesized modulator/demodulators for fiber optic IR system.
Circle (628)

DX Communications **(1345)**
DSA-656: C/Ku-band receiver; operates with full, half transponders.
DSA-525: very low noise Ku-band LNB block converter.
Circle (715)

Modulation Sciences **(4544)**
ModMinder: TV audio modulation status panel; with wideband TV demod gives at-a-glance total modulation (metered), peak indicator, status of all subcarriers.
FM ModMinder: FM radio status panel; use with any FM demod or high quality receiver.
Circle (909)

Motorola-AM Stereo **(117)**
Model 1400: C-Quam AM stereo exciter.
MC13024/13022: C-Quam low and medium voltage AM stereo receivers.
Circle (915)

Rohde & Schwarz **(2706)**
EMFT TV receiver: synthesized for all US off-air, CATV channels; data capability, demod for TV transmitter; synchronous demodulation, envelope detection, MTS wideband output; Q-output for ICPM.
Circle (1000)

Telemet **(3722)**
Pro channel demod: allows remote/field crews to receive Pro BTSC channel for communications purposes.
Tunable demod: all TV channel capability.
BTSC synchronous detector: use with various non-stereo demodulators to measure ICPM.
Circle (1084)

TFT **(1109)**
Model 886/887: AM/FM EBS receivers with integral up/down clock.
Circle (1094)

Wegener Communications **(1133)**
SDM2000: Dolby digital audio transmission system.
Series 1800: addressable audio/data receiver; low-cost unit.
Circle (1158)

R5: RF exciters, generators

- Paging
- Stereo, FM, TV
- Subcarrier

Acrodyne Industries **(3833)**
Marconi B7500: UHF exciter and drive system.
Circle (506)

Inovonics **(770)**
#705: FM stereo generator; FMX option.
Circle (819)

Marti Electronics **(525)**
SCG-10, SCD-10: subcarrier generator, demodulator; stand-alone components for subcarrier link service on microwave systems; processing options for pre-emphasis, encode/decode boards; ac/dc operation, auto mute.
Circle (881)

Micro Controls **(202)**
ULX 2001: FM Uniphase exciter.
Model 57: 57kHz subcarrier pager generator.
Model 51: 88-108MHz scan subcarrier pager; alpha-numeric display.

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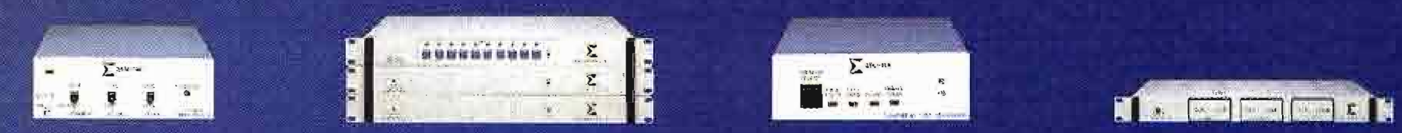

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Model 88: pager/telephone compilar.
Circle (895)

Philips T&MI/Pro TV **(3177)**
PM 5687: TV digital sound modulator.
Circle (965)

TTC/Television Technology **(1801)**
XD-20UA: Silverline exciter; correction circuitry, pulser system.
Circle (1117)

R6: Satellite
- Antennas, controllers
- Electronics

Andrew **(1811)**
Transmit upgrade: allows uplink transmissions with 7.3m antenna systems.
4.5M ESA: 4-port C/Ku Cherry-Picker system.
C/Ku upgrade: kit for 5-, 6-port uplink capabilities.
Circle (541)

AVCOM of VA **(H5331)**
SCS-200: tunable satellite audio receiver; wideband with high-stability downconverter, frequency agile demodulator; presets for 4 frequencies; AVPAND-A processing.
Circle (574)

MCL **(PL)**
#20076: 5W Ku-band communications adapter, transmitter.
Circle (888)

Microdyne **(2515)**
M.A.T.: Microdyne automated satellite terminal; includes 1100 BKR(M) broadcast receiver, meets RS-250B.
Newslock: satellite video/audio encryption system for news gathering backhaul.
Circle (896)

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Pinzone Communications **(1119)**
Model 9270 receiver: all-format C/Ku system with Comtech and Vertex antennas; 16 automatic formats cover 36 satellites (Intelsat included); stereo audio, eight subcarrier presets, automatic offset for ½ -transponder operation.
Circle (969)

Standard Communications **(1048)**
LNBC-4B: HEMT GaAs FET C-band low-noise amplifier, block downconverter.
Agile Omni Pro: RS250B video/audio satellite receiver, full feature.
LNBC-12C: HEMT GaAs FET Ku-band, low-noise amplifier, block downconverter; available for various ITU frequencies.
Agile Omni International: video/audio satellite receiver for all ITU frequencies and satellite formats; applicable for NTSC, PAL, SECAM and MAC transmission standards.
Circle (1048)

Thomson-LGT **(3333)**
Line ARES: satellite-to-terrestrial broadcast transposer/translator.
Circle (1102)

WATCO **(H5006)**
8606A transmitter: 300W, Ku-band; rack-mount.
W8716: remote controller for uplink transmitters.
W8713 transmitter: 600W, Ku-band, rack-mounted.
8705: power combiner, redundancy switch; rated 2kW at Ku-band.
8602 transmitter: 300W, Ku-band, antenna-mounted.
Circle (1154)

Supporting products
S1: Automation
- Hardware, software
- Business, equipment
- Newsroom, programming
- Remote control
- Clocks, timers
- Data transmission

Adrienne Electronics **(H5318)**
PC-207M: interface links IBM PC/XT/AT to SMPTE 207M machine control standard.
Circle (511)

Advanced Micro-Dynamics **(H5829)**
ARC-16: expanded transmitter remote control; modular for multiple site, walk-away applications; includes phone lines, subcarrier, dial-up communications options with computer control.
Circle (513)

Alamar USA **(3801)**
Ala-Patch: VTR video, audio, remote, RF switching control; allows A/B selection of remote control from 1-of-2 VTRs to single control or from single VTR to two separate control devices.
News-Cue: automatic tape cue and confirmation system; reads data from cue track, shows descriptive information on CRT; allows local,

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"Hands-free" continuous wireless communications

QTR-1 Portable (top view)

"Q" PLUS—convenient full-duplex wireless intercom

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Up to six Cetec Vega "Q" PLUS remote beltpack wireless intercom units (portables) can communicate full-duplex through a central master station. The six portables talk continuously ("conference" style) without pushing a push-to-talk switch or without the annoying one-person-at-a-time limitations and syllable cutoffs of VOX (voice-operated) systems.

The compact Model QTR-1 portables are built to take abuse, and are housed in a welded aircraft-alloy aluminum case.

The portables are very easy to use; they have only two operating controls — a combined on/off and headset volume control and a push-button audio control switch.

The portables operate 8-10 hours on two inexpensive 9-volt batteries.

System audio is crisp and clear, with extended frequency response, low distortion, and audio processing for low noise.

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The Model QX-6 master station has comprehensive provisions for control and monitoring, plus a user-programmable intercom interface and auxiliary audio inputs/outputs. Interfacing is DIP-switch programmable to a wide variety of wired-intercom systems, including Clear-Com, RTS, ROH, David Clark, most "carbon mic" systems, etc.

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For more information, contact your nearest Cetec Vega dealer or sales representative, or call **1-800-877-1771**.*

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remote control of VTR playback.
Circle (519)

AMX **(H5910)**
SX-DCU: data control unit for serial and IR-controlled equipment.
Circle (540)

Automated Business Concepts **(1651)**
MAPS: station business software—accounting, sales, management, programming.
Circle (573)

BASYS **(3884)**
Release 9: newsroom software enhancements; auto display refresh, variable split screen, call/capture.
Archive 1: integrated multiuser newsroom archiving software; on-line, information storage/retrieval; addressing capability to six millions stories.
B.I.T. Function: stand-alone Betacart control system.
TIMESLOT: personnel scheduling software; tracks, controls complex scheduling of personnel under union and non-union contract conditions.
ANGIS: election system and character generator/titler interface.
Circle (581)

Broadcast Automation **(H5824)**
BAI-108: live-assist controller; 8-source input, 24 events.
Circle (605)

Broadcast Management Plus **(2166)**
J-Plus software: joint venture with Jefferson Data Services, combines data storage capacity of Series 1 with the PC; improved electronic interface between station, rep firm.
Circle (608)

Broadcast Video Systems **(2226)**
VIC900: VBI data transmission system.
Circle (610)

CAT Systems **(1861)**
Model 9012: 12-site satellite remote control.
Circle (627)

CBSI Custom Business Systems **(653)**
System Interfaces: radio automation to broadcast business computer.
Circle (630)

Colorado Video **(2609)**
#240/#241: vertical blanking interval freeze-frame video transmission system.
Circle (651)

Columbine Systems **(3274)**
Preview: financial management application software.
Salmon Sales Management: for IBM PC, PS/2.
Enhancements: sales, traffic, billing software.
Circle (652)

Cycle-Sat **(H5433)**
Cyclecypher: decoder-controller for satellite reception of commercials, news, other programming; addressable receiver provided to TV stations on $1/year lease; printer provided.
Circle (687)

Data Center Management **(H5015)**
DCM election reporting system: electronic newsroom equipment, featuring prompting, generic character generator/titler interface.
Circle (690)

DKW Systems **(0000)**
CABS system: computer-aided broadcasting software; CABS/PS programming, scheduling, CABS/LA live-assist and CABS/LA+ live-assist plus full automation.
Circle (711)

Dynatech NewStar **(3344)**
PC NewStar: terminal for newsroom systems.
LEADER: newsroom election system.
APS robotic camera: NewStar option controls camera moves, prompter, auto Betacart tape playback, closed captions, timing, camera scripting.
Circle (721)

Enterprise Systems **(4020)**
Betacart interface: links business system to cartridge playback equipment.
Electronic tie-in: direct connections between station business computer and various computer-based agency systems.
Circle (747)

Gentner Electronics **(265)**
Studio timer: remote controllable count-up in 1s intervals to 9:59:59; weighted base, non-glare hood.
Circle (779)

Gentner RF Products **(265)**
Antenna monitor interface: VRC-1000 accessory; enables interface to directional array antenna (phase) monitor to check all array parameters.
SETUP utility: PC software simplifies setup of VRC-1000 remote control unit; enables IBM PC/compatible with modem to setup or change programming of control system.
Isolation amplifier: VRC-1000 accessory; dc/ac isolation to 100V for metering samples;

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200-4 Delayed video DA, up to 750 nS.
200-5* VCA video DA, remote control system DA.
215-1 Line driver V DA, bal/unbal in-out 75/125 ohms.
220* DC 12 V powered video DA, 8 outputs.
230* 10 outputs video/2 ch audio, dubing system DA.
232* 20 outputs video/2 ch audio, dubing system DA.
233* 50 outputs video/2 ch audio, dubing system DA.
240-1 Plain vanilla audio DA, 12 outputs.
240-2 VCA audio DA, remote control system DA.
273* Component video DA one gain control for 3 CH.
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—The unique Omega Drive puts less stress on your tape, so the cumulative tension of a thousand start/stop passes won't reach your tape.

—Heads designed and manufactured by TASCAM means Sync frequency response equals Repro, so you don't have to rewind and change modes to make critical audio decisions.

—Sync Lock and the most responsive servo control in the business will keep you working instead of waiting for a machine to lock up.

—Time Code Lock keeps code coming from the Sync head, regardless of the audio monitor mode, so your synchronizer won't get confusing double messages when modes are switched.

—Input Enable/Disable allows you to monitor any source without repatching or changing mixer settings, avoiding a common cause of aborts.

—Long cable runs don't bother a TASCAM ATR-60, since +4 dBm, +8 dBm and even +10 dBm levels are available.

There are five ATR-60 recorders: the ATR-60-2T (IEC Standard) Center Track Time Code; ATR-60-2N/2D Quarter-inch Mastering; ATR-60-2HS Half-inch High Speed Mastering; ATR-60-4HS Half-inch 4-Track High Speed Mastering or Multitrack; and the ATR-60-8 Half-inch Production Quality 8-track.

To see, hear and feel them, visit your nearby TASCAM dealer, or call TASCAM for the name of the dealer nearest you.

Production is a demanding business. And the ATR-60's are built to meet the demand.

Pure Performance

TASCAM

TEAC Professional Division

7733 Telegraph Rd. • Montebello, CA 90640
Telephone: (213) 726-0303

Circle (257) on Reply Card

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simplifies interface to UHF TV transmitters.
Radio version firmware: enables VRC-1000 to operate on subcarrier, telemetry or push-to-talk radio link or dial, dedicated phone circuits.
Temperature sensor: accessory for four thermal sensing systems for air, water, etc.
VRC-1000 firmware: version 3.0 expansion;accommodates auto commands, adds 10 features, additional access capability.
Circle (780)

HEDCO (1820)
RSC-100: remote serial control card for small switchers with RSP-100 control panel.
Circle (799)

Kinemetrics/Truetime (4015)
OM-DC: Omega synchronized clocks; accuracy within ±5ms based on VLF radio-navigation signals.
Circle (842)

Media Computing (4275)
NC1 interface: links newsroom computer system to character generator; supplements ANGIS election system.
Circle (891)

3M Broadcast-Related (2305)
RS-422: 3M machine control system.
Circle (907)

Moseley Associates (2315)
MRC-2 software update: faster telemetry updates allow operator's knowledge of system status.
MRC PC: remote control system interfaces to PC as control terminal.
DAVR: Dial Access/Voice Response enhancement for MRC-1600 remote control product.
Circle (914)

Odetics (H5813)
Expanded interface: input/output enabling cart machine to control and switch external recorders, players and other program sources.
Automation interface: advanced traffic/station automation interfacing; fully automates play list and "as run" log information exchange with TCS-2000.
TCS-2000: expanded line includes SP, M-II formats.
Circle (940)

Pinzone Communications (1119)
Timeslot schedulers: Microtek *Facilities* and *Personnel* software; IBM PC/AT/XT/PS2 and compatible; 640k RAM and 10Meg hard disk suggested.
Circle (969)

Reach Electronics (4180)
21TYE1: Liaison dial access paging terminal; voice storage capability; compatible with most digital formats; configurations for Liaison, tone only, tone and voice paging.
Circle (989)

Sony Broadcast (2902)
Library Management System: production model.
BVW-95: enhanced Betacart Betacam-SP deck; improved picture quality, wider audio options.
Circle (1037)

Total Spectrum Mfg. (2069)
Teleconferencing: remote control products, including *VS-200M* pan/tilt, *UNI-11-SND* uniplexer.
Circle (1110)

Townsend Broadcast (4356)
DC-80: auto video cart machine; commercial playback system available for SP, S-VHS, M-II, Betacam formats.
DC-80DL: auto program delay, continuous from 4 minutes to over 2 hours without intervention; enhanced video processing, stereo audio, record-only, play-only, push-pull schedule adjustment.
DC-800: multiple channel program playback; handles programs, commercials, PSAs and IDs.
DC-800A for walk-away automation system.
Circle (1111)

Utah Scientific (3344)
RAS-1: real-time switcher control; computer scheduling of time referenced events for execution by routing switchers and machine control systems.
TAS-1: on-air station automation; full-featured, with intelligent machine control.
Circle (723)

VG Electronics (503)
#1075: data encoder for use with FM radio transmitters.
Circle (1137)

Video Design Pro (H6114)
VidCAD 2.4: expanded CAD drawing library for TV facility design.
CAD Spec: costing database allows automatic costing of VidCAD drawings.
VidCAD systems: turnkey CAD software and hardware.
VidPAD 3-D: full 3-D TV facilities layout tools with shading and perspective.
VidPAD: paper-aided design, automates TV facility design, engineering.
Circle (1142)

S2: Wire, cable

- Connectors
- Fiber optics (FO)
- Patch panel products

ADC Telecommunications (3480)
ICON: Integrated Cable Organization Network audio cable management system.
#5-9: SMPTE 9-pin patching system.
Circle (508)

Artel Communications (2077)
FiberWay 802.3 Bridge: links Ethernet networks to 100Mbit/s FiberWay FO LAN.
T3080: FO transmitter at 1,550nm; for Series 3070 receivers on single-mode fiber link; meets EIA-250B short-haul spec; 45km range; compatible with T3100 audio/data subcarrier modules.
Wave Division Multiplexer: signal combiner for T3070 1,300nm and T3080 1,550nm transmitters in dual uni-/bidirectional transmission; bridges T3080/WDM to existing fiber link using 1,300nm equipment.
Circle (554)

Cam-Lok (H5931)
EO400 series: Posi-Lok power distribution panel; 400A, 500V; meets NEC spec; special polarization, interlock design contacts ground first; avoids cross phasing.
Circle (620)

Canare Cable (4556)
A2V1: camera remote cable; 1-video, 2-audio circuits.
BCJ-R: BNC receptacle.
L-2E5: miniature microphone cable.
GS-4: miniature high-Z cable.
BCP-C3: BNC connectors, in-line type; 75Ω.
A2SP: ENG/EFP remote snake system.
Circle (623)

Catel Telecommunications (1252)
#3100: synthesized fiber material.
Circle (628)

Chester Cable (H5325)
Component video cable: complies with SMPTE standards; individual coax cables in common jacket.
Circle (639)

Comlux (4338)
Video codec: 9-bit video FO encoder/decoder.
Digital video: fiber optic hardware.
Circle (655)

Connectronics (172)
STUDIFLEX-24: 24-pair, shielded, jacketed color-coded in single outer jacket; for studio, interconnect wiring.
Circle (672)

Dynair Electronics (3730)
Fiber optic link: for HDTV applications.
Circle (716)

Gentner Electronics (265)
Versapatch/FB-1: chassis-enclosed patch panel with Flexiblock 100 termination on rear panel; 48 jacks, offset spacing for stereo; T-R-S, normals brought to rear panel.
EasyTerm/FB-1: rack-mount termination, 320 punch-down terminals in 3.5" rack space; 4 wires per circuit, stranded or solid; hinged panel for easy access.
Flexiblock FB-100: increased termination density for stranded wire punch block; 2x50 terminals, two connections per terminal; 4-wire per circuit capability; Mil-spec with gas sealed connections.
Circle (779)

IMC/International Music (H5728)
PG1000, M21000: universal patchbay programmer with 12" RGB monitor.
DP3200, DP2000: 32 in/out audio patchbay; 16 in/out audio and video patchbay.
Circle (815)

J-LAB (1019)
Component cable extender.
Video DA: battery operated.
Circle (830)

Neutrik USA (4587)
Weatherproof XLRs: rustproof, splashproof, withstand corrosion; *NC3FX-HD* female with rubber boot, *NC3MX-HD* male is stainless steel.
NM, NA series: Neutrik modular, adapter connectors; create custom adapters from XLR, RCA, BNC connectors; can include transformers, etc.
Circle (1219)

Switchcraft (130)
E11IL: ¼ " locking jack.
A3FS/A3MS: small diameter Q.C. cable clamp.
A3FBAU/A3MBAU: black/gold Q.G. connectors.
Audio patch panel:.
Circle (1063)

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Union Connector (2584)
Prototype: 200A outdoor electrical distribution center.
Patch panels: various types including single pin patch, hanging cord.
Model 20-2P&G: 20A stage pin plug, connector; easier wiring.
Circle (1121)

S3: Cases, racks acoustical material, studio furnishings

Acoustic Systems (H5224)
SD-47: acoustic door.
Circle (505)

Alpha Audio (2258)
Acoustic materials: new forms of Sonex, Soundtex, Acoustilead, Sonex 1.
Circle (527)

Anvil Cases (1881)
M.I.C.S.: modular interlocking case system.
Circle (546)

Arben Design (4563)
Studio sets: new line of flats for studio use.
Display kiosks: interactive videodisc or other programming displays.
Circle (550)

Arrakis Systems (465)
Modulink: factory prewired studio systems; pedestals prewired with connectors, ready to plug in and go; standard configurations with Arrakis consoles and custom designs; distributed through Allied Broadcast.
Circle (552)

Calzone Case (1852)
Proline: lighter duty version of Escort series; for regional and local transport.
Convoy: 1/8" ABS plastic molded case for lightweight transport use.
Escort: transport case series; maximum protection; exceeds ATA spec for flight case.
Circle (619)

Centro (3569)
VPC-1: video production console, for video, graphics, audio production.
CRK-1: collapsible rack kit.
DRK-1: 3-bay display rack for production, off-line editing.
Circle (634)

Ferno Washington (H5624)
#293 Freelancer: audio-video equipment transporter with 293-1 battery gimbal; 293-2 shelf; 293-3 light support pole.
Circle (757)

Alan Gordon Enterprises (2538)
Special effects: acrylic devices; ice cubes, spills, pours, bubbles, smoke bombs.
Circle (784)

Kangaroo Video Products (2214)
Case: for portable TV monitor.
Raincover: for Sony BVP-360 studio camera.
Waist-belt production pack.
Case/raincover: for Sony Betacam SP, Panasonic M-II camera/recorder models.
Camera case: design case with viewfinder support for Sony Betacam SP, Panasonic M-II cameras.
Circle (836)

K&H Products/PortaBrace (3374)
Producer-Director: compact briefcase.
Shoulder cases: for Sony BVW-505, Beta, Panasonic M-II camcorder combos; with rain-top feature.
G2 Cart: includes front wheels.
Lighting case: stores lighting kit for easy transport.
Run bags: general purpose, light-weight ditty bags for miscellany.
Recorder cases: for Sony BVW-35, BVV-5/VA5, Panasonic AU-500, AG-7400.
Camera cases: Sony BVW-505 and camcorder combos from Ampex, BTS, Ikegami, NEC, Panasonic.
Circle (841)

Kintronic Labs (1040)
SER series: standard equipment racks; unique features and decor.
Circle (845)

Lake Systems (1039)
Custom control consoles.
Circle (850)

Nalpak Video Sales (4280)
SP-9948: professional soft tripod case.
TP-1248: expanded line of TriPak, tubular tripod cases.
Circle (923)

RPG Diffusor Systems (1125)
Complete acoustical treatment: expanded line of broad-bandwidth sound QRD diffusors, Abfussor absorbers and Triffusor variable

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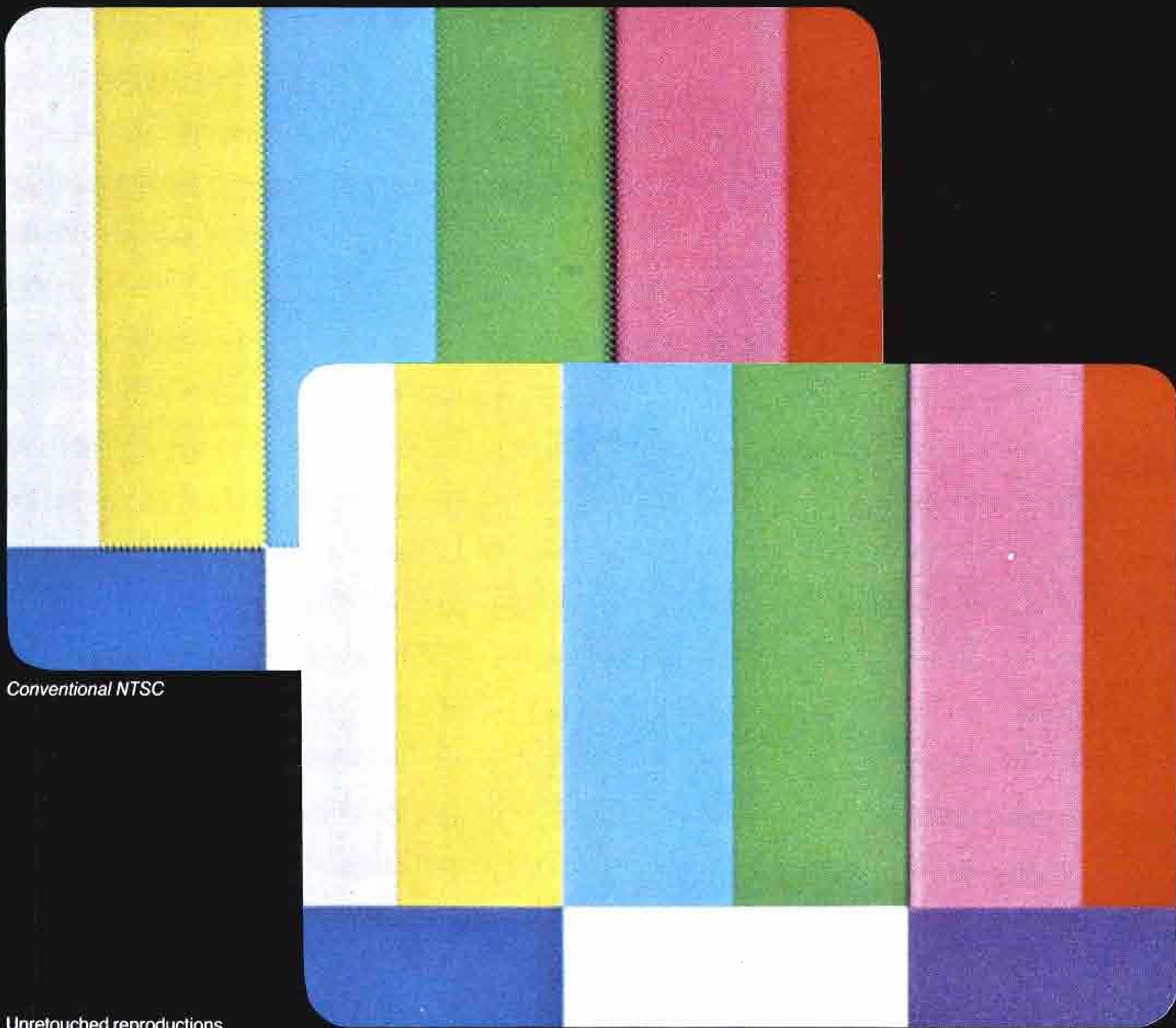

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Faroudja Laboratories improved NTSC is fully compatible with the present system. Faroudja technology is licensed to Conrac, Fortel, Ikegami, JVC, Sony, etc...

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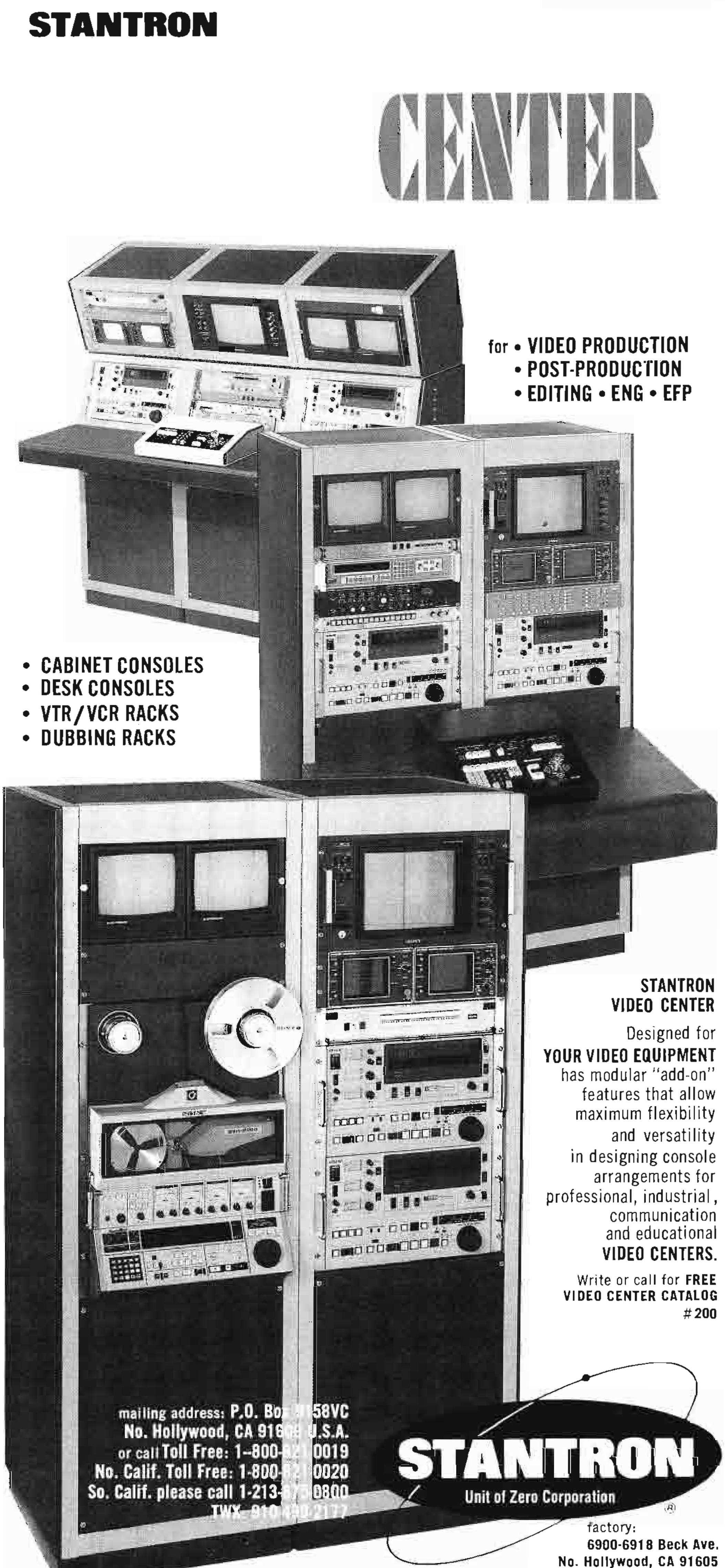

Circle (164) for CALL ME, I'M INTERESTED
Circle (165) for SEND LITERATURE ONLY

acoustics modules.
Circle (1005)

Star Case **(2487)**
Case product enhancements: additional colors in bordeau and turquoise for ATA-STAR, Super STAR and Ultra STAR lines.
Circle (1051)

Storeel **(2653)**
CD-160: storage system for compact disc media; accommodates 160 to 640.
BC-280/360: set-up truck for Betacart; capacity of 360.
BC-200/10: mobile high density Beta/M-II storage units.
Circle (1055)

Telepak San Diego **(4569)**
T-80 HC: shipper case for EVM-8010, BVM-8021, PVM-8020.
T-80: case for EVM-8010, BVM-8021, PVM-8020 monitors.
T-Rain IV: raincover for Panasonic AG-150-55-60.
T-UCP: universal camera case; styled as carry-on luggage.
Circle (1086)

Uni-Set **(1834)**
DBS cabinets: stores your downlink business TV network equipment.
Studio staging: 3-ft modular systems.
Circle (1122)

Wheelit **(2583)**
Model 8400: computer or editing console.
Circle (1161)

Winsted **(2680)**
Vertical equipment racks.
Tape storage: for Beta, VHS, M-II cassettes.
30° Slope: modular console series.
Circle (1164)

S4: Recording media

- Audio, video
- Cassettes, reel tape
- Cleaners, conditioners
- Degaussers, shippers

Agfa-Gevaert **(3880)**
Agfa Betacam: prototype cassette.
Broadcast Pro U-matic: prototype cassette.
Demonstration: videocassette loading with PEV-192, Strand tape loader.
Circle (516)

Ampex MTD **(3302)**
Packaging systems: anti-static plastics in #187 broadcast and #197 master broadcast U-matic cassettes.
Circle (537)

Audico **(830)**
Videocassette loader: unload, rewind, cycle, length verification for all ½ ", ¾ ", 19mm and 1" formats.
Circle (561)

CMC Technology **(2853)**
Service: full, partial refurbishing of Sony BVH1100/2000 PAL, NTSC upper drums.
Circle (647)

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Data Security **(N.A.)**
Type II: degausser for desensitizing Type II video, high-energy instrumentation and high energy computer back-up tape; DOD approved.
MP7 degausser: 1-pass, conveyor-belt system; for 1500Oe metal-particle tape (M-II, Beta-SP).
Circle (691)

Fidelipac **(515)**
#1000 tape: cartridge format, cobalt formula; offers high level of sound fidelity with original source.
Circle (760)

Fife-Pearce **(H5933)**
2PT5: tape degausser, conveyor design; automatic, continuous operation.
Circle (761)

Fuji Photo Film **(4307)**
Pro-S S-VHS: 30, 60, 120 minute cassettes for S-VHS; 20-minute for S-VHS-C.
Circle (772)

Maxell **(2383)**
TF20-5000F/-4400GN: pancake VHS duplication packs; *-4400GN*—14,436 feet; improved base film increases performance, strength.
Maxell video floppy disk: 50 single-field, 25 frame still picture capacity.
Circle (885)

3M Magnetic Media **(2305)**
PB series: Master broadcast Betacam SP videocassettes; 60- and 90-minute Betacam cassettes.
SP series: ¾ " cassettes for broadcast.
MM series: Master Broadcast M-II videocassettes.
ST series: S-VHS videocassettes.
PB metal: Betacam Master Broadcast metal formula videocassettes.
Circle (906)

Quantum Audio Labs **(2301)**
BTE 1900 series degaussers: -1900 S-VHS/Beta SP; *-1905* M-II; *-1915* for D-1, D-2; *-1925* conveyor-type for high energy metal tape.
Circle (980)

RTI/Research Technology **(2466)**
Model 6120: 1" videotape evaluator/cleaner; high-speed operation.
Model D-11: dropout analyzer; allows dual size dropout counting.
TapeChek: videotape evaluators for ¾ ", Betacam, M formats.
Circle (1007)

Sony Magnetic Products **(2902)**
D-2 tape: metal formulation for digital composite recording format.
Circle (1038)

TDK Electronics **(4580)**
Cassette accessories: HD-30 cassette deck head demagnetizer; *HCL* (dry), *HCW* (wet) head cleaners; *TCW* VHS wet cleaner.
EC-30-S: endless audio cassettes.
Super VHS XP: videocassettes for Super VHS format; line includes VHS-C product.
Super D: high-bias, Type II audiocassette tape.
Super Avilyn: improved SA Type II audio cassettes; elevated low/high frequency MOL, reduced bias noise, improved low/high frequency dynamic range.
Circle (1076)

Zonal **(1621)**
920, 960 series: 75 and 125 micron polyester magnetic sound recording film; improved mechanical characteristics with electro-acoustic performance of 900/950 series.
830 series: broadcast audio tape; formulated for EBU standards for improved distortion, noise and HF response characteristics.
Voice logging tape: full range of logging tapes, compatible to most communications recorders.
Circle (1173)

S5: Distribution

- Distribution amps
- Routing switchers

Adrienne Electronics **(H5318)**
AEC-1: 10x1 video, stereo audio router; 30MHz video bandwidth.
Circle (511)

AMX **(H5910)**
ASW-500: audio, video switcher.
ATP: LCD control panel.
Circle (540)

BTS Broadcast TV Systems **(2920)**
BSX-350A/BSX-350V: 10x10 compact routing switchers for audio and video.
TAS/TVS-2001: video/audio HDTV compatible distribution switcher.
BAS/BVS-350: 10x1 or 20x1 video, stereo audio routing switcher; 30MHz bandwidth
Circle (615)

CEL Electronics **(1433)**
P164: 16x8 crosspoint video routing switcher.
(Circle 631)

Datatek **(2356)**
D-802: 10-output video DA.
D-810: 10x1 audio-video switcher.
D-2400: audio-video routing switcher systems.
Circle (693)

Di-Tech **(2180)**
Model 9002: virtual matrix control system.
Model 5863: RS-422/RS-232 data router; 32x32 matrix.
Circle (710)

Dynair Electronics **(3730)**
Switcher controller: includes multiple-bus, multiple-level display.
Mini control panel: full-feature, low cost for Dynasty switching systems.
Modular DA series: mix/match coax and fiber optic inputs/outputs.
Circle (716)

ESE **(1800)**
ES247 VDA: quad 1x6 video amplifier.
Circle (749)

FOR-A **(3169)**
VRS-1000/ARS-2000: video/audio router; expandable 16x16 matrix system.
Circle (767)

Future Productions **(H5830)**
AVD-12S: A/V distribution amp for S-VHS; 12-output.
Circle (774)

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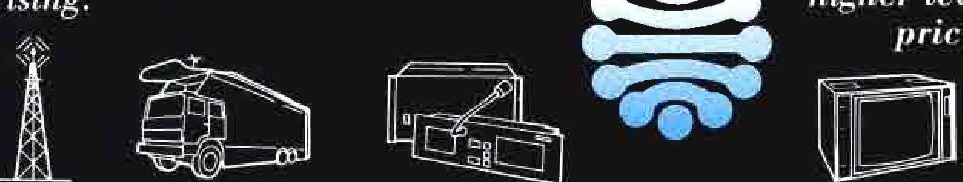
Pesa in the Studio
With these products and others like the SIM4000 Intercom System, Pesa is making a big name for itself in the studio, offering ***high-technology at competitive prices.***

Pesa is prominent in transmission too with TV transmitters and transposers, powers ranging from 1W to 10KW *and rising.*

Pesa in Broadcasting Systems
Active in all areas of broadasting, Pesa has supplied well over 100 OB vans from small ENG units right up to major production vehicles. Customised studio systems are in the portfolio too. So, whether it's a single piece of equipment or your next major project, talk to Pesa. - ***we'll offer you higher technology, always at lower prices.***



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Introducing the Cycle Sat Satellite Courier System.

With the dramatic increase in the number of spot commercials and the revenues they generate, your television station faces a critical need for a dependable, fast, accurate system for receiving network quality spots and traffic instructions on time.

Any commercials OR traffic instructions that are misplaced or damaged due to land or air courier error can mean financial loss to your station or the inconvenience of "make-goods."

Now there's the *Cycle Sat Satellite Courier System.* Cycle Sat can provide you with network quality spots AND traffic information – including updates in a timely fashion, allowing you more scheduling time. Changes in trafficking can now be instantaneous instead of late or lost.

Cyclecypher downlinks fast!

Cycle Sat's proprietary Cyclecypher®, when installed in your station, is capable of automatically recording **only** those spot commercials

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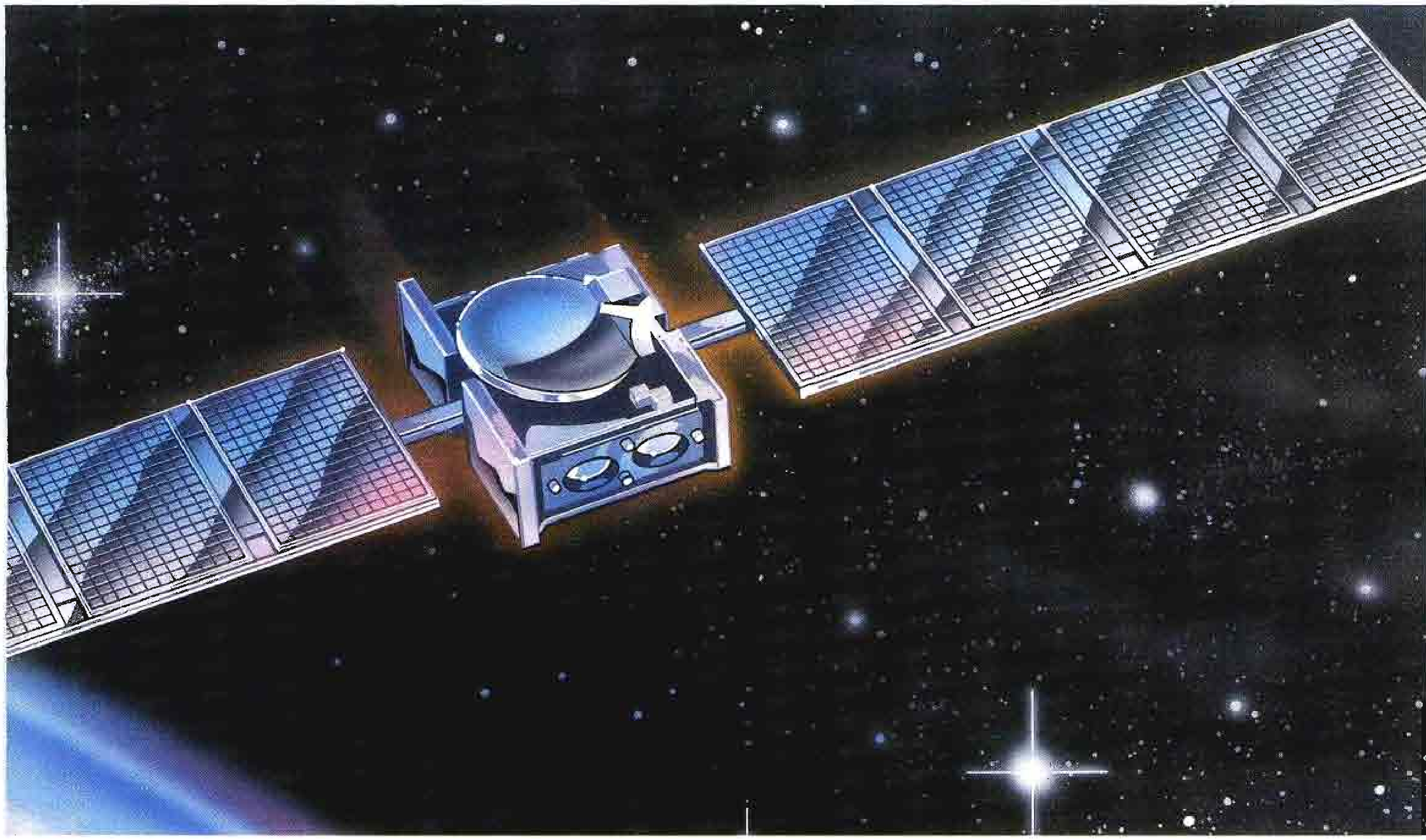
to deliver TV spots...



way to receive them.

intended for your station. What's more, they may be recorded in off-peak time periods.

With reception of either Ku-band or C-band, our nightly transmission schedules reduce your recording equipment conflicts by allowing you to receive all scheduled commercials during a **single** feed. By the use of the Cyclecypher system, you can reduce operation time and store commercials in just 25% of the space required to store a similar number by conventional means.

The Cycle Sat Package.

When you sign-up for the *Cycle Sat Satellite Courier*, you will receive the Cycle Sat package, which includes: a Cyclecypher, Ku-band/C-band satellite data decoder/receiver, a high-speed Cycle Sat printer, a remote record indicator, two interface cable packs, and $100 to help cover your installation costs.

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Gentner Electronics (265)
Routing DA: 8x28 audio DA; any combination of 8 inputs to any of 28 outputs.
Circle (779)

Grass Valley Group (2928)
DDA-101: digital DA, 1x4 format.
Enhancements: to HORIZON and TEN-20/20-TEN routing switchers.
Circle (788)

James Grunder & Associates (1433)
P164: 16x8 crosspoint video routing switcher.
(Circle 793)

Harrison Systems (125)
ARS-9: audio-only routing-distribution switcher.
Circle (798)

HEDCO (1820)
TWS-100, TWS-200: 12x1 video and stereo audio routing switchers.
HD16 switcher: 16x16 routing switcher, with RS-232 serial controller.
Circle (799)

Ikegami (2320)
TSW-502: source selector system.
Circle (812)

Image Video (3584)
#9520: 20x10 video routing switcher; 1-rack unit required.
VDA-160: 16-channel, 3-rack unit video DA package.
#9521: 20x10 dual-audio routing switcher; requires 1-rack unit space.
Circle (814)

J-LAB (1019)
Routing switcher: 5x1 matrix.
Circle (830)

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Leitch Video (2169)
DDA 6001: digital equalizing 4x1 distribution amps; for CCIR-601 signals.
Circle (859)

Lenco (3956)
STARFLEX: distribution system.
Circle (861)

McCurdy Radio (1849)
ADS-800: audio distribution system.
Circle (887)

3M Broadcast-Related (2305)
Routing switchers: audio, video systems.
Circle (907)

Moseley Associates (2315)
ARS-256 PC: PC control option for audio routing switcher.
Circle (914)

Omicron Video (1870)
Model 330: digital component video DA.
Circle (943)

ROH (2235)
#7000: audio routing switcher; summing crossbar design allows assignment of any or all inputs to any or all outputs; specs exceed broadcast requirements.
Circle (999)

Sierra Video Systems (H5315)
Series 5: new design component video 5x1 router.
Series 8/16: new design 8-RU frame.
Circle (1028)

H.A. Solutec (4541)
SOL 5532: audio DA, stereo.
Circle (1035)

Utah Scientific (3344)
DVS-1: digital video routing switcher; for parallel CCIR-601 signals; fully compatible with existing Utah Scientific A/V routing control systems.
Circle (3344)

Video Accessory (2617)
Video DA: 1-in, 6-out, clamping.
Circle (1138)

Videotek (3074)
RS-103, 103A: 10x1 video switcher with computer control; -*A* version includes three audio channels and breakaway.
Circle (1147)

Vortex Communications (753)
GC-16x16: expandable routing switcher systems; 4-level master, multislave switching; for video, RGB, YUV, digital, HDTV, audio, control RS-422/232 signals.
Video DAs: wide bandwidth, high stability.
GC-5x1: RGB/component routing switcher; loop-through inputs; equivalent of 15 DAs.
Circle (1151)

S6: Test equipment

Altronic Research (1250)
#6735: 35kW air-cooled RF coaxial dummy load resistor.
Circle (530)

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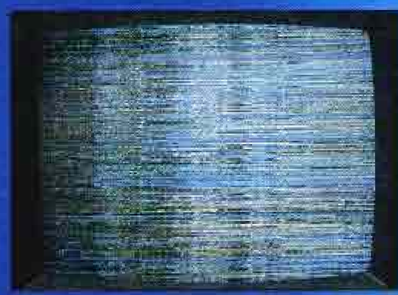
HOW TO PROTECT YOUR IMAGE



Scrambled

Descrambled

S-234

The Microtime S-134 and S-234 will protect your video image with the most advanced capabilities for synchronizing and correcting remote feeds. And, with video scrambling, you ensure the security of your video image. Features include:

- Four field memory with four field freeze
- Composite digital sampling for transparent video processing
- Sophisticated "hot cut" performance to correct incoming signals
- High level of noise immunity to synchronize poor quality signals without freezing
- Selectable response to fading signals
- Audio steering output to correct lip sync problems
- Complete proc amp controls and optional remote control
- Available in NTSC, PAL-B or PAL-M standards

S-234 Four Field Synchronizer/TBC

The S-234, available in NTSC only, has all of the features of the S-134 and in addition, includes an infinite window NTSC TBC. You can operate the S-234 with or without advanced sync to a heterodyne VTR. A 3.58 sub-carrier output is provided for wideband TBC operation. Auto mode circuitry selects TBC mode or synchronizer mode based on the video output.

Scrambler Option

If you are concerned about the theft of your video signal, use the scrambler option to turn the S-134 or S-234 into a scrambler/descrambler system. All you need is a scrambler at the transmit location and a descrambler at the receive location.

- 4,300,000,000 user selectable key codes
- Random line-to-line scrambling
- Random code changes during transmission
- Scrambled video can be recorded by VTR for time delayed de-scrambling

For more information, call Microtime.

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Visit Us At NAB Booth #2638

Microtime, Inc., 1280 Blue Hills Avenue, Bloomfield, CT 06002 USA
Telephone: (203) 242-4242 • 1-800-243-1570 • Telex: 4938290 MCRO UI • Telefax: (203) 242-9876

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Amber Electro Design (1201)
Wow/flutter option: for #5500 audio noise/measurement system.
Phase option: for #5500 system.
Software revision: latest version of AudioCheck, for control of programmable #5500 instrument.
5100, 5300: programmable audio oscillator and distortion analyzer instruments; essentially the #5500 divided into a transmitter, receiver where measurements require separated units.
Circle (531)

ATI/Audio Technologies (359)
MicroMeters monitors: VU200/-400/-600/-800; display 1-4 stereo signal pairs on 2-color vacuum fluorescent bar-graph indicators with peak storage; balanced adjustable gain.
Circle (560)

Audio Precision (1030)
PCI-3: interface to IBM PS/2 computer family.
Software: for automated alignment of Studer A820, 821, 810, 807 record/reproduce electronics using existing reference tapes.
Circle (566)

Audio-Video Engineering (1848)
HSC-1/-2: video hum-stop coils.
Circle (568)

B&B Systems (2473)
AN2HR series: 1/2-rack format X-Y audio signal monitor scopes; available with Lissajous or patented ImageScope display; integral audio power amp allows engineer to hear signal as well as view phase condition.
Circle (582)

Belar Electronics Lab (553)
FMM-4: FM digital frequency meter.
TVM-100: TV aural modulation monitor; mono/stereo compatible.
SCM-2: SCA modulation monitor.
Circle (585)

Bird Electronic (635)
#8891-400/420: series of high power, 2.5kW and 5kW, combination load and wattmeters for hybrids and other balancing networks.
Circle (594)

Bradley Broadcast Sales (140)
SA-3050A: Audio Control industrial real-time analyzer.
Circle (602)

Broadcast Video Systems (2226)
Digivision: test system for CCIR R601 4:2:2 digital component video signals; module fits PC and compatibles.
FASTIME: BAL smart video delay system.
Circle (610)

BTS Broadcast TV Systems (2920)
PD-TB 7184: digital test pattern generator.
Circle (615)

Coaxial Dynamics (1112)
Meters-line sections: appropriate elements included with 4-1/16" and 6-1/8" products.
#7510 frequency counter/wattmeter: peak power readout capability.
Circle (649)

Control Concepts (4159)
Islatron Plus: small power line protection system for microprocessor-based equipment; protection begins within ±2V of preset level, response time <5ns; *BC-105* 120Vac to 5a; *BC-115* 120Vac to 15a.
Circle (675)

Current Technology (H6110)
Power Server Line: power condition, distribution to serve digital equipment.
Circle (686)

Peter W. Dahl (865)
Custom: high voltage power supply for TV klystron applications.
High level: modulation transformers, reactors for 1-5kW transmitters; 1ϕ-3ϕ plate transformers.
Circle (688)

Delta Electronics (134)
Splatter monitor: measures out-of-band emissions for AM radio; remote output adjustment; interfaces to remote control equipment; frequency agile, 12Vdc system with optional loop antenna for field measurements from vehicle.
Circle (697)

Electro Impulse Lab (413)
DPTC-75KFM: improved model; dry, forced air-cooled FM dummy load; replaces DPTC-65KFM.
Circle (737)

Grass Valley Group (2928)
CBM-85N: SMPTE color bar generator for 8500 series frame.
Circle (788)

HEDCO (1820)
HTG-200: audio tone generator; part of HEDLine series.
Circle (799)

Hipotronics (4546)
Peschel: automatic voltage regulator.
Circle (801)

This new QuantAural™ QA-100 Audio Program Analyzer gives you the advantage in competitive broadcasting

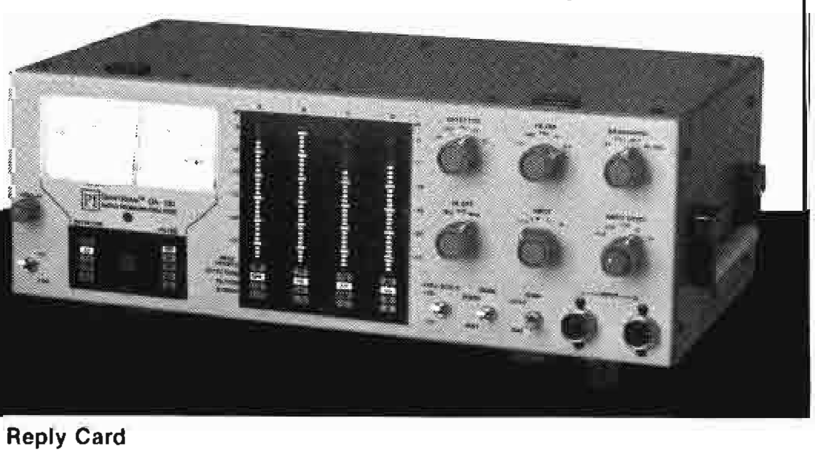
Simply put, the QA-100 quantifies what you hear. Your station sound can now be electronically monitored the way you hear it. Exactly. And, you can monitor the competition too!

Real time analysis of any audio signal. From a receiver, tape recorder, or processing equipment. You see the measurements as you hear the sound. Changes in processing or variations in system performance are immediately shown on the QA-100 panel meter or bargraph display—using program material as the signal source.

The QA-100 hears like a program director and talks like an engineer. With it you can monitor maximum peak level (relative peak modulation), overall processing effectiveness (average level), tightness of sound and processing control (peak density), tonal balance, consistency and preemphasis (four band real time analyzer), stereo image width (L + R to L − R ratio) and "punch" (special "aural intensity" measurement).

Interested? To learn more about how the QA-100 will help your station compete, call Potomac Instruments today.

QuantAural is a registered trademark.



POTOMAC INSTRUMENTS
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Holaday Industries **(1114)**
HI-3600: VDT video display terminal radiation monitor.
Circle (805)

Jensen Tools **(4016)**
JTK-11: broadcast engineer's tool kit.
Circle (829)

Kintek **(1611)**
KT-932: dynamic audio phase meter.
KT-960: correlation monitor and polarity corrector.
Circle (844)

Kintronic Labs **(1040)**
MP-TCA: meter plug-in for Delta Electronics metering system.
Circle (845)

Leader Instruments **(3472)**
LCG-413: EFP test signal generator with source ID.
LVM-9042A: automatic video level meter.
#5870: combo waveform-vector monitor with SCH-phase error indicator on CRT.
#5854: handheld ENG/EFP vectorscope; dc-powered portable unit.
Model 411: synthesized sync/text signal generator with source ID.
LSN-9044A: video noise level meter.
Circle (855)

LEA Dynatech **(3344)**
PH-series: transient voltage surge suppressor; diverts lightning-induced surge current and high-voltage impulses to utility common point earth ground.
PT-series: transient suppressor, clamps impulse voltages to a safe level; installs at distribution panel or just ahead of studio equipment.
Circle (720)

Leitch Video **(2169)**
MTG-2600N: component test signal generator.
Circle (859)

Magni Systems **(H5105)**
4004/4005: converts output of Amiga PC to broadcast video.
1517: component test signal generator; 24 625-line CAV signals; optional component digital output.
1510A/1510S option: composite digital output for signal test generators.
1515: component and composite test signal generator; supports NTSC, RGB, Beta, M-II, SMPTE/EBU, S-VHS; component digital output option.
Circle (875)

Marcom **(103)**
#701-00M kit: modification kit for TFT 701/702 modulation monitor; enables unit to monitor composite BTSC total modulation; includes PLL decoder, LP filters, calibrator; does not affect 701/702 performance in mono mode.
Circle (878)

Marconi Instruments **(2518)**
#2924: universal television signal analyzer.
#2926: television generator, inserter.
Circle (880)

McCurdy Radio **(1849)**
ATS-100: audio test set.
Circle (887)

Minolta **(2573)**
LS-100: luminance meter.
CS-100: non-contact colorimeter.
Circle (903)

Nalpak Video Sales **(4280)**
EF-AC: detects ac/dc voltage without a connection.
Circle (923)

Narda Microwave **(1428)**
Model 8696: averaging module for RADHAZ meters.
Series 8700: RF meter (#8716), probe (#8721) for 0.3-40GHz and #8761 probe for 0.3-1000MHz.
Model 8520: combination E-H field monitor, 50-220MHz.
Circle (924)

Philips T&MI/Pro TV **(3177)**
PM-5640: TV test signal generator; full-field and VITS functions.
Circle (965)

Quality Video Supply **(4387)**
UT-CX1: 3-blade coaxial cable stripper.
Circle (978)

RAM Broadcast Systems **(170)**
PS-1000: phasescope.
Circle (985)

RF Technology **(4243)**
Faraday filters: range of video, aliasing filters, delay lines.
Circle (995)

Rohde & Schwarz **(2706)**
ATF TV data analyzer: line store/freeze with remote transmission capability; measures signals NTSC, PAL, SECAM standards with

TAKE IT ON THE ROAD. SEE WHAT IT WILL DO.

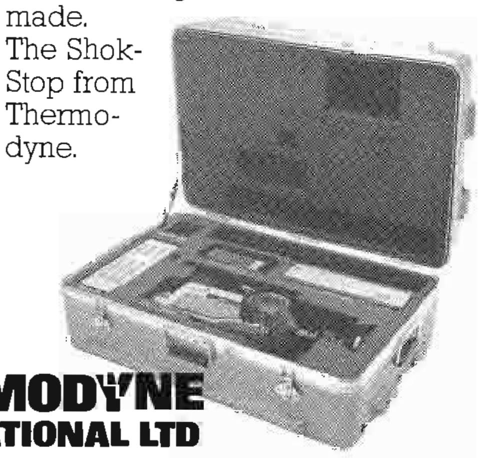
Shok-Stop™ cases are tough. Hit the road with them once, and you'll know exactly what we're talking about.

Built like no other, Shok-Stop cases can take a beating that would turn other cases into so much scrap metal and sawdust. The Shok-Stop's rugged high density polyethylene shell, with its unique ribbed design, absorbs virtually all impact shock. The little remaining vibration reaching the interior is instantly overcome by the high density custom fitted foam. And, your very valuable extremely sensitive broadcast equipment is left totally unharmed.

Shok-Stop cases are water tight, scuff resistant and are the only field repairable cases on the market today. They can be ordered with optional EMI/RFI shielding and pressure release valves.

So, the next time you hit the road for one of those knock-down drag-out sessions, remember to pack it all in the toughest transit cases made.

The Shok-Stop from Thermodyne.



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20850 Alameda St., Long Beach, CA 90810 (213) 603-1976

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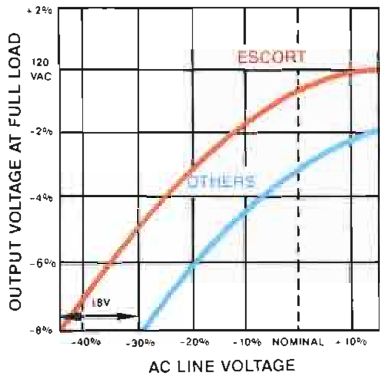
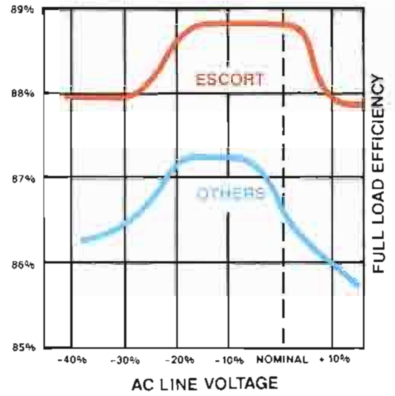
8 Strong Reasons To Choose ESCORT™ Micro Power Conditioners

The new ESCORT Power Conditioner from Topaz is the first *truly* computer-grade ferroresonant power conditioner. It's superior to ordinary ferroresonant devices in 8 Important Ways:

1 Better Voltage Characteristics

Provides greater low-voltage protection and longer power-outage ride through, and always operates closer to the utility standard 120V rating.



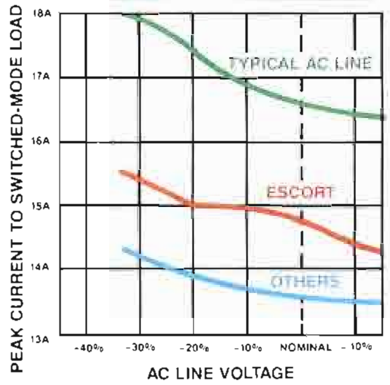


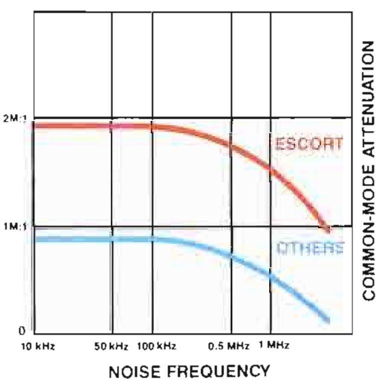
5 Better Energy Efficiency

Provides significant dollar savings in operating costs and in related air conditioning costs.

2 Better Peak-Current Delivery

Provides more of the peak-current power that many of today's microcomputers need in order to operate properly.



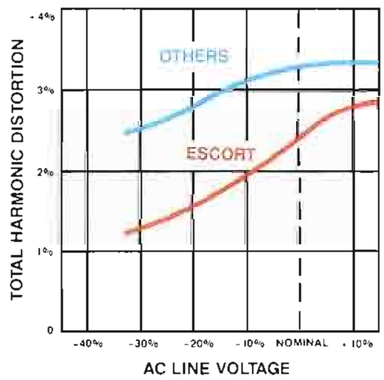


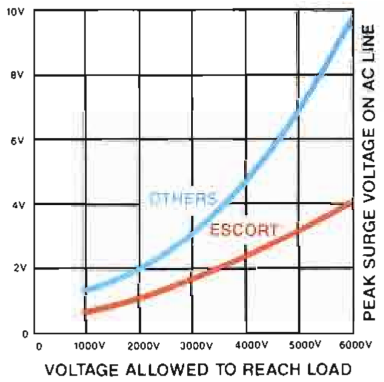
6 Better Noise Attenuation

Provides up to twice as much protection against common-mode noise, the most frequent electrical power disturbance.

3 Better Harmonic Content

Eliminates low-order harmonics that can degrade equipment performance.



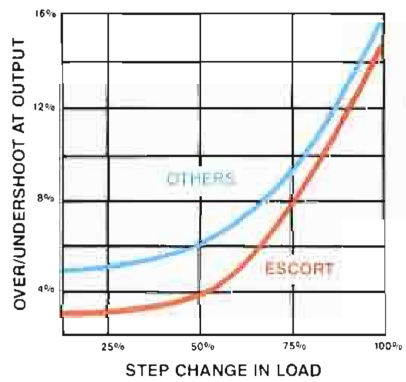


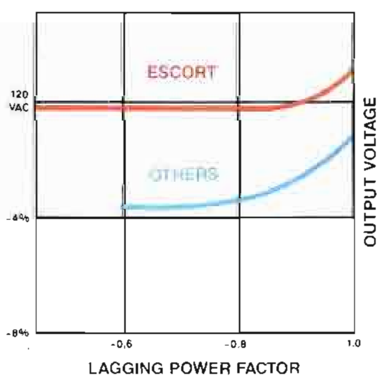
7 Better Surge Protection

Protects sensitive equipment against power surges as specified by ANSI/IEEE C62.41-1980.

4 Better Dynamic Response

Responds more quickly and more accurately to sudden changes in line voltage and load current demand.





8 Better Power-Factor Compatibility

Maintains a smooth, constant output voltage over a wide range of power factors.

For power that makes the grade with computers—and with electronic industrial equipment as well—try an ESCORT Power Conditioner. It's 8 Ways Better. Available in seven power ratings from 70 VA to 2 kVA. For more information call us today at (619) 279-0831, or call your local Square D Distributor.

TOPAZ®

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NABTS, WTS, Teletext, Videotext.
ODF digitizing waveform monitor: enhanced system, displays, measures, drives external plotter; for 525-/625-line signals and HDTV; supports R&S group delay meter, side-band analyzer; Q-mode shows carrier phase; TALIS trigger after line select and D2MAC triggers.
Circle (1000)

SESCOM **(2206)**
SC-3: includes transformer-balanced line inputs.
TEST-1: all-in-one audio test system; AF oscillator, DMM, frequency counter, acV/dcV, ohms, dB, distortion analyzer; includes 3" oscilloscope.
ASG-1 upgrade: push-button frequency selection; adjustable output range -60dBm, +10dBm in 1dB steps.
CT-5: cable tester with F and 3.5mm stereo jacks.
Circle (1022)

Sierra Video Systems **(H5315)**
CBG-1: component video color bar generator.
CIK-1K lever arm control panel.
Circle (1028)

H.A. Solutec **(4541)**
SOL 20/20: VU/PPM meter and phase indicator.
Circle (1035)

Sound Technology **(2479)**
MP300M: audio test software for ST Model 3000 audio test system and IBM or compatible computer.
3200B: audio analyzer; graphic output to dot-matrix printer.
Circle (1042)

Tektronix **(3320)**
VM700: video measurement set.
TSG-100: test signal generator.
DP-100: digital video probe.
#1730HD: high definition waveform monitor.
Circle (1083)

Telemet **(3722)**
Stereo broadcast demod upgrade: improved S/N ratio; input changed to 50Ω only; demod tester module improvements.
Circle (1084)

Tennaplex Systems **(1814)**
MKF-48: all-channel radio-TV field strength meter.
Circle (1091)

Tentel **(4017)**
TQ-300, TQ-1800: Dial torque gauges for Betacam and U-Matic VCRs, respectively.
Circle (1092)

TV Equipment Associates **(2601)**
VerySmall filters: encapsulated filters; 2.05x0.8x0.43"; 1.7-12MHz, phase-equalized 75.
Matthey passive: video delays in metal housing (BNC) or rack-mountable PCBs; adjustable switches, taps, ±1ns.
Zeroloss delays/filters: PCB format, loss compensation; one type infinitely variable from 10ns to 1630ns; filters operate from dc power.
Video filters: removes MTS and audio buzz, out-of-band noise, audio subcarriers.
Brickwalls: STL/ENG microwave filters; flat to 4.2Mz, -40dB at 4.48MHz.
Thick film: audio anti-aliasing filters, increased stopband rejection, improved group delay control; by Matthey.
Circle (1089)

Video Accessory **(2617)**
Color bar generator: low cost unit.
Circle (1138)

S7: Facility design, studio, mobile, construction, consultants

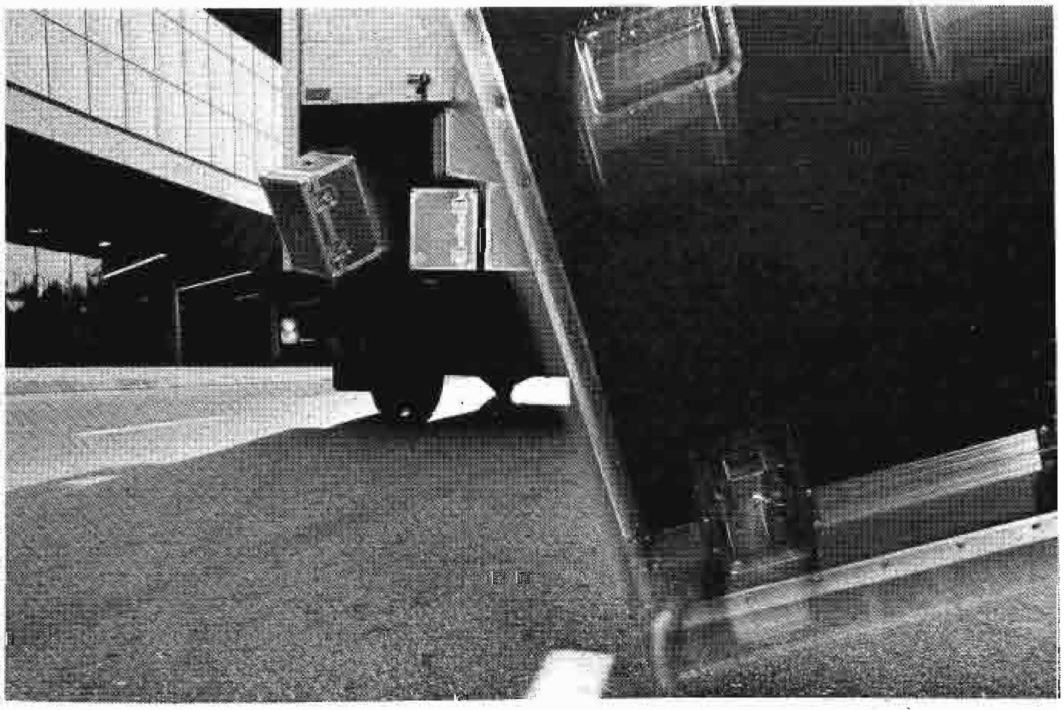
Acoustic Systems **(H5224)**
BB-440: prefabricated, acoustically engineered voice-over booth.
Circle (505)

BAF Communications **(H5429)**
BAF 450-B, 435-B: SNV satellite news vehicles; 6-rack models.
Circle (576)

B&B Systems **(2473)**
Turnkey services: facility engineering, design, construction; audio, video, broadcast.
Circle (582)

Camera Mart **(2366)**
Special: rental video production packages.
Circle (622)

Centro **(3569)**
Networker 2: 2nd generation Networker SNV vehicle.
EFP-1: electronic field production truck; 22' length; 1/2", 3/4", 1" tape capability.
Circle (634)



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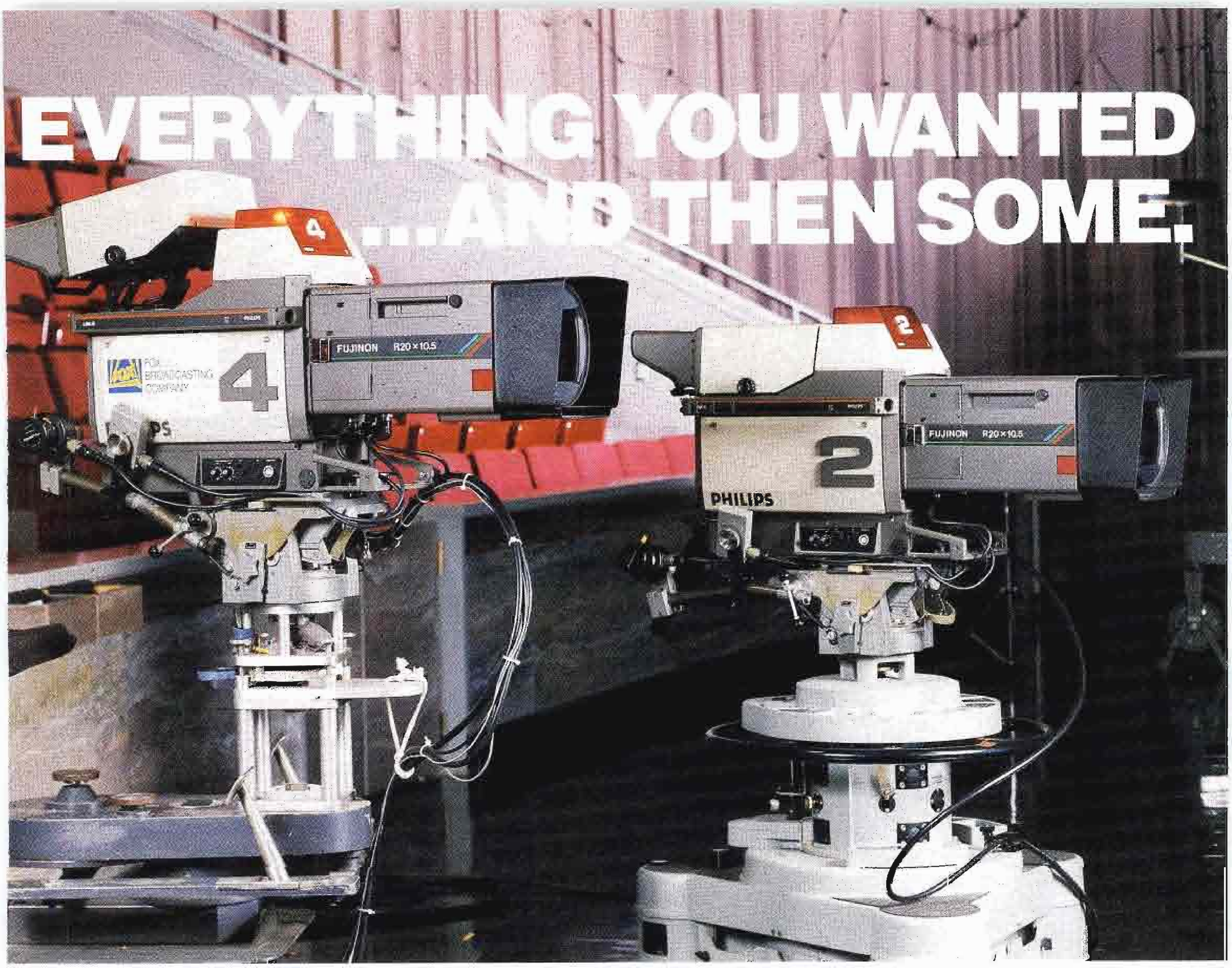

We asked camera operators, engineers and directors what they needed and wanted most in studio lenses. Here are the results. Whether you're behind the camera or behind the scenes, you'll appreciate what Fujinon has accomplished.

These new lenses are lighter, more compact, more maneuverable. Optically, electronically, electro-mechanically...in terms of performance, range, operation, setup and servicing, they offer advantages you can't get in other lenses.

All major components, including power supply and pattern projector, are modular. Motherboard construction and no wiring harnesses simplify trouble shooting to make field servicing a practical reality. Without removing the shroud, there's easy access to the tally light switch, back focus adjustment/lock, circuit breakers, and pattern projector color levels and chart positioning.

Production guesswork is gone. Focal length and aperture are reported through viewports in the lens shrouds or via LED indicators. (Combine this with Fujinon's microprocessor-controlled shot boxes for unerring production control.) Zoom speed control is smoother and ramping can be avoided completely by limiting the zoom range to match lighting levels. You can also see if an extender is deployed and which one. And deploy extenders from a remote demand unit, shot box or manually from the lens itself.

Whether you choose the 17X (Fujinon's best selling studio lens) or the 20X for its greater wide angle coverage, your programming and productions benefit from Fujinon's traditionally better optical performance — higher MTF, better edge-to-edge resolution, freedom from flare, ghosting, distortion, lower longitudinal chromatic aberration, and greater contrast and brightness.

THE WIDEST

P20x14ESM
14-280mm (21-420mm; 28-560mm)
F2.1 (14-210mm); F2.8 (280mm)

R20x10.5ESM
10.5-210mm (16-315mm; 21-420mm)
F1.6 (10.5-161mm); F2.1 (210mm)
Minimum Object Distance: 0.75m Weight: 20.5kg

THE PERFORMANCE/ VALUE LEADER

P17x16.5ESM
16.5-280mm (24.8-420mm; 33-560mm)
F2.1 (16.5-223mm); F2.7 (280mm)

R17x12.5ESM
12.5-215mm (18.75-318mm; 25-424mm)
F1.6 (12.5-170mm); F2.0 (215mm)
Minimum Object Distance: 0.75m Weight: 19.5kg

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For more information or a demonstration . . .

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SOUTHERN	2101 Midway, Suite 350, Carrollton, Texas 75006	(214) 385-8902
MIDWESTERN	3 N. 125 Springvale, West Chicago, Ill. 60185	(312) 231-7888
WESTERN	118 Savarona Way, Carson, Calif. 90746	(213) 532-2861

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Fort Worth Tower (3066)
Enclosure: mobile communications equipment building; optional roof-mounted tower.
Circle (768)

Giant Boom Box Industries (PL)
Boom Box: mobile/portable studio facilities; including Giant Boom Box, Son of Boom Box, Giant CD.
Circle (781)

Gray Communications (2242)
Custom: studio systems, mobile production vehicles.
Circle (789)

Midwest Communications (4342, PL)
S-23F: satellite communications system; standard Midwest S-23 SNV with modular electronics of the S-1 Fly Away system; 1.8m antenna stores in its shipping case inside the unit; antenna and all electronics can be easily removed, freeing the vehicle for other use.
Circle (901)

Roscor (3141)
STARFLEET 25: satellite news unit on Iveco-450 chassis; 20kW generator, custom A/C, large storage, production areas; antenna mast, electronics rack combined in rigid-rack support system.
Circle (1003)

Shook Electronics USA (PL)
Mobile TV production vehicles.
Circle (1026)

Television Engineering Corp. (1856)
Mobile units: new designs in electronic news gathering vehicles.
Circle (1088)

Video Financial (4571)
Factoring: business improvement plan to ease cash flow; immediate cash for accounts receivables.
Circle (1143)

S8: Programming, promotion products

- Program formats
- Satellite time brokers
- Music, effects libraries
- Gifts, labels, stickers

Associated Production Music (2216)
Broadcast One: CD music library.
Sonoton: music library.
Original music: by Richard Honoroff.
Circle (557)

Blimpy/Bend-A-Lite (0000)
#1200: Blimpy floating signs, 12x5-1/2 ft.
#2014: roof-top hot air balloons; 20ft tall, 14ft wide; multicolored nylon finish.
Circle (595)

COMSAT/Intelsat Services (2387)
Demonstrations: International news gathering; Comsat TV Scheduling (CTVS) service.
Circle (666)

GE American Communications (2629)
Satellite distribution: domestic communication services.
Circle (776)

Omnimusic (118)
Professional Broadcast: 400 10s, 30s, 60s CD music beds; original, copyright-cleared.
Circle (944)

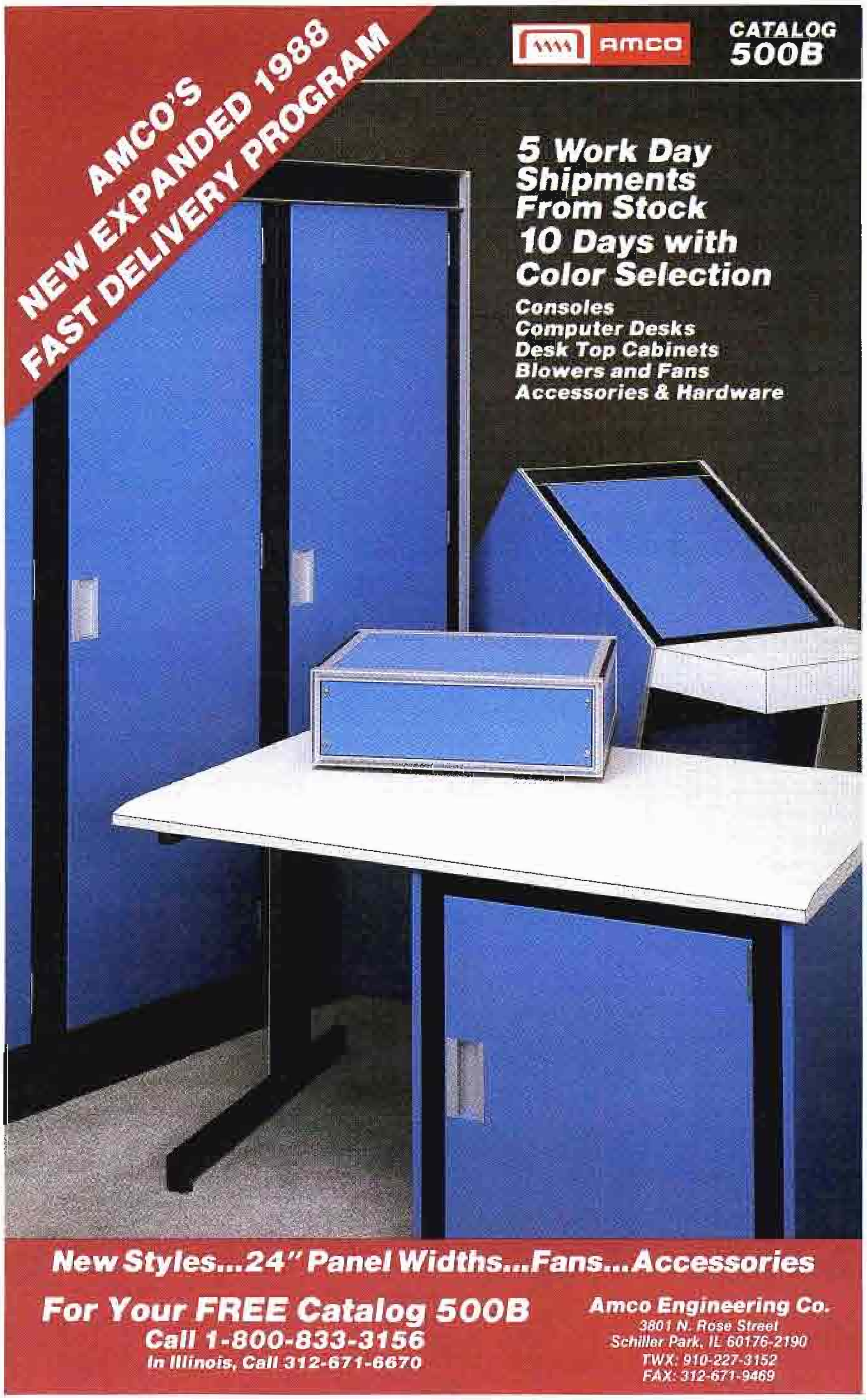
Whirlwind (353)
Service rates: small-market, educational now available; rights licensed by Network; no direct dealing with ASCAP, BMI, SESAC required.
Circle (1162)

Video Products
V1: Cameras

- ENG, studio cameras
- Camera tubes, CCDs
- Control systems
- Lens systems
- Pan/tilt heads
- Pedestals, tripods

A.F. Associates (2869)
Camera control: Radamac-Evershed Power Optics TV camera remote control equipment.
Circle (515)

Amperex Electronic (2541)
89XQ: high definition Plumbicon; tetrode gun, electrostatic deflection.
FT-CCD: high resolution frame-transfer CCD imager.
Circle (535)



See us at the NAB Show—Las Vegas, NV
Booth #2709-2710

Circle (178) on Reply Card

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New Life For Your Old Video Batteries.

CHRISTIE'S CASP IS THE WONDER BOX THAT BRINGS YOUR WEARY NI-CADS BACK TO LIFE.

ALSO AVAILABLE IN ECONOMY MODEL, CASP/1000.

TOTAL BATTERY SUPPORT

Christie's microprocessor-based CASP was specifically created to keep your valuable batteries in top shape while making maintenance simple. Meets your support needs **six ways:**

Rejuvenates Old Batteries

Christie's exclusive ReFLEX® process literally resuscitates batteries that will no longer hold a charge. Miraculously erases memory and restores badly faded capacity.

And with CASP, batteries are more fully charged, stay cooler, have less cell imbalance, and therefore last longer. CASP can pay its way in the savings on replacement batteries alone.

Handles Any Battery

CASP is a truly universal battery maintenance system. Whether your batteries are ni-cad, silver-zinc, lead-acid, or lithium — whatever the voltage or current ratings — CASP will charge them and maintain them. Pre-programmed for the most popular makes, too, with the flexibility to handle new batteries as they are developed.

Operates Unattended

Connect as many as six different batteries to CASP at once and the system charges them without your intervention. Senses and identifies the battery types, provides the correct charging method, and automatically sequences through the set. Interchange batteries at will, and CASP automatically recognizes them.

Every battery gets charged to perfection.

Charges Superfast

Conventional chargers are slow, and build up heat that prematurely ages batteries. CASP's unique ReFLEX process charges in a matter of minutes rather than hours. Keeps batteries cool, maintaining their health and longevity.

Analyzes Battery Status

CASP is a professional, logic-controlled, programmable testing system. Takes all the guesswork out of determining the state of your rechargeable batteries. And with an optional serial printer, you can have a hard copy printout of battery condition.

Operates Worldwide

Lightweight, portable CASP accepts power inputs from 90 to 265 VAC, at frequencies from 47 to 440 Hz. Now you can stop worrying about battery charging facilities, no matter where you go in the world.

AND NOW ECONOMY

The newest addition to Christie's CASP line is the CASP/1000. This exciting, microprocessor-based instrument offers most of the features and benefits of the fully loaded model at a significant saving in price.

CONTACT CHRISTIE TODAY

If your video batteries are on their last gasp, you need CASP. For an informative, full-color brochure or system demo, contact Mike Diamond at Christie Electric Corp., 20665 Manhattan Place, Torrance, California 90501, U.S.A. Phone (213) 320-0808, TWX 910-349-6260.

CHRISTIE

See the magic of Christie's CASP demonstrated at NAB, Booths 2217/2218

www.americanradiohistory.com

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There and Back With My Ikegami HL-79

By Ken Jobson, WTN Camerman

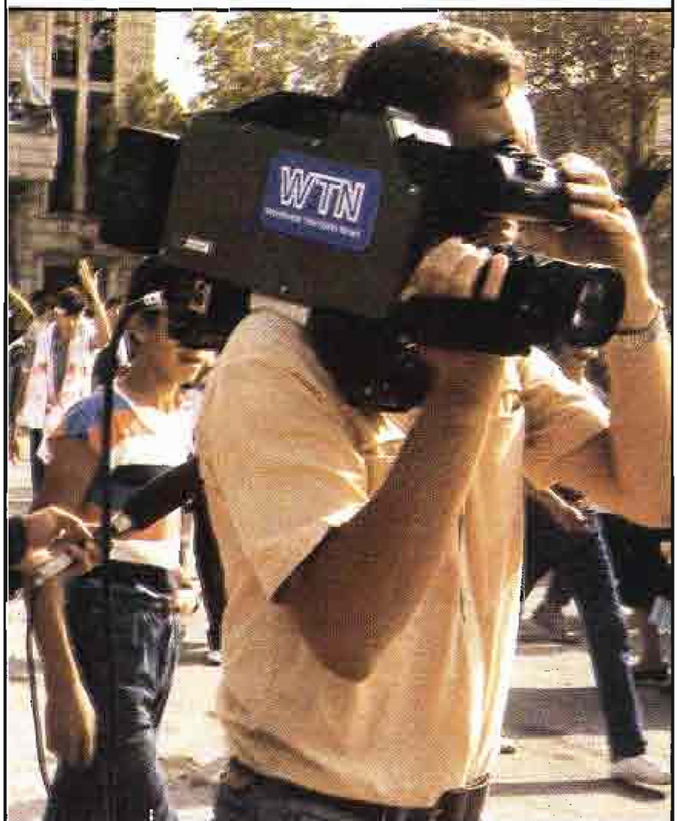
As a hardened cameraman of many years, I consider myself fortunate that UPITN/WTN has provided for my professional use, an Ikegami HL-79 video camera which produces quality images often under the most adverse conditions, is electronically reliable, robustly constructed and designed in such a way that it relates to the operator's body. The camera after all, is only a device which facilitates the recording of images seen by the human eye and therefore becomes an (electronic) extention of the human body.

I have very strong emotional feelings about all of 'my' electronic cameras — all Ikegami's.

Using Ikegami cameras has given me tremendous professional satisfaction and, I hope, established my reputation as a cameraman who will go to extreme lengths in order to capture 'the shot'. My Iky's have been taken from me at gunpoint, survived several car crashes, travelled in helicopters, tanks, armored cars, innumerable jeeps, fire engines, on camels, rowing boats to battleships, have been stolen, have boiled in midday sun in the Sudanese desert and chilled on the ski slopes of Lebanon, have witnessed the most appalling degrees of human inspired destruction, a fighter falling to the ground one meter in front of the camera as he was hit in the stomach by a sniper's bullet, glamorous fashion models on the catwalk, the Prince who loves playing polo, a famous parrot now alas no longer with us reknowned for his voluntary impressions of incoming shelling, hundreds of correspondent standuppers, the happiness at weddings and the sorrow of bereaved relatives, the innocent child at play and another innocent child staring into infinity from his hospital bed wondering why that phosphorous bomb exploded in his house. My Iky's have never let me down on any of these shoots. But one incident, which demonstrates the remarkable characteristics of Ikegami cameras, will remain firmly in my mind forever.

Location: Main street in Bhamdoun (pronounced without the 'B') an attractive mountain town in central Lebanon on a sunny afternoon. We had just finished taping the totally deserted street (or so we thought) and locked up shop fronts, when the distinct crackle of automatic gunfire could be heard breaking the eery silence. It took perhaps five to ten seconds for us to realize those bullets were coming at us. As my soundman and I both took independent evasive action, the Ikegami HL-79 and video recorder both fell from our shoulders onto the pavement. The Iky laying on its side (and as I realized minutes later, my finger had touched the roll button as it fell out of my hand) was now happily recording the sound of incoming bullets hitting the surrounding shop fronts. Our cries in Arabic that we were press and the gunmans order in English "Get out, get out,' were followed by another burst of gunfire.

Carefully, I crawled across the pavement and uprighted the still rolling Iky, pointing it in the direction of its crew who were to be seen crouching behind a sand heap for shelter. Minutes later, thinking our ordeal was over, I bent down to press the stop button, when an M-16 bullet tore through my right neck muscle. It was only the sudden feeling of wetness down my back that made me aware that something was seriously wrong. I was hit. Once again I flung myself down behind the gravel pile, as the gunman fired at least another twenty bullets at us. The firing then ceased, and I was put into the back of a car and taken to an Israeli medical unit, who treated the wound, gave me a pain killer injection and hot coffee. Later at the American University Hospital in Beirut, doctors gave me a local anesthetic, cleaned the wound internally (very painful), x-rayed, took blood pressure, etc.



The bullet which miraculously missed my spinal cord by two millimeters has left two holes three inches apart in the back of my neck. Subsequent viewing of the video reveals twenty five recorded gun shots at us before I was hit. Plus approximately twenty shots as I lay bleeding. I was very happy not to be going home as a waybill number. And today while the memories linger; my work as it must, goes on.

www.americanradiohistory.com

Ikegami Celebrates 10,000 HL-79's Sold Worldwide With Their Latest Direct Dockable Versions —and welcomes your memorable HL-79 stories.

Since its introduction, the HL-79 series cameras have been sold to over 10,000 users worldwide making it the most popular camera of all time. The latest HL-79 (shown above) is the direct dockable version of the HL-79. Totally flexible, the camera can be used as a stand-alone, one piece with on-board VCR (Beta or MII), or a remote using multicore or triax. It is versatility at its best. Features include selectable gain, SMPTE color bar generator, high S/N ratio, and much more.

For more information call your regional Ikegami office for the dealer near you.

If you have a fascinating HL-79 story to tell, please send it to our Maywood, N.J. office. We may use it in an upcoming ad.

Ikegami®

Ikegami Electronics (USA), Inc. 37 Brook Avenue, Maywood, NJ 07607 East Coast: (201) 368-9171 West Coast: (213) 534-0050 Southeast: (813) 884-2046 Southwest: (214) 869-2363 Midwest: (312) 834-9774 Hawaii: (808) 946-5955

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Ampex AVSD **(3302)**
CVC-50: 3-chip CCD camera for sports/ENG/EFP; frame interline transfer design, switchable electronic shutter; studio, camcorder configurations.
Circle (536)

Angenieux **(2634)**
Model 40x9.5: lens for Ikegami HK-323.
Model 20x8.5: lens for Sony BVP-360.
Circle (542)

Arriflex **(2669)**
ARRI matte boxes: for video cameras; includes follow focus.
Zeiss: prime lenses; 10-100mm, 12mm, 40mm, 60 Macro and 300-600mm lengths.
ARRI geared head: full-swing/tilt, geared head for film or video cameras.
Circle (553)

BTS Broadcast TV Systems **(2920)**
LDK-900: studio CCD camera with triax to 2km; extended intercom facilities, utility 70W power output; HiFi audio channel; SMPTE/EBU VTR connector; optional teleprompter channel; NTSC or PAL versions.
LDK 90 triax: companion to LDK 900; CCD pickup, cable to 2km.
KCB 590: recorder camera; combines LDK90 with BCB5 Betacam SP recorder.
KCH-1000: HDTV camera system, adaptable to any of current standards.
Circle (615)

Camera Mart **(2366)**
InnoVision: lenses.
Circle (622)

Century Precision Optics **(2880)**
C-to-Sony adapter: optical relay system; for C-mount lens on video cameras.
Nikon-to-Sony: optical relay adapter; for Nikon lens on video cameras.
Circle (636)

EEV **(3384)**
P8454/5: 30mm Leddicon camera tube for TK47 updates.
Circle (731)

Elicon **(N.A.)**
roboGlide: automatic guided vehicle; moving platform for dolly, pedestal or other camera support device.
FACETRACKER: IR-transponder system; allows camera to track talent or objects within a studio environment.
Circle (741)

FOR-A **(3169)**
HMC-1000: Multicam high definition still camera; produces HDTV stills.
Circle (767)

Fujinon Optics **(4301)**
A34x20.5ESM: 1400mm maximum focal length, ⅔ " optics; f/2.4 aperture flat from 20.5mm-480mm, f/3.5 at 700mm, f/7.0 at 1400mm; available with integral pattern projector; 19kg with lens hood.
R34x29.5ESM: 2000mm maximum focal length; f/3.5 aperture 29.5mm-700mm, f/5.0 at 1000mm; integral pattern projector; weight 26.5kg.
A34x10ESM: lightweight EFP zoom for ⅔ " tube optics; f/1.6 from 10mm-229mm; f/2.4 at 340mm; integral 2x extender for 680mm focal length; 13.6kg with lens hood.
HR5x12SD: High Definition zoom; 1" format; 12-60mm range with constant f/1.2 aperture; iris, zoom, focus servo or cine-type manual controls; 15kg; *HP5x16SD* for 1- ¼ ".
Circle (773)

Future Productions **(H5830)**
Multiple camera CCU: available for Ikegami HL-79/95-379, ITC-730, Sony BVP cameras; full function remote; cable compensation to 1,000 ft; sync/SC phase adjustments; intercom/tally, monitor out; PS-400 power supply.
S-VHS output: modification provides S-VHS signals from HL-79 A/D/E, HL-59.
Circle (774)

Alan Gordon Enterprises **(2538)**
REVPOD: product shot turntable.
Argus Compact: dolly with mini-jib.
Circle (784)

Karl Heitz **(2263)**
564GL: mono Studex Giant Luxe; 6-section support, ranging from 2- ½ -12 feet height.
564G: mono Studex Giant; 4-section ranges from 2- ½ -8 feet; charcoal finish; supports camera while operator is on ladder or limited area raised surface.
Circle (800)

Hitachi Denshi **(3324)**
FP-C1: 3-CCD color camera; 280,000 pixel; I/Q (NTSC) or U/V (PAL) encoding; numerous automatic functions and diagnostics.
FP-C2: 3-CCD camera for ENG; docking VCR; accessories for in EFP/studio multiple camera setup.
FP-C1HS: 3-chip FP-C camera; additional remote control of zoom, focus, filter disc, character display.
Z31A camera: auto setup system for ENG/EFP; twist-field LOC MS Saticons for improved overall resolution; horizontal resolution, 800

MODEL VA-16
1-in/16-out Video/Audio Distribution System

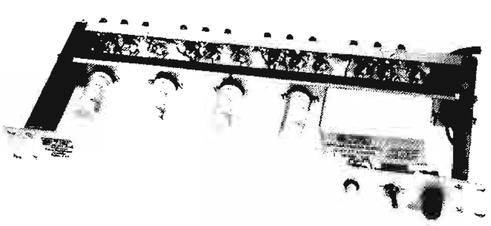
Size: 10"x12"x5" Deep
"Halliburton" Alum Case
Wt: 8 lbs Price: $695

DESCRIPTION—
The Model VA-16 1-in/16-out Video/Audio Distribution System is useful as a network feed for courtroom or as a classroom feed for up to 16 monitors and audio amplifiers.
SPECIFICATIONS—
VIDEO: BNC Connectors
DC to 8 MHZ (-1db)
Diff Gain: 0.1%
Diff Phase: 0.2 deg
Tilt & Overshoot <1%
Hum & Noise: -60db
Isolation >40db at 3.58 MHZ
R_i =75 Ohms
R_o =75 Ohms
Unity Gain
In-Phase
AUDIO: XL-Type Connectors
Bal-in (10K), Bal-out (600 Ohms)
30 HZ to 15 KHZ (-1db)
Output Level: +18 dbm
THD: 0.05%
Signal/Noise: >70db

MODEL A-24/2ML
2-in/24-out (mic/line) Audio Press Box

Size: 13"x18"x6" Deep
"Halliburton" Alum Case
Wt: 16 lbs Price: $895

DESCRIPTION—
The Model A-24/2ML Audio Press Box is a high quality transformer isolated versatile unit for conferences, meetings, courtroom, auditoriums, etc. it is a portable unit mounted in a Halliburton aluminum case.
SPECIFICATIONS—
INPUTS:
Two Balanced microphone (switchable to line inputs at 10K ohms)
Gain controls
Vu Meter
OUTPUTS-24 SEPARATE OUTPUTS EACH ONE:
Transformer isolated
"XLR", ¼" PhoneJack, RCA and 3.5mm Jack
Mic/Line Switch
+18 dbm Output capability
Ground Floating (Does not require ground lift)
50HZ-15KHZ (-2db)
50 db Channel isolation
POWER:
105-125V, 50-60 HZ, 5 Watts



COVER PLATES INCLUDED

Size: 1¾"H x 19"W x 6"D
Wt: 5 lbs

MODEL V-44
4-Channel Video Dist. Amplifier
DESCRIPTION
The Model V-44 Video Distribution Amplifier consists of a Model 512 Power Supply, 4 Model 404 Video Distribution Amplifiers mmounted on a Model H-5/V Panel-Chassis. The back panel has a loop-thru BNC input connection and 4 output BNC connectors for each of the 4 channels.
SPECIFICATION (per channel)
DC to 8 MC (± 1db)
DC to 4.2 MC (± 1db)
Diff. Gain: 0.1%
Diff. Phase: 0.2 deg.
Tilt & Overshoot: <1%
Hum & Noise: -60 db
Isolation: >40 db at 3.58 MC
PRICE: $400

MODEL A-44
4-Channel Audio Dist. Amplifier
DESCRIPTION
The Model A-44 Audio Distribution Amplifier consists of a Model 520 Power Supply, 4 Model 422B Audio Distribution Amplifiers mounted on a Model H-5/A Panel Chassis. The back panel has four 12-terminal barrier stripe for input-outputs. There is one electronic balanced input and four balanced outputs for each of the 4-channels.
SPECIFICATION (per channel)
Bal. (Electronic) Input Imp: 20K Ohms
Freq. Resp: 20CY to 20KC (± 1db)
Gain: Unity (0 dbm)/THD: 0.05%
Output Imp: (600Ω) for 600Ω load
Output Level: +24 dbm
PRICE: $440

OPAMP LABS INC.
1033 N. SYCAMORE AVENUE
LOS ANGELES, CA. 90038
(213) 934-3566

MANUFACTURERS OF AMPLIFIERS (MIC, MAG, PHONO, LINE, POWER, VIDEO, RGB)-OSCILLATORS-AUDIO TRANSFORMERS -POWER SUPPLIES-AUDIO/VIDEO ROUTING SWITCHERS-AUDIO CONSOLES-AUDIO MATRICES
FREE CATALOG WITH OVER 80 APPLICATIONS

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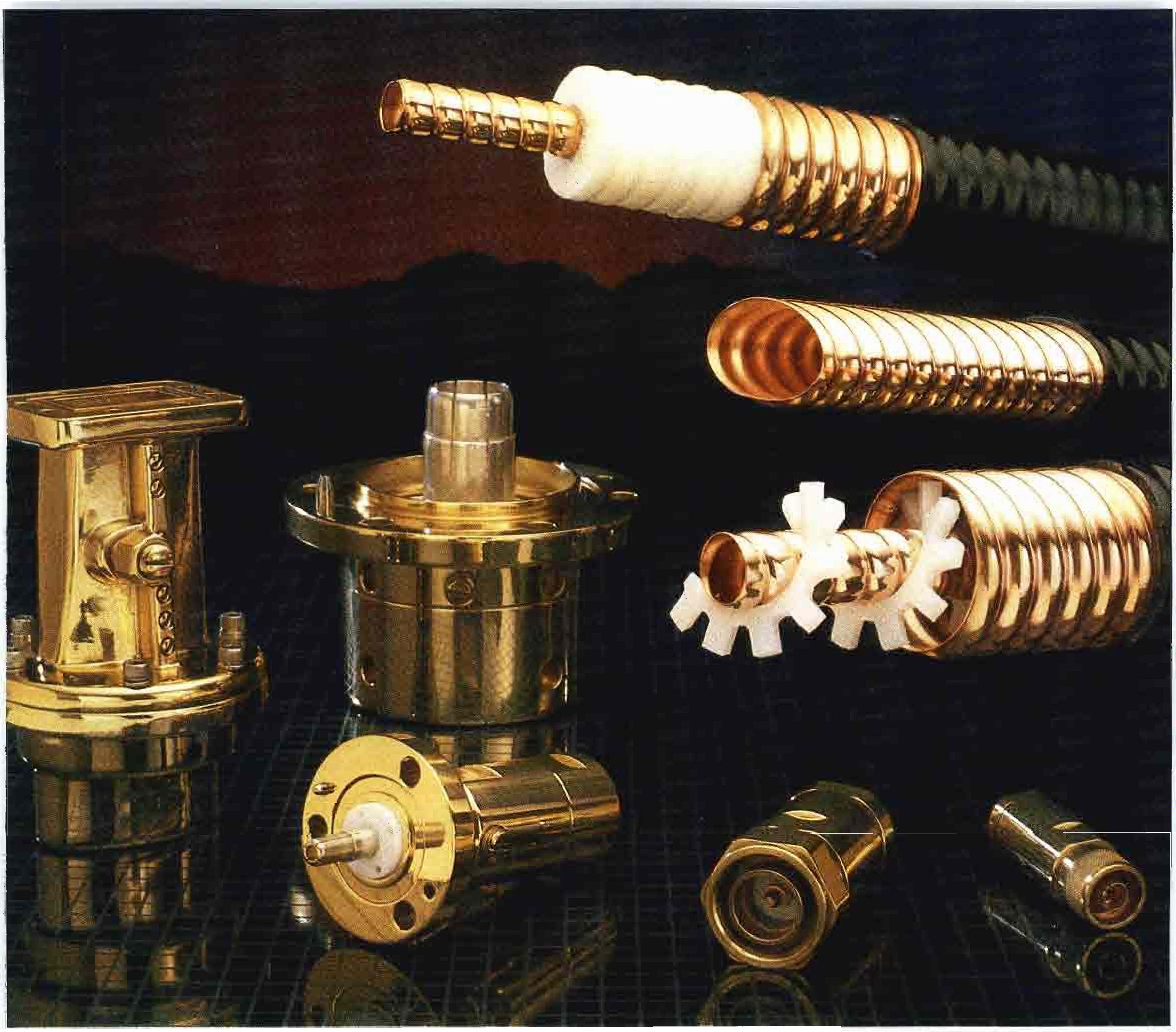

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More than 50 years of technological leadership is embodied in HELIAX coaxial cable, waveguide and connectors.

Top quality and performance are assured by the HELIAX trademark on cable and connectors available only from Andrew.

Rapid delivery from stock will meet your project needs.

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For more information about HELIAX products, call our Customer Support Center, toll free, at 1-800-255-1479 and ask for Bulletin 1456 and Catalog 33.

See our NEW HJ12-50 at NAB booth 1811

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Andrew Corporation
10500 W. 153rd Street
Orland Park, IL U.S.A. 60462
Telex: 25-3897

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lines; S/N 60dB NTSC; available also in PAL-B.
SK-971: auto setup for ⅔ " broadcast Computacam camera; wideband RGB over triax, ac utility power at camera head.
DK-8000: 1,049 scan line camera; 800-line horizontal resolution, 700-line vertical; for microscopy, large screen projection source.
Circle (802)

Ikegami **(2320)**
ITC-735: economical ENG/EFP camera; full feature.
EC-1125P: HDTV camera, many cinematography features.
Chip cameras: HL-379A, CCD-770; production versions of systems shown previously as prototypes.
HL-791: EFP camera; dockable version of HL-79E.
Circle (812)

ITE/Innovative TV Equipment **(2623)**
T17/H17: ENG tripod/fluid head for CCD cameras.
H90 fluid head: for studio, OB cameras to 165 lbs.
P6L: low-boy P6 studio pedestal; minimum height 23.5"
T55 series: tripod family for loads to 30 lbs.
T48/H48: ENG/EFP tripod/fluid head for cameras under 25 lbs.
P9 pedestal: pneumatic; loads to 110 lbs.
Circle (823)

J-LAB **(1019)**
Genlock CCU.
Circle (830)

JVC **(2656)**
KY-15: 3-CCD camera.
BY-10: 1-CCD camera.
KY-75: 3-tube color camera; docking for M-II recorders.
Circle (833)

Landy Associates **(2677)**
Ikegami cameras: HK-323, HL-379, CCD-770.
Nostalgia: RCA TK-60 monochrome camera, operating.
Circle (851)

Miller Fluid Heads **(2364)**
#340: lightweight system 20 Special.
#355: System 80 EFP field support system.
#352: lightweight System 40 ENG Special.
Circle (902)

NEC America **(2747)**
EP-3: CCD color EFP camera.
Circle (926)

O'Connor Engineering Lab **(2674)**
Model 35: quick-release ENG tripod.
Model 127: pneumatic studio pedestal.
Circle (939)

Panasonic Industrial **(2938)**
WV-200CLE: 3-CCD camera; NTSC composite, Y/C S-VHS component analog; 600 TVL resolution, >56dB S/N ratio; color masking matrix for multiple camera setup; 2.5 foot-candle minimum sensitivity.
CCD cameras: modular *WV-D5000*, *WV-3260/8AF*; 286,000 pixel matrix for 380 TVL horizontal resolution; ATW auto-tracing white balance; electronic shutter from 1/60s to 1/1000s; *WV-CR12* RCU.
Circle (922)

Quickset **(4120)**
#1030A: counterbalanced fluid head, 7-35lb capacity.
QRTH-1: Rainbow pro fluid system; 20 lb fluid head, 100 lb capacity tripod.
QST-5: Samson ¾ -size tripod with column; collapses to 21" height.
QKTH-30: HUSKY fluid system; 2-section legs, struts, safety column.
QRH-7: cam/fluid head; 5-50 lb capacity, 100mm ball base.
Circle (981)

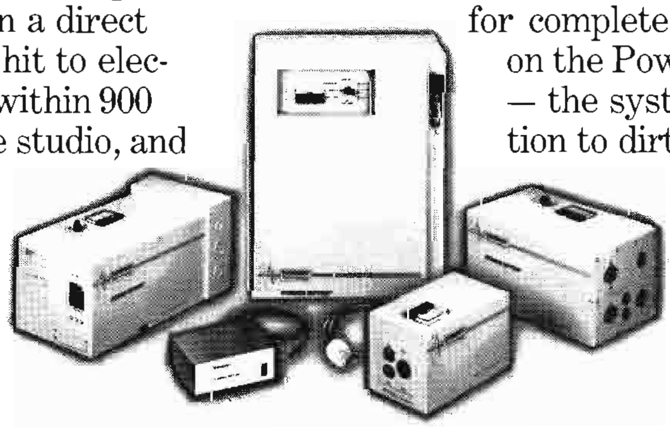
Sachtler **(4380)**
#8080: fluid head with OB-tripod for camera-lens combos to 200 lbs.
#6202: OB elevator column, 2-stage tripod.
Series II: fluid heads with selectable drag including; *Video-16*, 1-step; *Video 14/17*, 3-step; *Video-18*, 7-step; *Video-20/25*, 7-step with dynamic counterbalance; *Video 30*, studio, field head.
#5198: combi pedestal; folding design requires no tools.
#6200: tripod OB-2 for OB use.
Circle (1009)

Schneider **(4110)**
B+W filters: coated optical filter products.
TV-80 enhanced: 17x8.5mm wide angle zoom lens for studio use; integral diascope, range extender.
TV-85: 35x11 μP control tele/sports zoom lens; integral diascope, extender, diagnostics; fully sealed system with humidity absorption feature; no mechanical cams.
TV-64: 14.5x13mm studio zoom lens; integral range extender, optional diascope; for Ikegami HK-323 1" camera.
Circle (1017)

You can stake your reputation on the Power Siftor.®

Gerald Dalton did. "We have four Power Siftors on line here at KKDA AM/FM," says Dalton, Director of Engineering for the Dallas radio station. "Since we installed one in our production room two years ago, we've had no more damage from line glitches or surges. But the real life saver has been the one on the studio mains. It's prevented damage at least twice — in a direct lightning hit to electric lines within 900 feet of the studio, and when a downed utility pole 200 yards from the studio caused arcing between severed lines.....I recommend Power Siftor highly..... Every radio and television station should have at least one, protecting its microprocessor-based audio and video machines."

We couldn't have said it better. Write or call today for complete details on the Power Siftor — the system solution to dirty power.



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CURRENT Technology

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In the farmlands of western Illinois, people value the things that last. That's why John Conner called Harris when the AM transmitter at WRMS finally gave out. After 28 years on the air.

It had seen a lot of history. New faces. New owners. Even its original manufacturer, Gates Radio, had a new name — Harris.

Over the years, Harris experts had kept WRMS' transmitter in top condition. "They were always there when we needed them," says Conner.

So, when the old transmitter finally wore out, an urgent call went out to Harris, 71 miles away in Quincy. Yes — a new transmitter was available. Immediately.

"The next day," remembers Conner, "it was on our pickup. And by the following morning, we were up and broadcasting."

From major networks to small-town broadcasting, Harris understands what commitment and customer support are all about.

"That's why," says June Conner with a smile, "when Kyle buys our next transmitter — many years from now — he'll be calling Harris."

Find out how Harris is leading broadcast manufacturing into a new century. Call TOLL FREE:

1-800-4-HARRIS
Extension 3009

HARRIS

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www.americanradiohistory.com

Schwem Technology (4584)
FP-1 Gyrozoom: image stabilizing lens for most ⅔ " ENG/EFP cameras; eliminates most image vibration caused by unstable camera support; fast pan model permits pan rate of 30°/s; weight, 7.25 lb.
Circle (1018)

Sharp Electronics (4316)
XC-A1SS: professional color video camera, Y/C outputs.
Circle (1024)

Sony Broadcast (2902)
BVP-50: CCD EFP/ENG camera; vertical smear eliminated, electronic shutter, larger S/N ratio.
HDVS camera.
CCU-350: camera control unit for full EFP remote control of BVP-350, BVP-50.
Circle (1037)

Sony Professional Video (2902)
CCD camera.
Circle (1040)

Steadi-Film (H5113)
N.C.E.: cradle gear head; real-time, 4-axis servo control.
MANIPULATOR: joystick, servo-controlled; 4-axis motion control with 3 levels of hardware, software.
Circle (1053)

Telemetrics (4177)
Microprobe: for video cameras.
Pan/tilt heads: remote computer-control systems.
IR controller: for pan, tilt, zoom and focus.
Miniature system: pan/tilt for single chip cameras.
Circle (1085)

Thomson Electron Tubes/Devices (1219)
TH-X898: HDTV camera tube; 1" Primicon photoconductive layer; electrostatic deflection, magnetic focus, bias lamp; output target capacitance <5pF; limiting resolution 1800 pixels/line.
TH-7866: 550 pixel/line frame-transfer CCD; compatible to NTSC/RS-170, ⅔ " optics; antiblooming gate, controllable integration equal to 3 diaphragm stops; 30dB S/N at 40mlux illumination; *TH-7864* for 50/625 line systems.
Circle (1099)

Thomson Video Equipement (3333)
TTV-1640: production models; 3-CCD design; various control configurations available.
Circle (1101)

Tiffen (2223)
#934 filter case: holds 24 series-9, 3x3 or 3x4 filters in any combination; fine-texture lining; reinforced aluminum, safety latch, lock.
#456 filter case: holds 18 series 4x4, 4- ½ round, 4x5, 4x5.650/Panavision or 4x6 filters in any combination; reinforced aluminum, safety latch, lock.
Video presentation: "Which filter should I use?" explains filters for image improvement, creation of *the look*, effects of filters on flare, contrast, resolution.
Circle (1103)

Toshiba (4320)
IK series CCD cameras: single ½ " CCD color cameras; electronic shutter; external sync capability, NTSC interlaced video output.
Circle (1109)

Total Spectrum Mfg. (2069)
Controller: software-based for HS-110P, HS-105P servo pan/tilt systems; touch screen input with menus; interface to newsroom computer; equipment maneuvers can be edited.
Servo pedestal: X-Y axis option for servo control system.
Accessories: for ENG cameras.
Circle (1110)

Vinten Equipment (1425)
Vinten Vision 5: system includes fluid pan/tilt head, tripod, spreader, foam-filled case; for next generation portable CCD cameras.
Prototype: automated, servo-controlled gliding pedestal with hands-free people tracking; from MicroSwift remote camera control series.
Vision 5 head: fluid pan/tilt head; 15lb capacity, ±85° tilt from horizontal; 100mm ball base.
Circle (1149)

V2: Recording

- Analog, digital
- Editing, animation
- Time code equipment
- Transport synchronizers

Adams-Smith (1513)
ZetaThree remote: remote control for ZetaThree audio-video-MIDI synchronizer; multiple machine control, autolocation.
Circle (507)

Adrienne Electronics (N.A.)
PC-TIMECODE: time code reader; card for IBM PC/XT/AT.
Circle (511)

Alpha Video & Electronics (2980)
Type 5SP: SP retrofit for Type 5 VTRs.

Stereo echo, to be exact. There's also stereo chorus and flanging. Pitch change. Four kinds of reverb. Plus reverb and gate.
Thirteen different kinds of effects in all. In our new SPX90II, an encore performance of the most successful digital processor in audio history.
And now we've expanded the delay times. And expanded the possibilities.
There are 30 preset variations, each with up to nine separate controls. So you can get precisely the sounds you want.
But that's just the beginning. Because there's also room for 60 more custom variations, your own "signature" sounds that you can create and store in memory.
The SPX90II lets you label each custom effect with its own title. And you can instantly

There's an e

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TCGR: integral time code generator, reader for VO-6800.
HTS-101: high tension sensor, mast dump system.
EI-9: editor interface for Type 9 VTRs.
Circle (582)

Ampex AVSD **(3302)**
ACE-25: economical edit controller; for ENG, corporate-industrial, off-line; four VTR interfaces, three GPIs, 3.5" disk standard; two slots for optional composite/component video or audio switchers.
VPR-300: studio VTR; records, plays D-2 composite digital format; plug compatible with existing composite equipment; 208-minute record time on standard 19mm digital cassette.
Studio VCRs: Betacam SP; *CVR-70* recorder; *CVR-65* player with AST; *CVR-60* player.
Circle (536)

ASACA/ShibaSoku **(2642)**
ADR 5000/5500: magneto-optical disk recorder; provides up to 100 minutes time in 10-minute increments; 4:2:2 compatible; analog, digital component, composite.
Circle (555)

BHP/enVision Systems **(H5619)**
TouchVision: non-linear, film-style videotape editing controller system.
Circle (592)

BTS Broadcast TV Systems **(2920)**
DCR-100: digital tape recorder; D-1 standard, 19mm cassettes.
BCB 35 VCR: portable recorder/player; 19.2 lb including battery, cassette; Betacam SP for field recording/playback.
BCB 22: Betacam SP field player.
BCB 75: Betacam SP studio editing VCR.
BCB 65: studio Betacam SP VTR; dynamic tracking; *BCB-65-N* for NTSC; integram TBC, time code reader.
BCB-60-N/BCB-70-N: Betacam SP studio player and player/recorder/editor; integral TBC, time code equipment; NTSC standard.
Circle (615)

Calaway Engineering **(3344)**
CED series: software enhancement to videotape editing controllers; handles up to 6 RS-422 protocol VTRs/VCRs.
Circle (718)

Camera Mart **(2366)**
ADX: time code monitor system.
Circle (622)

Dwight Cavendish **(4574)**
Videocassette duplicator: computer control.
Circle (629)

CEL Electronics **(1433)**
P158 ERIC enhancement: editing control system including low cost triple time code reader, generator card, time code calculator.
Circle (631)

Cipher Digital **(3369)**
CDI-4810: phantom VTR emulator.
CDI-4890: Softouch-PC.
CDI-4835: Shadowpad-Maxi.
CDI-4825: Shadowpad-Mini.
Circle (645)

Colorado Video **(2609)**
#941 system: digital image storage unit.
Circle (651)

Cubicomp **(4310)**
Enhancement to Vertigo V-2000 animation system.
Circle (685)

Digital Services/DSC **(3556)**
DiSC: real-time digital disc recorder; keying multiple video sources into a background shows no generation loss.
Circle (707)

Dubner Computer Systems **(2928)**
DSS-4 still store: 4-field video capture, storage, retrieval; dual-channel outputs; complete graphic tools for image enhancement, modification, correction.
Circle (714)

ESE **(1800)**
ES456/ES455: multispeed, bidirectional time code readers; *-455* with inserter.
ES956: multispeed bidirectional time code reader with 2" displays.
ES263: portable SMPTE time code generator.
ES453/ES453VI: play-speed time code readers; *-VI* with inserter.
ES461: time code generator; jam sync, user bits features.
Circle (749)

FOR-A **(3169)**
TGR-2000: time code generator, reader; LTC format.
EC-740: edit controller; operates with FA-740 parallel effects TBC in A/B roll system.
Circle (767)

Fostex **(4251)**
4011: video character inserter, VITC generator.
Circle (770)

call up an effect with either our MFC1 MIDI foot controller, remote controller or just a standard footswitch (all optional).

But even if you don't need custom tailored sounds, the factory preset effects give you maximum signal processing in minimum rack space.

So whether you're an acoustical consultant, a sound contractor or audio engineer, see and hear the new SPX90II.

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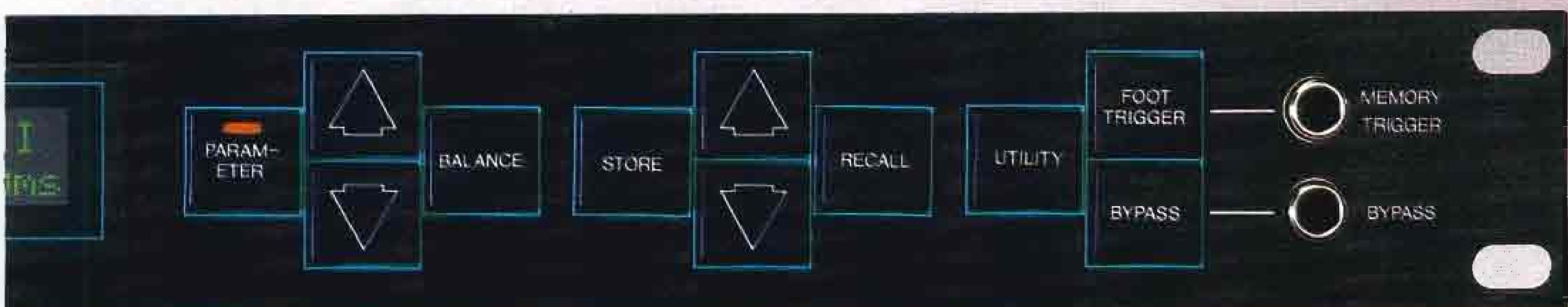

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Future Productions (H5830)
MMC-100, MMC-500: monitor main control; expands to 96 VCRs and 504 VCRs.
Circle (774)

James Grunder & Associates (1433)
P158 ERIC enhancement: CEL editing control system including low cost triple time code reader, generator card, time code calculator.
Circle (793)

Interactive Motion Control (4367)
2x2: animation stand; two feet of X, Y motion, 360° rotation.
Slide system: attachment for 2x2 system; provides X/Y motion, rotation, zoom, focus functions with 2¼" or 35mm transparency artwork.
REMOT head: combines keyboard, plasma display, jog box into single unit; places control up to 4,000 feet from IMC 3565 power/driver to operate animation table; graphic display with RGB output available; faster movement speeds.
Circle (820)

JVC (2656)
BR-S410: portable S-VHS docking recorder.
BR-S810: S-VHS editing recorder.
Circle (833)

Landy Associates (2677)
Interformat editing: console for ¾ ", Beta-SP, M-2, 1"; Paltex Elite editor, Ampex, Sony, JVC VTRs.
Circle (851)

Leitch Video (2169)
DSF-3100N: digital *Still-File* enhancement.
Circle (859)

Lyon Lamb Video Animation (2251)
In/Out System 1: RS-170A RGB output for frame-by-frame recording; ENC VI NTSC encoder/sync generator, Mini VAS animation controller, optional VTR, NTSC monitor in portable rack; 9600-baud RS-232 port; VITC, SMPTE LTC timing accuracy.
In/Out System 2: frame-by-frame recording, image capture/storage in RGB frame buffer; *Grabitizer* software links system to Ethernet network; all system functions controlled from host.
In/Out System 3: frame-by-frame recording, image capture/storage, video painting to modify stored images; digitizing tablet, RGB monitor; paint software.
Circle (873)

Montage Group (1009)
System II: Montage picture processor; nonlinear, random-access editing controller; configures for 17 SuperBeta Hi-Fi VCRs, intelligent interfaces with time code readers/generators.
Circle (912)

NEC America (2747)
VSR 10: solid-state video recorder.
Circle (926)

Odetics (H5813)
On-Line: remote spot record unit, updates TCS-2000 database as each new recording is made.
Play-only: low cost play-only system complements On-Line recorder unit.
Circle (940)

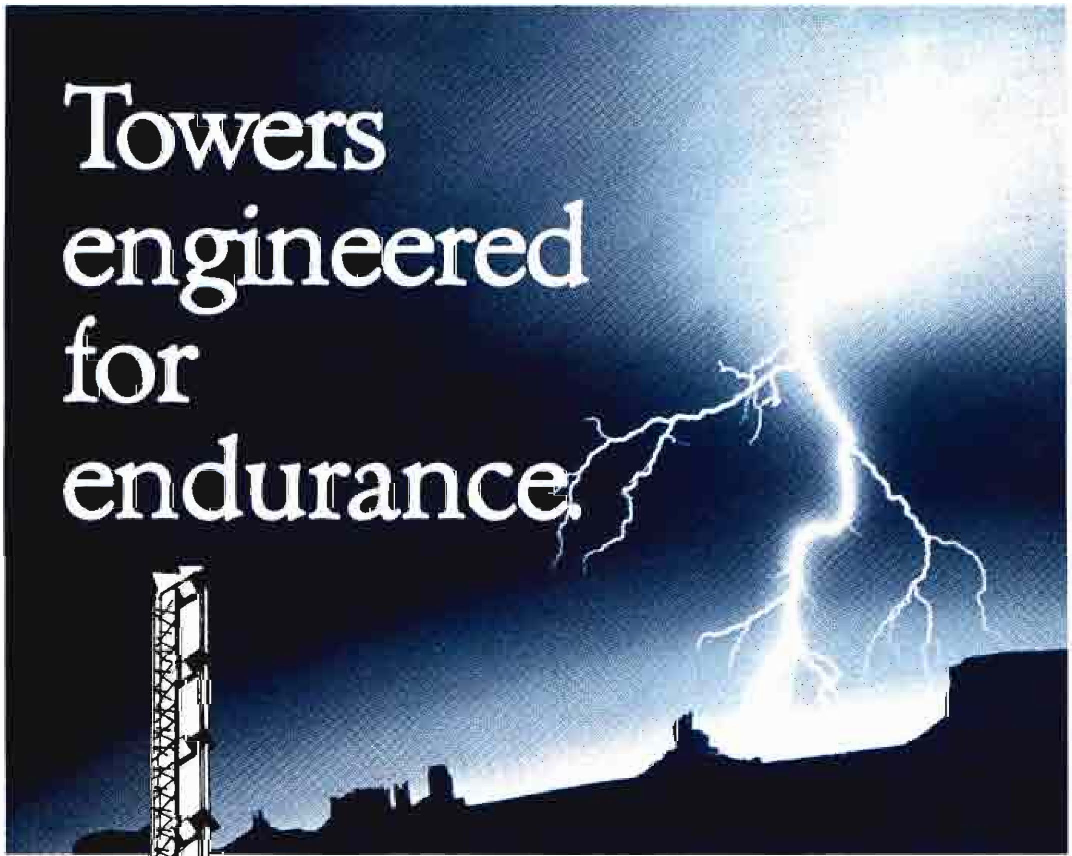
Optical Disc (H5321)
Demonstrations: new disc technologies.
Circle (945)

Paltex (2301)
ELITE 3/12: 3-machine system.
Esprit Plus 8/16: range of videotape editing systems including 8-machine roll.
ES/D 6/12: 6-machine system with slow motion.
ELAN 4/12: 4-deck system with SpeedScan.
Circle (954)

Panasonic Industrial (2938)
AG-7300 player, -7100 recorder: S-VHS VCRs; 400-line resolution, 46dB S/N ratio, comb filter; multiple step dial search mode; Dolby noise reduction.
AG-7800: Pro series S-VHS; Y/C system with >400 TVL resolution, HiFi audio; VHS mode; integral serial remote receiver allows 500 decks in duplication system; 4-channel audio with 90dB dynamic range.
WJ-MX10 digital AV mixer: editor with integral frame synchronizer, frame memory, freeze, mosaics, adjustable paint, 17 wipe patterns; joystick image positioner; optional *WV-KB12A* titler; 4-input audio mixer.
Circle (922)

PEP (2701)
InterFormat IF34V series: edit control interfaces; *-33U* for Panasonic S-VHS; *-9U* for Sony RM440 9-pin serial control.
IF45V series: edit control interfaces; *-33U* for JVC S-VHS; *-9U for Sony RM330 9-pin serial control.*
Circle (961)

Recortec (H5430)
EPA-500: VHS extended play adapter; for record, immediate playback of uninterrupted segments, sequences to 150 hours in SSL mode; external synchronized transport for handling large reels of ½ " tape, houses standard VHS player.
Circle (990)



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Sharp Electronics **(4316)**
XA-2500S: pro series S-VHS VCR; jog-shuttle dial, rotary erase heads; digital special effects.
Circle (1024)

Sony Broadcast **(2902)**
Betacam-SP: series additions; *BVW-60* playback for on-air or edit suite; *BVW-65* playback with Dynamic Tracking; *BVW-70* play/record deck without DT.
D-2 digital VTR.
BVU-950: broadcast U-matic recorder, player, editor; SP technology; optional TBC module.
Circle (1037)

Sony Professional Video **(2902)**
VO-7600, VO-7630: second series of Type VII U-matic recorders; improved picture quality, computer interface capability.
Circle (1040)

Steadi-Film **(H5113)**
Video-Cue: computer-controlled, time code related video cuing device for overdubbing.
Circle (1053)

Thomson Video Equipement **(3333)**
TTV 3100: digital still store.
Circle (1101)

TimeLine **(1629)**
LYNX: post-production time-control system and supervisor.
Circle (1104)

United Media **(4363)**
Model 30: 3-VTR A/B roll edit controller with multi-tasking; editing, list management, data input/output, auto assembly can be done individually or simultaneously.
Model 60: 6-VTR A-F roll edit controller; includes multi-tasking software.
Model 90: 9VTR A-J roll editing controller; multi-tasking; eight user keys with learn, playback verification; sync roll, sync chase; eight GPI channels; 3.5" or compatible disk drive.
Model 505: TCR/TCG/character generator; time code rephasing capability.
Circle (1124)

Videolab **(H5005)**
Time code retrofits: TCR-5 for Sony Type 5 VCRs; *TCR-6* for Sony VO6800 VCRs; *TCR-9* for Sony Type 9 VCRs.
IFR-423: interfaces communication between RS-422, RS-232, 33-pin VTR control protocols.
Circle (1145)

Videomedia **(3966)**
Version 2 software: Mickey editor upgrades; adds jog/shuttle, non-volatile memory, field upgradable options, software assignable VTR features.
V-MAX: modular videotape editing for high-end post-production.
PC-Link: puts IBM PC in control of Mickey editors.
LM-Option: advanced list management for Mickey edit controller.
Circle (1146)

V3: Film, cine

- Video-for-film equipment
- Telecine systems
- Film-tape transfer
- Film editing products

A. F. Associates **(2869)**
B3410-03 telecine: Marconi line array system.
Circle (515)

Arriflex **(2669)**
CSC door: orientable, full-swing video door for ARRI 35-3 film camera.
Circle (553)

Century Precision Optics **(2880)**
DupLikin III: 35mm slide-to-video transfer device; for Ikegami HL-79, -95 cameras.
Circle (636)

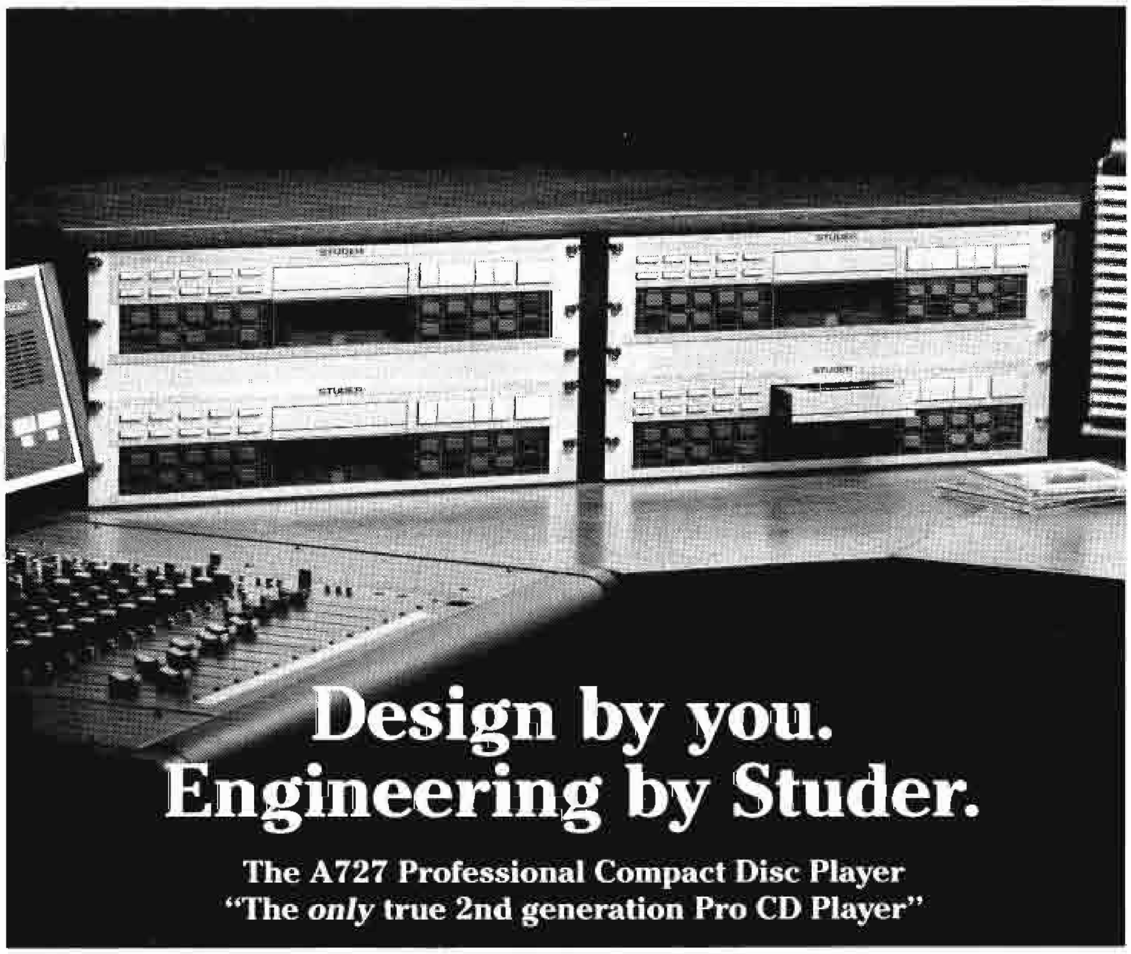
J&R Film/Moviola **(2711)**
Model 600 LOKBOX: hard-lock synchronizer.
Circle (832)

Lipsner-Smith **(2466)**
CF-200: ultrasonic film cleaner system.
Circle (865)

Marconi Communications Systems **(2869)**
B3410-03: line-array telecine, complete with working options.
Circle (879)

Polaroid **(4576)**
UL-544 FreezeFrame: video recorder, accessories; 4x5 and 8x10 film backs; foot switch control.
Circle (971)

Quality Video Supply **(4387)**
PSS-912: deluxe production slate.
Circle (978)



Listen to the A727. . .What you hear is Studer sonic quality: • separate 16-bit D/A converters • 4-times oversampling • proprietary Studer digital and analog filtering.

Use the features that professionals demanded: • very quick *direct* access to tracks *and* indexes • Auto Cue (aka, "cue to music") to find exact start of program material • Auto Stop to pause at end of any track • Start Review & End Review to allow quick checks of "in" and "out" cues • parallel remote with status tallies *and* fader start • bright self-illuminating display shows elapsed and remaining time for both track and disc • provision for RS 422 serial interface. I/O configurations: Analog—stereo balanced XLR, 2 sets of stereo unbalanced RCA (fixed level and variable level), *and* mono; Digital—balanced XLR, unbalanced RCA; Clock—input for vari-speed, output for synchronization.

If the A727 seems to be everything you need in a professional CD player, it's no accident. Studer engineered it that way.

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STUDER REVOX
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WHY THE WORLD'S BROADCAST INDUSTRY IS BUYING AMEK

The growing demand for many different types and configurations of audio consoles for broadcast and video production requires a diverse and flexible approach from console manufacturers. As one of the world's leading names, AMEK has the time, resources, knowledge and engineering skills to develop broadcast consoles suited to your needs.

We have created two console systems which in their versatility and adaptability can cover all applications from the smallest edit suite to the largest production studio environment.

AMEK BCII, a compact system, has 3 chassis types and 15 modules, including mono and stereo inputs, subgroups and outputs and several monitor options. From this we can create configurations as different as a 6/2 in drop-through format to a 24/4/2 in a free-standing studio chassis with Dynamics on all inputs and jackfield. In addition to standard facilities such as remote starts, oscillator with 18 spot frequencies, and two-way talkback, there are a vast range of options.

Finally, BCII faders can be fitted with VCAs and a serial AFV port to allow interface with ACE, CMX, CONVERGENCE, SONY and all other leading editors.

AMEK CLASSIC has a similar wide range of modules to BCII but with more advanced facilities such as 4-band swept equalisation and 8 auxiliary sends in mono and stereo formats. Chassis are available in nominal configurations of 32, 48 and 64 inputs but many re-configurations are possible.
AMEK CLASSIC may have 8 mono or 8 stereo groups and has, in addition, 2 separate stereo busses. A multitrack monitor option for 8, 16 or 24-track production work is also available.
The CLASSIC may also be fitted with Audio Kinetics 'Mastermix' VCA fader automation or the GML Moving Fader Automation System.

It goes almost without saying that both BCII and CLASSIC meet build specifications and technical performance parameters of the highest order. Additionally, both consoles have balanced virtual earth mix busses.

AMEK has many broadcast and video production customers worldwide, such as the BBC, NBC, and other leading organizations. We also have many lesser-known but no less successful clients also placing repeat orders for our broadcast consoles. So there's no reason not to let us tell you more about why the world's broadcast industry is buying AMEK . . . .

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Telephone: 061-834 6747. Telex: 668127. Fax: 061-834 0593.

In the USA: AMEK Controls Inc. 10815 Burbank Blvd, North Hollywood, CA91601.
Telephone: 818/508 9788. Telex: 662526 AMEK USA E-MAIL: AMEK US. Fax: 818/508 8619.

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Rank Cintel (2334)
Film gate: 3-perforation design for enhanced MkIII-C Digiscan 4:2:2 telecine.
ADS-1 telecine: improved CCD imager.
Circle (986)

RTI/Research Technology (2466)
TV-2000: high-speed TV film editor.
Circle (1007)

Steadi-Film (H5113)
Festival: enhancement kit for Rank-Cintel Mark III; improves contrast ratio, shading, afterglow circuitry; single board with low-noise head preamps.
High speed lens: replaces standard Rank lens; equivalent color, resolution characteristics; doubles light transmission for improved S/N ratio, longer lamp life, reduced burn.
Circle (1053)

Steenbeck (2480)
ST-701: 35mm flatbed film editing table; 6-plate, 1-picture, two magnetic sound track; film-to-tape transfer capability.
ST ADR: computer-controlled automatic dialogue replacement system.
ST-921: 16mm flatbed editing table; 8-plate, 2-picture, two magnetic sound tracks.
Circle (1054)

Total Spectrum Mfg. (2069)
FCS-20, FCS-30C: title, color art stands.
Circle (1110)

Thomson Video Equipement (3333)
TTV 2710: digital slide scanner system.
Circle (1101)

V4: Batteries, lights

- Batteries, packs, belts
- Chargers, reconditioners
- Lighting instruments
- Lamps, lighting accessories

Alexander Batteries (2205)
BP-1-11 charger: µP controller determines full charge.
BP-1-11 battery: directly replaces NP-1, NP-1A.
BP-1-11 analyzer: revitalizes batteries while determining their condition.
Circle (521)

Anton/Bauer (2239)
Lifesaver: µP-controlled 4- and 8-position chargers.
PROBE: programmed battery evaluator.
LOGIC: battery series.
Gold Mount system.
Circle (545)

Arriflex (2669)
ARRI video light: high-intensity, lightweight unit for video camera use.
ARRI Obie: lightweight on-camera *eye* lights.
ARRI grip: line of film/video grip equipment, accessories.
Fresnel kits: 300W, 650W Fresnels; kits packaged in heavy duty shipping cases.
Circle (553)

Christie Electric (2217)
CASP enhancements: battery reconditioner, charger, analyzer; 6-channel system charges any type of battery in unattended operation; increased software capabilities; RS-232 port includes hard copy graphing on serial printer.
Series: NiCad batteries.
Circle (640)

Frezzolini Electronics (2438)
MicroMaster 9529: ac/mobile dc microcomputer controlled Nicad charger.
9407/9418: PAG Speedcharge 6000+ sequencer; sequentially charges eight batteries, revitalizes Nicads.
UPS-14: On-Board uninterruptible power supply.
MF series: On-Board lights, accessories.
Frezzi-Max series: premium grade Nicad batteries, 1.5-8ah.
PAG-LOK series: full lines of Nicad batteries, brackets by PAG (UK).
Circle (771)

Great American Market (2684)
GamColor: polyester color lighting filters; deep-dyed for extended useful life.
Circle (791)

ILC Technology (H5230)
DayMax HMI: 5600°K metal halide lamps; 200W, 757W, 1.2kW, 2.5kW, 4kW, 6kW, 12kW.
Circle (813)

Lee Colortran (3580)
Prestige Series: software and other enhancements for lighting control console.
Lee filters: color-effect, correction, diffusion materials; resin camera filters; polyester photographic filters.
Circle (857)

LTM (4135)
HMI system: 220Vac 19" 6kW Fresnel instrument.
220V: 12kW HMI mini ballast.
The Blue Torch: 290W HMI battery-powered SunGun.
Pepper Pot: 3-channel dimmer system.
Cinepar: 200W light.
Circle (870)

Matthews Studio Equipment (4374)
Matthflector: soft, expendable reflector material; now available in bulk or 6x6, 12x12, 20x20 recut reflectors.
Special packs: including Snap in/Articulating Arm, Mini-Matth Boom, Medium Kit Stand, Gaffer Grip, Lite-Lift, Light/Heavy Stand, C-Boom Clamp.
Triple Riser C, Combo Combo: combines steel legs with aluminum risers.
Van Griptruk: sized to fit in the van.
Mini-Meat Axe & Flag: where standard size unit won't fit.
Matth GoboBalls: styrofoam balls; designed as safety device on ends of gobo arms.
Series: stainless steel stands.
Gobo arms: 20" and 40"; stainless steel, resists rust, twisting and bending.
White Bobbinet, ¼ Stop Silk: reduce light by approximately ⅓ stop.
Super Sky Mote.
Circle (883)

Musco Mobile Lighting (PL)
Foursome: in-door lighting unit; four light heads; attaches to any structural area inside; remote controllable.
Circle (918)

L. E. Nelson/Thorn-EMI (2260)
FMR: 600W ellipsoidal lamp for Colortran instruments.
FGM/FGN: 1kW PAR64 5600°K daylight lamp, 800-hour.
MID: 200W to 12kW 5600°K daylight linear lamps.
Circle (927)

Paco Electronics USA (1452)
DP-11: NiCad battery pack; equivalent to Sony NP-1; rated 13.2V, 1.9ah.
Circle (952)

PAG (2438)
PAG-LOK series: full lines of Nicad batteries, brackets.
Speedcharge 6000+: sequencer; sequentially charges eight batteries, revitalizes Nicads.
Circle (953)

PEP (2701)
Model UMC: Universal MicroCharger; for all ENG batteries.
Circle (961)

Pro Battery (4483)
PRO 500 charger: computer control, each of four ports operate independently, charge simultaneously; digital charge time readouts; auto trickle mode at full charge; 120/230Vac input; 14-16 hour typical charge; handles most common battery types.
Circle (974)

Teatronics (4514)
Comstar Genesis: lighting control system.
Dimming system: high density, modular.
GLX-1212.
Circle (1078)

Tekno (H5802)
Galaxy: modular soft-light system.
Circle (1081)

Theatre Service/Supply (2580)
PANIX: emergency lighting controller for Strand CD80 dimmers.
Circle (1096)

Times Square Lighting (2472)
Microstar II: memory lighting control system.
Q145: 1kW, focusing scoop instrument.
L2200: set light instrument.
Circle (1105)

V5: Digital effects, graphics

- Character generators, titlers
- Digital effects equipment
- Digital graphics systems
- Prompting systems
- Video production systems

Abekas Video (1439)
A72: digital character generator; instant font sizing, full color logos; single, dual channel configurations.
Circle (502)

Accu-Weather (4151)
Front Door 750: PC-based hardware, software

Continued on page 322

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1″ Quality, ¾″ Umatic

Modified VO-6800 Recording—Unretouched photograph

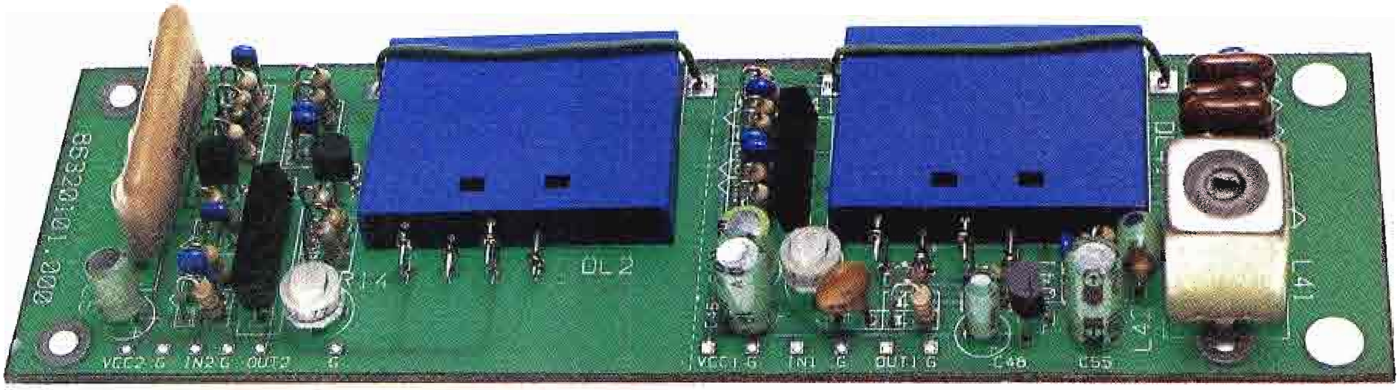
CCI MOD 500 HIGH RESOLUTION KIT

Why change formats when a cost-effective alternative is available? Cottonwood Communications introduces a modification to improve resolution and signal to noise in 3/4″ Umatic and 1/2″ SVHS to nearly 1″ C Format quality . . . without changing tapes and without changing formats.

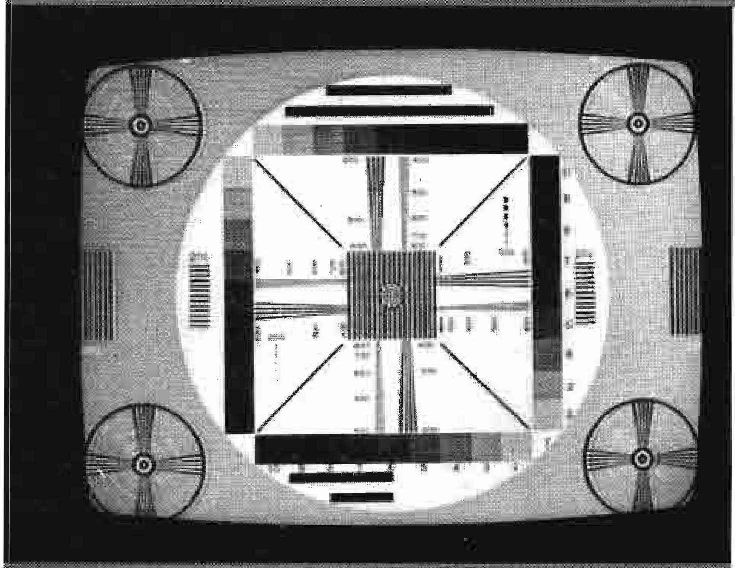
The MOD 500 PC board maximizes quality through two CCI proprietary circuits; a *Homer TSF* tunable specific frequency filter for record or playback Y/C separation and a differential chroma noise reduction processor.

Protect your investment in Umatic and upgrade your quality . . . the CCI MOD 500 will give your tapes a 1″ look for 3/4″ prices.

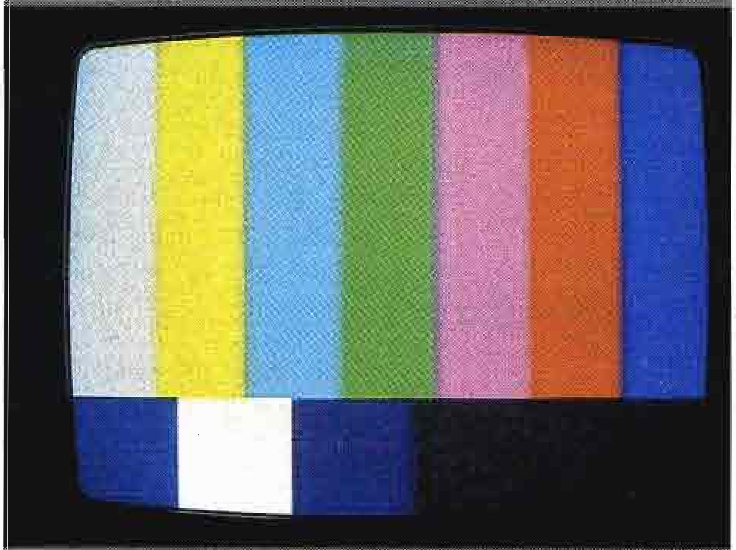
Cottonwood Communications, Inc.



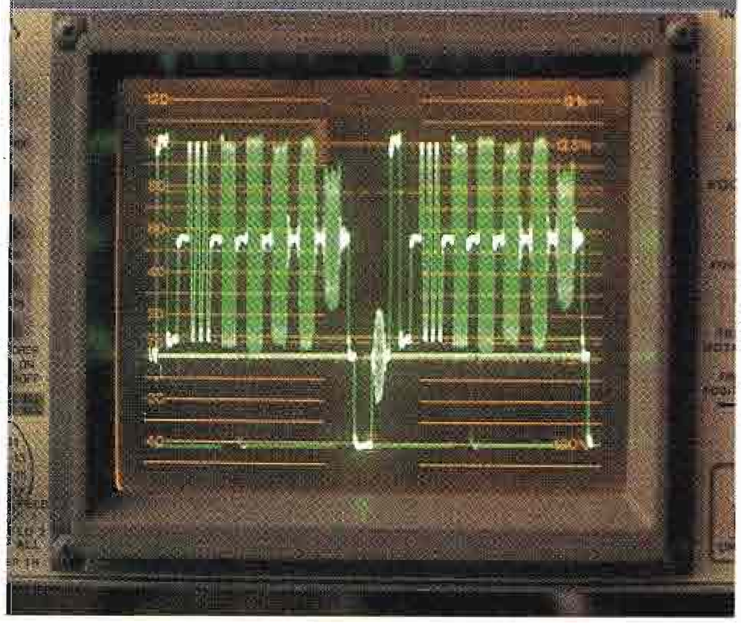
Unretouched photograph



Modified CR-850U Recording—Unretouched photograph



Modified CR-850U Recording—Unretouched photograph



Modified CR-850U Recording—Unretouched photograph

FEATURES

- Over 350 lines color and luminance resolution
- Over 6 dB chroma signal to noise improvement
- 1.5 dB to 2 dB composite video signal to noise improvement
- Over 4 MHz luminance bandwidth
- Eliminates moire and color cross bleed
- Quality 4th generation recording
- Fully compatible with standard 3/4″ Umatic VCRs Unmodified playback recovers better than 300 lines color resolution with full signal to noise improvement
- Kits available for all manufacturers 3/4″ Umatic portable and studio recorders
- Installation of the PCB is minimal and all information is included in the kit
- Optional CCI MODEL 500 HR Wide Band Component Time Base Corrector with Component outputs for compatibility with BetaCam and MII formats
- CCI MOD 501 High Resolution Module with S connectors for SVHS recorders to improve color resolution and signal to noise
- Patent pending
- Lease plan available

Cottonwood Communications, Inc.

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Los Alamos, CA 93440
805-344-3335

California **800-826-7025**
National **800-331-8333**

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Continued from page 130

common-carrier microwave. Four 11GHz channels are relayed through Baily's Crossroads, VA, to the uplink and three 6GHz return channels from the uplink.

A second 11GHz 2-channel outgoing and 6GHz 1-channel incoming microwave system relayed through an apartment building in Washington, DC, provides supplementary feeds as required. The 11GHz band must be used for transmission from the studios to the uplink because of the interference created by the uplink at 6GHz.

Signal control

One of the major design goals for the new facility was to build a highly integrated and automated plant where major systems worked together under computer control. This had been one of the factors that allowed the network to remain on the air as long as it did the night of the fire.

The routing switcher is the heart of the network control center. The switcher provides routing for video and three channels of audio. The video and audio channel 1 and channel 2 matrices are 90 x 100 and expandable to 130 x 110. The audio channel 3 matrix is 40 x 40 and expandable to 130 x 40.

The routing switcher has redundant power supplies for each card frame and redundant control cards. The frame containing the control cards has separate power cords plugged into separate circuits for each of the power-supply modules. The routing switcher software provides *downloadable mnemonics*, which enable

One of the four videotape origination bays.

NATIONAL CONVENTION

BROADCAST ENGINEERING CONFERENCE

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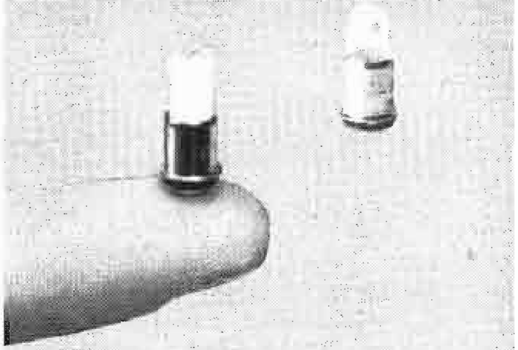

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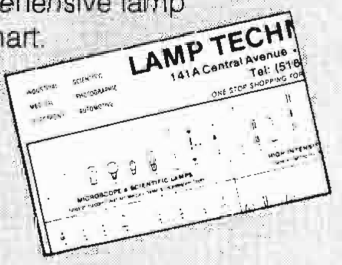

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The transmission area monitors all of the network's operations. Video control is on the left, and audio is on the right.

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Because of the diverse facilities at member stations, it is necessary for PBS to distribute both mono and stereo signals over the satellite system and to monitor both signals throughout the plant. The problem of simultaneous handling of mono and stereo feeds was solved by creative use of the video switcher and controller.

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The automation system relies on a Hewlett-Packard 310 computer operating with 2Mb of RAM, a touch-screen color display, a 40Mb hard disk and a 3.5-inch floppy disk drive. A separate computer system controls the on-air switching and all associated machine events. This system also controls the auxiliary schedule switching on the B-channel bus. The automation system is capable of automatically recording off-air feeds through the routing switcher.

The air automation system prompts the operator to load tapes or to put machines into remote. All manual actions performed on the master-control switcher also are logged through the automation computer. Because of the processing power inherent in the computer, it is possible to run other computer functions while the system maintains the on-air schedule.

The main videotape area has support positions for 20 type C VTRs arranged in four groups of five outside each control room. This enables one operator to have complete responsibility for loading, airing and monitoring an air schedule.

Two separate, isolated rooms contain a single 1-inch VTR and monitoring equipment for technical evaluations. These screening rooms also have ½-inch and ¾-inch dubbing capability, so that cassettes can be recorded during the screening process.

The new facilities were dedicated in March 1987 and named in honor of the first PBS president, the late Hartford N. Gunn Jr. The Gunn Technical Center operates around the clock, providing TV programming for 319 PBS member stations.

Although the 1984 fire at the network's offices was disastrous, the challenges it created have been successfully met. Through the cooperation and innovation of a dedicated and resourceful staff, a new, efficient and cost-effective broadcast plant was built. The decision-making processes used by PBS engineers can be a useful model for other stations facing similar (albeit not as unexpected) studio and equipment purchasing questions.

Acknowledgment: This article was adapted from a paper written by Alfred A. Norcott and Gregory T. Tarver, which is contained in the 1987 NAB "Proceedings."

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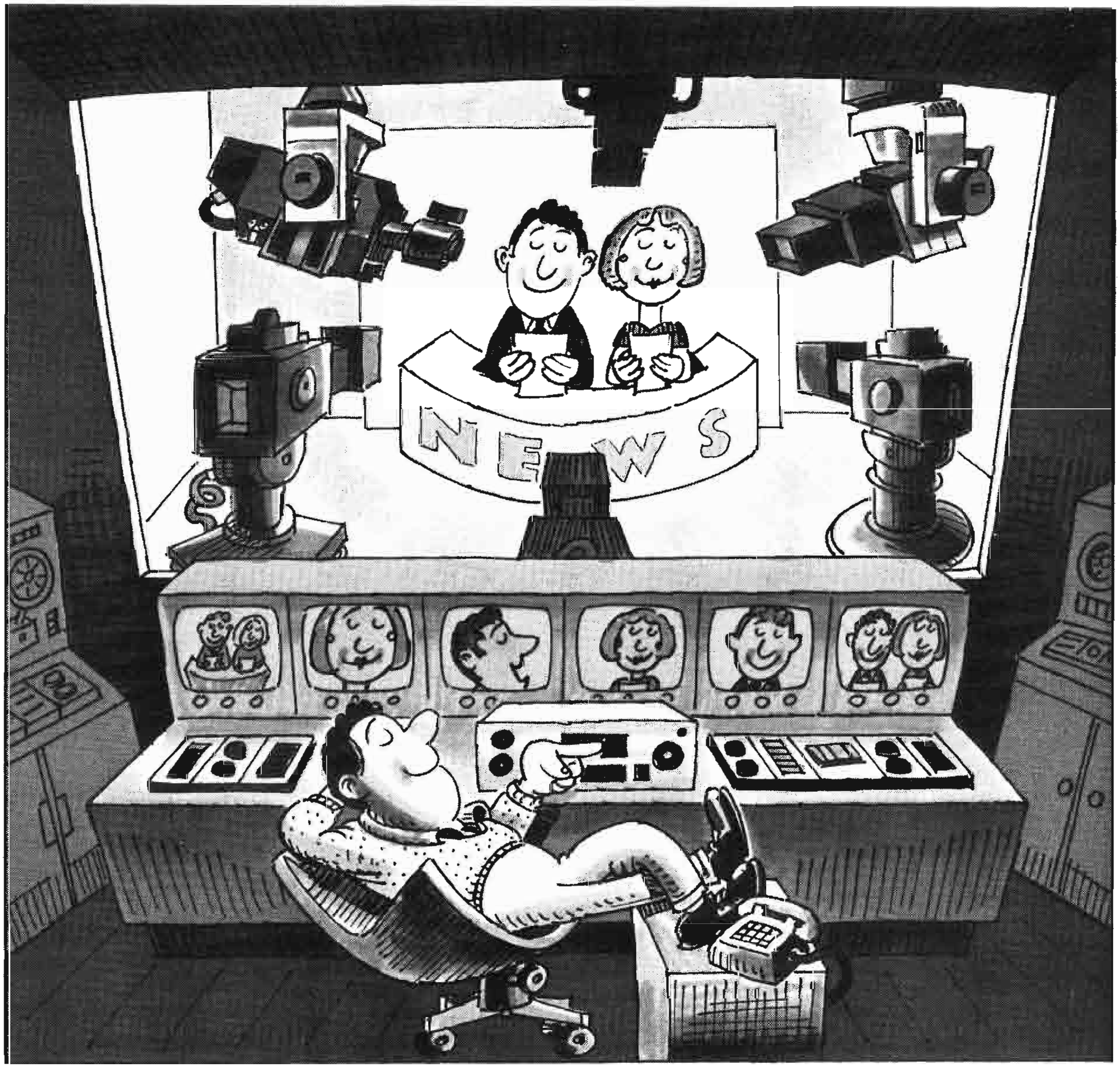

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Acoustical design and construction

By Eric Neil Angevine, P.E.,
and Renee Kolar

When it comes to studio acoustics, look for help.

Few broadcasters, if any, would attempt the design and construction of a new studio facility without engaging an architect. And not many broadcasters would allow a building to be constructed without the guidance of competent structural or mechanical engineers. Yet, it is commonplace to rely on the architect or the station's chief engineer to make decisions on studio acoustics and noise control.

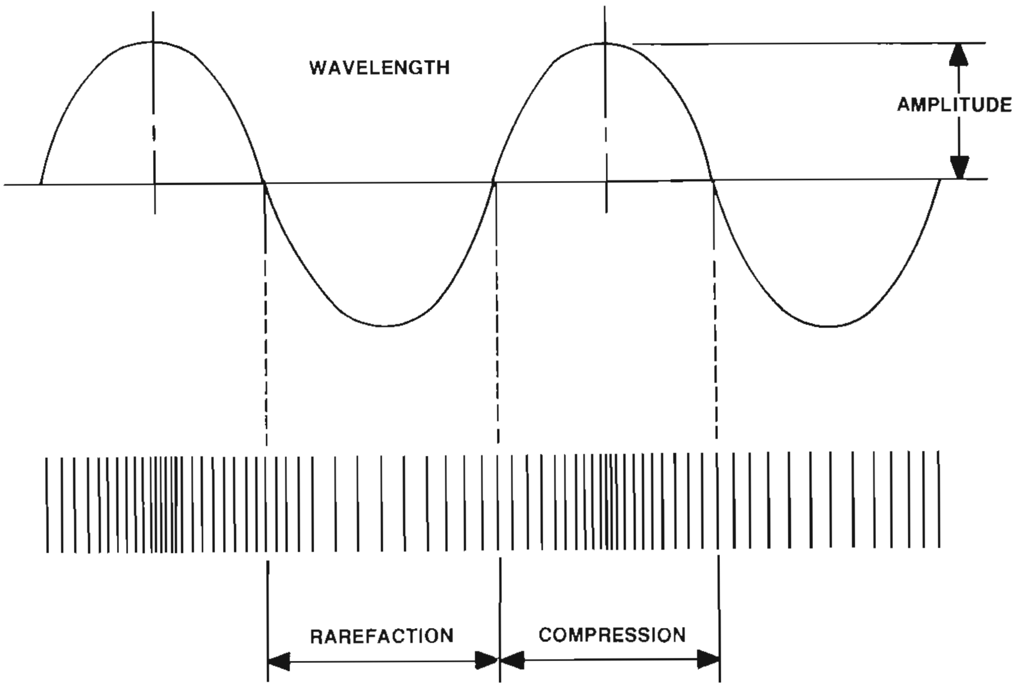

Figure 1. *Two-dimensional representation of sound waves.*

Acoustics, the science that deals with the production, control, transmission, reception and effects of sound, is an attribute of every building. Acoustics is one of the essential determining factors in all studio projects in which the creation and broadcast transmission of sound are the owner's primary products. However, it is extremely rare to find architects or broadcast engineers who have any depth of knowledge about acoustics.

The goal of the building designer is to establish the appropriate environment for every building function. Acoustical objectives must be included in the design from the preliminary stages of the schematic design phase. At these stages, poor room shapes and placement still can be avoided.

Acoustical comfort, which is primarily the absence of unwanted sound, is the main goal of effective acoustical design. Providing an environment free of distracting or disturbing sounds is the major function of good acoustical design. A properly designed acoustical environment involves the integration of many different elements, all essential to the overall effectiveness of the facility.

Angevine, an associate professor of architecture at Oklahoma State University, Stillwater, OK, is **BE**'s broadcast acoustics consultant. Kolar is a 4th-year student of architectural engineering at OSU.

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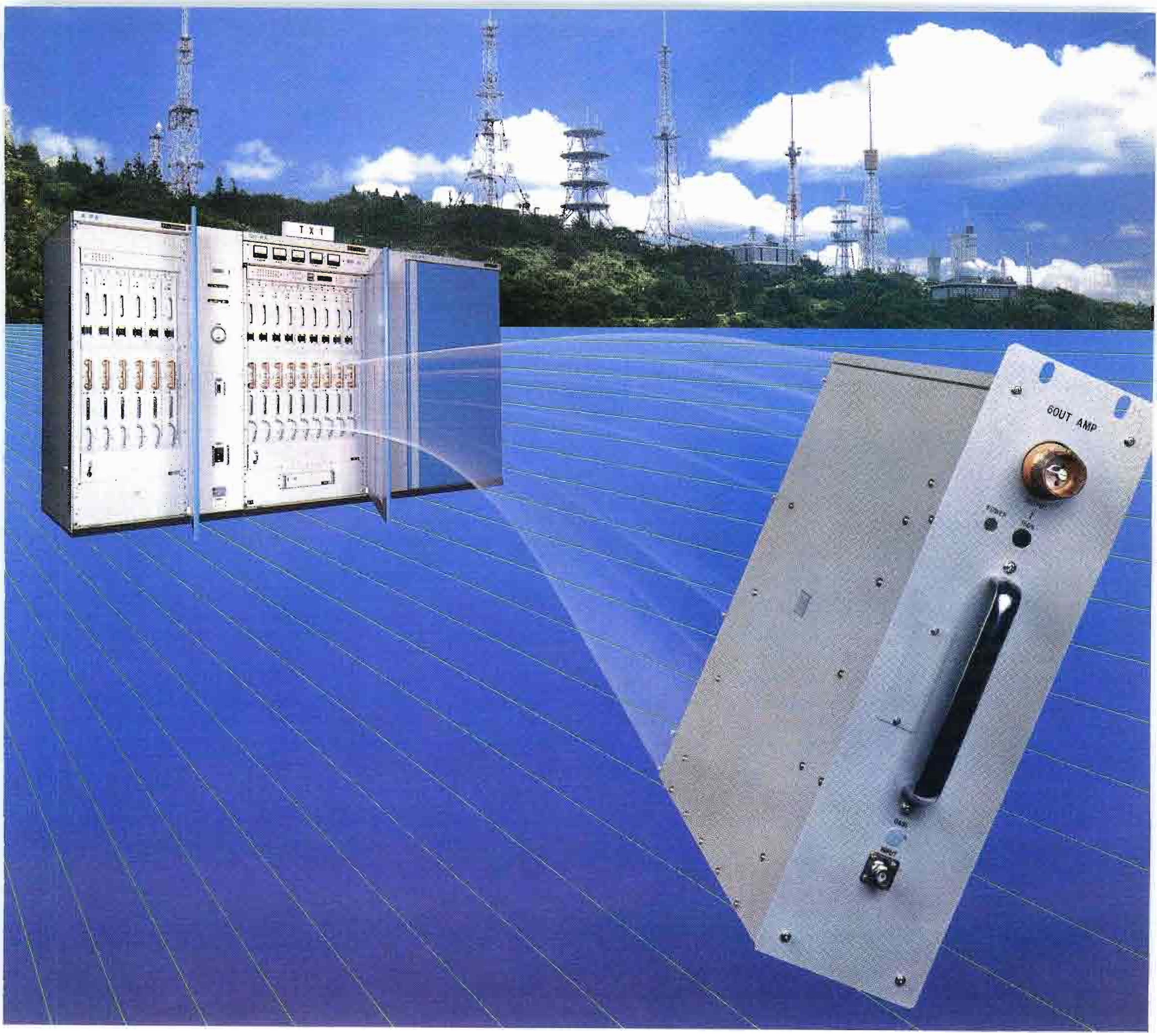

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Properties of sound

Sound is best described as a physical disturbance (usually in the air) that is capable of being detected by the human ear. Sound originates from a vibrating object and travels through the air as a series of compressions and rarefactions. Figure 1 shows a 2-dimensional representation of wave motion. This principle is the key to understanding how sound is affected by different materials, and how it can travel through and around openings.

Many properties of sound affect the way in which a room should be acoustically designed. The acoustical requirements of the room determine which aspects of sound control must be considered, and how they should be applied. Following are brief descriptions of the major properties of sound and their effects on acoustical design.

- *Sound intensity* refers to the magnitude of sound energy in a specific direction in a sound field. It is measured in units of power (watts) per unit area (square meters). Because intensity describes only the energy within the transmitting medium, the concept of sound *level* is used to relate more accurately how sound is perceived by humans. The decibel (dB) is a logarithmic function of the sound intensity compared with a reference intensity. Intensity is related to the subjective concept of loudness.
- *Frequency* is defined as the number of complete vibrations that sound makes in a medium in one second. It is the number of times a point in the medium goes from compression, through rarefaction, and back to compression again. Frequency is associated with the subjective property of sound called pitch. Human hearing generally is within the range of 20Hz to 20,000Hz.
- *Velocity* of sound is a function of the medium in which the sound propagates. It is a function of temperature, humidity and other properties of the medium, but for general purposes, may be considered essentially constant in air. The speed of sound in air at room temperature is approximately 1,130 feet per second.
- *Wavelength* is the distance between two successive compressions or rarefactions. It is related to frequency and velocity by the equation:

$$c = \lambda f$$

where c is the velocity of sound, λ is the wavelength of the sound of interest, and f is the frequency. From this equation it can be seen that low-frequency sounds (below 100Hz) have wavelengths of more than 10 feet, while sounds at frequencies above 8,000Hz have wavelengths of less than two inches. These dimensions are significant in selecting the thickness of acoustical materials.

Sound transmission

Sound transmission is the amount of sound that penetrates a solid barrier and enters the space on the other side. It is common to measure sound *transmission loss* (TL), or how much the sound level (in decibels) is reduced while passing through the barrier. In general, sound transmission loss obeys the "mass law,"

$$TL = 20 \log f + 20 \log w = 33dB$$

where TL is the sound transmission loss at the frequency (f) of interest, and w is the *surface* mass of the barrier in lb/ft^2 of surface area (not density). Observe that the mass law predicts only a 6dB increase in the sound transmission loss for each doubling of a barrier's mass. Note also that according to the mass law, all materials have a greater sound transmission loss at high frequencies than at low frequencies.

Reflection

Reflection of sound waves is similar to that of light in that the angle of reflection is equal to the angle of incidence for reflection from a plane surface, as shown

Continued on page 274

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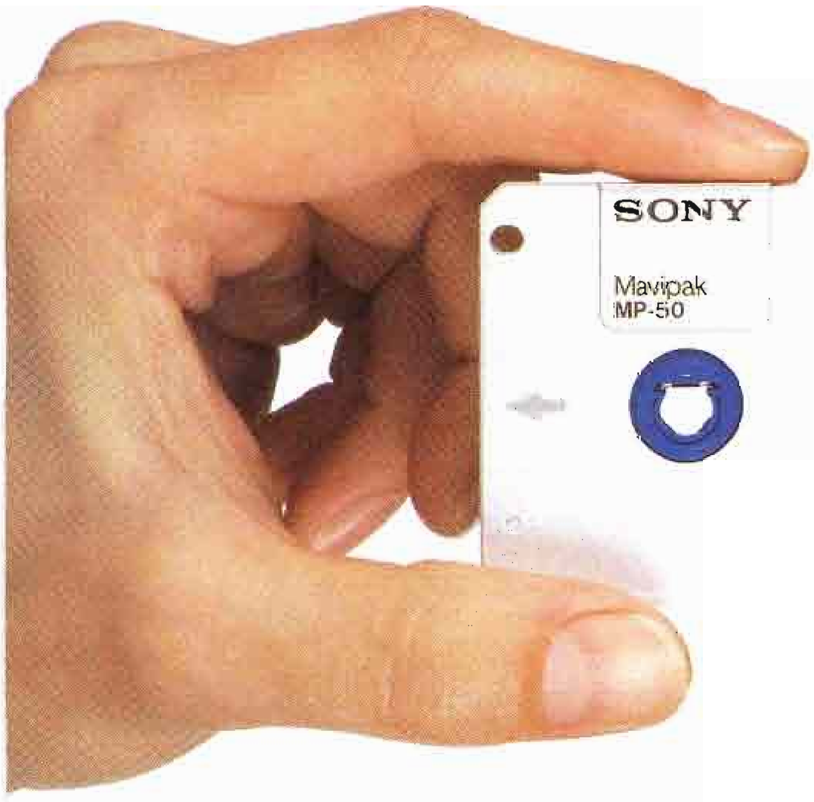

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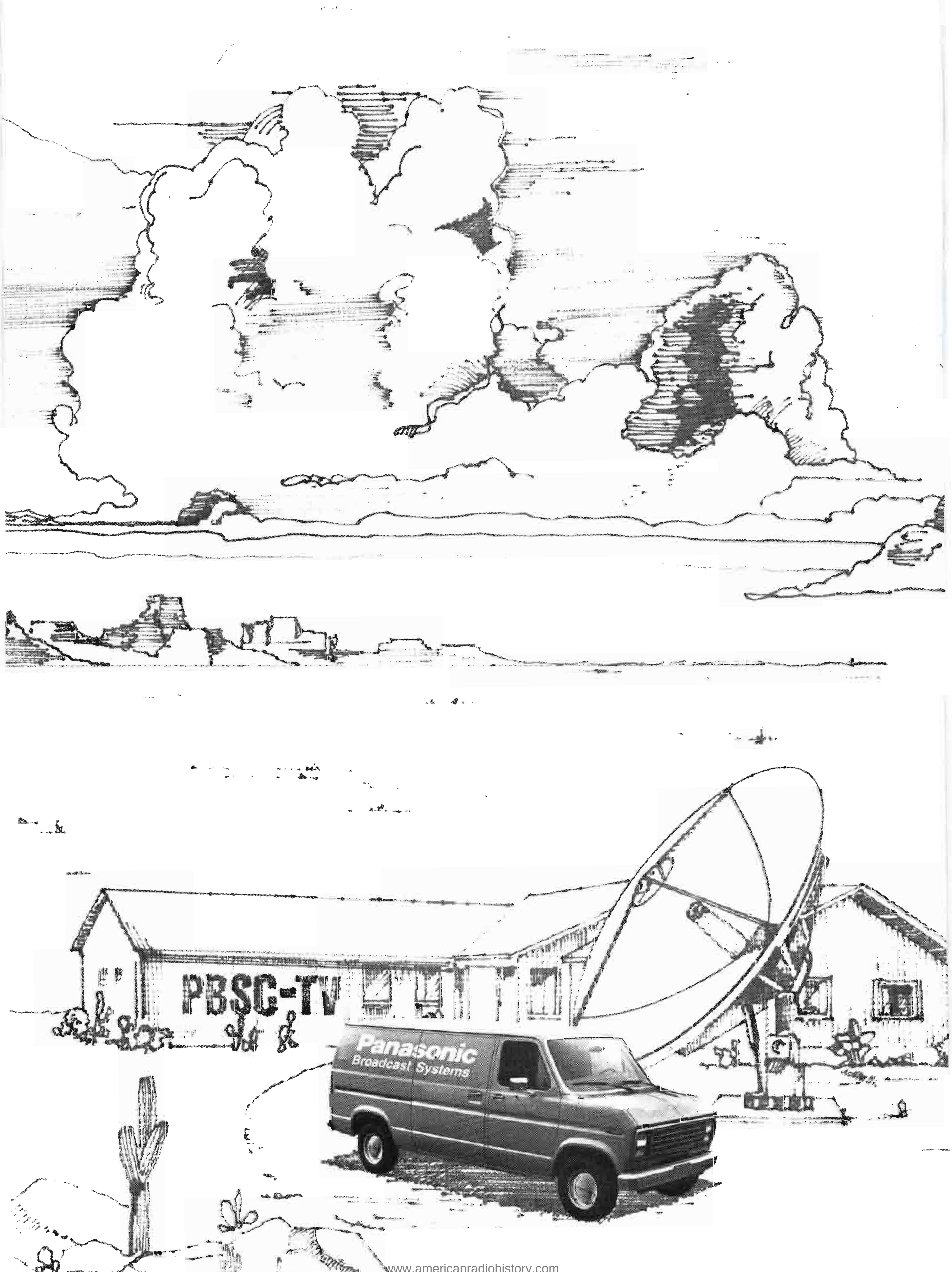

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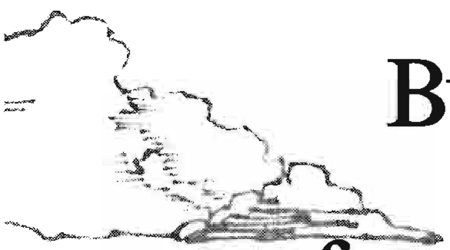

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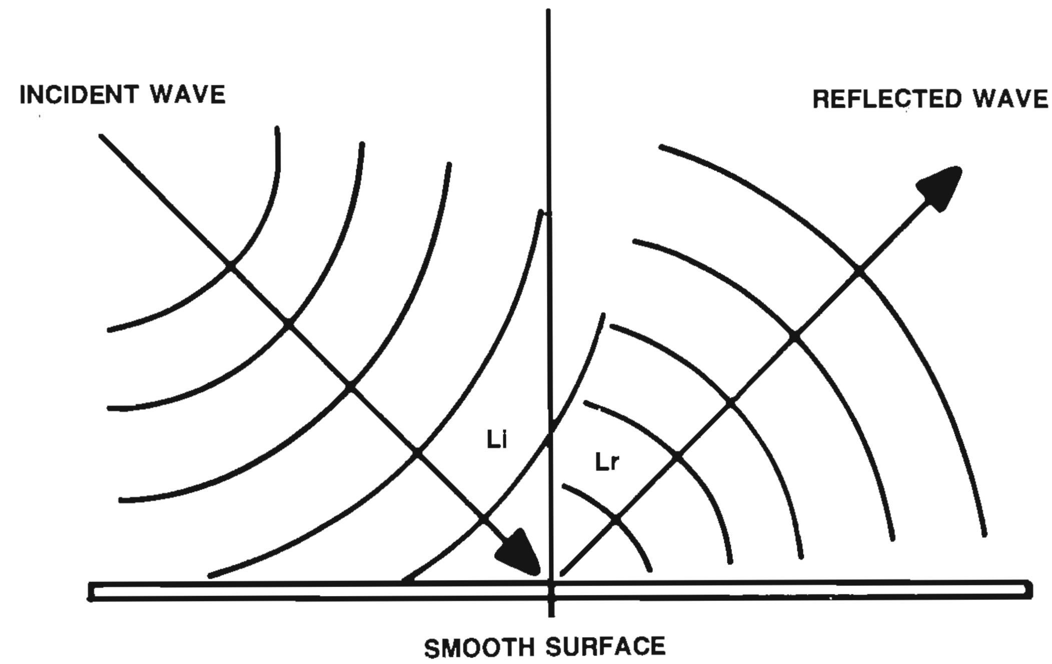

Figure 2. Sound reflections from a smooth surface.

Continued from page 270
in Figure 2. Because sound travels as waves, it is reflected as waves. But because a sound made up of many frequencies has waves of many wavelengths, a surface that appears flat and smooth to low-frequency sounds with long wavelengths may not appear plane to high-frequency sounds with their short wavelengths.

Typical room surfaces are hard, relatively smooth surfaces with little or no relief. As reflective surfaces, they may reflect sound to locations within the room that otherwise might not receive adequate direct sound. Reflective surfaces may be helpful tools in acoustical design but, on the other hand, they may be a hindrance. The correct placement of reflective surfaces is one of the keys to successful acoustical design.

Sound absorption

As sound in air encounters a porous material, much of the energy carried by the wave stays in the material. Sound is *absorbed* by a mechanism that converts the sound energy into other forms of energy and, ultimately, into heat. Porous or fibrous materials make the best sound absorbers because of their multitude of small, deep pores. Sound propagates into these spaces where it is converted into other forms of energy by friction and vibration.

The absorptive properties of a material also are a function of frequency. These properties are measured as the fraction of the incident sound energy, which is absorbed. The sound absorption coefficient (α) of a material at any frequency can vary from 0.00 to 1, the latter figure indicating that all incident sound energy is absorbed. Table 1 lists some common building materials and their absorption coefficients

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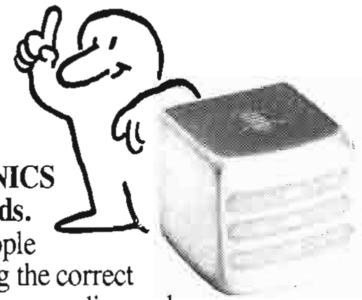

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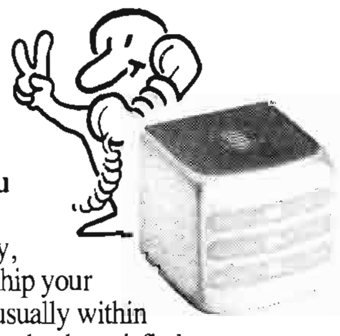

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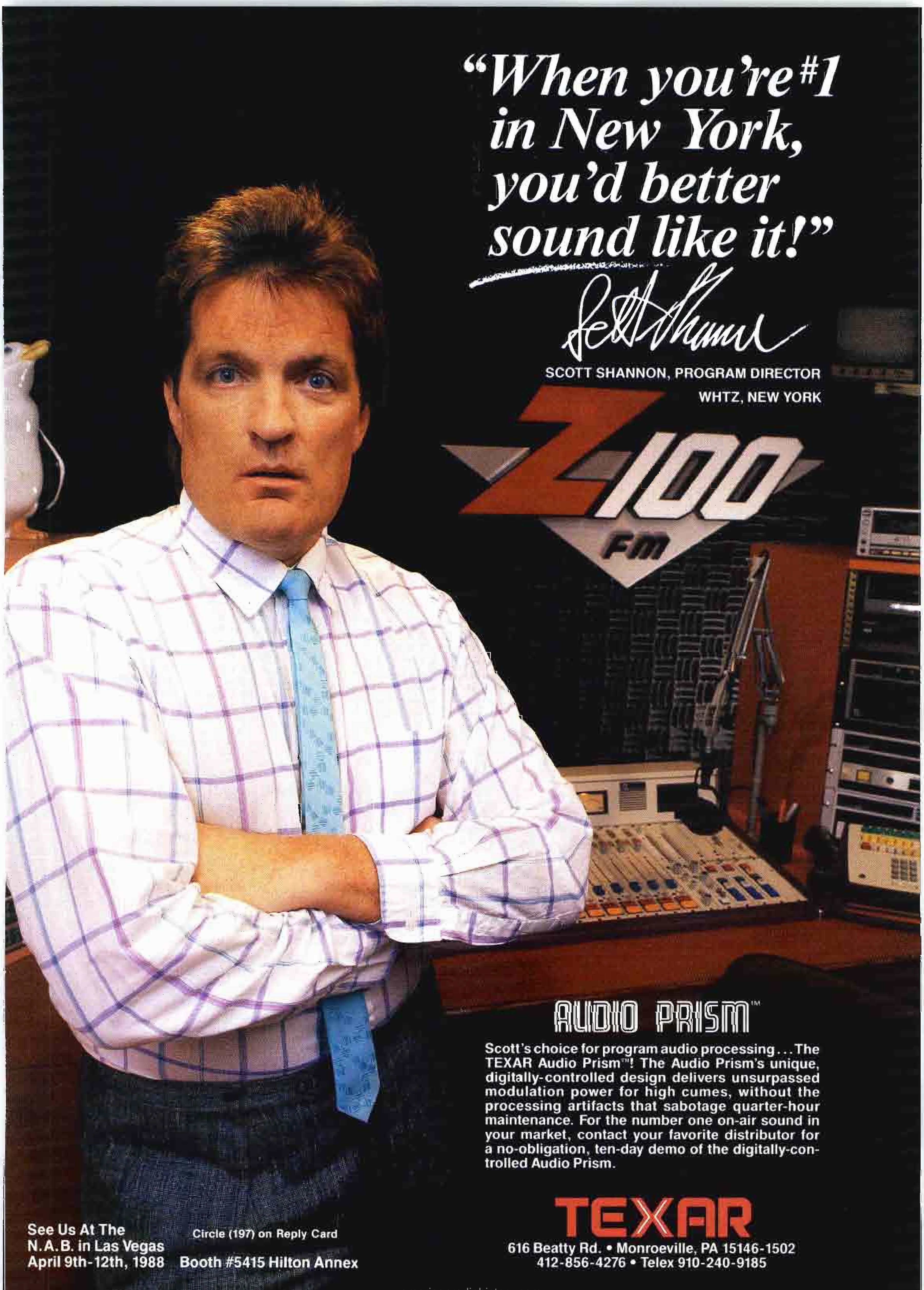

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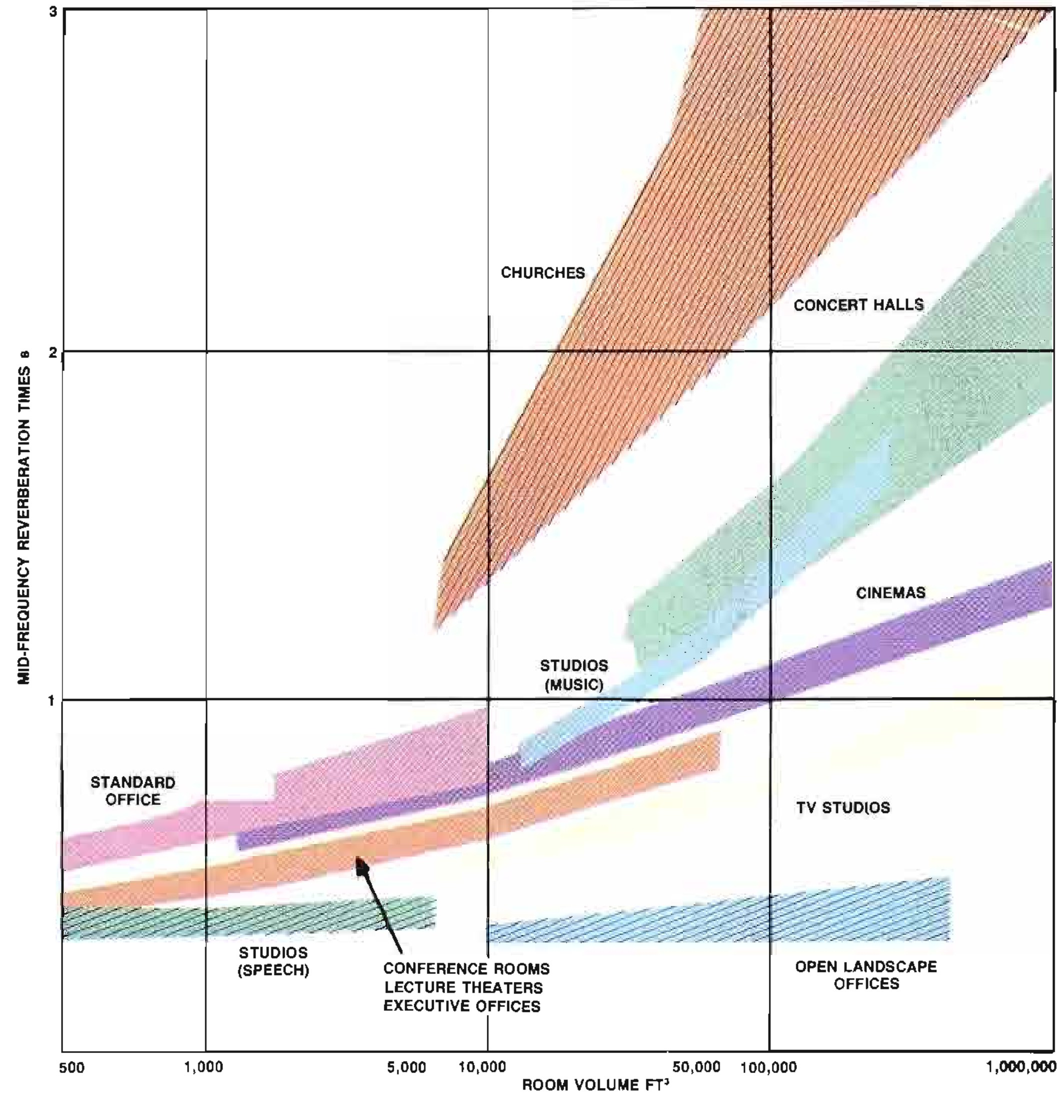

Figure 3. *Optimum mid-frequency reverberation times.*

at the six frequencies commonly used to measure absorption. Note that *all* materials are acoustically absorptive to some degree, not just those that are porous or fibrous.

Sound absorption also can be measured in *sabins*. One sabin is the amount of absorption provided by one square foot of complete absorption ($\alpha = 1$). The amount of absorption provided by any material can be found by computing the surface area of the material(s) and multiplying it by the absorption coefficient of the material at each frequency of interest:

$$A = S\alpha$$

where A is the absorption in sabins. The total absorption present in a room may be computed by summing the absorptions of individual materials.

Note that most common materials have different absorption coefficients at different frequencies. This is usually a function of the thickness of the material or construction. (You may correctly guess that this is due to the large difference in

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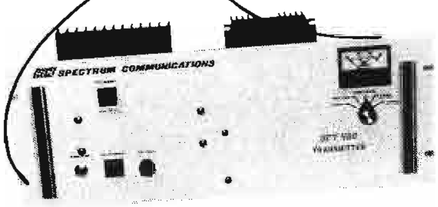

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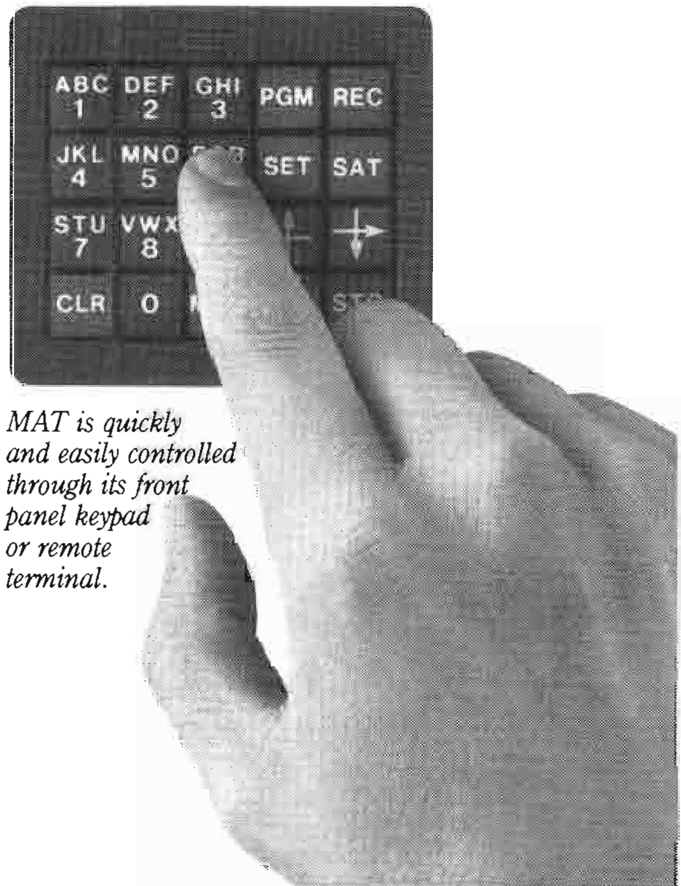

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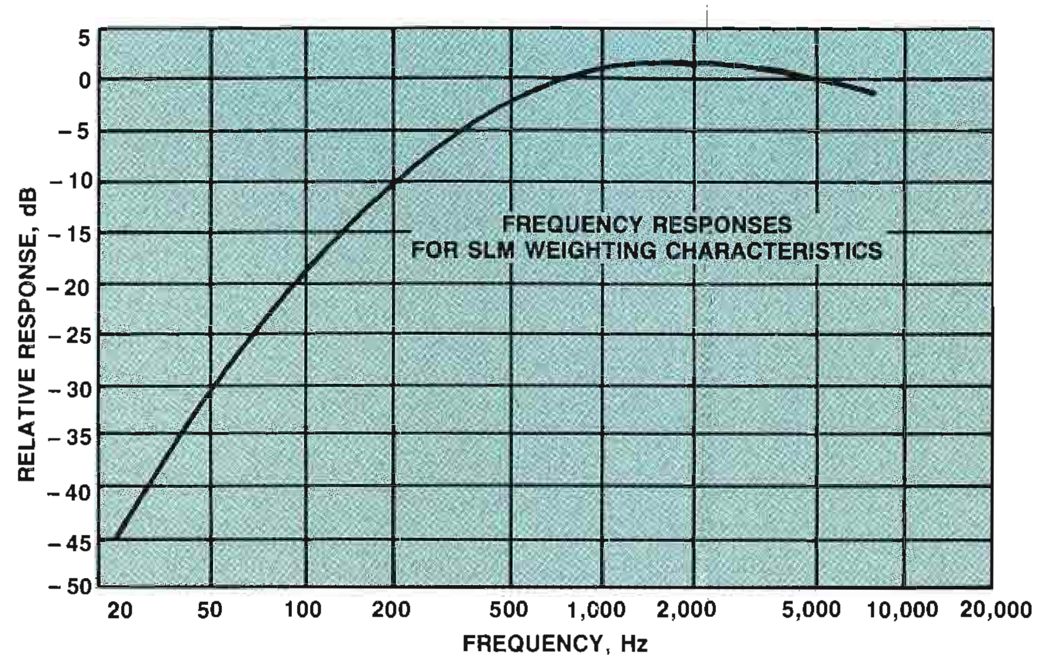

Figure 4. *A curve showing an A-weighting network.*

wavelength between high-frequency and low-frequency sounds.) It is important to note that thin materials *cannot* have high-absorption coefficients except at high frequencies. Despite some manufacturers' claims, thin wall coverings do not provide much acoustic absorption unless they are installed over other materials that provide the bulk of sound absorption.

Reverberation

As sound is reflected from surface to surface, some of its energy is lost through absorption and transmission, and the remainder stays in the space. *Reverberation* is defined as the sum of all sound energy in a space after the source has stopped. Reverberation potential is commonly measured as the time required for sound to decay 60dB, and is called reverberation time (RT or RT_{60}).

Reverberation time can be approximated for any space as a function of the room volume (V) and the total absorption present (A) by the equation:

$$RT = 0.049 \frac{V}{A}$$

Optimum reverberation times have been determined for various uses as a function of room volume. Figure 3 is a useful guide for establishing the range of acceptable reverberation times for a given room use. Although the diagram gives only the optimum reverberation time at "mid-frequency," it is generally found that the reverberation time should be relatively constant across all frequencies, while allowing slightly longer reverberation times at frequencies below 250Hz.

Room acoustics

Room acoustics often are a major concern to a studio owner. Sound may travel directly from a source to a listener (or microphone), or it may be reflected and mod-

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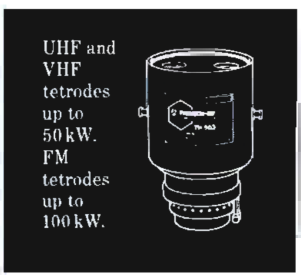

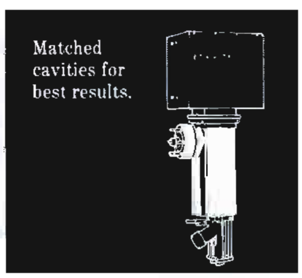

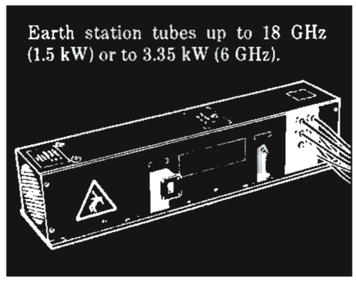

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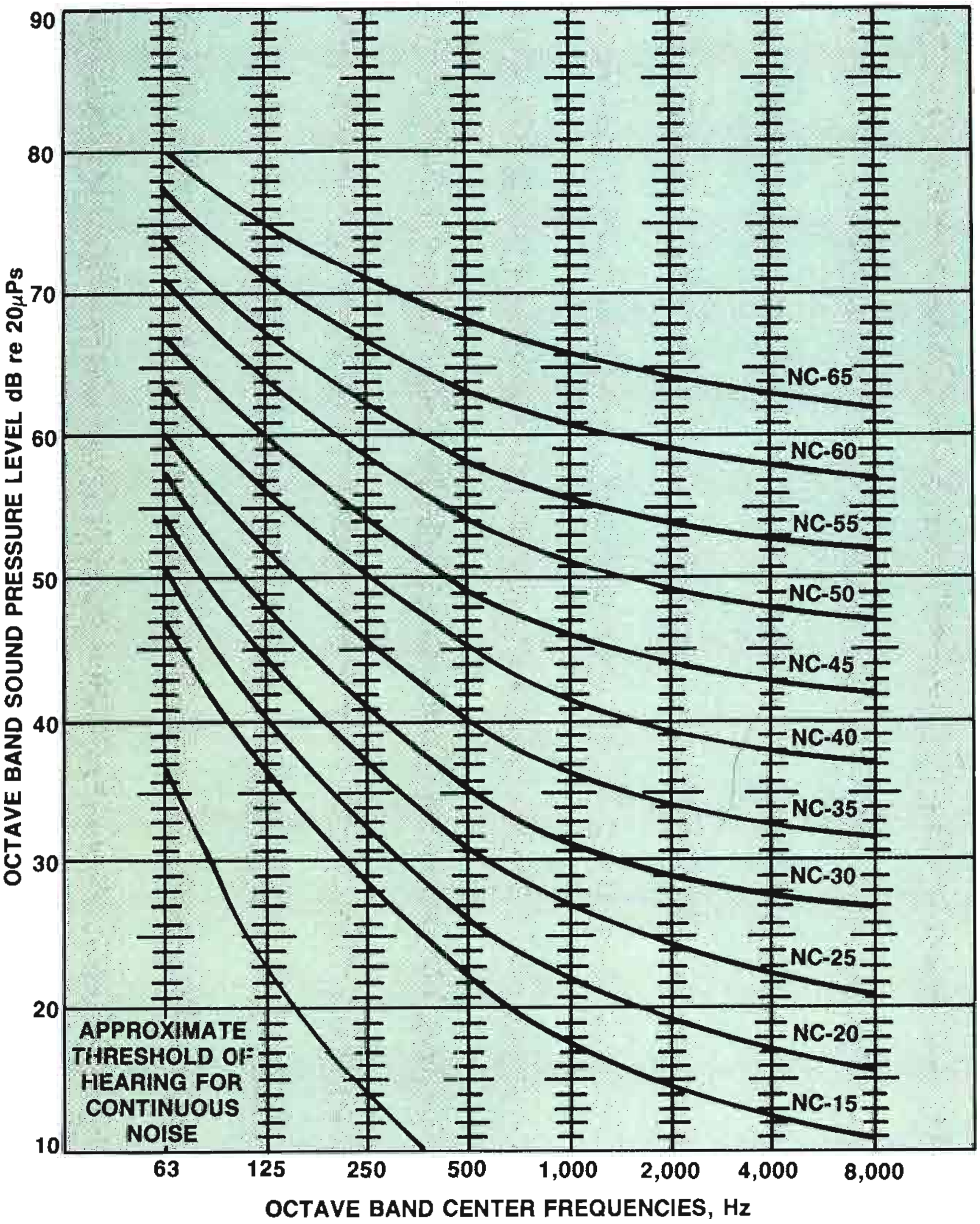

Figure 5. *Noise criteria (NC) curves.*

ified by many surfaces before it reaches the listener. How the sound is reflected and where it travels depends upon the shape of the room, the position and nature of surface materials and the shape and nature of masses the sound encounters.

Every room or space is an acoustical vessel which, like a musical instrument, can be tuned to resonate at particular sound frequencies. The frequencies at which a room comes alive are known as resonant frequencies or room resonances, and they are a function of the room shape and size, as well as the nature of the construction materials.

There is some disagreement about the ideal proportions of a rectangular room. The authors recommend dimension ratios of 1:1.25:1.6 or, for larger rooms, 1:1.6:2.5 or even 1:2.5:3.2. In reality, such precision is not necessary. However, square rooms or rooms whose dimensions are nearly equal multiples of one another (such as 1:2 and 1:3) should be avoided. Non-rectangular rooms also are encouraged. In designing rooms with more than four walls, avoid regular polygons.

Also avoid circular rooms or rooms with concave curved walls, but for other reasons, which will be discussed. Keep in mind that walls can be made non-parallel to opposing walls by tilting them out of the vertical plane as well as off the horizontal axes of the building.

Reflection and diffusion

In general, sound intensity decays with distance traveled. (Outdoors, sound intensity decays according to the *inverse square* law, where the intensity at any point is inversely proportional to the distance from the source.) To achieve greater sound intensity at a distance from the sound source, you can use reflections to bring additional sound to the listener. This, of course, requires large areas of reflecting surfaces to provide the needed sound paths for reflection.

Acoustically "hard" reflecting surfaces should be used for the floor beneath the performing area, the walls that surround the performers and any portions of the ceiling that can be used to reflect sound toward the audience or microphones.

It is desirable to break up large, flat reflecting surfaces to *diffuse* the sound. Diffusion is the spreading of sound waves by reflecting them in different directions. Diffusion disperses sound energy so that it is not all concentrated in a small area.

Convex surfaces and architectural detail may be used to accomplish this, if they are used correctly and in large enough proportions. Again, the physical size of diffusive elements must relate to the size of the sound waves; architectural features with dimensions of only a few inches will diffuse only very high-frequency sound.

Concave surfaces tend to cause the focusing of sound and, in turn, unwanted echoes. If a hard concave wall faces the performing area in a large room, the performers actually hear reflections of their own performance. In studio spaces, concave surfaces should be avoided at all costs. The use of hard reflective surfaces and diffusive elements is not critical in small studios, where the need for absorptive treatment is more important.

"Live" vs. "dead"

Reverberation time is not a critical concept in studio design. In practice, it is found that broadcasters (both technical personnel and station management) prefer studio spaces that are as "dead" (that is, non-reverberant) as possible.

It occasionally is argued that modern microphones allow the use of studios that are more "live" or reverberant, having reverberation times greater than those recommended. Although that may be true, every broadcaster known to the authors prefers studios that are "too dead" to those that are "too live." As pointed out by one broadcast engineer, it is possible to add reverberation electronically, but it is not possible to electronically remove reverberation from a recorded program.

Again, the physical dimensions of absorptive materials are important. Because materials even one inch thick are *highly* absorptive only at frequencies of 500Hz or more, it is commonly necessary to provide *bass traps* in studio spaces to absorb low-frequency sound. Bass traps are special constructions that employ an entrapped air space to provide required depth for absorbing long-wavelength sounds.

Noise control

All these acoustical considerations will not create a good studio unless the interior environment can be kept *quiet*. Although they are part of the science of acoustics, the techniques of noise control are completely separate from those of room acoustics.

Continued on page 284

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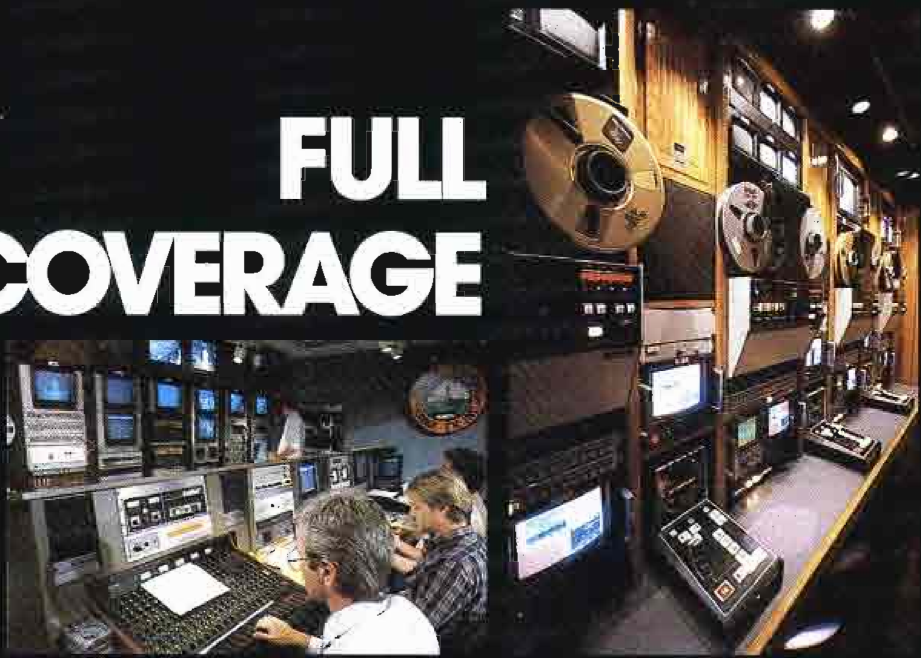

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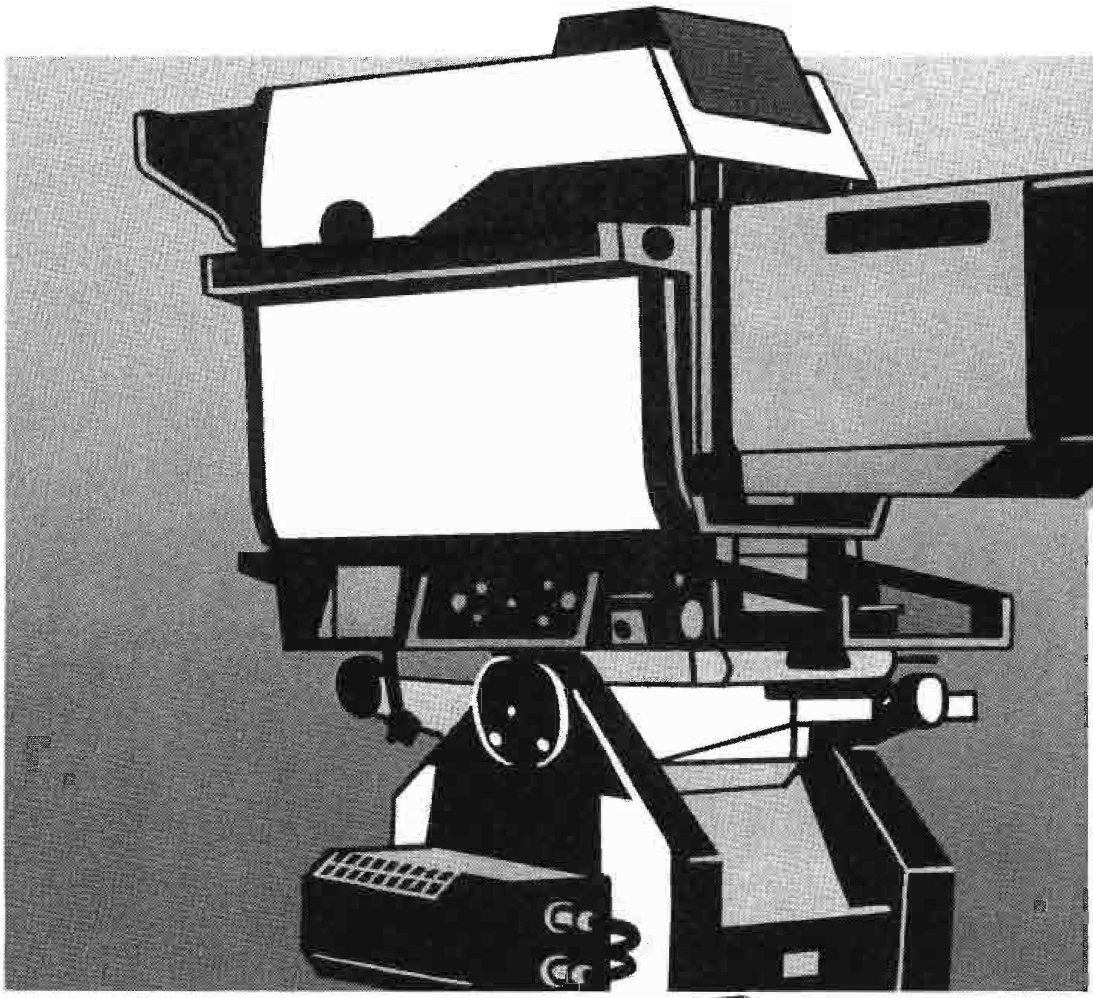

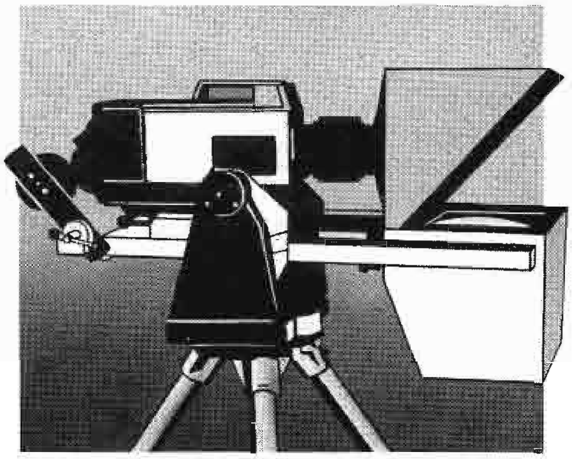

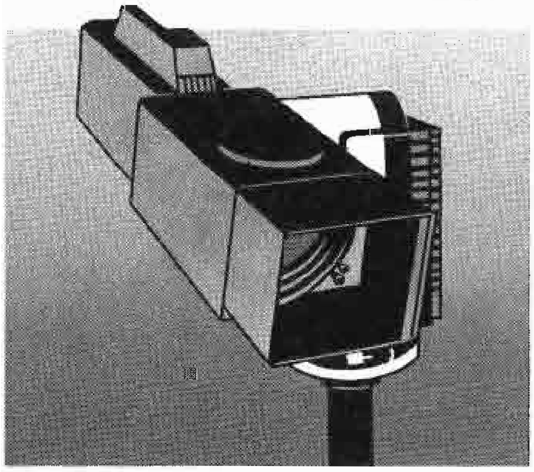

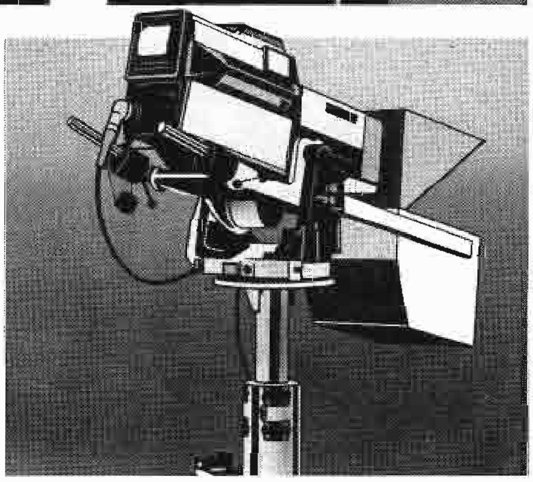

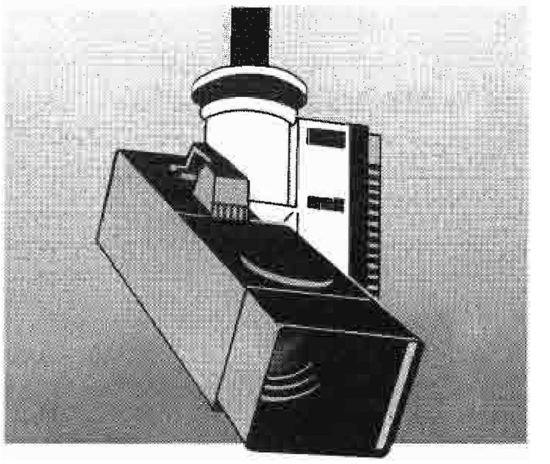

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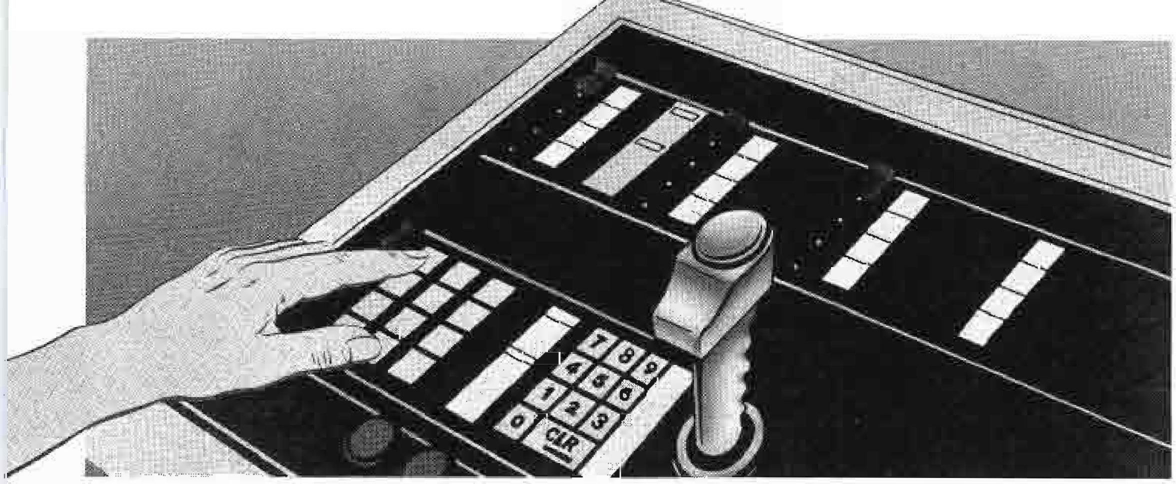

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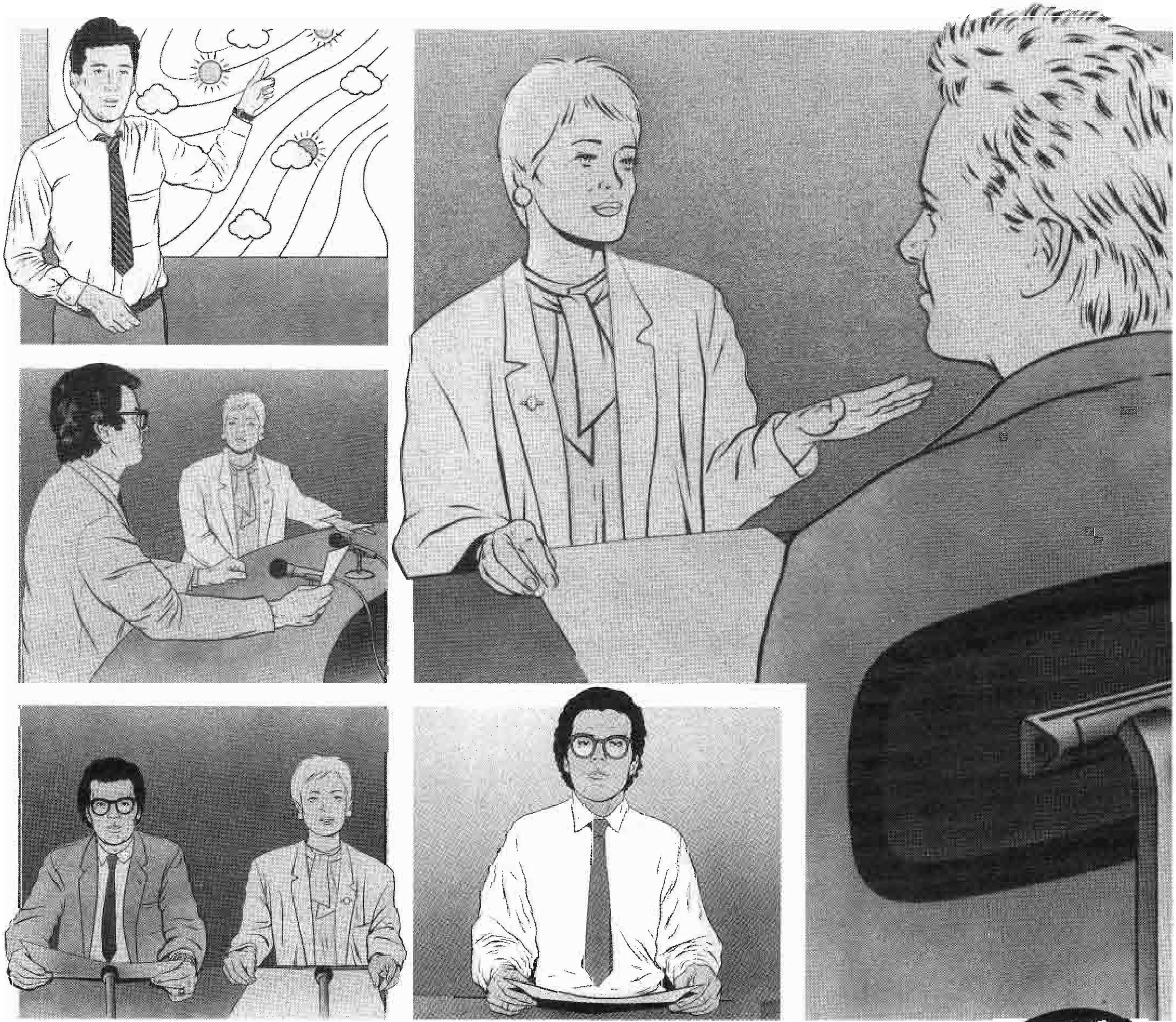

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Continued from page 280

MATERIAL	ABSORPTION COEFFICIENTS 125Hz	250Hz	500Hz	1,000Hz	2,000Hz	4,000Hz
Acoustical Tile:						
¾″ mineral fiber						
hard backing	0.03	0.27	0.83	0.99	0.82	0.71
suspended	0.68	0.67	0.65	0.84	0.87	0.74
1″ fiberglass						
hard backing	0.06	0.25	0.68	0.97	0.99	0.91
suspended	0.69	0.95	0.74	0.98	0.99	0.99
Brick, unglazed	0.03	0.03	0.03	0.04	0.05	0.07
Brick, painted	0.01	0.01	0.02	0.02	0.02	0.03
Carpet on concrete	0.02	0.06	0.14	0.37	0.60	0.65
Carpet on foam pad	0.08	0.24	0.57	0.69	0.71	0.73
Concrete Block, coarse	0.36	0.44	0.31	0.29	0.39	0.25
Concrete Block, painted	0.10	0.05	0.06	0.07	0.09	0.08
Fabrics:						
10 oz medium velour						
hung flat to wall	0.03	0.04	0.11	0.17	0.24	0.35
14 oz medium velour						
draped to half area	0.07	0.31	0.49	0.75	0.70	0.60
18 oz heavy velour						
draped to half area	0.14	0.35	0.55	0.72	0.70	0.65
Floor materials:						
concrete or terrazzo	0.01	0.01	0.01	0.02	0.02	0.02
tile on concrete	0.02	0.03	0.03	0.03	0.03	0.02
wood parquet on concrete	0.04	0.04	0.07	0.06	0.06	0.07
wood on wood joists	0.15	0.11	0.10	0.07	0.06	0.07
Glass:						
ordinary window glass	0.35	0.25	0.18	0.12	0.07	0.04
heavy plate glass	0.18	0.06	0.04	0.03	0.02	0.02
Gypsum Wallboard						
nailed to 2x4 studs	0.29	0.10	0.05	0.04	0.07	0.09
Plaster						
smooth finish on brick	0.01	0.01	0.02	0.03	0.04	0.05
rough finish on lath	0.14	0.10	0.06	0.05	0.04	0.03
Plywood Paneling (¾″)	0.28	0.22	0.17	0.09	0.10	0.11

***Table 1.** Absorption coefficients of typical building materials.*

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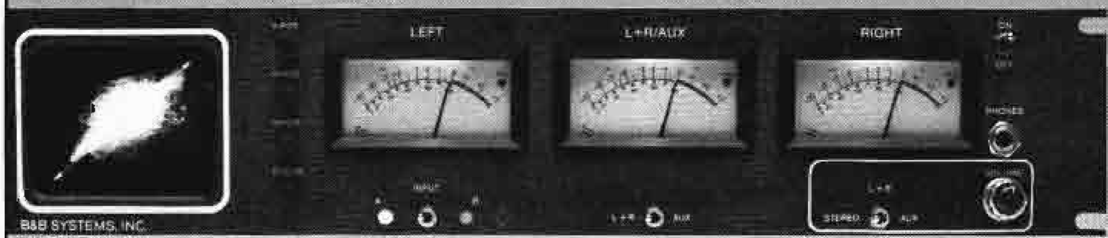

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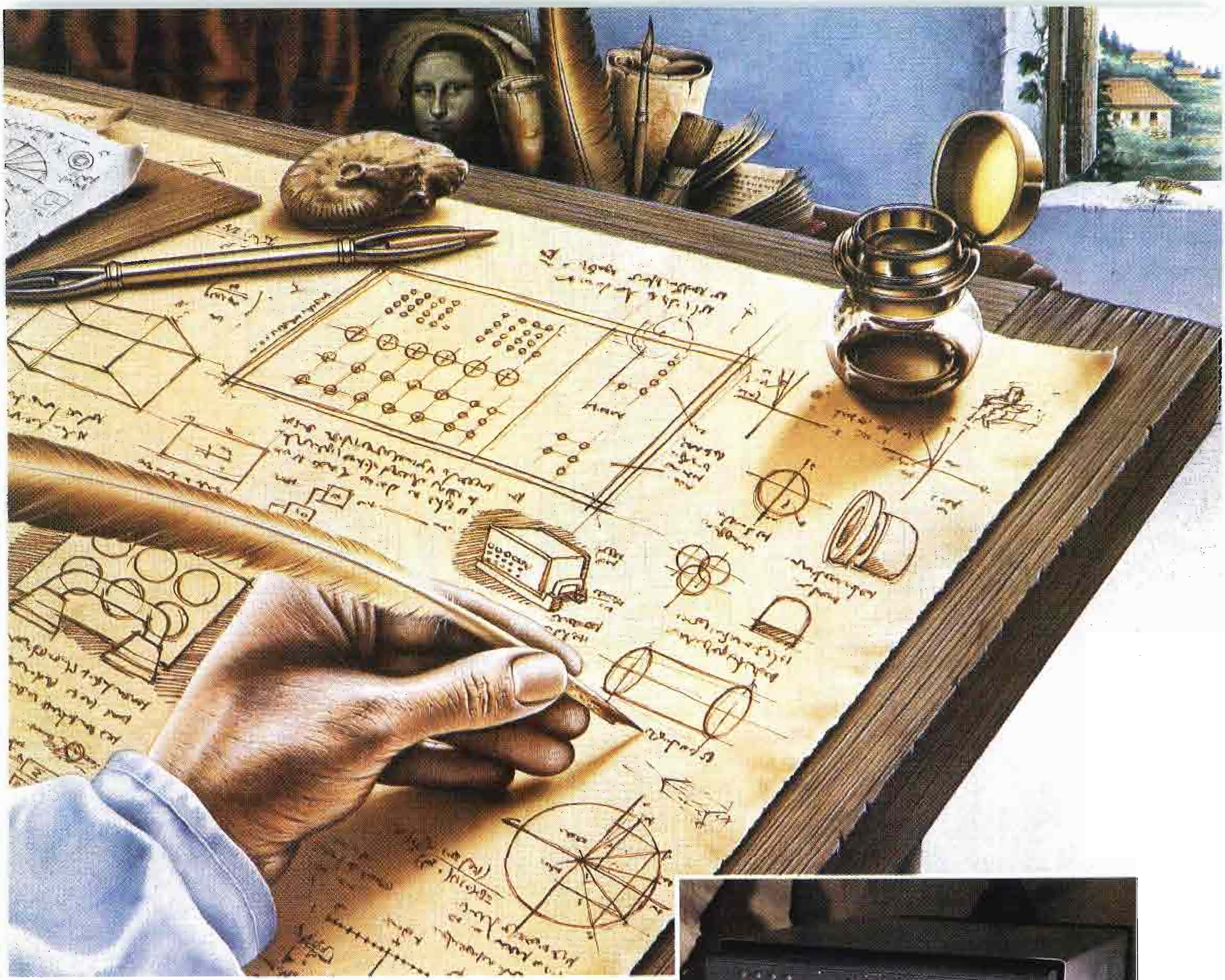

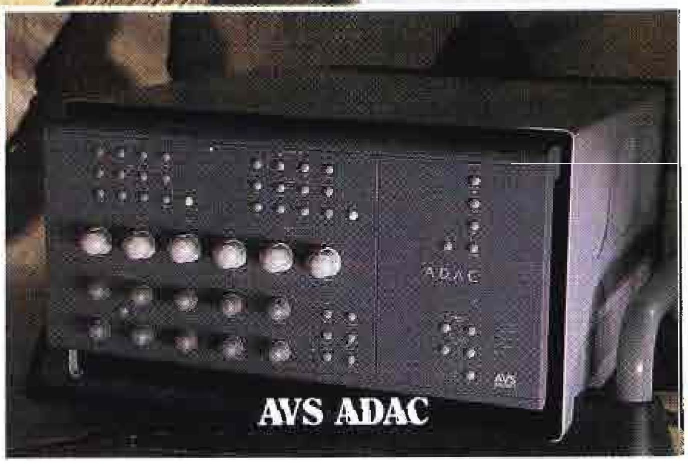

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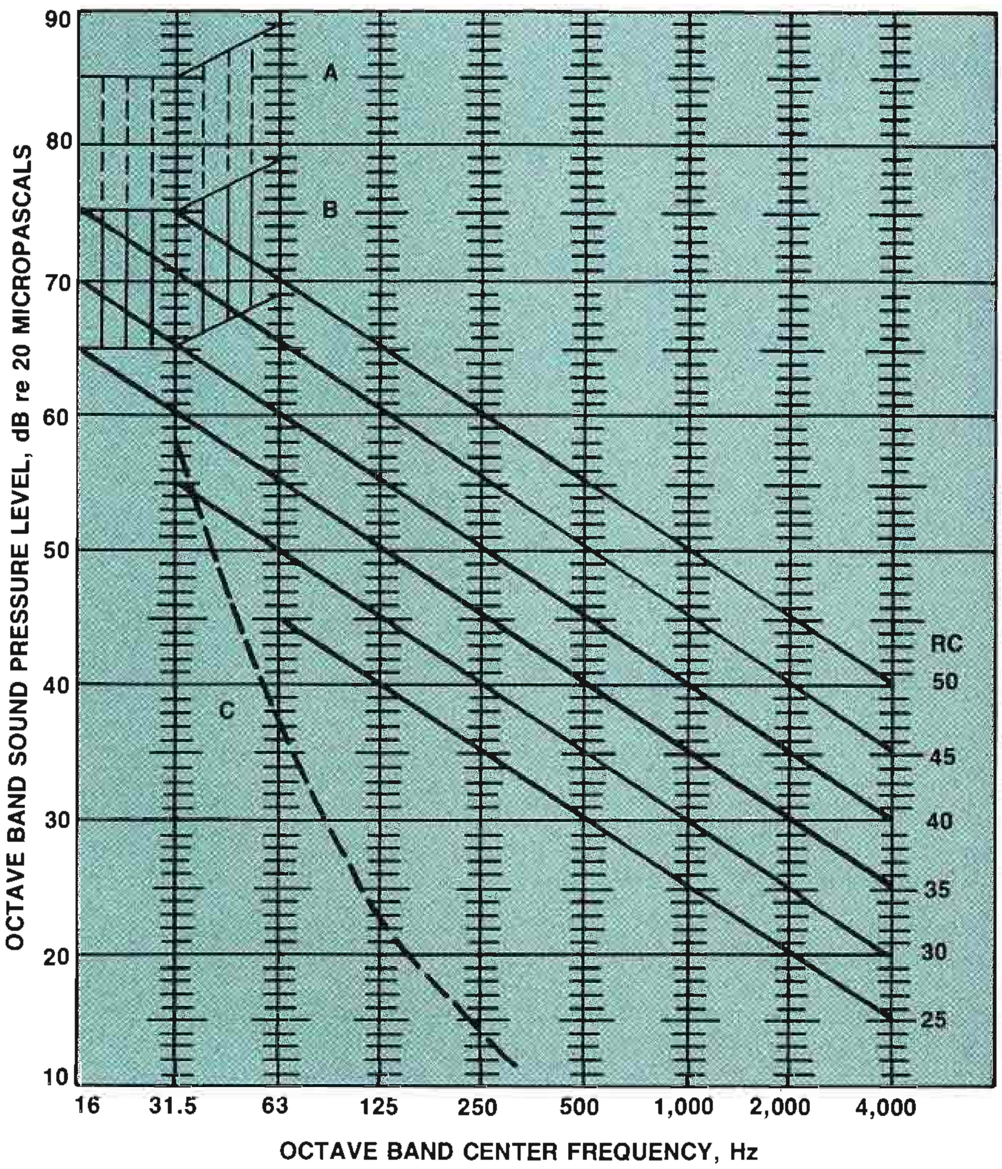

Figure 6. *Room criteria (RC) curves.*

The problems of noise control fall into two general areas, both of which must be of concern to the broadcaster and the acoustical consultant. These are airborne sound transmission and structure-borne sound transmission.

Airborne sound transmission can be further subdivided. Of greatest concern is room-to-room sound transmission where the problem may be either sound that enters the studio from an adjacent space or sound from a studio that disturbs the occupants of an adjacent space. There also is the potential for the intrusion of exterior noise through walls, roofs and floors. One final area of airborne sound transmission is the noise that may be introduced to a quiet space by the mechanical air-conditioning system.

Structure-borne sound problems usually fall into three basic areas. The first of these, and the easiest to control, is the sound of impacts to the structure—primarily footfalls. Of greater concern is the energy that may be imparted to the structure from mechanical equipment and plumbing systems. Occasionally, airborne sound sources in a studio (such as large monitor loudspeakers) also impart significant energy to the structure, which can be reradiated as sound elsewhere in the building.

Maintaining quiet

It is important to predetermine how *quiet* is to be defined. Two (or three) common systems are employed for rating the noisiness of built environments. The most common, and least useful, is the A-weighted sound level. The A-weighting curve (see Figure 4) is applied to the full-frequency spectrum of a sound environment. It provides a single number that indicates the magnitude of the sound intensity as it would be detected by the human ear, which does not hear all frequencies equally well. The A-weighted sound level can be measured using a simple sound-level meter.

The other two systems require more knowledge of the frequency content of the sound spectrum under consideration. For each, the sound level must be measured at each of eight frequencies, an octave apart. These are plotted against standard rating criteria, allowing the full sound spectrum to be given a single-figure rating based on a comparison with the criteria.

The older of these two systems, the noise criteria (NC) curves, shown in Figure 5, still is the most commonly used rating system for interior sound environments dominated by air-conditioning noise. The NC rating is determined by the lowest curve not penetrated by the measured sound levels. The room criteria (RC) curves, shown in Figure 6, are similar to the NC curves, but require that the measured spectrum approximate the rating line that it falls below. This assures that the sound spectrum itself will not be "rumbly," "hissy" or otherwise unpleasant to listen to.

Typically, background sound levels of RC-20 (NC-20) or less are specified for studio spaces.

Sound insulation

Once the required level of quiet has been determined, the amount of sound insulation required can be calculated for any known level of sound in adjacent spaces. The most effective method of reducing airborne sound transmission between a quiet space and its surroundings is to completely separate the two with solid barriers. Because the sound transmission loss of common materials follows the mass law, the most effective barrier materials are heavy ones.

As noted, however, a doubling of the mass of a wall produces only a 6dB increase in the sound transmission loss it provides. Therefore, it is unrealistic to attempt to improve a wall only by increasing its mass.

Composite walls

It can easily be seen that two corridor walls, each providing 30dB of sound attenuation, should produce about 60dB sound transmission loss between the rooms on opposite sides of the corridor. Following the same logic, it should be possible to design a composite wall whose sound transmission loss is equal to the sum of the TL of its component parts. The trick in making this happen is that all of the various components must be independently supported.

In designing and building composite walls, it is most important to minimize the structural contacts among the various layers of sound barrier materials. Ideally, the individual layers would not touch each other and would be supported only at the edges, but this is seldom practical.

Although two sheets of gypsum wallboard attached to wood studs provide only 6dB more sound transmission loss than the TL of a single sheet, the same two sheets of wallboard can provide nearly twice the TL of a single sheet if supported by resilient, lightweight metal channel studs. Where composite walls cannot pro-

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Teaching audio technology

By Brad Dick, radio technical editor

Audio engineers for recording and broadcast applications are in constant demand. An even more specific need is for trained people to work within the non-commercial broadcast arena. This lack of trained personnel led National Public Radio (NPR) to develop a program to teach the art and science of audio technology to the staffs of its member stations. The result is the NPR Music Recording Workshop (MRW).

Although NPR provides several types of training programs to its member stations, many would agree that MRW is one of the more successful. The yearly workshop is held in two sessions, each of which concentrates on a different type of music. One session addresses the unique techniques of recording classical music, and the other is directed at jazz and folk music.

In the past 16 sessions, more than 1,200 public broadcasters have attended. Topics covered in the workshop include console operation, mixing, microphone selection and placement, monitoring, troubleshooting, acoustics and digital-recording techniques.

Practical application

The workshop takes a hands-on approach by combining lectures and practical applications. At last year's classical session, the bulk of the instruction was provided by industry experts including David Moulton, Skip Pizzi, Neil Muncy, David Glasser, Paul Blakemore, David Peelle and Curt Wittig. The interaction of the students with the instructors, as well as with one another, provides valuable learning situations.

The 6-day workshop is one of the most intensive educational experiences a recording engineer may ever encounter. The training sessions begin at 8 a.m. and continue well past 10 p.m. The students then gather with the instructors to critique their own work and exchange ideas.

Although many of the topics could be learned by reading any of a number of books, Dave Moulton's "Ear Training Drills" are a notable exception. Through a total of 12 ear-training exercises, the participants are taught how to critically listen to sound. In one of the exercises, a digitally produced tape is used to reproduce pink noise with different octaves, either boosted or cut by 12dB. As the students become more knowledgeable, the tests become more difficult. Pink noise is replaced by program material. Later tests require the students to identify the two different octaves by listening to program material.

Amplitude alternations are not the only ear-training drills. Moulton also subjects the students to other drills in which they must correctly identify program anomalies, such as stereo-vs.-monaural programming, equalization, distortion, time-delay/reverb, companding and amplitude changes. Although the students typically complain about the tests, which really are hard work, most admit that they are useful.

The students are invited to participate in live recordings with performing ensembles and orchestras. The highlight of the classical workshop is the simultaneous recording of a symphony orchestra with 12 different micing techniques. Each micing technique is recorded separately on a 24-track recorder so that later comparisons can be made. This particular demonstration helps students identify the unique sound characteristics produced by the various techniques.

The careful integration of such learning experiences have made NPR's music recording workshop a much-sought-after program. Applicants often must be turned away because of the limited number of openings. If you are interested in learning more about this training program, write National Public Radio, Training Coordinator, 2025 M Street N.W., Washington, DC 20036.

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Acoustical terminology

Absorption:	The conversion of sound energy into other forms of energy and ultimately into heat, such that energy is neither reflected nor transmitted.
Acoustics:	The science that deals with the production, control, transmission, reception and effects of sound.
Attenuation:	A reduction in amount, force or magnitude. In acoustics, a reduction in sound level.
Compression:	A region (in a sound wave) of maximum pressure, where the sound pressure is in excess of the normal atmospheric pressure.
Diffusion:	The spreading or scattering of sound energy by reflection of sound waves in different directions.
Frequency:	The number of sound waves per second produced by a sound source.
Rarefaction:	A region (in a sound wave) of minimum pressure, where the sound pressure is less than the normal atmospheric pressure.
Reflection:	The return of sound energy (in the form of sound waves) from a surface.
Reverberation:	The sum of all sound energy in a space after a sound source has stopped.
Sabin:	The unit of sound absorption, equivalent to one square foot of complete absorption.
Sound:	A physical disturbance capable of being detected by a human ear.
Sound intensity:	Rate of flow of sound energy through a unit area.
Sound level:	Intensity of sound expressed in decibels, defined by the equation: $dB = 10 \log \frac{I}{I_{ref}}$, where I is the sound intensity and I_{ref} is a reference intensity of 10^{-12} watt/meter^2
Sound transmission:	The passage of sound energy through a space or material.
Sound transmission loss:	The reduction in sound level (in decibels) due to the passage of sound energy through a material.
Wavelength:	The length of a sound wave (usually in air) between two points of equal sound pressure.

Main story continued from page 286
vide the required sound transmission loss between two spaces, the use of a *buffer space*, such as a corridor, storage room or other quiet area, will allow the designer to actually employ two walls between critical areas.

STC ratings

Many designers, particularly those with only an elementary understanding of acoustics, like to use single-figure descriptors to compare and evaluate available construction materials. The single-figure rating used for sound transmission loss is the sound transmission class (STC). Although the method used to determine STC is complex and beyond the scope of this article, a few observations should be made about its use.

The determination of STC evaluates only frequencies between 125Hz and 4,000Hz. STC was developed primarily as a tool for evaluating the sound transmission of speech and music and is not valid for noise sources with frequency spectra that differ significantly from these. Thus, it may not provide an accurate estimation of sound transmission loss for the sound of mechanical equipment, motor vehicles or even some music containing a large component of very low-frequency sound.

Sound leaks

To provide 60dB of sound transmission loss between two spaces, the spaces must be completely separated by barriers, all of which provide the required TL. This includes walls, floors, ceilings, doors and windows. In reality, the overall sound transmission loss of a wall is limited by the sound that escapes through or around an enclosure, through construction cracks, weaknesses in materials and small openings. The limitation created by small openings can be approximated by the equation,

$$TL \leq 10 \log (\text{wall area} \div \text{area of openings})$$

At first glance, this equation does not appear to create problems for the designer. For example, it predicts that an opening equal to 1% (0.01) of the area of a wall will limit TL to 20dB. A crack one-tenth of 1% (0.001) of the wall area will limit TL to 30dB. But if TL is required to be 60dB, then cracks and openings must be limited to 0.000001 (one ten-thousandth of 1%) of the wall area. (Note that a 1/32-inch crack below a 3-foot-wide door in a wall 100 feet long and eight feet high limits the overall TL to 50dB.)

Of course, doors and windows seldom provide the same TL as the wall in which they are installed. They lower the composite TL of the wall by an amount proportional to their size. In general, if windows and doors are of good quality, and are no larger than absolutely necessary, their effect is not serious.

However, it should be pointed out that to provide 60dB of sound transmission loss between two spaces, the spaces must be separated by a barrier providing *more* than the required 60dB, with a minimum area of high-quality doors and windows and *no* sound leaks.

Air-conditioning noise

Airborne noise problems due to air-conditioning systems are typically of two types. One is the noise of the fans and other mechanical equipment that can travel through ductwork into studio spaces. The second problem is that of noises created by the moving airstream. Because these may be created within or

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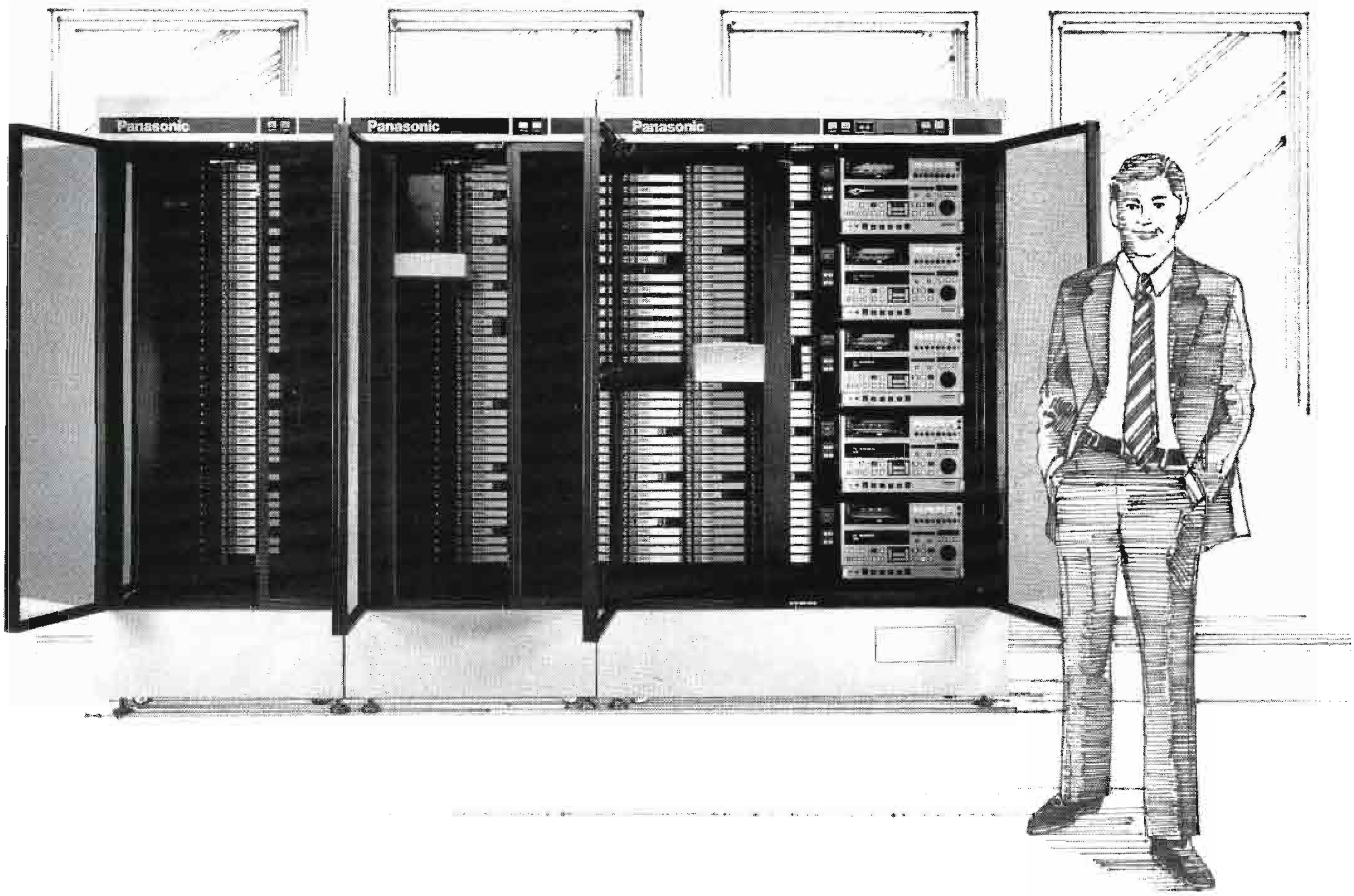

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near the studio, they are usually more critical.

Noise associated with a moving airstream is created either by turbulence or by the velocity potential of the air. Aerodynamic noise is roughly proportional to the fifth power of the linear velocity of the airstream (in feet per minute, not the volume airflow in cubic feet per minute). Thus, the best method of minimizing aerodynamic noise is to keep air velocity low, which can be done by keeping sizes large. Turbulence can be minimized by streamlining the duct system. Avoid sharp turns without turning vanes and successive turns close together.

Because a duct is an open pathway for sound, the duct can transmit sound from room to room as well as from the mechanical equipment room to a studio. To minimize the transmission of airborne sound through duct systems, all ductwork leading to or from studio spaces should be acoustically lined with an absorptive duct-liner material. Elbows and turns further reduce the sound through ducts, but their use must not create added turbulence. It is often necessary to install silencers (sound traps) in ducts serving studio spaces. Noise control in air-conditioning systems is an exact science, but one commonly misunderstood. It is not something that the novice should attempt unassisted.

Structure-borne noise

The capability of a material to transmit structure-borne sound is a function of its mass and stiffness. However, the degree to which materials transfer sound energy also is a function of the amount of energy available from the source. The best method of reducing structure-borne sound transmission is the use of discontinuous constructions.

Materials that isolate vibration can be used to stop the transmission of sound energy between two component parts of a composite wall or floor/ceiling system.

Vibration damping or energy-absorbing materials also can be used to reduce structure-borne sound transmission. This is the principle by which carpet can be used to reduce impact noise from footsteps on hard floors. Note that damping materials are most effective when applied at or near the source of energy.

Get help

On the assumption that the construction or renovation of a studio facility is justified, it only makes sense to do the job right. Acoustical treatment of a sound-critical environment is best left to experts.

Selected reference books

"Environmental Acoustics," by Leslie L. Doelle; McGraw Hill Book Co., New York, NY. 1972

"Acoustic Techniques For Home & Studio," 2nd Edition, by F. Alton Everest; Tab Books, Blue Ridge Summitt, PA. 1984

"The Master Handbook of Acoustics," by F. Alton Everest; Tab Books, Blue Ridge Summitt, PA. 1981

"Noise and Vibration Control in Buildings," by Robert S. Jones; McGraw Hill Book Co., New York, NY. 1984

"Studio Acoustics," by Michael Rettinger; Chemical Publishing Co., New York, NY. 1981

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SPA-277Y	277/480VAC	3ph 4 wire + gnd	435
SPA-480D	480VAC	3ph 3 wire + gnd	455

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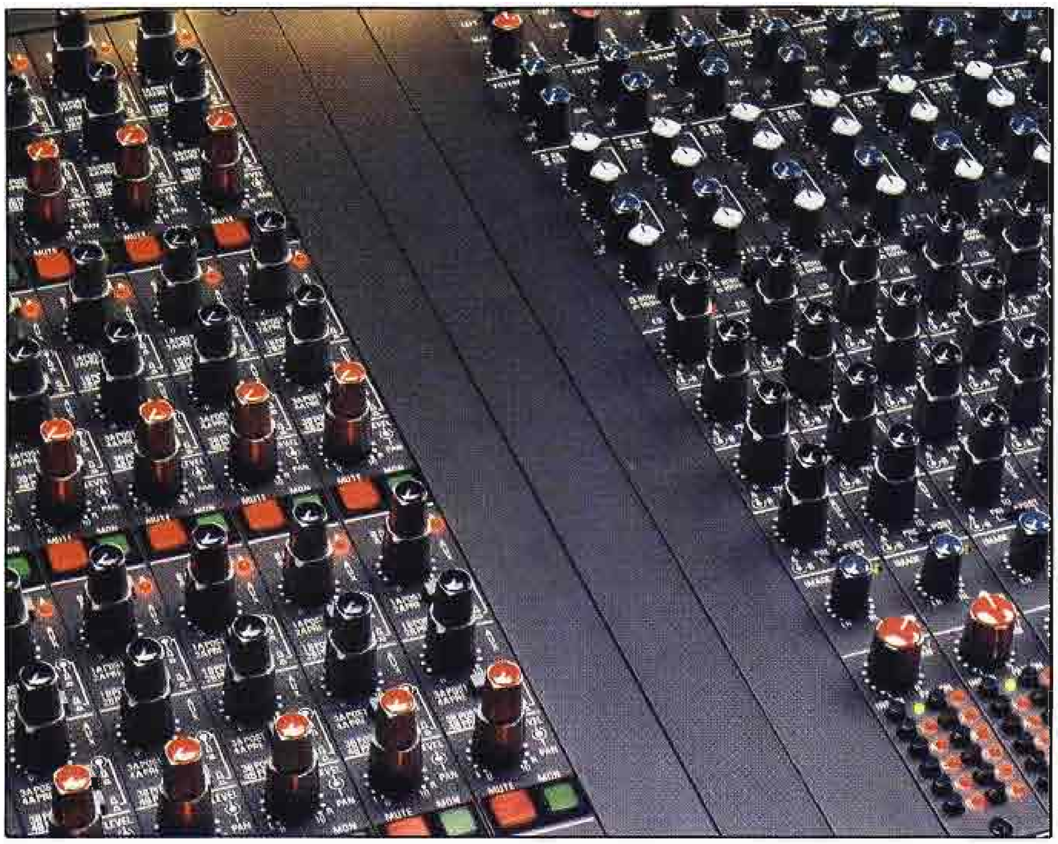

High-definition radio: Will it work?

By Douglas Fearn

This UHF broadcast band could open a whole new world of opportunities for daytime AM station owners.

Many daytime AM broadcasters are hoping something will be done to improve their chances for success in an already competitive situation. Many of these stations currently are forced to leave the air for most of the post-sunset period. Although these stations can apply for presunrise and post-sunset authorizations, the power levels permitted are quite small—often only a few watts.

One proposal for improving this situation relies on opening a new broadcast band. The band, covering the frequencies from 578MHz to 596MHz, would allow many daytime stations to become full-time operations. These frequencies encompass UHF-TV channels 32, 33 and 34. The TV stations currently operating on these channels would be afforded full protection under the proposal. However, no new UHF-TV stations would be licensed on these frequencies.

This new service would be called high-definition radio (HDR) because of the addition of FMX encoding. The proposal calls for mandatory use of FMX, thereby opening the door for a high-quality broadcast service.

The HDR proposal

The original HDR proposal was developed by station owner Larry Tighe, engineering consultant Clarence Beverage and communications attorney Larry Roberts. Under the plan, originally called FM2, many of the approximately 2,400 daytime-only AM stations would have the first opportunity to apply for an HDR channel. This group makes up half the existing AM stations.

After the daytimers have had the chance to begin operation in the new band, other

Fearn operates the engineering consulting firm of D.W. Fearn & Associates, West Chester, PA.

	MILES	KILOMETERS
CO-CHANNEL	106	170
200kHz	68	109
400kHz	40	64
600kHz	32	52

Table 1. *Minimum distances between HDR stations in the 578MHz to 596MHz band.*

CONTOUR	MILES	KILOMETERS
100dBu	3.7	5.9
80dBu	12.2	19.6
70dBu	20.0	32.1
60dBu	28.4	45.7
54dBu	39.3	63.2
40dBu	77.2	124.2

Table 2. *Theoretical distances to various signal-strength contours for HDR stations.*

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potential users would be permitted to apply. The second group of applicants would include those AM stations that share time with another station. Next, Class IV AM stations and other AMs demonstrating serious coverage problems may apply. The next group of eligible applicants to be considered would be those non-commercial applicants that were unable to be licensed on the FM band. Any remaining allocations would be assigned to other applicants that can demonstrate a need.

Upon FCC approval, both the existing AM station and the new HDR station may be operated for five years. At the end of that time, one of the licenses must be relinquished. If the HDR band becomes viable during this period, the licensee may choose to receive a formal HDR broadcast license and return the AM license to the FCC. The AM station then would shut down, and the station's frequency would not be reallocated by the commission.

The proposed plan also would allow the band to be used for STL, TRL and RPU applications. These low-power services would operate on a non-interfering basis and would be available to all broadcasters, not just HDR licensees. This service would benefit many stations in urban areas where STL and RPU frequencies are in short supply. To minimize the potential for interference, secondary users would be licensed on frequencies offset from the HDR channels by 100kHz, for example 580.2MHz.

Benefits

As the total number of AM stations dwindles through the conversion to HDR operation, the remaining full-time and part-time AM stations might be able to improve their service through increased power and/or relaxed directional requirements. The result of these changes could be a reduction in the number of marginally profitable daytimers. The proposal also may provide full-time service to the many communities that currently lack such coverage.

HDR transmission quality would be much better than that currently available from today's AM service. As the number of HDR stations increases, there also would be less interference to the remaining AM stations. From the perspective of many AM station owners, this plan represents a "win-win" situation for everyone.

Because the wavelength at 580MHz is less than one-fourth that of the present FM band, signal penetration into buildings should be better. Transmitting antennas could be lighter and have less windloading, thereby requiring lighter, less expensive towers. Receive antennas, especially those used in automobiles, could have higher gain.

The proposal would relax the receiving and transmitting relative bandwidth requirements because of the lower modulation index. Ducting and temperature-inversion propagation anomalies are less severe at the HDR frequencies, which should improve reception reliability. SCA paging reliability also should improve.

HDR proponents claim other benefits to the proposal. For instance, as the number of AM stations is reduced, thousands of acres of prime real estate, now used for AM antenna arrays, could be sold to generate working capital for the HDR stations. Finally, as the number of HDR stations increases, and the number of small AM stations decreases, the AM band might be able to return to its former role as a wide-area service.

Technical considerations

To be viable, the HDR band should use existing FM technology standards (with the addition of FMX), thus simplifying transmitter and receiver design. This realistic approach requires HDR to be com-

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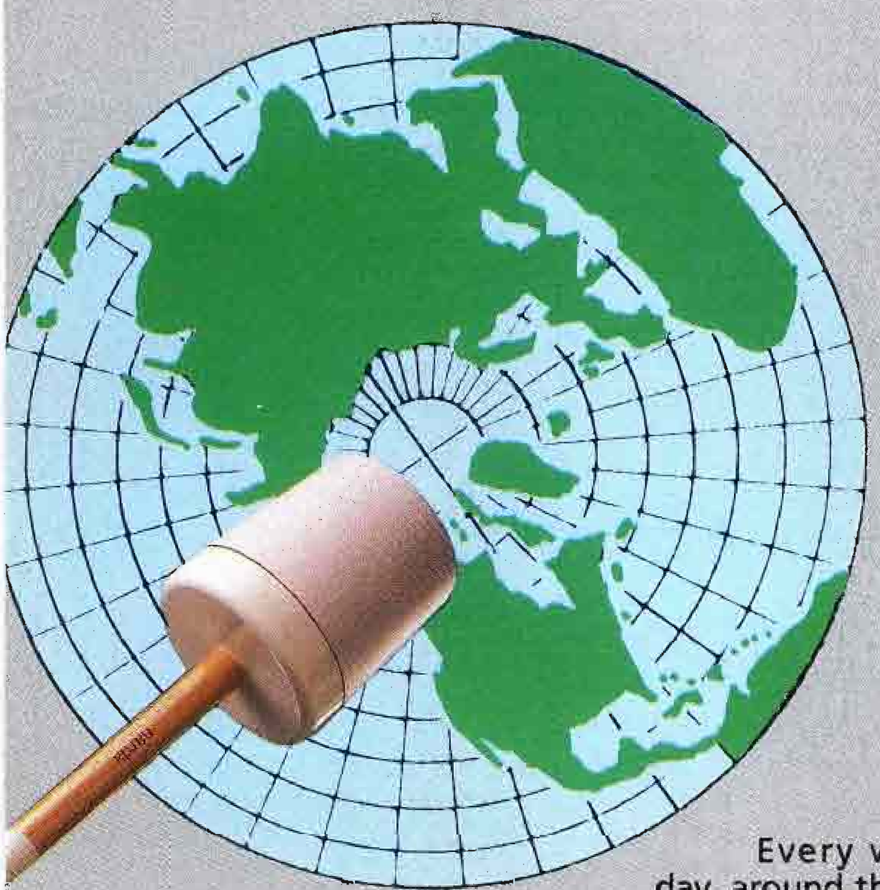

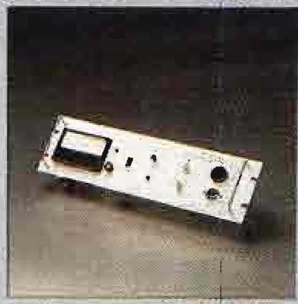

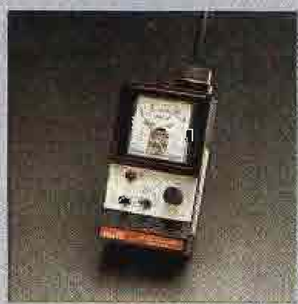

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patible with current equipment. Unfortunately, this approach eliminates the opportunity to apply new technology techniques, such as digital transmission.

Maximum modulation will be limited to ±75kHz. Frequency response, noise and distortion specifications would be the same as those for the current FM band. Stereo will be achieved using the conventional 19kHz pilot and 23kHz to 53kHz subchannel. Subcarrier (SCA) operation is permitted between 53kHz and 92kHz.

As proposed, HDR stations will operate on 90 channels of 200kHz each, with 50kW ERP at an antenna height of 500 feet above average terrain (HAAT), or with equivalent facilities. The minimum station separation distances are shown in Table 1.

These parameters will give HDR stations coverage similar to that of Class B FM stations—28 miles to the 60dBu contour, as shown in Table 2. Because of the propagation differences at the higher frequencies, interference will be less than that on the standard FM band.

There will be only one class of license available. Stations have to operate with at least 5kW at 328 feet HAAT to be licensed. This is designed to encourage full use of the new band and to discourage the short-spaced problems now facing many FM stations.

Receivers

No new service can succeed if receivers are not readily available. Fortunately for HDR, this seems to be an easy problem to solve.

Many modern FM receivers use phase-locked loop (PLL) synthesized tuning, as evident by the use of digital-frequency displays. The upper and lower tuning limits for such receivers are programmed in a ROM. It's a relatively minor modification to reprogram these chips. The receiver would tune from 88.1MHz to 107.9MHz, then jump to 578.1MHz, the first HDR channel. The receiver then would continue to tune, in 200kHz steps, to the last HDR channel at 595.9MHz. The next frequency would be 88.1MHz again (or perhaps 530kHz). The technique of using one knob for more than one band has been successful in television for many years.

Will it work?

A large number of questions remain to be answered before HDR can become a viable broadcast service. The first is whether the FCC will seriously consider a proposal. The most crucial question may be whether the broadcast industry will support such a proposal.

HDR promises to solve a variety of problems afflicting daytime stations, and it ultimately could benefit other current and future broadcasters. It will be an interesting proposal to watch.

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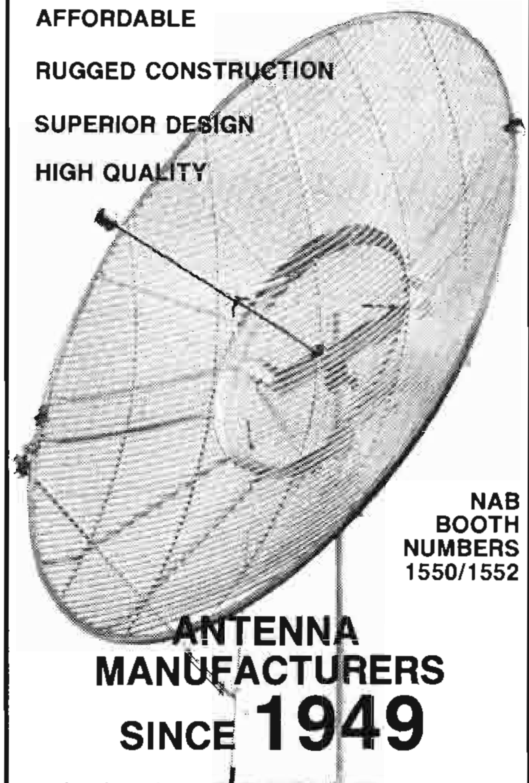

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Digital modulation: DX-10 AM transmitter

Edited by Brad Dick, radio technical editor

An amplitude-modulated (AM) signal, as used in radio broadcasting, is a constant-frequency RF signal whose amplitude varies with the audio input signal. The constant-frequency RF output signal is referred to as the carrier. The modulating signal—in this case, audio—varies the amplitude of the carrier.

Until recently, AM transmitters generally relied on only a couple of basic designs. Digital modulation is a new amplitude modulation technique that can increase greatly the efficiency and audio performance of a transmitter. The key to the effective implementation of digital modulation techniques lies in the use of a power-multiplying digital-to-analog converter (DAC).

Although the digital modulation process may be implemented in different ways, the one described here requires four basic steps and is based on the Harris DX-10 AM transmitter. A simplified diagram of the transmitter is shown in Figure 1.

An overview

In the first step, the modulating audio signal is low-pass-filtered, and a dc control voltage is added. The audio-processing stage provides an output signal that determines both the carrier level and modulation level.

The preceding composite (audio-plus-dc) signal then is digitized into a digital datastream of 12-bit words. The A/D conversion takes place in a high-speed converter. The audio is sampled at the carrier frequency or at a submultiple of the carrier frequency.

In the third step of the digital modulation process, a modulation encoder encodes the data into on/off signals for the RF power-amplifier stages. The digital bitstream now contains the signals required by 42 of the 48 RF power-amplifier modules.

Switched amplifiers

The fourth and final step involves using the modulation encoder signals to switch the individual RF power amplifiers on and off. Recall that an amplitude-modulated signal has a constantly changing RF level. In a digital AM transmitter, the RF level at the transmitter output is changed by switching on either a larger or smaller number of RF power amplifiers. Based on the signals from the modulation encoder, the correct number of RF amplifier modules are turned on or off. These amplifiers then are combined to produce the total output.

The RF power amplifier consists of 48 RF amplifier stages. Because 48 equal steps are not enough to accurately reproduce the modulation envelope required, binary-weighted steps are used to obtain the required resolution. The 42 amplifiers controlled by the modulation encoder are called big steps. Each big-step amplifier contributes an equal voltage to the combined output.

The binary steps (bits 7, 8, 9, 10, 11, 12) are controlled directly by the A/D converter and contribute ½, ¼, $^1/_8$, $^1/_{16}$, $^1/_{32}$ and $^1/_{64}$ the voltage of the big steps, respectively. This process will be examined more closely at another point in this article.

The RF amplifiers are, essentially, constant-voltage sources in which the outputs are combined in a multiturn primary, single-turn secondary, ferrite combiner. The outputs are combined to form an amplitude-modulated carrier with a quantized envelope. The quantized AM waveform then is filtered by a bandpass network to remove the unwanted spectral components.

Let's look more closely at how this digital technology is implemented in the DX-10 transmitter.

Audio processing

The audio processor (see Figure 2) contains a low-pass Bessel filter, which atten-

This article was adapted from a paper written by Nicholas G. Richards, Broadcast Group manager, Harris Corporation, Quincy, IL.

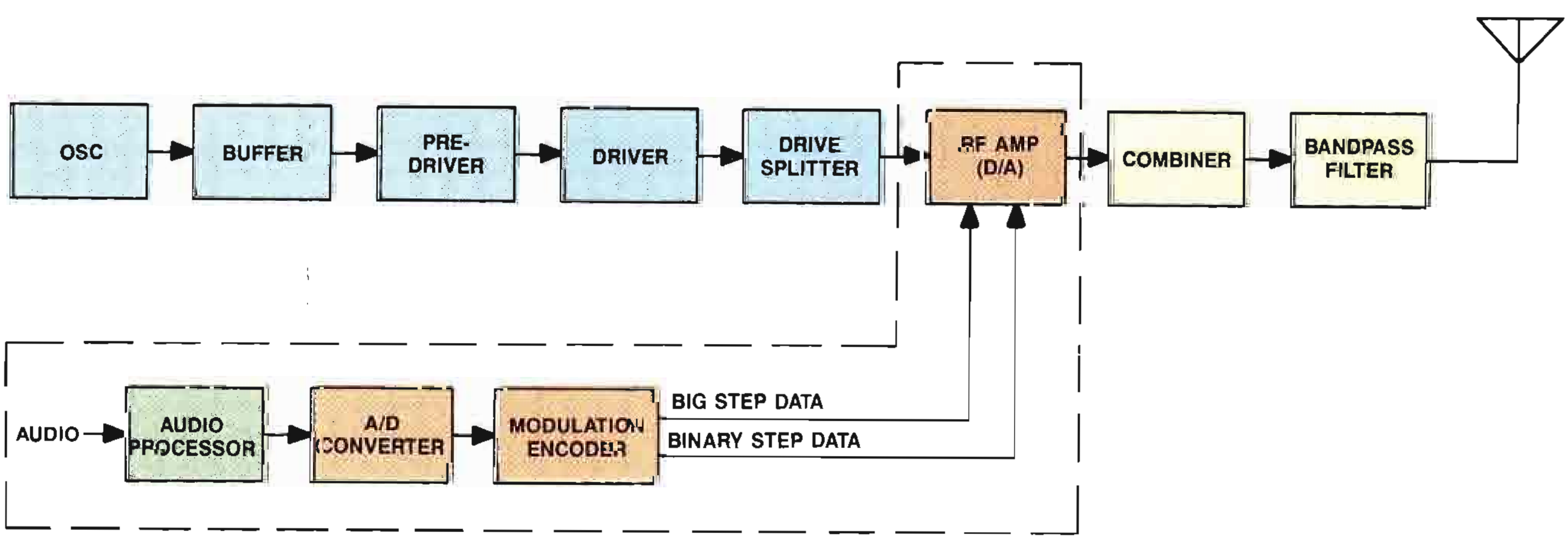

Figure 1. Basic digital AM transmitter block diagram. The sections within the dotted lines represent the digital portion of the transmitter.

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	BIT NO.								BIG STEP							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
ROM NO. 1	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	0
	0	0	0	0	0	1	X	X	1	0	0	0	0	0	0	0
	0	0	0	0	1	0	X	X	1	1	0	0	0	0	0	0
	0	0	0	0	1	1	X	X	1	1	1	0	0	0	0	0
	0	0	0	1	0	0	X	X	1	1	1	1	0	0	0	0
	0	0	0	1	0	1	X	X	1	1	1	1	1	0	0	0
	0	0	0	1	1	0	X	X	1	1	1	1	1	1	0	0
	0	0	0	1	1	1	X	X	1	1	1	1	1	1	1	0
	0	0	1	0	0	0	X	X	1	1	1	1	1	1	1	1
	001001XX TO 111111XX								YIELDS 11111111							
	BIT NO.								BIG STEP							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	000000XX TO 001000XX								YIELDS 00000000							
ROM NO. 2	0	0	1	0	0	1	X	X	1	0	0	0	0	0	0	0
	0	0	1	0	1	0	X	X	1	1	0	0	0	0	0	0
	0	0	1	0	1	1	X	X	1	1	1	0	0	0	0	0
	0	0	1	1	0	0	X	X	1	1	1	1	0	0	0	0
	0	0	1	1	0	1	X	X	1	1	1	1	1	0	0	0
	0	0	1	1	1	0	X	X	1	1	1	1	1	1	0	0
	0	0	1	1	1	1	X	X	1	1	1	1	1	1	1	0
	0	1	0	0	0	0	X	X	1	1	1	1	1	1	1	1
	010001XX TO 111111XX								YIELDS 11111111							

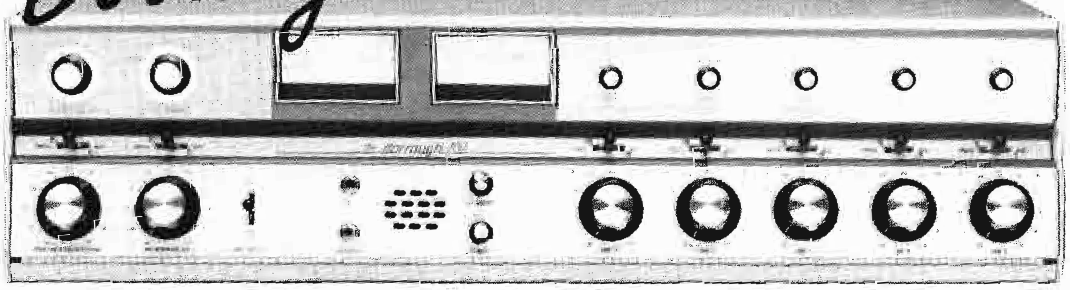
Table 1. When addressed by the modulat coder, the ROMs develop the drive signa the power amplifiers.

uates frequencies above the require dio frequency range. The output of Bessel filter feeds the input of an ampl with adjustable gain that compensate nominal audio input signal levels fr +10dBm to −10dBm.

The transmitter's power level at any stant is dependent upon the number of amplifiers that are turned on. The unm ulated, maximum power level is set usi a summing circuit, consisting of a differe tial amplifier with the audio signal on o input and a negative dc voltage on t other. This small negative dc voltage d termines the unmodulated carrier outp level. The maximum transmitter unmo ulated carrier output level is set by var ing this dc voltage.

The audio then feeds the input of an IC analog multiplier, which is connected to operate as a divider. The divider circui develops a control voltage that maintains constant transmitter power output with varying supply voltages. The audio signal is applied to one input of the divider, and a sample of the high-voltage power-supply output (+230Vdc) is applied to the other

The Dorrough Console Model 700



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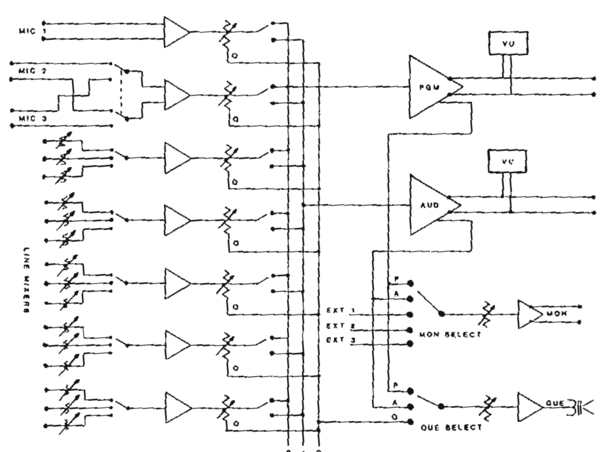

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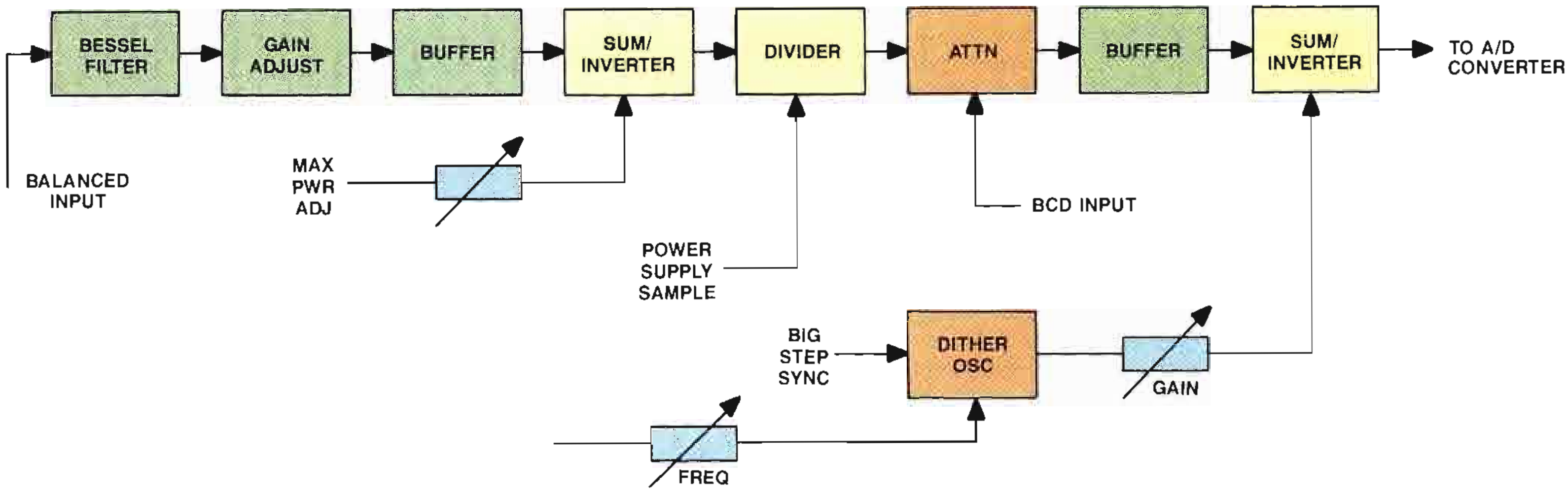

Figure 2. *The audio processor develops the audio + dither + dc control voltage signal, which is digitized.*

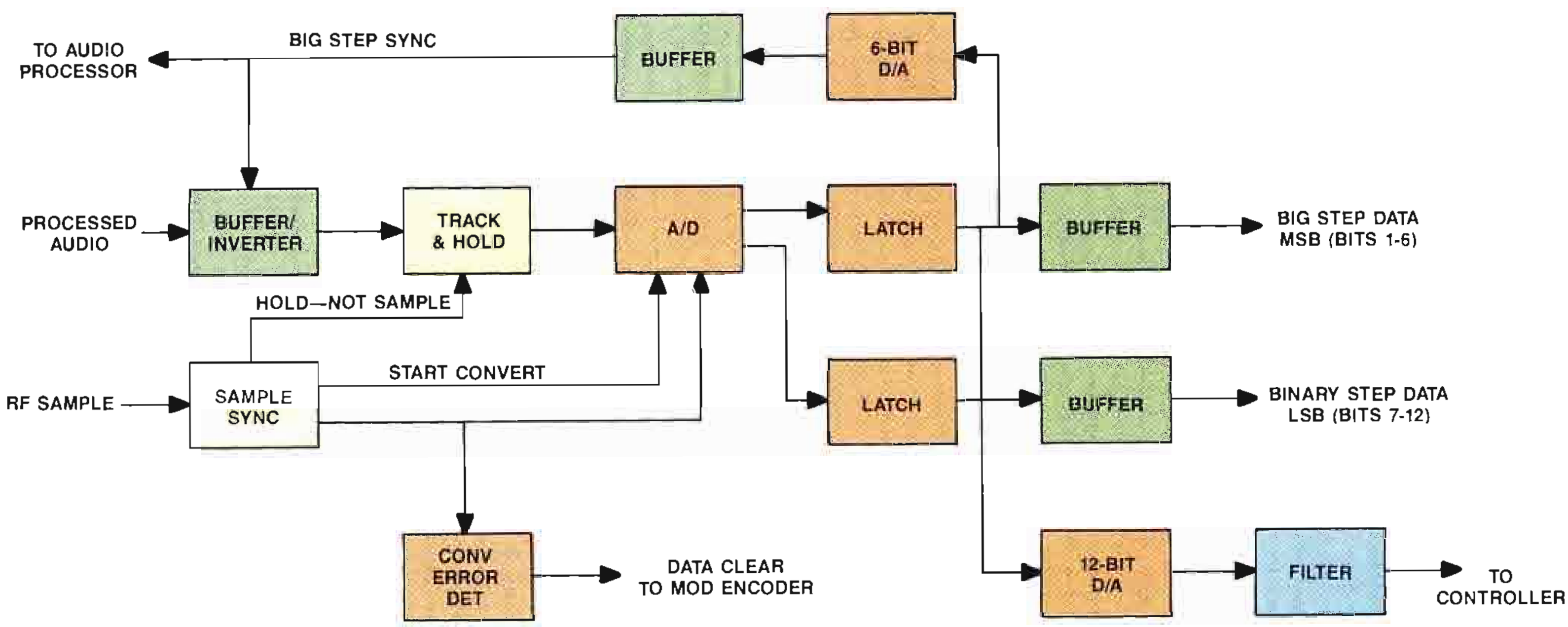

Figure 3. *The RF sample is used to synchronize the track-and-hold and A/D converter, which produce the big-step and binary-step data.*

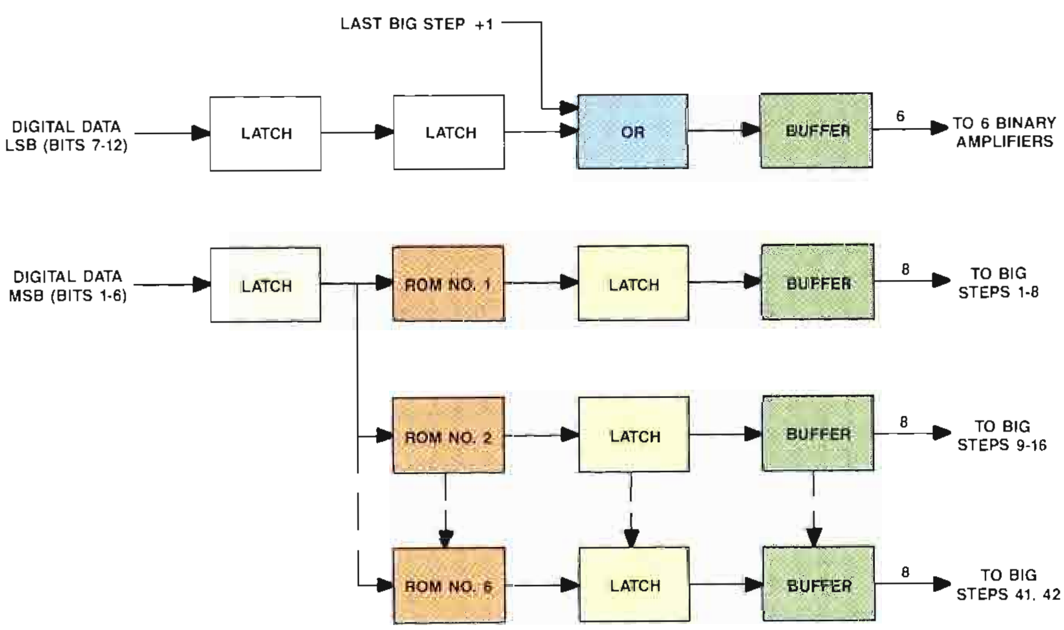

Figure 4. *The modulation encoder develops the specific control signals required by the binary- and big-step amplifiers.*

input. If the +230Vdc changes, which could cause the RF power output to change, the divider changes the audio + dc level in the proper direction to compensate for the supply-voltage variation.

The divider output is coupled to the input of a digitally controlled attenuator. The circuit consists of two ICs: an attenuator and a low-input, offset, precision op-amp. The attenuator has a 3-digit BCD control input that receives data from the transmitter power-level control circuits. When the digitally controlled attenuator is set to minimum attenuation, the maximum power adjust control (discussed previously) determines the transmitter power.

A *dither* signal also is added to the audio + dc signal. The dither signal is used to reduce noise that could result from the A/D conversion process. The dither signal is a low-level (approximately 60dB to 70dB below the nominal audio level),

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The dither oscillator receives a big-step synchronizing signal from the A/D converter board. This signal synchronizes the dither signal with the switching of the big steps and "forces" a decision in the A/D converter when the converter is faced with low-level audio signals. The dither signal level represents approximately the size of the 12th bit of resolution. The process results in an effective audio resolution of 13 to 14 bits.

The output signal from this audio-processing circuit then contains an audio signal with a dc component and a small dither signal component. The dc component determines the unmodulated power output, and the audio component determines the modulation level.

The dc + audio signal also is used to help regulate the B-voltage. The dc+ audio modulates the B-regulator output, thereby effectively providing a dynamic bias voltage for the RF power transistors. The technique improves the switching performance of the RF power transistors when they are operating under high-current conditions.

A/D conversion

The A/D converter (shown in Figure 3) takes an analog signal (with a dc component to control carrier power level) and converts it to a digital signal consisting of a 12-bit binary word. The A/D converter section also contains circuitry to provide:

- Logic control signals (derived from an RF sample) for the A/D conversion process,
- Synchronization of the 12-bit digital word with the RF carrier signal at the power amplifiers so that power-amplifier stages switch on and off at the proper time,
- A conversion-error logic signal for the status indicators,
- The big-step sync signal to ensure that unwanted steps or glitches (noise) in the modulated output signal do not occur, and
- A 12-bit D/A converter that provides an audio signal to the envelope error-detector circuit in the controller.

The A/D board's analog input stage inverts the audio + dc signal and also adds a small big-step sync component. The added big-step sync component ensures that when a big-step amplifier switches on or off, it does not change state again, which would cause a transient or glitch in the RF output.

The A/D conversion process requires two steps to complete. The analog input signal (audio + dc) is first sampled and stored by a track-and-hold circuit. The stored signal then is fed to the input of the A/D converter. The A/D converter requires less than 1μs to complete the conversion process.

The input signal to the A/D converter

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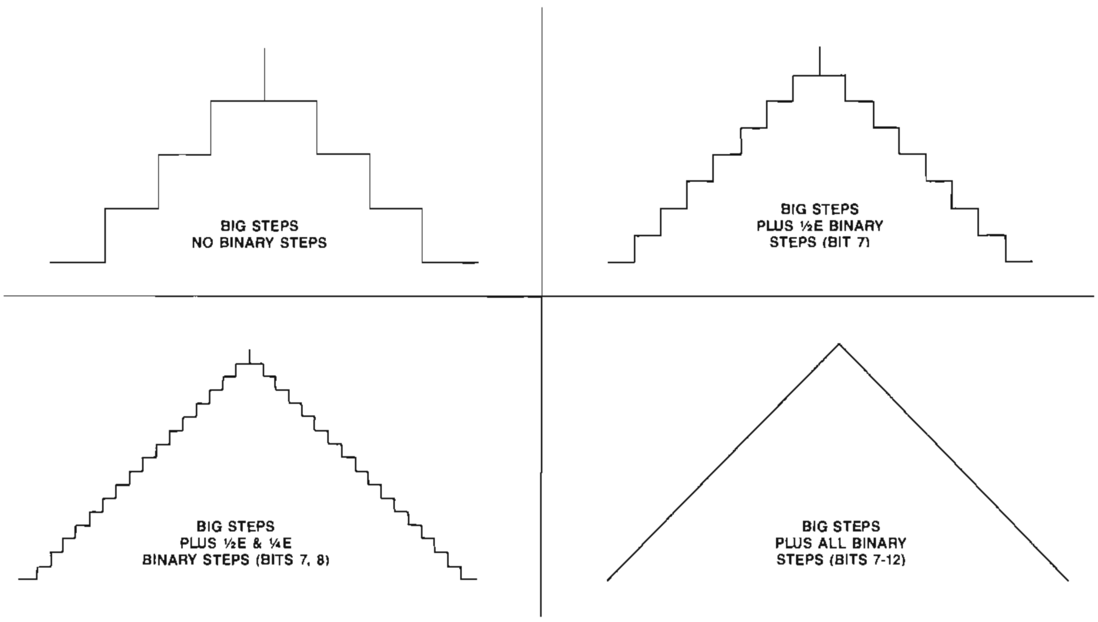


Figure 5. *Adding the binary steps to the big steps produces a low-distortion waveform.*

should not change during the conversion process. The function of the track-and-hold circuit is to ensure that the signal input to the A/D converter remains constant while the conversion process is taking place.

The two conversion steps must occur in a certain time sequence. After the sample has been stored, a start-convert signal is fed to the A/D converter. When the conversion process is complete, the A/D converter IC provides an end-of-conversion logic signal.

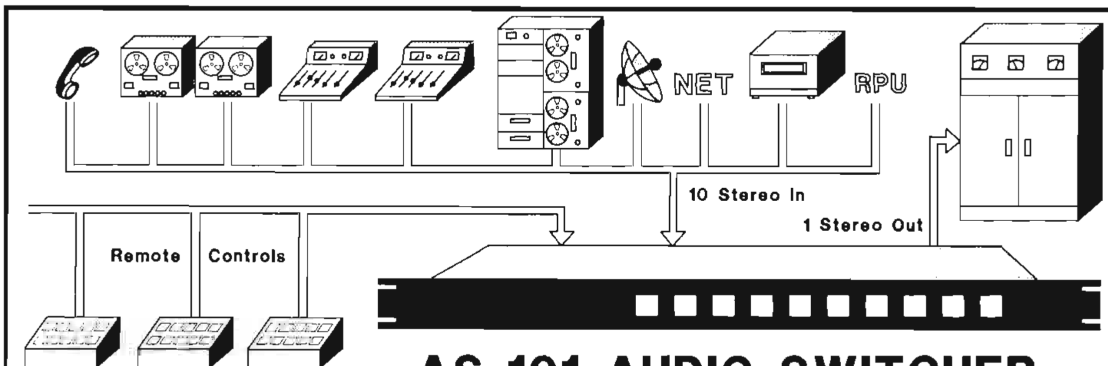
Two logic signals (external to the A/D integrated circuit) are required to control the A/D conversion process. The first is a hold-not-sample signal, and the second is a start-conversion signal. These signals are provided by the sample sync circuits.

The sample sync circuits take an RF input sample from the power-amplifier RF drive splitter, divide it by 1, 2 or 3, depending on the transmitter operating frequency, and generate the hold-not-sample and start-conversion logic signals.

The sample sync circuits also determine how often the A/D conversion takes place. The A/D sampling process generates a digital audio spectrum at baseband and replicates this spectrum at multiples of the sampling frequency. The sample rate is somewhat critical, to ensure that all unwanted spectral components fall outside the filter passband. The sample rate, determined by the output of the divider in the sample sync circuit, ranges from 400kHz to 820kHz and depends on the operating frequency. The spurious products generated are filtered easily because of the RF output network's bandpass filter's attenuation at these much higher frequencies.

The end-of-conversion logic signal from the A/D converter provides data strobe signals to latch on the A/D and modulation encoder boards. Each time another analog-to-digital conversion is performed, the output of the converter is strobed or latched, where the output data is stored until the next conversion.

If the A/D conversion process does not take place because of some fault, conversion-error circuits provide a data clear



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logic signal to clear the latches so that their outputs can go to zero, and all the power-amplifier stages are turned off.

Big-step sync circuitry ensures that glitches do not occur in the transmitter's modulated output. The big-step sync circuitry provides two signals: one to synchronize the dither oscillator, and one that is added to the audio + dc analog signal.

Modulation encoding

The modulation encoder (see Figure 4) accepts the 12-bit digital audio information and encodes it into on/off signals for the RF power-amplifier stages. The 12-bit digital input signal from the A/D converter is first stored in latches.

For the six least significant bits (bits 7 to 12), the data latch outputs provide the PA on/off control signals through latches, OR gates and drivers for the six binary amplifiers. The data latches for the most significant bits (bits 1 to 6) address read-only memories (ROMs).

Based on the input signals supplied by the latches, a binary address, or location, within the ROM is identified, and a predetermined sequence of logic high and low signals appears at the ROM's output pins. The ROM outputs are first stored in data latches, then buffered before becoming the control signals for the 42 big-step RF amplifiers. Jumpers are used to connect the latch outputs to the buffer inputs, permitting patching around a failed power-amplifier stage.

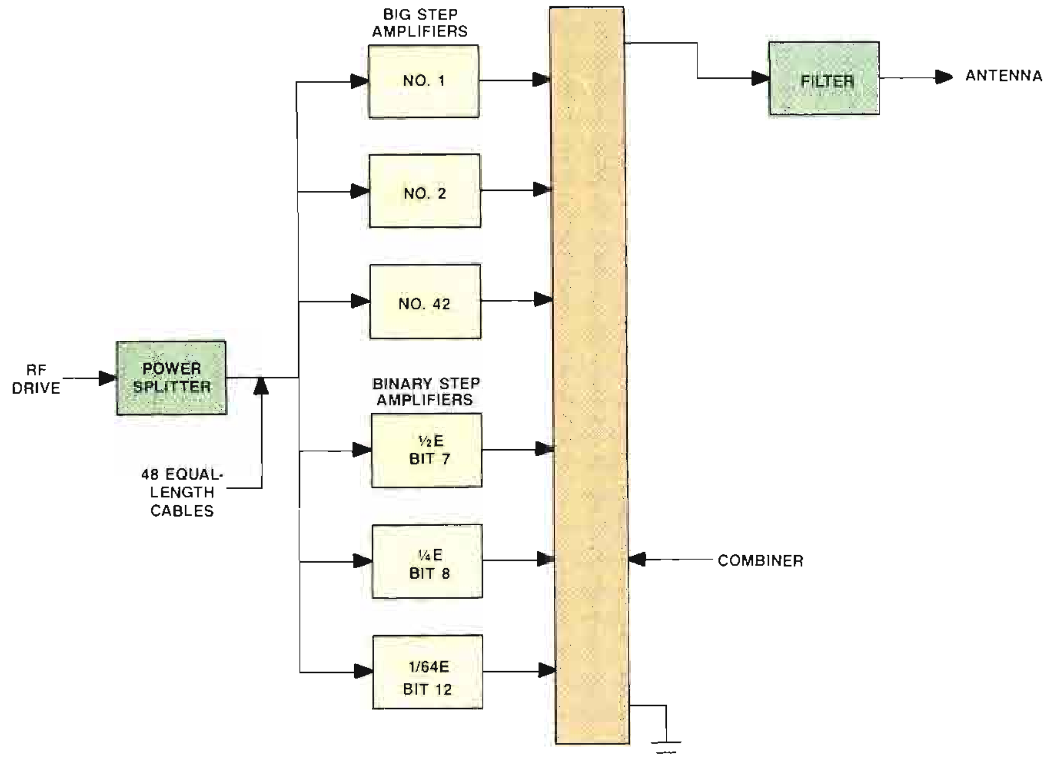

Figure 6. *The power amplifier comprises 42 big-step and six binary-step amplifiers.*

If an RF stage fails, it is possible to substitute another amplifier. The loss of one

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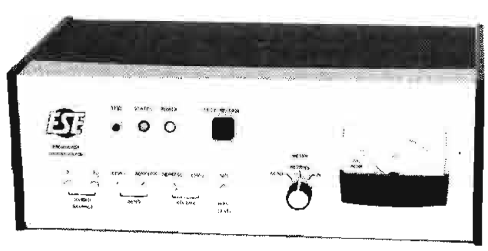

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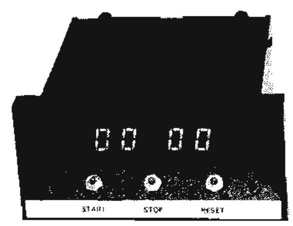

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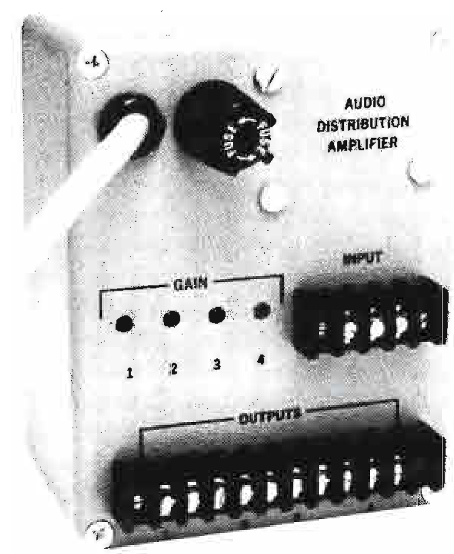

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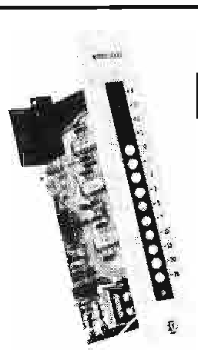

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Table 2. *Typical measured performance with a digital modulator operating at 10kW.*

amplifier increases the distortion to approximately 2%. Substituting one of the amplifiers used only during modulation peaks reduces both the distortion and available peak power.

The modulation encoder circuit contains six identical ROMs. Each ROM is 8x8 (eight binary inputs and eight status outputs) with 2^8 (256) possible addresses. See Table 1.

While bits 1 through 8 from the A/D converter are required to step through all the ROM addresses, only bits 1 through 6 are used to select the turn-on signals for the 42 big steps. The X's shown in bit columns 7 and 8 indicate a "don't care" value and are used to simplify the explanation of the ROM table.

Before each new big step is turned on by a status output change from 0 to 1, bits 7 and 8 clock through the sequence of 00, 01, 10 and 11. This sequence is shown only once with X's on the first four lines at top left of the table, for simplicity.

As bits 3 through 6 for ROM No. 1 are clocked through binary 1 through 8, the bit-step control outputs change from 0 to 1 for big steps 1 through 8. The binary input to ROM No. 1, after reaching 001000XX (big steps 1 through 8 and higher), continues to 111111XX. (All ROMs receive the same binary data.) The first eight big steps,

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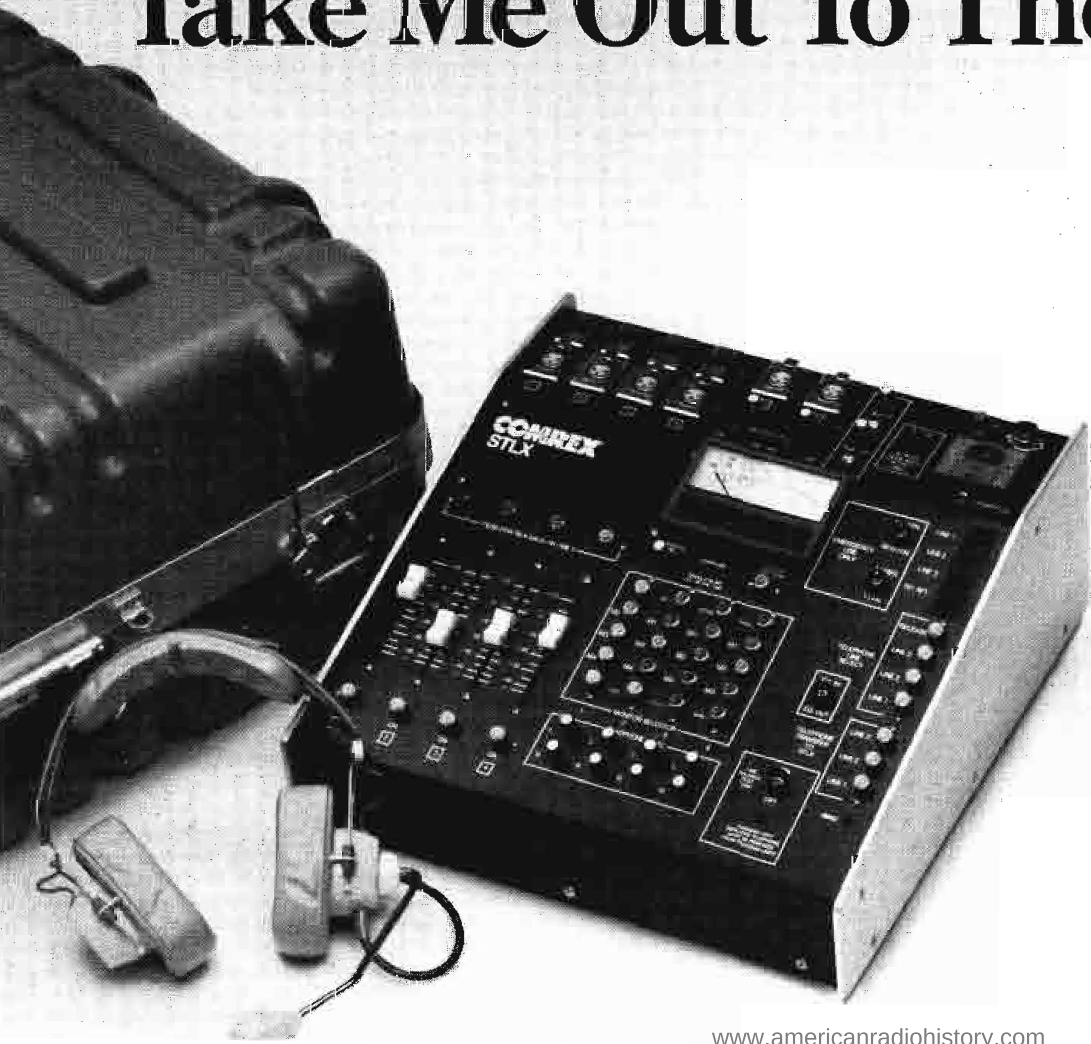

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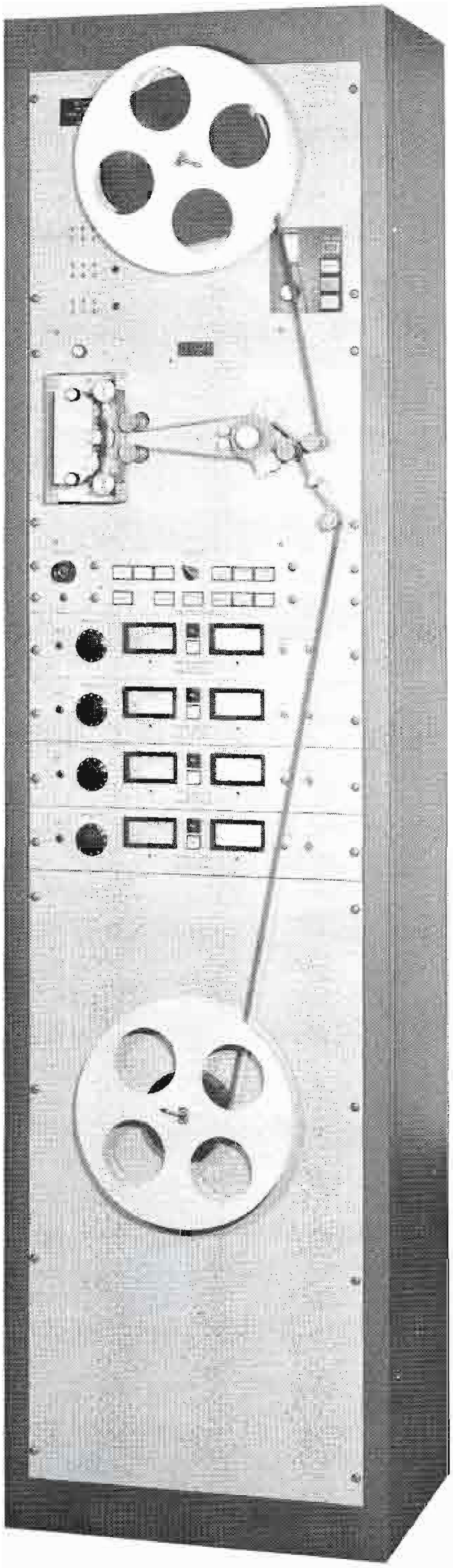

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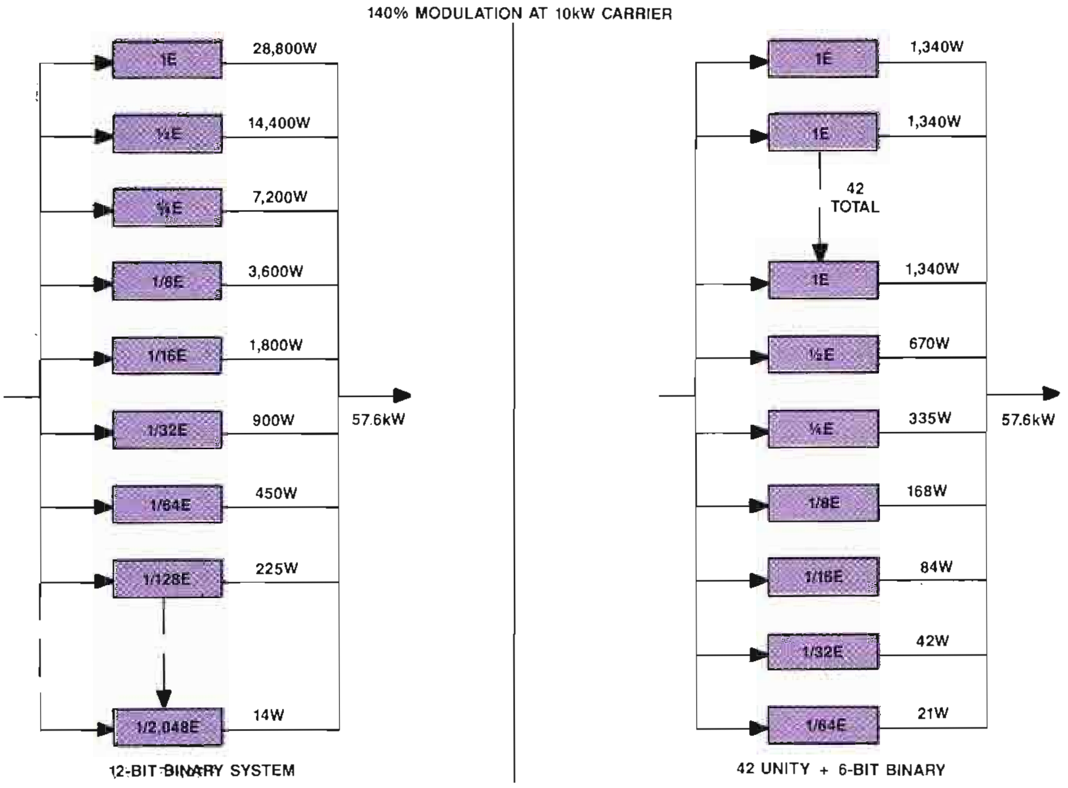

Figure 7. *A true binary implementation of digital modulation would require an amplifier capable of 28.8kW. The pseudo-binary design requires a maximum of only 1.34kW from any single amplifier.*

therefore, are kept on for all binary inputs above the count of 8.

ROM No. 2, which controls big steps 9 through 16, does not turn on any big steps until the binary count of 9 is reached. From binary 9 through binary 16, ROM No. 2 turns on big steps 9 through 16, then keeps them on through binary 256 (111111XX). The remaining four ROMs continue turning on big steps in the same manner until all 42 big steps are active.

If the modulating signal continues to increase after all available big steps are turned on, the binary steps would continue to turn on and off, causing a sawtooth to appear on the top of the clipped waveform. This is prevented by feeding the last big step +1 logic turn-on signal to the input of the six OR gates. This signal turns all of the binary steps and holds them there until the peak has passed.

The six binary steps can contribute $(2^6)-1$ steps or 63 different power levels. Before each big step is turned on, the binary steps must go through the entire count from 1 to 63. With all 42 big steps active, the total number of levels traversed becomes the number of big steps times the number of discrete levels produced by the six binary amplifiers, or $42 \times 63 = 2{,}646$.

After the last big step has turned on, the binary steps count through one more sequence to 63. There are also 42 individual big steps, so the total of available steps becomes $2{,}646 + 63 + 42$, or 2,751. This is approximately equivalent to 11.43 bits of resolution ($2^{11.43} = 2{,}750$). The waveform

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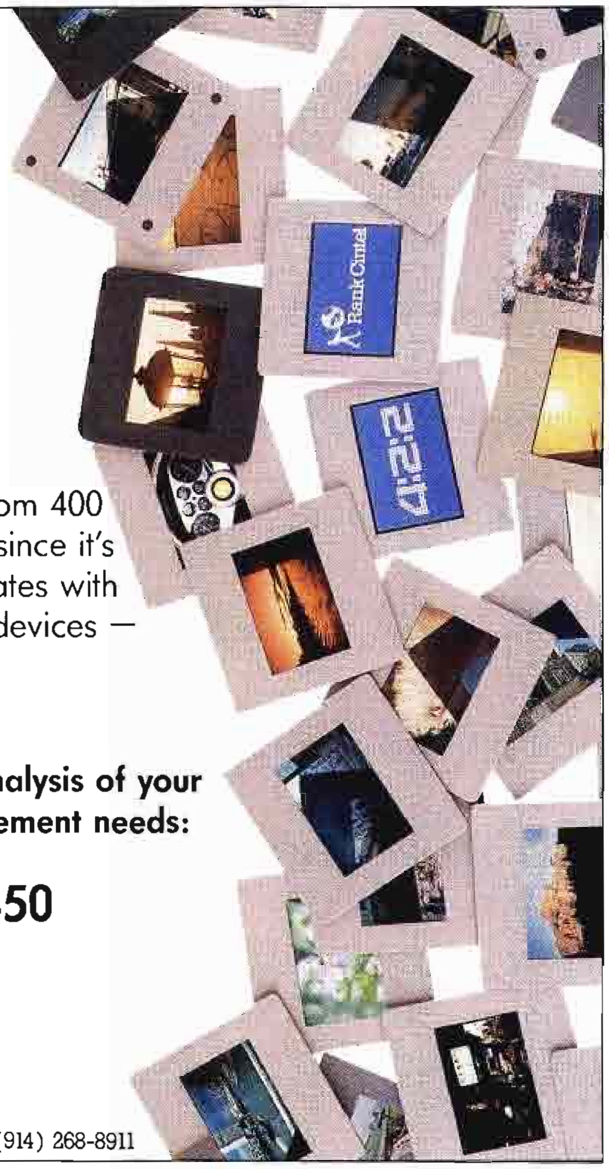

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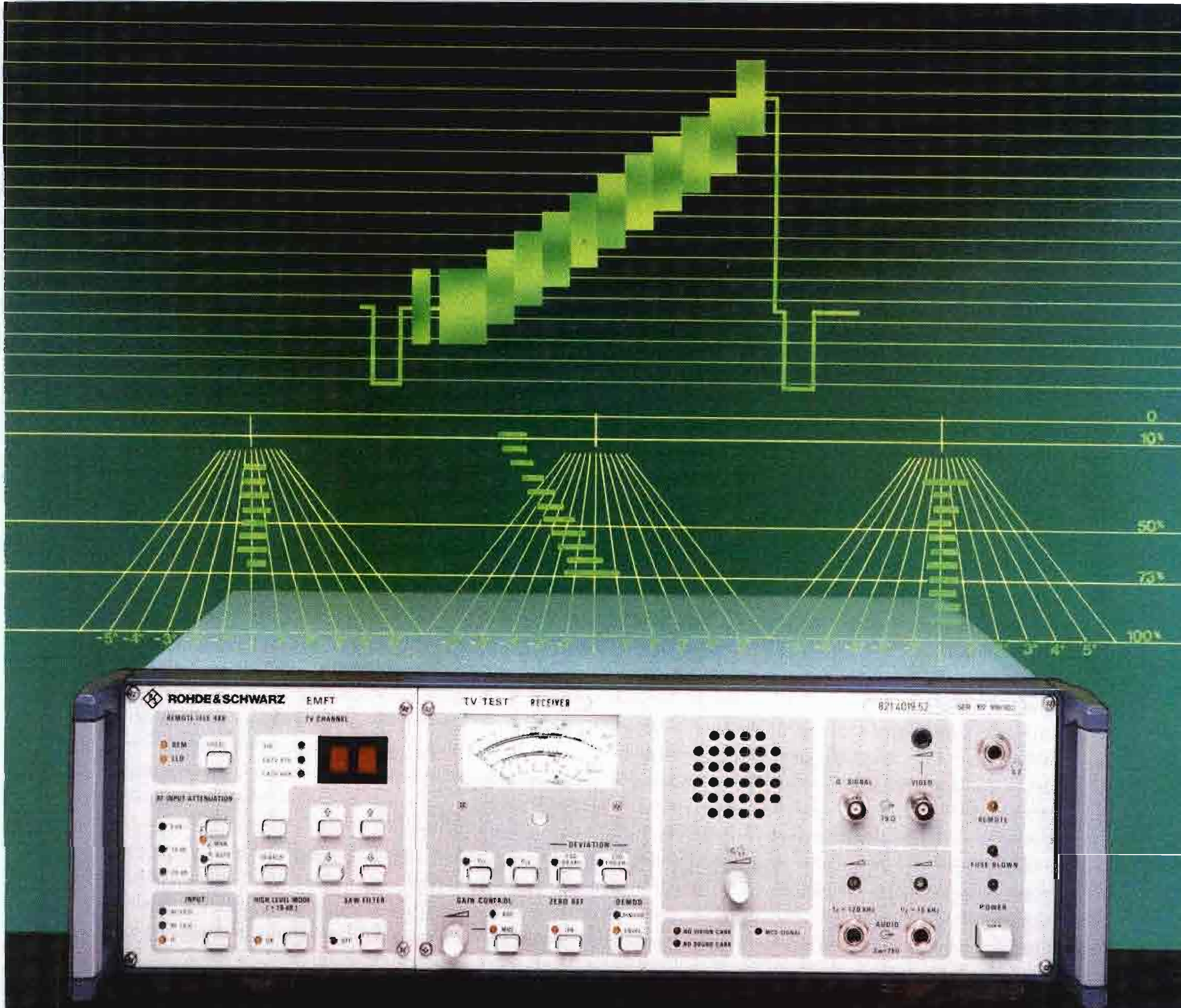

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Glossary of technical terms

The discussion of analog-to-digital and digital-to-analog conversion includes some terms, abbreviations and concepts that may not be familiar to all readers. A summary of terms is included here for review or reference.

Analog: Refers to a signal that contains a continuous range of values, rather than one that changes in steps. Examples of analog signals include the audio signals from a microphone or turntable.

Quantized: Related to digits, or discrete quantities. An analog signal changes continuously, while a digital signal changes in steps and has a finite, or limited, number of possible values.

Binary: Has only two possible values. A binary number is represented using only the digits 1 and 0. Binary also refers to a series in which each step is either multiplied or divided by two to get the next step.

Bit: A binary digit, 1 or 0.

Digital word: A series of numbers, or a group of bits, representing a complete piece of digital information. The term "digital word," as used here, refers to a binary number, which is a series of 1s and 0s. The number of bits in a digital word is the total number of digits. An example of a 12-bit digital word would be "0110 1000 1101."

MSB and LSB: Abbreviations for most significant bit and least significant bit. In a digital word, as in a decimal number, the first digit represents the largest change and is the MSB. The last digit represents the smallest change and is the LSB.

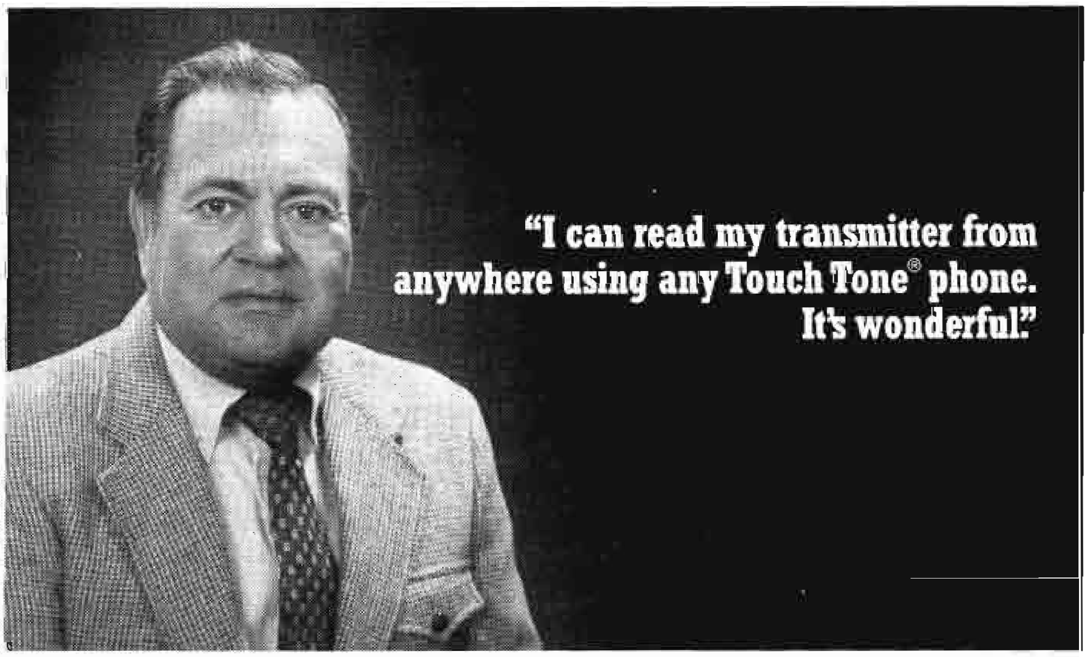
Bit 1, bit 2, etc.: In a 12-bit digital word, the bits are numbered from 1 to 12, where bit 1 is the MSB, and bit 12 is the LSB.

A/D and D/A: Abbreviations for analog-to-digital and digital-to-analog, respectively.

ADC and DAC: Abbreviations for analog-to-digital converter and digital-to-analog converter, respectively.

Track and hold: Also referred to as sample and hold. An integrated circuit whose function is to track an input analog signal for a predetermined duration of time, then hold (latch) the value and hold it for a subsequent operation.

Latch: An integrated circuit whose function is to latch (or store) a digital input (1 or 0) for a subsequent operation.



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developed by switching on the big steps and binary amplifiers is shown in Figure 5.

Digital-to-analog conversion

The digital information generated by the A/D converter switches units of RF voltage on or off by switching RF amplifiers on and off. The RF power amplifier may be thought of as a D/A converter, where the digital input signal is converted to a high-power, amplitude-modulated (analog) RF signal.

The output combiner and power amplifiers (shown in Figure 6) produce equal RF voltage steps (not equal RF power steps) at the combiner output. The PA amplifier output power depends on the total number of stages that are switched on. Switching on twice as many RF amplifier stages will produce twice the voltage output and, therefore, four times the output power. The binary-weighted voltage contribution of the six binary amplifiers is obtained by the proper selection of supply voltage, number of output transformer primary turns or a combination of both.

A transmitter with a carrier power of 10kW produces a peak output power of 57.6kW at 140% positive modulation. In a full 12-bit binary sequence D/A converter, the RF amplifier corresponding to the most significant digit in the digital word must deliver an output of 28.8kW. The next most significant digit would correspond to 14.4kW. Because such large amplifiers are not only more difficult to build, but also difficult to switch on and off quickly, this transmitter design uses binary-weighted amplifiers only at the low-output levels (up to 1.34kW).

Figure 7 illustrates the power levels that would be required in both the 12-bit binary and pseudo-binary (42 unity + 6-bit binary) configurations. Note that in the latter configuration, the maximum power required from a single RF amplifier is 1.34kW, compared with the 28.8kW required in the 12-bit binary configuration.

Power amplifier

The transmitter uses Class D switching amplifiers, each with four power MOSFETS operating in a bridge configuration (see Figure 8). The RF drive to each power MOSFET is provided by separate secondary windings on T1 and T2.

Back-to-back zener diodes CR1, CR2, CR3 and CR4 provide protection for the MOSFET inputs from transients and excessive drive. Each power MOSFET in the bridge acts like a switch and is either on or off at any particular time. Transistors Q1 and Q4 are driven 180° out of phase with transistors Q2 and Q3.

The amplifier output is coupled to the output combiner by transformer T3. During half of the RF cycle, transistor Q1 and Q4 are driven into saturation (on), while Q2 and Q3 are in cutoff (off). During the other half of the RF cycle, transistors Q2 and Q3 are driven into saturation, while Q1 and Q4 are in cutoff. This produces a square wave peak-to-peak voltage of twice the bridge voltage (dc supply voltage) across the output transformer winding.

When the control signal is in the logic zero state, the amplifier is turned off by the modulation control circuit, and the amplifier is incapable of delivering any power. The transformer's primary circuit, however, is essentially complete. The drive signal for the top two devices is still present. Current is allowed to flow through the active transistor, the transformer winding, and the reverse diode of the other top transistor. This design prevents the combiner from becoming an open circuit when the amplifier is turned off.

The modulation control turns the RF amplifiers on and off, as directed by the modulation encoder. The RF amplifier's modulation section turns the amplifier off by removing RF drive to the bottom two transistors, Q2 and Q4.

When the input to the modulation sec-

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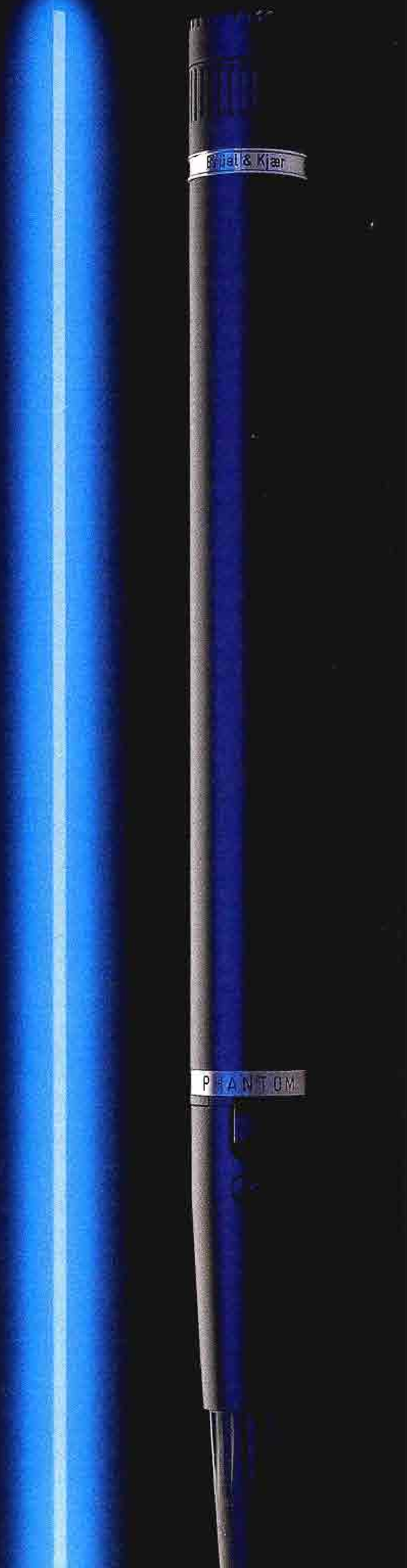

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tion is approximately 1V or more positive, the modulation control circuit shorts the RF drive signal to RF amplifier transistors Q2 and Q4 to ground through diodes CR5 and CR6. The RF transistors Q2 and Q4 do not conduct; therefore, no current can flow through the combiner transformer primary winding. If the input voltage to the modulation section is negative, the short is removed, allowing RF drive to flow to the gates of PA transistors Q2 and Q4.

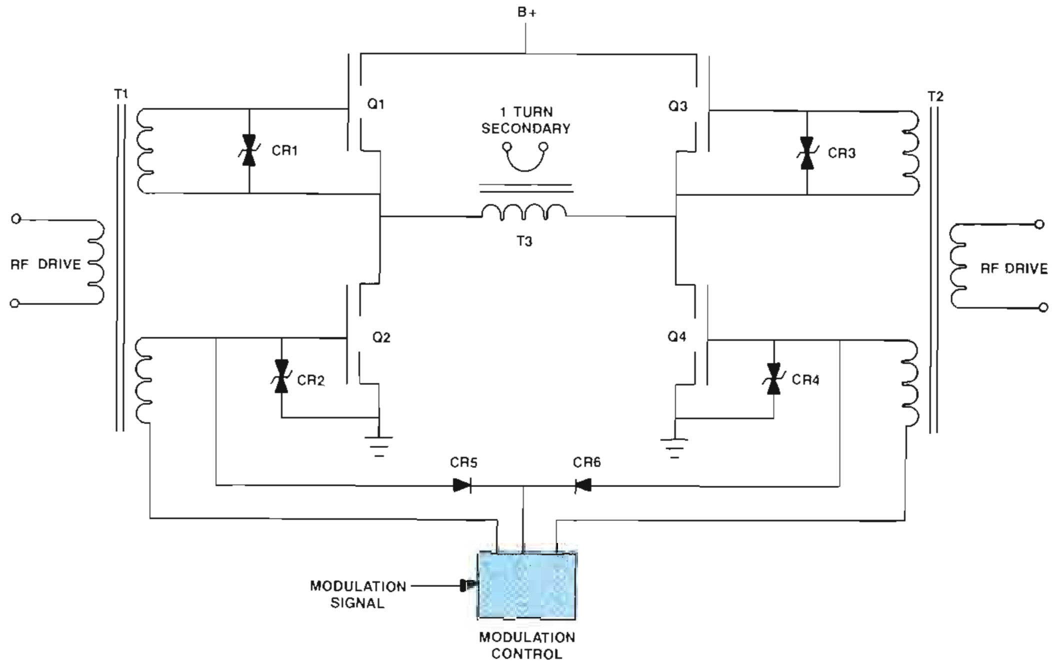

Figure 8. *Power amplifier simplified schematic.*

Efficient operation

Digital techniques, in themselves, may not be beneficial to the broadcaster, but in the case of digital modulation, two benefits seem apparent.

One is that the ac-to-RF efficiency in a digitally modulated transmitter is greater than in a tube transmitter. This transmitter is approximately 86% efficient, compared with similiar power tube transmitters, which are approximately 60% to 70% efficient. The approximate power consumption for the DX-10 is 17.5kW at 100% modulation. A similar 10kW tube-based transmitter consumes approximately 28kW. The cost-effectiveness of the reduced power consumption can be computed for any particular location.

The second advantage offered by the digital modulation technique lies in audio performance. Table 2 lists some typical performance specifications for a digital transmitter operating at 10kW.

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VOA program trains field engineers

By Brad Dick, technical editor

Obtaining the required experience to operate a 500kW medium-wave transmitter is not an easy task. The Voice of America (VOA) recognized this, but that didn't change the need for engineers to operate its transmitter sites. To solve the problem, the VOA developed a unique training program that teaches qualified engineers to operate its high-powered equipment.

The program

The VOA soon will be selecting candidates for its third technical training program for field engineers. Upon completion of the program, graduates will be considered for career positions as officers in the U.S. Foreign Service. In this capacity, they will serve as technical supervisors at the agency's overseas transmitting facilities. Twelve to 16 engineers are expected to be selected for the program, which begins this spring. The program, however, is dependent on congressional appropriation.

The people selected for the training program will receive six months of formal classroom instruction in technical and administrative subjects at VOA's relay station in Greenville, NC. This will be followed by approximately six months of on-the-job training at one of the Greenville transmitting facilities.

As opportunities become available, program graduates will be assigned to positions in VOA's worldwide network of relay stations, where they will supervise the work of Foreign Service National staff members, who operate the stations. Overseas assignments may be to such countries as Germany, Greece, Morocco, Thailand, Philippines, Sri Lanka, Liberia, Botswana or one of several locations in the Caribbean.

MODULE NUMBER	TITLE	CLASSROOM HOURS
1	INTRODUCTION TO VOA (DELETED MARCH 1986-RESERVED FOR FUTURE USE)	3
2	THE VOA NETWORKS	24
3	PROPAGATION AND MONITORING	22
4	MODULATION	22
5	LABORATORIES	34
6	ANTENNAS	30
7	TRANSMITTERS	96
8	RECEIVERS	42
9	MICROWAVE LINKS	42
10	SATELLITES	24
11	AUTOMATION	144
12	TRANSFORMERS	24
13	GROUNDING	24
14	SYSTEM INTEGRATION	25
15	POWER GENERATION AND DISTRIBUTION SYSTEMS	40
	TOTAL CONTACT HOURS:	597

Table 1. *The intensive training program is designed to fully prepare the applicants for high-power transmitter operation.*

Curriculum

Classroom instruction at Greenville includes modules on topics such as transmitters, receivers, antennas, transmission lines, microwave links, satellite communications, digital systems, microprocessors, automation, transformers, grounding practices, power systems, and teaching methods and practices. Additional courses, in automatic test equipment, management methods and PCM audio systems, are being considered.

Because of the type of equipment typically used at VOA sites, the instruction emphasizes topics unique to high-power transmitters. The Greenville classroom location is particularly suitable for the training program because it is co-located with a facility that contains four modern 500kW transmitters, which were purchased as a part of a transmitter evaluation program. A nearby site contains VOA's extensive earth satellite communications equipment.

The training positions normally are filled at the civil service GS-9, -10 or -11 level, depending on the candidate's background and experience. Advanced appointments are possible for exceptional candidates.

If you are interested in learning more about this program, write the VOA personnel department, Room 1543, 330 Independence Ave. S.W., Washington, DC 20547, attention: Technical Training Program for Field Engineers.

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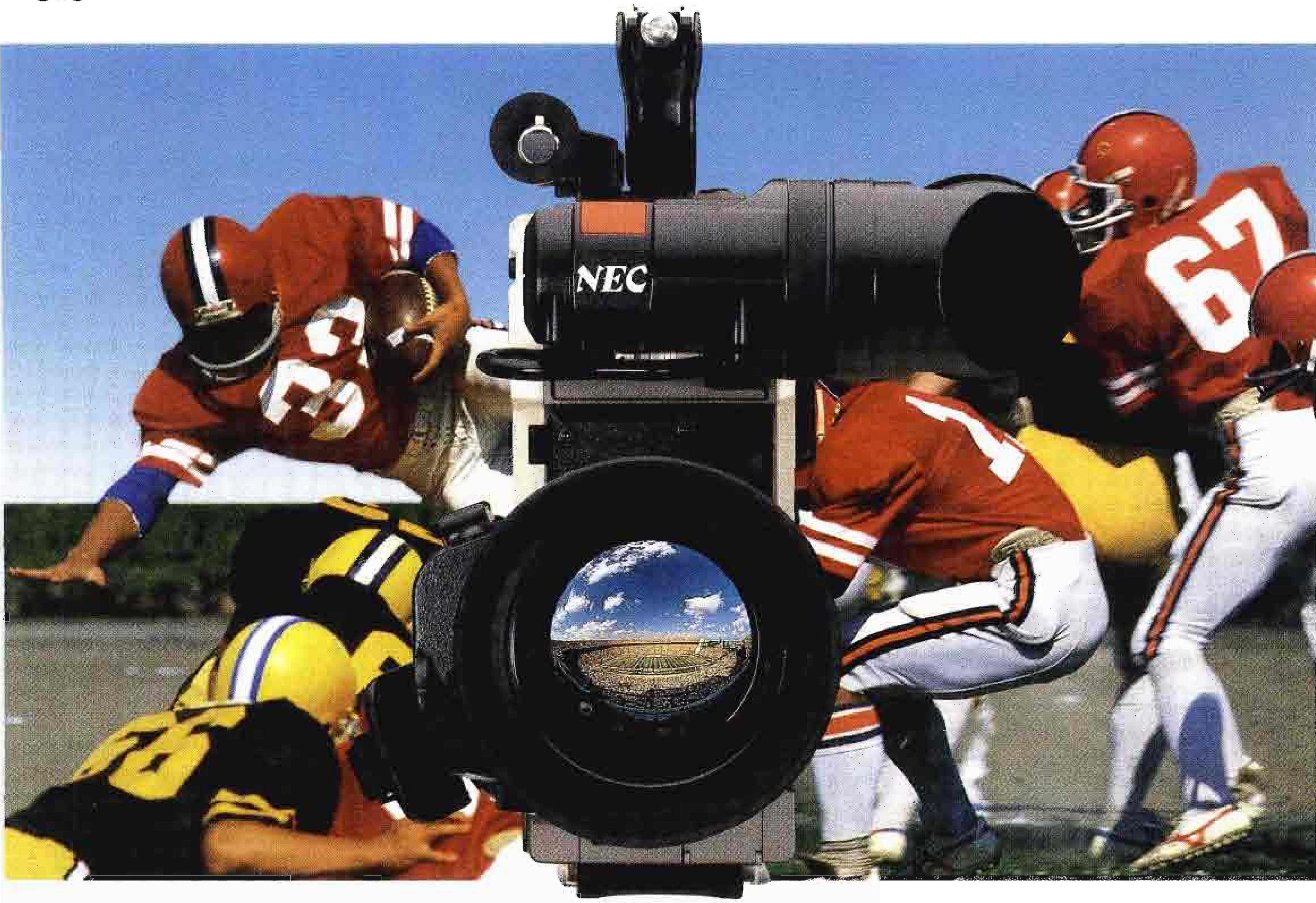

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Continued from page 264

to receive, display, archive satellite delivered weather graphics.
Graphics: more than 1,200 images per day including color, 3-D satellite/radar imaging and RadarPlus.
Accu-Data: advanced weather database; all forecasts, data plus AMPS Advanced Map Plotting System; color displays now include DIFAX.
Satellite Delivery: all weather data circuits including DIFAX via satellite.
WeatherShow/WeatherBreak: combines voice-over of Accu-Weather broadcast meteorologist with Accu-Graphics for complete 15-60s self-contained forecasting information service.
Circle (504)

Advanced Designs (4277)
Weather graphics: IBM PC/AT-based weather data, graphics system; allows graphics generation, satellite data acquisition.
Doprad II enhancements: LPATS, LLP lightning displays, simultaneous with standard weather radar.
Circle (512)

Alden Electronics (4566)
C2000R/S: weather radar graphics, satellite imagery.
C2000RC: weather radar composites, displays echoes from 10 radar units.
C2000M: weather radar designed for radio station operations.
Circle (520)

Ampex AVSD (3302)
Graphics studio: 4:2:2 component digital system interfaces ADO digital effects, AVA-3 video art and ESS-3 graphic composition/storage system into integrated studio; conforms to CCIR-601.
Circle (536)

AMX (H5910)
ASE-500: special effects generator.
Circle (540)

Aston Electronics (H5725)
Spectra: creates backgrounds with 2-level keying; color gradations; initiate from any direction; push image off screen; internal storage of 100 backgrounds plus disk memory.
Caption: title generator; anti-aliased, two independent text display planes, multimillion background colors; integral LogoMaster imports camera art for typeface masters with variable sizing; 20Mbyte hard disk memory.
Circle (558)

AT&T (3080)
TOPAS 2.2: 3-D object processing, animation software; for Truevision TARGA and VISTA videographics boards; includes modeler and animator modules.
Circle (559)

AVS/Avesco (2869)
Artmaster: graphic system; rotoscoping, color framegrab; RGB, PAL, CCIR-601; stencil, definable brushes, two work screens, two utility screens; texture fill, vector fonts, printer output.
Artstyle: graphics computer uses standard software; drawing pad, pen, keyboard, menu monitor, genlock sync, encoder, graphics board, extended memory, 20MByte disk, 1.2MByte floppy.
Circle (575)

BASYS (3884)
CUEWORD: prompter system; variable fonts, fully integrated to BASYS running order.
Circle (581)

Broadcast Video Systems (2226)
CI-200: clock, message generator, inserter.
Circle (610)

BTS Broadcast TV Systems (2920)
Vidivote graphics: includes pictures of major candidates, party logos, special format pages for candidate names (with pictures), vote totals, percentages, number of reporting precincts.
VidiVote enhancement: on-board memory for 900 races; 24 vote ports for external computer interfaces; race sequencing; data extraction by various user-defined characteristics.
VidiLink: for IBM PC/compatible links VidiVote to AP Election Data Service with auto data entry of national, state, regional, local returns.
Vidifont Viditext II enhancements: graduated backgrounds as third plane; third channel RS-232 interface; seven timed row speeds with time posting.
Pixelerator: high-speed image rendering engine for FGS graphic systems.
GraphicStore upgrade: 4-frame buffer for paint/still store system; anti-aliased airbrush; picture create, capture, montage with 4,096-palette; total color capability of 16.7 million colors.
Font/Logo Compose: full screen capture, auto tiling onto characters for full screen display, animation; integral resizing, scaling, slanting, italicizing without touchup or manual intervention; compatibility to 1,500-face Bitstreams library.
Circle (615)

CEL Electronics (1433)
P164 range: TBC/synchronizer with digital effects; meets 8-bit EBU, CCIR-601 4:2:2 standard.
Circle (631)

Chyron (3556)
Chyron 4100 EXB/4200 enhancements: interface to Angis, TUI, DCM, Telesource, NewStar and BASYS newsroom and election reporting systems; upgrade interface for series 4000 systems also available.
HDTV Logo Compose: tablet for HDTV Scribe; original art digitized in system's high definition resolution.
HDTV Scribe: demonstrations of high definition character/graphics generator.
Advanced Font Utilities: Scribe enhancement; adds glows, beveling, chiseling, embossing, 3-D texture mapping, neon effects; business graphics; camera capture; auxiliary entry package for off-line/election reporting interfaces; IOMEGA mass storage.
Off-Line Entry: Scribe enhancement; external interface allows entry of text into preformated template pages from standard ASCII terminal.
Auxiliary entry package: Scribe enhancement; off-line entry via PCs and other VT220 compatible terminals; perform on-line graphics composition while Scribe renders fonts, graphics off-line; off-line, computer interface operate simultaneously.
Circle (641)

Circuit Studios (3135)
Velocity 3D: Version 2.0 motion control,video animation system; real-time manipulation of solid, shaded 3-D shapes; Megatek 911S graphics engine base; 8,000 line resolution.
Circle (1180)

ColorGraphics Systems (3344)
LiveLine 5 upgrade: animation, paint, other new capabilities for on-air weather presentation.
ArtStar 4:2:2: graphic paint/animation equipment; Ethernet link to other equipment; NTSC or PAL encoded output.
Weather Central services: receive-only sequence and display system.
Circle (719)

Computer Prompting (2167)
CPC-1250 teleprompter: includes simultaneous scroll/edit feature.
CPC-2500/-3000: IBM PC prompters; simultaneous scroll/edit, closed captioning features; *-3000* for newsroom systems.
CPC-500: closed captioning system.
CPC-1500/-1750: teleprompters for electronic newsroom use; *-1750* includes simultaneous scroll/edit.
Circle (664)

Cubicomp (4310)
Enhancements to PictureMaker 60R including new modeling and animation capabilities.
Circle (685)

Digital F/X (5227)
DF/X-200: integrated 3-D digital effects, paint, titling generator and still store library for post production applications.
Off-Line workstation: wireframe modeling of motion sequences.
Circle (705)

Digital Services/DSC (3556)
Eclipse enhancement: optical effects including twist, curves, page turns, page scroll.
Circle (707)

Dubner Computer Systems (2928)
20-KEL: election computer assembles, analyzes voting data, compiles running totals for each race; after election becomes normal full-featured character generator.
GF-30 Graphics Factory: digital component video directly interfaces to CCIR-601 standards with outputs in NTSC, PAL, RGB; based on dual-channel, dual-operator, anti-aliased character generator.
Circle (714)

Dynatech NewStar (3344)
Closed captioning: PC/AT-based option for NewStar systems.
Circle (721)

FOR-A (3169)
VTG-12H timer: for HDTV system; displays month, day, year, hours, minutes, seconds.
VTW-240/VTW-800: title generators; anti-aliasing features.
TG-170 titler: character display generator interfaces through RS-232C for remote control.
MF-2000: Multifex digital image processor; optional dual channel controller; full 2-D effects, many additional features.
Circle (767)

Genigraphics (1239)
PowerPoint graphics: transparency, color prints, presentation graphic formats through alliance between Genigraphics, Microsoft.
High resolution imaging: Masterpiece film recorder, SCODL graphics description language, SCODL interface to IBM PC-AT, DEC VAX, PDP-11 computers.
Circle (1203)

James Grunder & Associates (1433)
P164 range: CEL TBC/synchronizer with digital effects; meets 8-bit EBU, CCIR-601 4:2:2 standard.
Circle (793)

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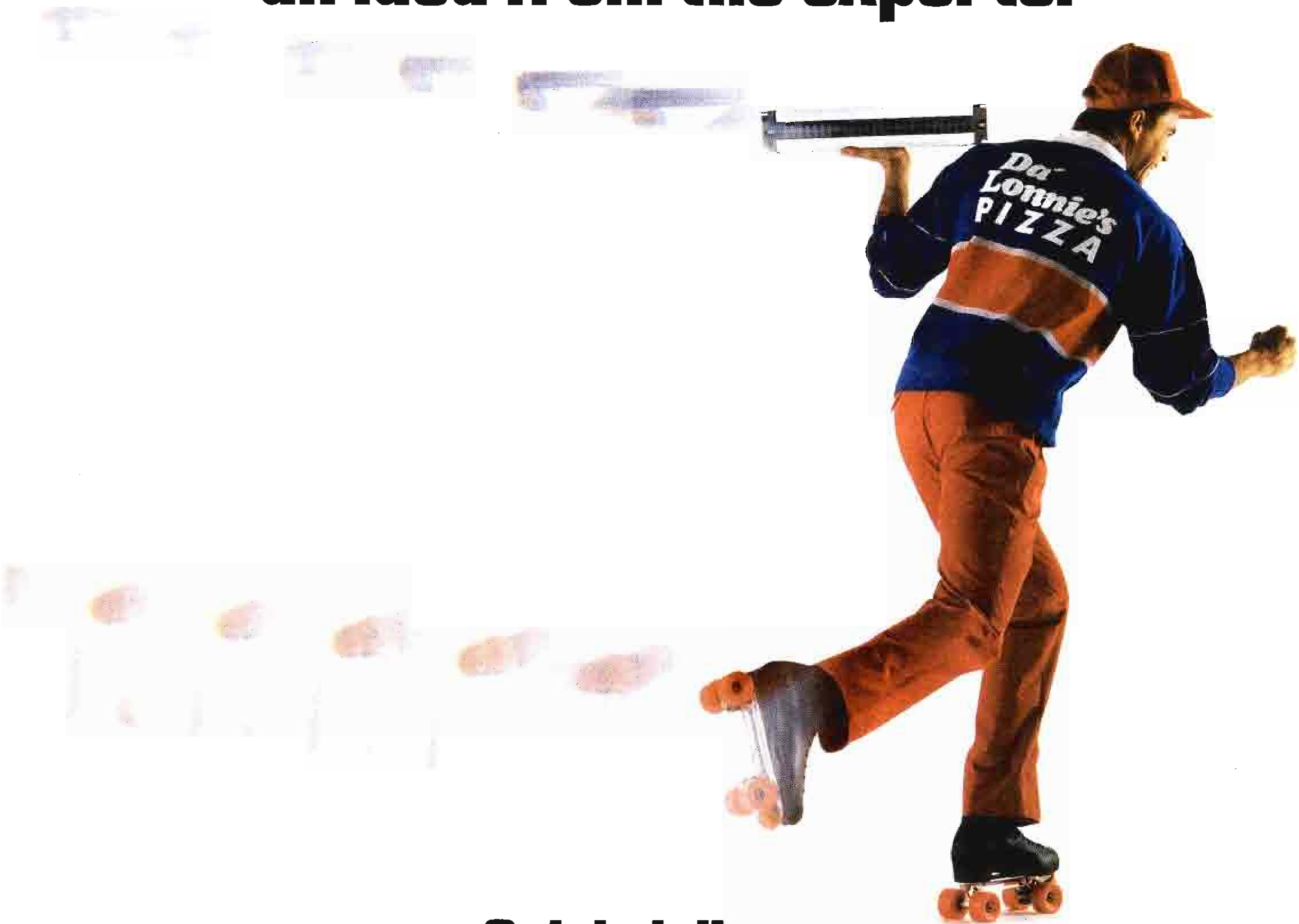

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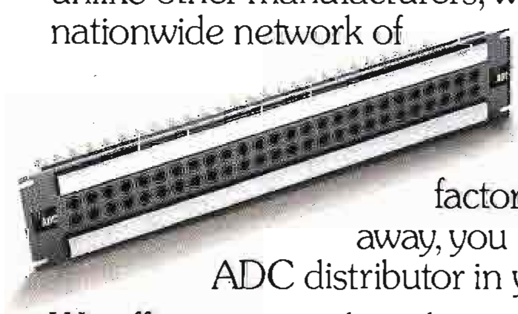

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PESA Electronica (3280)
CG-4711: video production titler system.
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Enhancements: for Series 2000, 3000 video workstations.
SV-1000: super V-1000 desktop video workstation.
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NP-1 NewsPrompTer 1: newsroom script entry prompter.
ScriptNet: expandable network of script preparation terminals.
On-Camera II: lightweight, on-camera display prompter unit.
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Quanta (3344)
QUANTAPAINT 32: flash-grab digitizer, full-color stand-alone paint system; TI34010 32-bit graphics processor runs at 49MHz; 4MByte RAM; floppy drive, graphics tablet, keyboard, status monitor; many hardware options.
Delta I, Orion: character generators; anti-aliased, free-form, virtual real-time operations; multiple on-line fonts; high-speed rendering, compositing, DSK, dual frame buffers; texture mapping, 9ns resolution.
QUANTAPAINT QVP-100/200: paint systems for XT compatible PC; graphics chassis connects with interface board; 640x486-pixel resolution NTSC; 16.7 million colors; RGB capture, five fonts; Pixel-Keying, DSK, optional business graphics, animation.
ARTISTA: full-color graphics, paint, anti-aliased fonts, 3-D modeling, animation; disk, streaming tape archive/backup; 24-bit/pixel plus 8-bit transparency, stencil; dual frame buffer; for RGB, PAL, NTSC; 16.7MHz 68020/68881 CPU.
Circle (722)

Quantel (3638)
Graphic Paintbox: digital paint, design and composition system with print resolution.
Production centre: complete digital editing suite with digital audio.
Circle (979)

Rank Cintel (2334)
Interface: links Gallery still library to BASYS newsroom automation system.
Circle (986)

Symbolics (H6003)
S-Record: software for paint, animation system for direct control of video recorder; works with Lyon Lamb Mini-Vas to control VTR, disc and other recording systems.
HDTV graphics: 2-D, 3-D animation, paint capabilities in HDTV format; accepts NTSC resolution images as part of HDTV image.
Circle (1066)

VG Electronics (503)
#1066: teletext editing system.
TDG-4: teletext generator system.
Circle (1137)

WSI (4171)
ASTROdata system: satellite-delivered weather data; includes three National Weather Service circuits; audible weather warnings, automatic printing functions; ASTROgraphics and ASTROfax.
SOFTfax option for ASTROfax.
PREview option for ASTROgraphics.
Circle (1169)

Zenith Electronics (H5630)
TE-521: EEG Electronics line-21 caption to World Systems teletext transcoder.
MET-2000: Metaphor Developments line-21 caption to World System teletext transcoder.
Circle (1172)

V6: Switchers
- Master control
- Production

Ampex AVSD (3302)
AVC Vista: 18-input production switcher; graphic-oriented display; two linear keyers, full-length independent key switching buses; DSK, optional Spectrakey; ADO interface.
Circle (536)

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Broadcast Video Systems (2226)
BB-500C: passive 5x1 component/RGB-sync switcher.
Circle (610)

Central Dynamics (4383)
Model 694: video production switcher.
STRATA-10: video production switcher.
Circle (632)

Crosspoint Latch (2374)
6129AHK: fully computerized post-production switcher; two independent M/Es, AutoDrive, 5-level keying, programmable fader handles, five GPI auto ramps.
8200C: two Y-C or composite TBCs with a switcher in one package; full switcher effects, digital effects, 2-level keying.
Circle (682)

ECHOlab (1866)
DV-5: programmable switcher, Archetect II with improved specs, construction and functions.
Circle (725)

FOR-A (3169)
CVM-600/CVM-1000: 12, 16 inputs component video switchers; complete transcoding interfaces; *-1000* has two M/E units.
PVM-600 enhancements: 12-input production mixer; full-feature switcher with DSK, edge generator.
Circle (767)

Grass Valley Group (2928)
KADENZA: digital video production switcher, integrates with KALEIDOSCOPE effects system for transparent signal processing.
MASTER-21: master control switcher; control panel, dedicated matrix, expansion interface for routing switcher; 16 video/16+4 stereo audio inputs; 4-input accumulative keyer; graphic Transition Status Display.
Circle (788)

Intergroup Technologies (2359)
Model 9608S: serial-control audio-follow unit for 9600 switchers.
Model 9629: extended wipe-pattern generator for 9600 switchers.
Series 8600: master control switcher.
REFEX II: software enhancement for series 9600 production switchers.
Circle (821)

Omicron Video (1870)
#507-15: master control switcher; 15 inputs.
Circle (943)

Quality Video Supply (4387)
QVS-VAM200D: digital video/audio mixer.
Circle (978)

Ross Video (3377)
RVS 416: 16-input production switcher; two MLE effects amps, rotary/matrix wipe option; simultaneous use of 4 keys, 3 backgrounds.
Circle (1004)

Thomson Video Equipement (3333)
TTV-5650/5655: digital component video production switchers.
TTV 5645: analog component video switcher.
Circle (1101)

Videotek (3074)
Prodigy: multilevel effects switcher with audio for production, post production.
Circle (1147)

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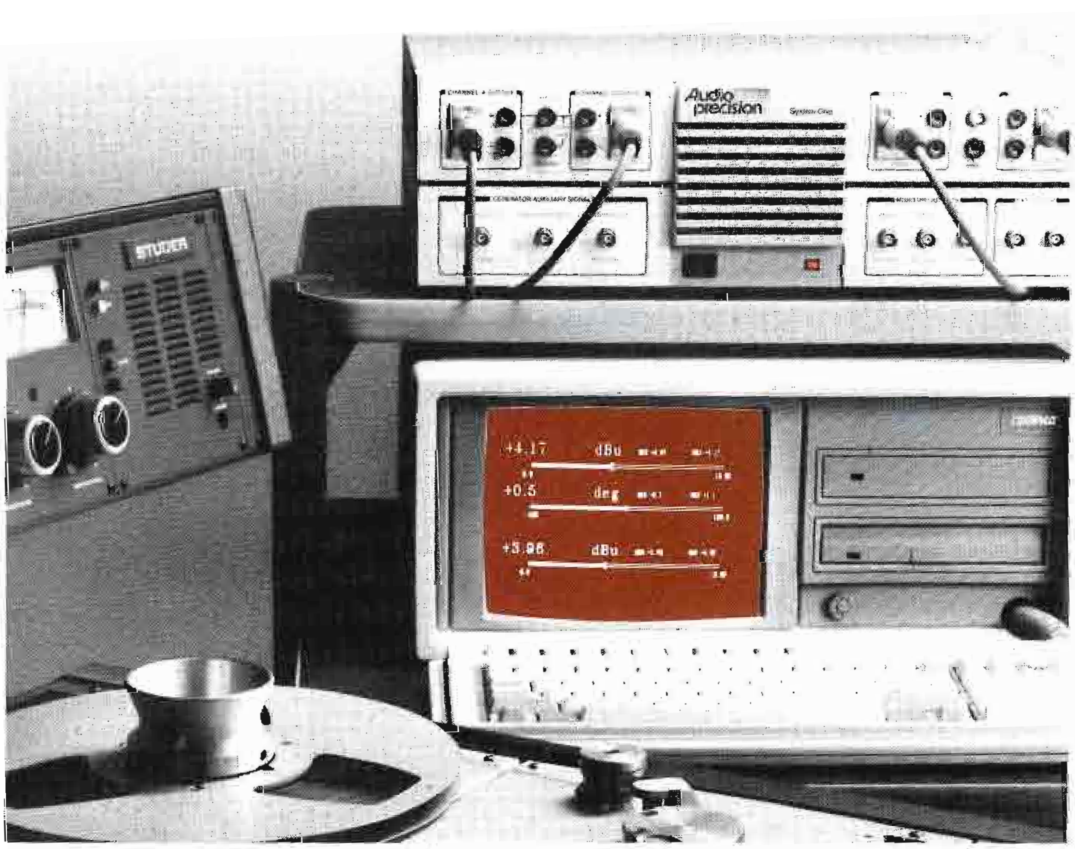

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V7: Processing

- Compositors, keyers
- Signal correctors
- Standard, format converters
- Sync generators, VBI IDs
- TBC/synchronizers

AEG Bayly **(719)**
Video processor: computer-controlled automatic scene transition recognition system; color correction and other post production functions.
Circle (514)

ALTA Group **(H5921)**
Centaurus: dual TBC/switcher with still store and Y/C inputs and outputs.
Dub converter: Y/C to Y-688, Y-629; bidirectional operation.
Pyxis-E: dual TBC/switcher with dual-channel freeze.
Circle (529)

Ampex AVSD **(3302)**
TBC-7: extended performance TBC; many features of Zeus processor, variable speed playback, time modification without picture bounce, digital velocity compensation, eliminates picture shift of non-color-framed edits.
Circle (536)

AMX **(H5910)**
IVT-9: S-VHS TBC.
APA-500: video processing amp.
Circle (540)

Broadcast Video Systems **(2226)**
#204: Cox NTSC encoder.
MASTERKEY: composite down-stream keyer.
Circle (610)

BTS Broadcast TV Systems **(2920)**
XD SMAC CD: S-MAC encoder converts 4:2:2 digital signals into studio MAC format.
HDTV noise reducer: full HDTV component, composite capability.
XD-PO NR 616: VTR noise reducer system.
HCN-5C decoder: comb-filter design; composite to RGB conversion.
XD-N5DC 7184A: NTSC decoder.
XD-ST NR 631: 4:2:2 digital noise reduction system.
XD-DC/XD-CD 7184A: decoder for digital 601/4:2:2 to analog component; encoder for analog component to 601/4:2:2.
Circle (615)

Digital Processing Systems **(4342)**
DPS-200: S-VHS TBC; low cost.
Circle (706)

Faroudja Laboratories **(4535)**
CTE-DP: detail processor/enhancer module for encoder.
CTC transcoders: bidirectional component-RGB; *-N* for NTSC, *-P* for PAL.
CDP component detail processors: -N for NTSC, *-P* for PAL.
Circle (754)

FOR-A **(3169)**
CT-600: component transcoder; Y/C composite, component formats, Y/C358 S-VHS.
FA-740 enhancement: independent A/B channels on parallel effects/TBC, C channel effects output.
FA-300: digital TBC with Y/C358 S-VHS input/output interfaces and Y/R-Y/B-Y component outputs.
CCS-4360: color corrector system, includes genlock, black stretch.
Circle (767)

Grass Valley Group **(2928)**
DAC-110: digital-analog translator, integral CBG; SMPTE or EBU standards; auto select 525 or 625 line/field rates.
CV-95N sync generator: color black reference, all standard pulses, GVG encoded SC; fits CV-20 module.
#7510 (receive): process amplifier; cleans incoming feeds; relay bypass, AGC, chroma level, phase, video gain, other proc amp adjustments.
ADC-120: translates CAV to component digital RP-1125 or EBU 3246-E signal.
Circle (788)

James Grunder & Associates **(1433)**
CVS950: YEM real-time scan converter; develops NTSC, PAL from computer high resolution RGB outputs; 1280x1024 64kHz scan converted without data omissions or modifications.
CVS900: YEM real-time scan converter; 38kHz analog input, resolution 704x704 8-bit system, 16,777,216 colors.
CVS801: YEM real-time scan conversion rates to 38kHz; 704x704 resolution and flicker elimination.
ENC 3000: YEM genlock color encoder; four encoded outputs; integral color bar generator for RS-170A, EBU specifications.
Circle (793)

Harris Video Systems **(503)**
#634: digital noise reduction, independent chroma, luma noise control to improve picture quality.
Circle (797)

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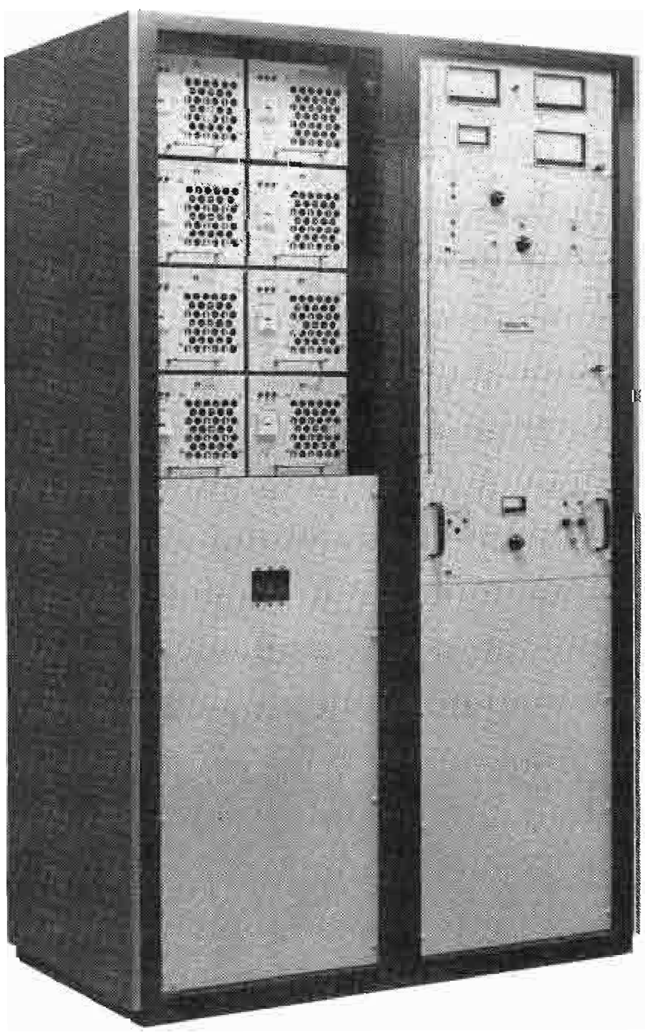

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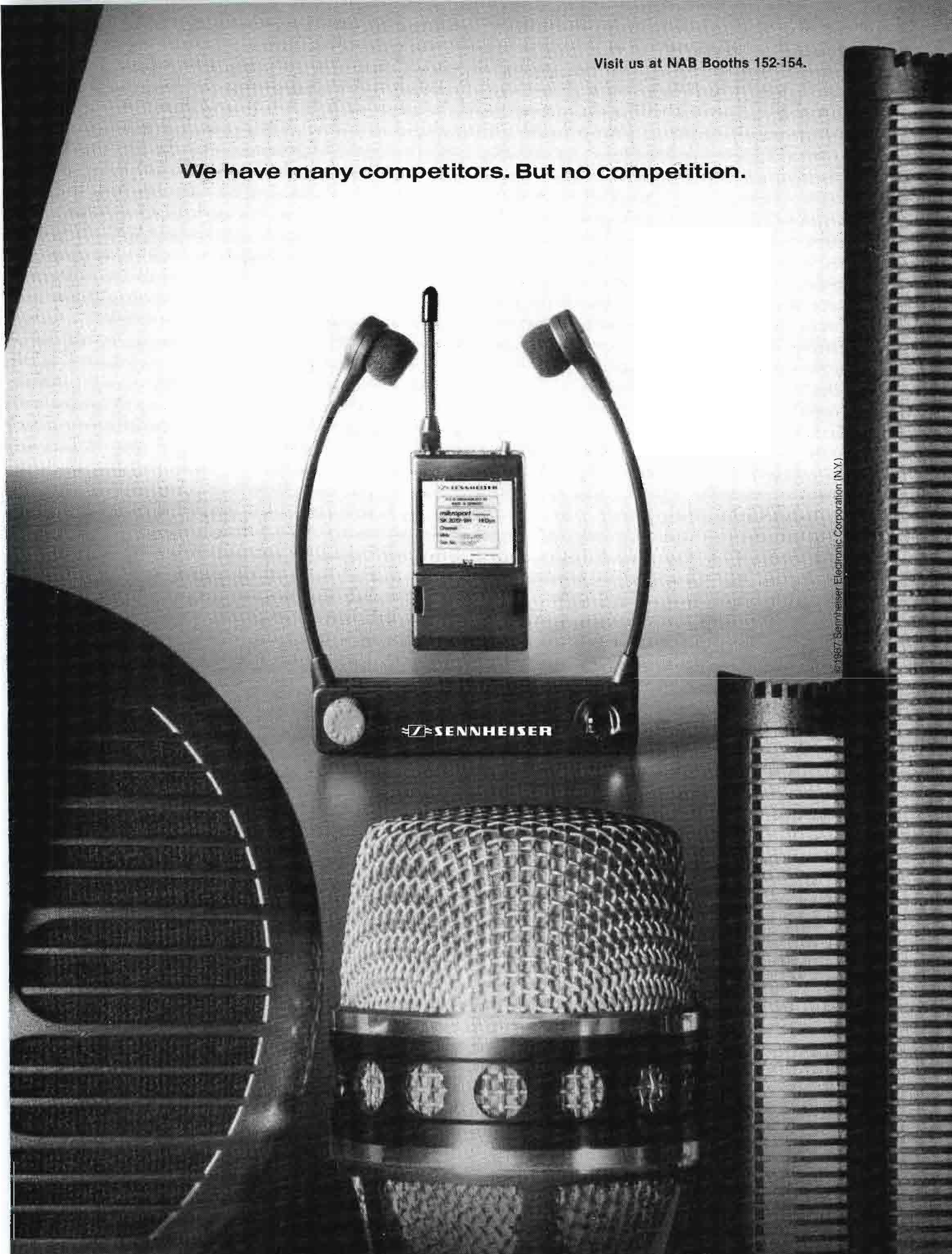

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HEDCO (1820)
HSG-100: NTSC source sync pulse generator.
Circle (799)

Hitachi Denshi (3324)
SE-110: super encoder for use with any RGB camera, improves resolution in saturated and dark portions of image.
Circle (802)

Hotronic (2571)
AF71: TBC, frame synchronizer; field, frame freeze feature.
AE61 TBC: Y/C inputs and outputs.
AF72 frame synchronizer: 16-bit, automatic matching of digital stereo/mono audio delay; cleans noisy satellite feeds; 2-frame/4-field freeze.
Circle (806)

Ikegami (2320)
ENC-700/DNC-750: digital codec; 20MHz bandwidth for 450 TVL vertical, 750 TVL horizontal resolution of 1,050-line signals.
DSC-1050: digital scan converter; 450 TVL vertical, 525 TVL horizontal resolution; converts 525 to 1,050 line structure from 4.25MHz to 30MHz bandwidth.
Circle (812)

J-LAB (1019)
CVCC: component video color corrector.
Circle (830)

Lenco (3956)
STARFLEX 4500: TBC, frame synchronizer; three fit in one STARFLEX system frame.
PGE-843: RS-170A sync-locking generator, NTSC encoder in single unit.
Circle (861)

Marconi Communications Systems (2869)
B4002: NTSC comb-filter decoder.
Circle (879)

Microtime (2638)
Microtime TBC: for S-VHS, other extended bandwidth formats; full-frame memory, field/frame freeze; integral sync generator, proc amp presets; NTSC or PAL.
Digital effects: in NTSC, PAL-M, PAL-B versions; composite, component input and output capabilities.
S-134 synchronizer: NTSC or PAL 4-field; eliminates picture shift of 2-field memory; optional video scrambling function.
S-234 TBC/synchronizer: S-134 with integrated TBC; time-share applications with auto select mode; NTSC only.
Microtime Graphics: paint, 3-D modeling, animation; RGB frame grab; RS-422 VTR controller.
Circle (899)

Midwest Communications (4342, PL)
DPS-200: S-VHS TBC by Digital Processing Systems.
Circle (901)

Nova Systems (4277)
NOVASync: synchronizer; full bandwidth, A/B inputs.
NOVA 620S: full-frame S-VHS TBC/framestore; S-VHS, composite processing in heterodyne and VTR-SC operating modes.
NOVA 700S: S-VHS TBC; integral S-VHS, heterodyne processing.
Circle (935)

Philips T&MI/Pro TV (3177)
PM 5638: component color coder unit.
Circle (965)

Quality Video Supply (4387)
TEL-ENC2: RGB-to-composite video converter.
Circle (978)

Sierra Video Systems (H5315)
CVCC: component video color corrector system.
Circle (1028)

Technov Industries (2484)
CSG-300: RS-170A color sync generator; oven-controlled crystal, gen-lock, split-field color bars, tone, blackburst, rack-mount.
Circle (1080)

Toko America (N.A.)
MP-3000: moving image processor terminal; HD video frame memory for computer simulation of moving image sequences; NTSC, PAL, YIQ, 525/625 inputs; *MP-5000* for 1125-line RGB, Y/Pb/Pr systems.
Circle (1177)

Ultimatte (2083)
U-300: video-compositer with digital memory; P analyzes, controls matte parameters for optimum composite image.
Circle (1120)

Video Accessory (2617)
Sync generator: RS-170A, genlock, low cost.
Circle (1138)

Video Associates Labs (2704)
Mark 10: PAL/NTSC single-slot EGA text, graphics overlay card for PC/AT, compatibles.
Circle (1139)

Video International Development (2577)
DTC-4500: 4-field standards converter.
Circle (1144)

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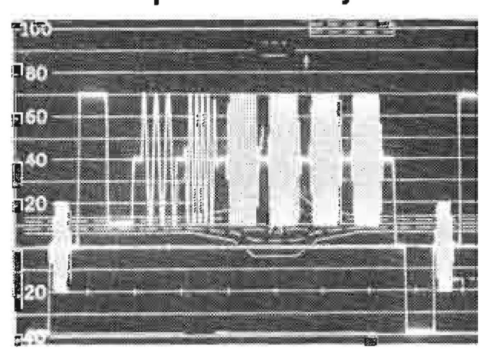

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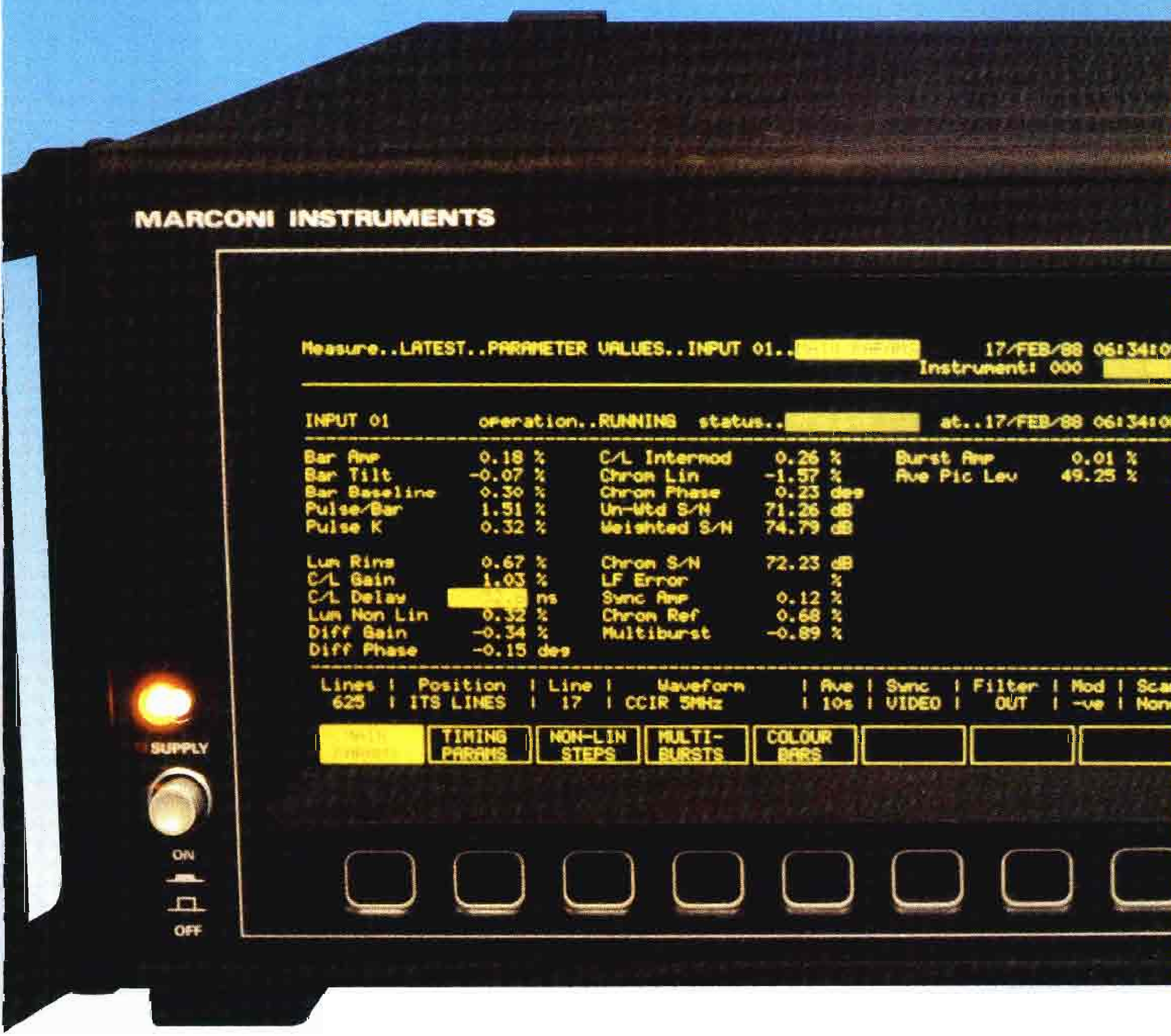

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Videotek **(3074)**
VDP-8000: digital frame store, synchronizer.
VSG-201: color sync generator with SMPTE color bars, audio tone.
Circle (1147)

Vortex Communications **(753)**
Sync generator: high stability SPG; multiple blackburst, test patterns, component or encoded video.
VTR clock: anti-aliased video ID generator.
Circle (1151)

Yamashita Engineering/YEM **(5913)**
CVS950: real-time scan converter; develops NTSC, PAL signals from computer high resolution RGB outputs; 1280x1024 64kHz scan converted without data omissions or modifications.
CVS900: real-time scan converter for 38kHz analog input, resolution 704x704 8-bit system with 16,777,216 colors.
CVS801: real-time scan conversion rates to 38kHz with 704x704 resolution and flicker elimination.
ENC 3000: genlock color encoder; four encoded outputs; integral color bar generator for RS-170A or EBU specifications.
Circle (1711)

V8: Displays
- Video monitors
- Projection systems

Barco Industries **(2985)**
CVM series: 14"/20" broadcast monitors; μP-control, high-stability color temperature, raster size; high-brightness, flat square CRT with 15% increased active screen; remote control of all control, display parameters; option slot.
CVS series: 14"/20" professional/broadcast monitors; digitally controlled calibration; programmable analog component input module; CCIR-601 digital component inputs; probe for auto alignment; multiple monitor remote controller for 48 units.
Circle (579)

FOR-A **(3169)**
MV-40C: color multiviewer; 4x compression allows four complete images on screen simultaneously.
Circle (767)

Hitachi Denshi **(3324)**
CM-150/210: high performance color monitor; added functions for broadcast with RGB, Y/C separate inputs and S terminal.
HDTV projectors: large screen systems; 54", 58", 110" models.
Circle (802)

Ikegami **(2320)**
TPP-50HLB: 50" rear-screen video projector.
Large screen projectors: TPP-700 TV projector; *TPP-1000* Super projector; teleconferencing, seminars, other applications.
Circle (812)

Leitch Video **(2169)**
DAM 6001: digital-to-analog monochrome monitor module; CCIR-601 input; one mono, luminance output.
Circle (859)

Nytone Electronics **(2442)**
VSS-1: sequential color slide scanner; tray, test slides, mounting rails, extender card.
VSS-2: random access color slide scanner, μP slide control, digital remote control box RA-2, tray, test slides, mounting hardware, extender card.
Pan/Zoom: programmable feature available for VSS-1, VSS-2.
Circle (938)

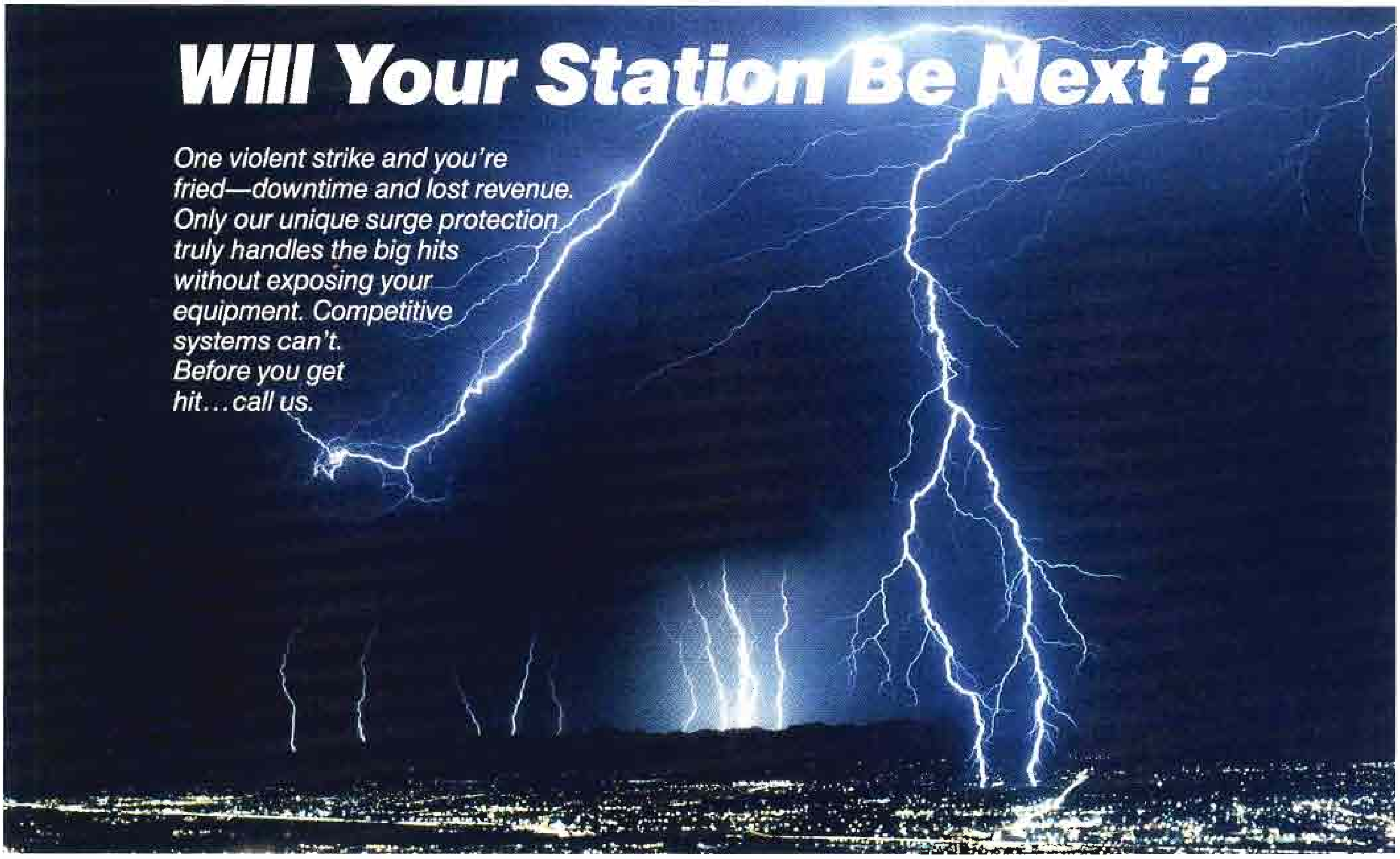
Panasonic Industrial **(2938)**
PT-101Y: S-VHS compatible video data projector; 650 peak lumens, 650 TVL resolution with video, 1,000-line resolution RGB; floor or ceiling versions.
WJ-450 Digital Quad system: display four complete images on one monitor; for editing suite or other multiple signal monitoring requirements.
Circle (922)

Sharp Electronics **(4316)**
QA-50: LCD computer projection panel; compatible to IBM PC/XT/AT/PS-2.
GZ-P21: color video printer; accepts composite, RGB, S-VHS inputs.
Circle (1024)

Sony Broadcast **(2902)**
BVM-1910: 19" video monitor; super high resolution CRT, automatic setup.
Circle (1037)

Sony Professional Video **(2902)**
VPH-1031Q: multiscan projector; dual hybrid lens/CRT, bright image, compact size.
PVM-1390: 13" monitor; 450 TVL resolution, S-video connector; analog, digital RGB inputs.
Circle (1040)

Videotek **(3074)**
AVM-19S: full-featured 19" professional color monitor with audio.
Circle (1147)



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Howe Technologies Phase Chaser 2300

By Dennis Ciapura

> ***Performance at a glance***
> - *Frequency response: ±1dB 20Hz-20kHz*
> - *THD: 0.02% maximum, up to +20dBm*
> - *IMD: 0.02% maximum, up to +20dBm*
> - *Overall S/N: better than −80dB*
> - *Channel separation: better than 70dB, 20Hz-20kHz*
> - *Phase-correction accuracy: ±2µs, 2kHz-20kHz*
> - *Maximum instantaneous phase correction: 2µs*
> - *Maximum long-term phase correction: ±150µs*

The Howe Audio Series 2300 Phase Chaser is one of the most interesting audio-processing devices to reach the broadcast audio marketplace recently. At first glance, it appears to be just another sonic "Band-Aid" for sloppy production. And, in this age of CD music sources, you might wonder if it isn't also a solution looking for a problem. However, a glance at Figure 1 reveals uncommon sophistication for a device of this type, with some unusual capabilities. The manufacturer's description of how it operates confirms this impression, and it doesn't take long to grow fond of the unit in actual field applications.

Problem source

The Phase Chaser is really a smart processor that senses the channel-to-channel delay in a stereo program source, then compensates for the shift without impairing stereo performance. That's a pretty tall order. After all, how can a device tell the difference between intentional delays, which are part and parcel of contemporary production effects, and the phase shift due to tape-head misalignment? The 2300 actually achieves this differentiation in most cases and corrects complete channel inversions and single-channel dropouts, all automatically.

Although audio phase-shift problems no longer plague broadcasters who are able to control their own program production and who enjoy comprehensive hardware maintenance, hundreds of stations use syndicated material, and others must depend on periodic maintenance by contract engineers. An associate who has extensive experience in syndicated radio confirmed, during a discussion on this topic, that maintaining correct phase is still a major problem around the country.

As MTS proliferates, TV broadcasters also must cope with audio phase errors. And, like it or not, the video signal is still top priority, with the audio signal receiving relatively little attention. It would be great to have a transparent box that would just sit there and do nothing most of the time, but would automatically correct any phasing errors that came down the pike without altering the overall response, distortion or stereo effect. The 2300 comes amazingly close to achieving this ideal.

Internal operation

The heart of the Phase Chaser is a proprietary phase-correction circuit called the cross-correlator. Perhaps the easiest way to describe how the cross-correlator works is to use an analogy that likens the circuit to an op-amp working in the time domain seeking phase equilibrium.

To avoid disrupting normal stereo effects, the circuit quickly adjusts the relative timing of the left and right stereo channels to the vicinity of statistically normal phase. The circuit then reverts to a

Ciapura is vice president of technical operations for the Noble Broadcast Group, San Diego.

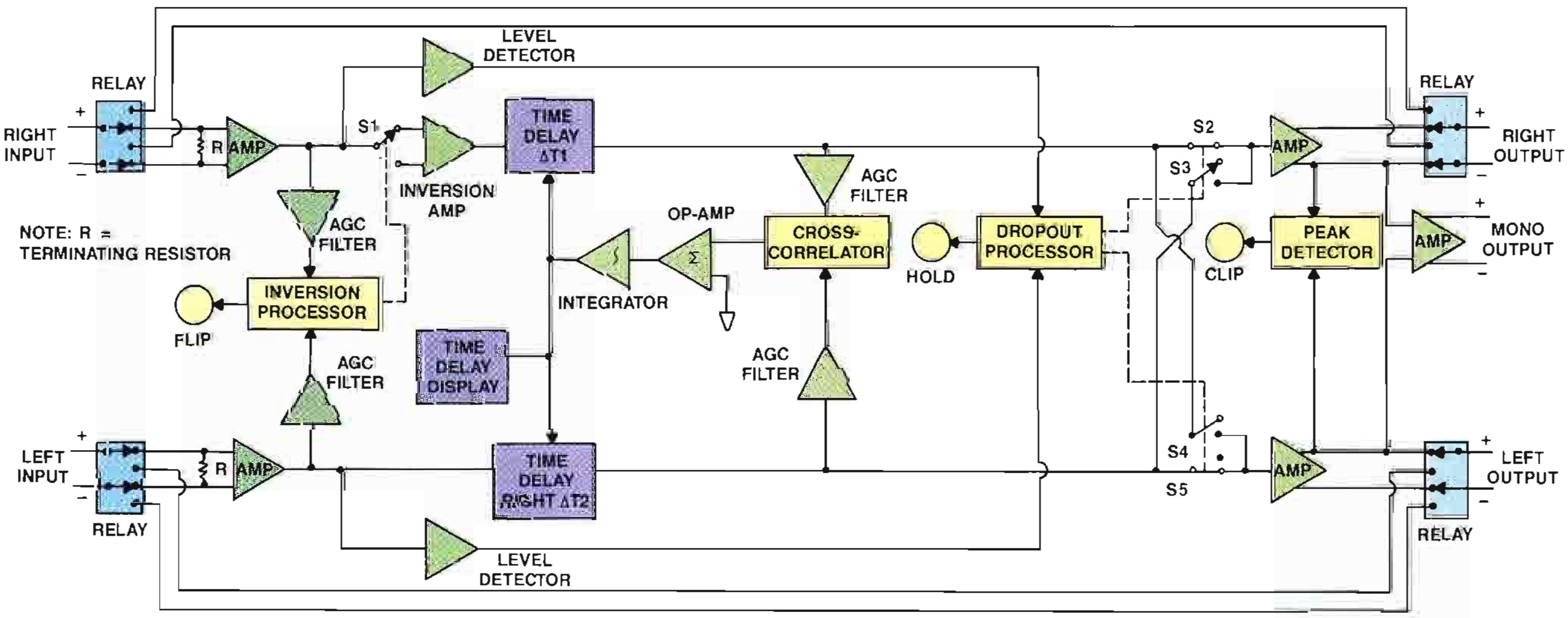

Figure 1. Block diagram of the 2300.

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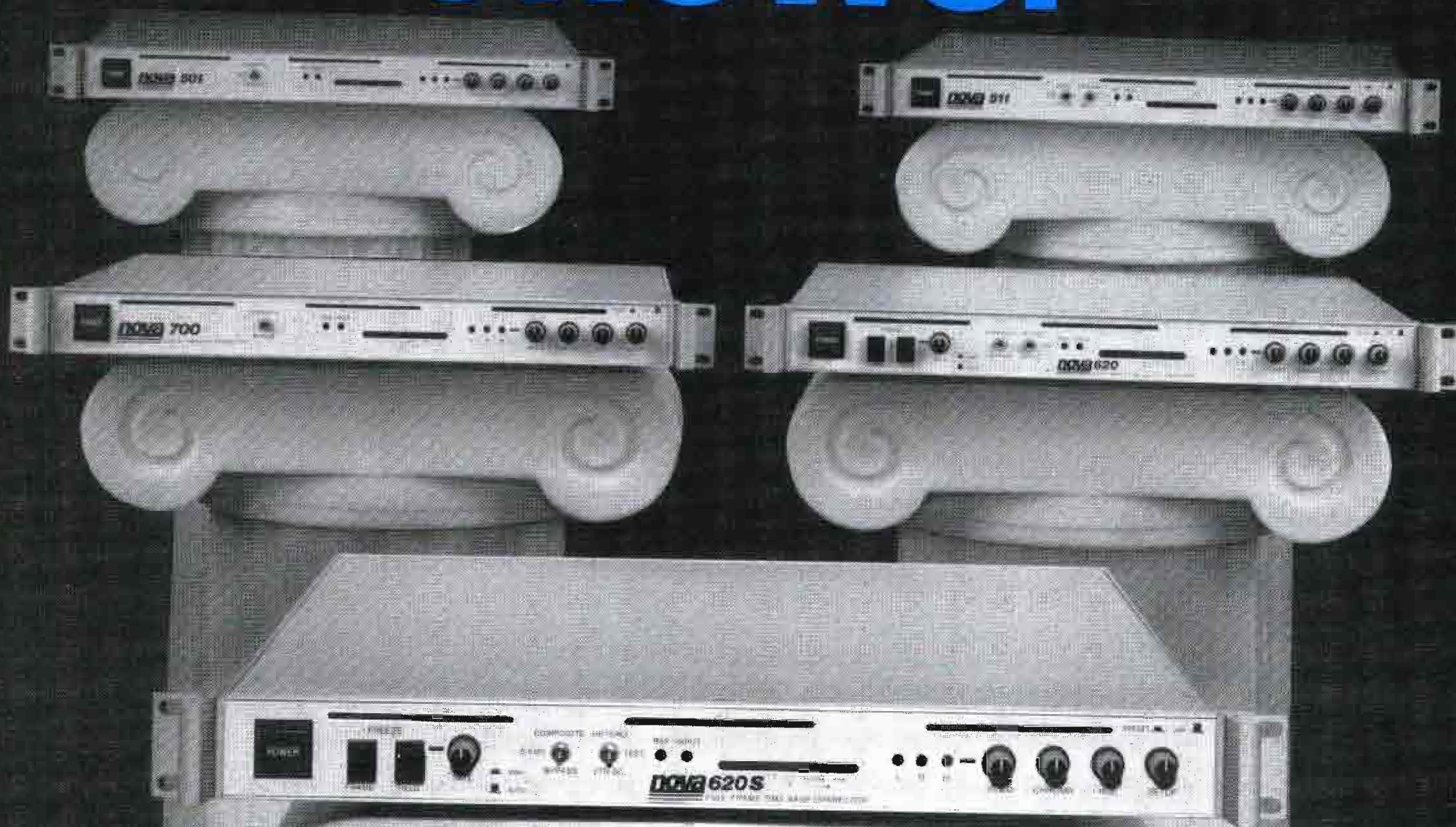
GOOD BREEDING SHOWS.



nova 620S S-VHS TBC.

NOVA's 620S TBC with S-VHS processing is the latest in a long line of high-quality time base correctors. It inherits all the fine features of the NOVA 620 . . . and it's the first TBC to interface with S-VHS VCRs. That means you maintain the quality of video, every generation. And if you own a NOVA 620, you can also exercise your "S" option, which upgrades your unit to a 620S.

From the first one-rack, low-cost TBC in 1983 to the 620S, each addition to the NOVA family clearly demonstrates our commitment to excellence. And if a problem ever develops, we stand behind our TBC family by offering quick, 24-hour turn-around service. It's a heritage we're proud of . . . and a heritage you can rely on.

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-3dB at 100kHz		
THD AT 0dBm OUTPUT LEVEL:		
FREQUENCY	LEFT	RIGHT
20Hz	0.05%	0.07%
50Hz	0.09%	0.08%
100Hz	0.08%	0.08%
1kHz	0.08%	0.07%
2.5kHz	0.06%	0.06%
5kHz	0.09%	0.08%
10kHz	0.11%	0.09%
15kHz	0.15%	0.11%
20kHz	0.17%	0.13%
NOISE: -75dBm (same as test equipment residual)		

Table 1. *The measured performance of the 2300.*

slow correction mode, passing through unaltered phase variations occurring within a predetermined window, which are typical of program content. The unit continues to monitor the relative timing, making small adjustments as required to keep the overall system in phase. Relatively fast program-generated phase differences pass through virtually unaltered.

If you're skeptical about how well this concept can work with real program material, it is useful to compare this process with that of the more familiar audio compressor using a slow AGC time constant. The instantaneous levels of the various audio program components are left substantially intact, but the overall average level is held constant over some range of input levels. The 2300 acts in a similar manner, but the changes take place in the time domain.

The block diagram is shown in Figure 1. The inversion processor senses com-

The NEWS from PERROTT

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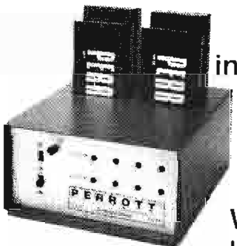
discharger/charger for NPI's and NPIA's



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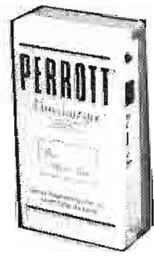

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plete 180° shifts and soft fades to an inverted mode to correct the error. The input to this circuit is bandlimited and level-controlled to prevent transients and high-frequency material from triggering an inversion.

The time delays, which have a maximum capability of 150μs, are controlled by the cross-correlator described previously. The cross-correlator inputs also are bandlimited and level-controlled so that the correlation is based on real left-right timing differences, rather than program content.

The channel dropout-correction circuit senses a lost channel and crossfades to mono using the remaining channel. The most recent phase correction is always stored so that the system has an accurate starting point when the dropout ends and normal stereo operation is resumed. The threshold level is adjustable or, if desired, the entire function can be disabled.

Performance

To be attractive to the broadcaster, equipment such as this must be highly transparent. After all, who wants to trade occasional phase problems for any significant degree of full-time fidelity loss? For this reason, the 2300 was subjected to somewhat more thorough audio testing than usual. Typical high-quality broadcast test equipment was employed, so these results should correlate with what broadcasters can expect to measure with typical station test equipment. See Table 1.

No frequency response deviation from 20Hz to 20kHz was noted. The −3dB point was 100kHz. The company specifies that the unit is flat to within 0.1dB from 10Hz to 20kHz. The 0.1dB variance probably is a result of typical engineering reluctance to declare absolutes. The THD at the 0dBm output level was at the test equipment residual limit, generally less than 0.1%. IMD also was about 0.1% at the same output level. The company specs both at 0.02% up to +20dBm.

The device is specified for +20dBm maximum output. Many broadcasters probably would operate with 20dB of headroom. For this reason, the 0dBm level was selected for the distortion tests. In any case, oscilloscope examination of the output distortion components showed nothing other than the test equipment third-harmonic residual signal, so the 0.02% value probably is conservative.

Wideband noise was also at the test equipment limit, which is −75dBm. The company specified noise level is −80dBm. Overall, the unit tested about as clean in the operate mode as it did in the bypass mode. In this configuration, the inputs are connected directly to the outputs.

Studio applications

After considering several more elegant methods to test the phase-correction capability of the 2300, we decided the brute-force method of changing the azimuth of a 2-channel playback head was the best approach. The Phase Chaser was then switched in and out of the test circuit while we monitored in mono.

The processor really works. Delays in excess of 180° at 5kHz were corrected smoothly and effectively. The inevitable treble loss due to the extreme azimuth error was all that was audible after correction. Typical broadcast equipment phase errors would be much less severe. Therefore, it's unlikely that any noticeable loss in mono or stereo quality would exist after phase correction.

Stereo operation was entirely normal, and the only thing that could probably fool the unit is a time-delay stereo synthesizer. Some MTS-equipped TV stations use this type of stereo synthesizer during mono program segments. In these instances, the Phase Chaser should be installed ahead of these devices. Otherwise, the phase correction may nullify some or all of the developed stereo effects. Overall, the best place for Phase Chasers in a TV station is at the audio output of stereo sources.

The 2300 also has a mono output, which is useful for radio stations simulcasting with a mono AM signal. A Phase Chaser installed in the stereo feed to the FM transmitter would help ensure optimum stereo for the FM and a compatible mono signal for the AM transmitter.

AM stereo stations may find the device useful for protecting the mono signal, too. Because virtually all AM receivers are still mono, few AM broadcasters would risk producing a less-than-optimum mono signal just to broadcast in stereo.

(After this field report was written, Howe Technologies released an updated version of the 2300 Phase Chaser. The new model, 2300A Phase Chaser, incorporates several changes. The Flip and Fill defeat switches have been moved to the front panel to improve flexibility. The new version can also be programmed to restore normal processing without a manual reset after power failure, and the control circuits have been made even smarter to recognize special effects such as surround sound. Maximum output of the 2300 has been improved to +23dBm, and the signal-to-noise ratio to 96dB.)

Editor's note: The field report is an exclusive **BE** feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting firm.

In essence, these reports are prepared *by* the industry and *for* the industry. Manufacturer's support is limited to providing loan equipment and to aiding the author if support is requested in some area.

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New products

Digital audio broadcast system

SDS Broadcast Services will begin delivery of its Digital Audio Broadcast System by the end of the first quarter of 1988. The system eliminates the use of any form of tape, records, CDs or reel-to-reel facilities. The system will record/playback any analog signal fed to it and has a performance level of 5Hz to 25kHz. The unit operates on a single PC (XT or AT) and can be connected for full networking configuration. The software supports multi-users and will produce a complete log. The system allows the user to locate any song or commercial in the system and play to air in no more than 28ms. The digital audio system will support from one to 12 channels at one unit. Some features include infinite playback; automatic log control; and balanced or unbalanced outputs. The system can be loaded for total automation, and it eliminates records, tapes, recorders, cart machines/systems and CDs.

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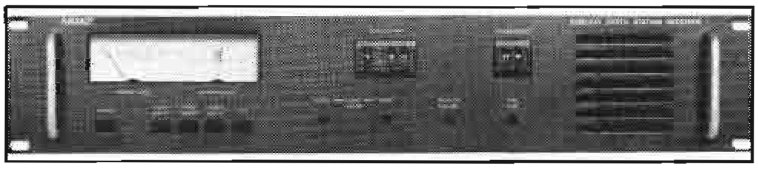
Earth station receiver



R.L. Drake Company has introduced the ESR2240, a receiver that mounts in a standard 19-inch rack panel. Features include block downconversion with Drake's BDC-24 weatherproof block downconverter or LNB, dual signal inputs with automatic or manual polarity changeover for dual-feed installations, and a 950MHz to 1,450MHz loop-through output that allows stacking of multiple receivers per polarity without splitters.

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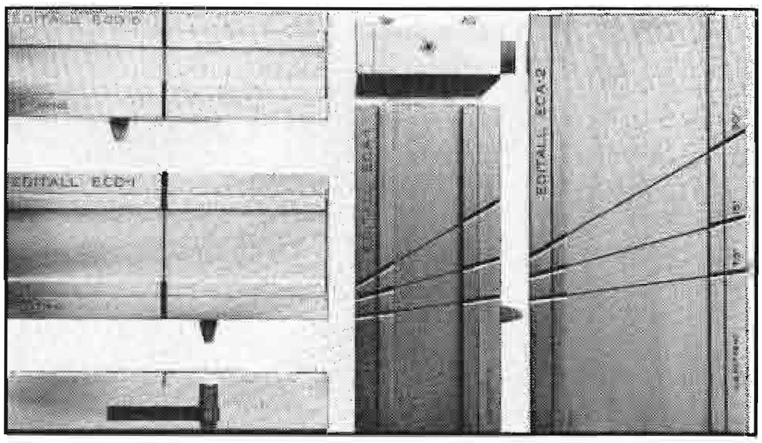
Magnetic tape splicing block

Editall has introduced the EC series of precision blocks, which handle and splice thin, fragile tape as used in various digital formats. The blocks' design prevents lifting and shifting of thin tape due to static attraction. The series includes the ECD-5 ½-inch digital, ECD-1 1-inch digital, ECA-1 1-inch analog, and ECA-2 2-inch analog.



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Mixing desk

Harrison Systems has introduced the PRO-790 general production mixing desk. Features include three mainframe sizes ranging from 12 to 28 inputs, two main stereo outputs, two separately derived main mono outputs, two auxiliary sends with level trims, PFL solo cuing, and Penny & Giles 3000-series 104mm linear faders.

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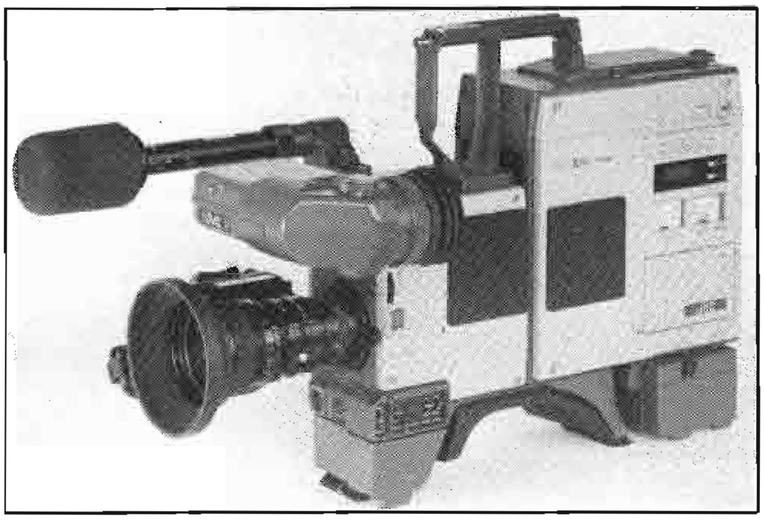
3-CCD video cameras

JVC Professional Products has introduced the KY-15U video camera, tailored for S-VHS and M-II environments, which can be used alone or in a camcorder configuration. It uses ½-inch CCDs that provide 360,000 pixels, and a f/1.4 prism-optical system. S/N is 58dB, and resolution is 500 lines in R, G, B and Y channels.



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Component digital and test signals

Magni Systems has announced the following products:

- The option for component digital (D-1) output for the 1500 series test signal generators. The option (−04) provides by front-panel selection four 4:2:2 component digital signals to SMPTE RP125-1987/CCIR D-601 standards—75% color bars, a 5MHz line sweep with 2T pulse and bar; a split field of luminance and color-difference with valid ramps and 100% color bars; and a dual-timing pulses and Bow-Tie combination. The option also provides a default output of 75% color bars via a back panel connector when any standard signal selection is made from the front panel, allowing an NTSC or component signal to be used simultaneously.
- SECAM test signal files are completely mathematical in nature. This ensures no distortion; that frequency modulation is perfectly linear, with no random AM or noise; and that the pre-emphasis and clipping are analytically correct.

Circle (455) on Reply Card

Capacitor/parts tester

The instrumentation products division of *Beckman Industrial* has introduced the CAPT6 compact, multifunction hand-held meter that features a 3½-digit LCD display, a rotary range selector dial, 0.5% accuracy, and more than 200 hours of battery life using alkalines. Field-service technicians can test capacitance, resistance, diodes and LED, and batteries under load conditions.

Circle (456) on Reply Card

S-VHS time base corrector

Nova Systems has introduced the 700S TBC, which processes the S-VHS format. It features a 32-line memory, heterodyne picture processing, 8-bit, 4x subcarrier sampling, and RS-170A output with digitally generated SCH.

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Headphone distribution amp

Stewart Electronics has introduced a 4-channel headphone distribution amplifier, the HDA-4. Each of the four outputs delivers up to 1W of output power, regardless of the impedance

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of the headphones. A master level control allows simultaneous control of all four outputs, and individual level controls allow independent control of each headphone.

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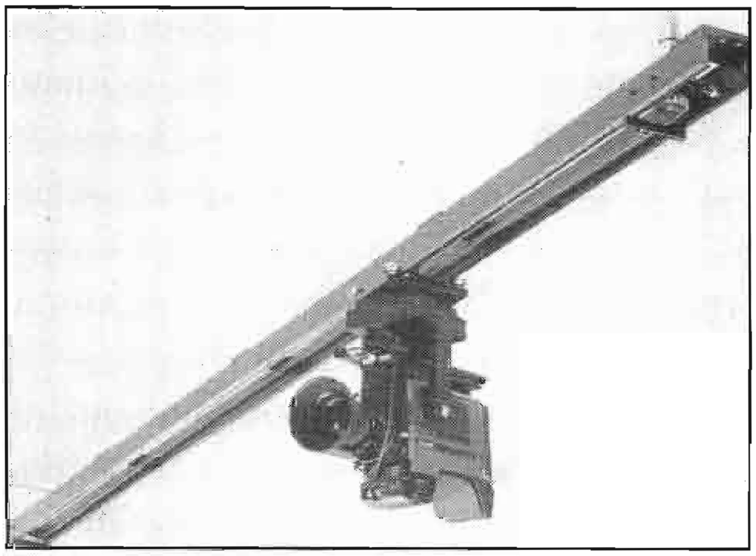
Remote portable camera mount

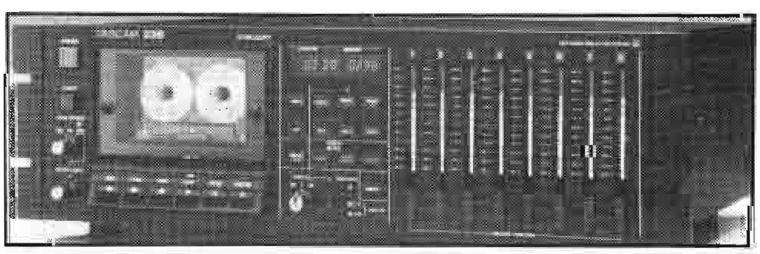
Telemetrics has introduced the model 68060 camera trolley assembly, a ceiling-mounted, or other overhead-mounted, camera motor-driven under remote control along a trolley track. The camera is locked into a broadcast-quality remotely controlled pan/tilt mount. Lens zoom and focus also are remotely controlled through the same feed cable. No modifications are necessary on standard portable cameras. Standard trolley-track lengths are five feet, 10 feet or multiples of five feet. A separate remote freestanding unit affects the controls at distances of up to 1,000 feet. Through this remote-control unit, the camera mount can be moved in either direction along the trolley track at speeds of up to one foot per second. Joysticks control lens focus and zoom, as well as a continuously variable 60° pan movement (at 20° per second) and up to 90° tilt movement at 40° per second.



Circle (459) on Reply Card

8-track multitrack cassette recorder

Tascam has announced the rack-mount 238 Syncaset, 8-track multitrack cassette recorder. It supplies twice the number of tracks previously available in a standard cassette multitrack recorder, with state-of-the-art control. The recorder features 3¾ips tape speed, full-function remote control, auto punch in/out, auto reverse, dbx II noise reduction and MIDI (FSK) compatibility. The unit also features a serial connector for external computer control and open architecture for future software development.



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V-LAN developers kit

Videomedia has announced the V-LAN developers kit. The user can have control of all videotape recorder functions (including frame-accurate animation, all editing functions and SMPTE time-code reading) of most current ½-inch, ¾-inch, 1-inch, Betacam and M-II format VTRs from virtually any

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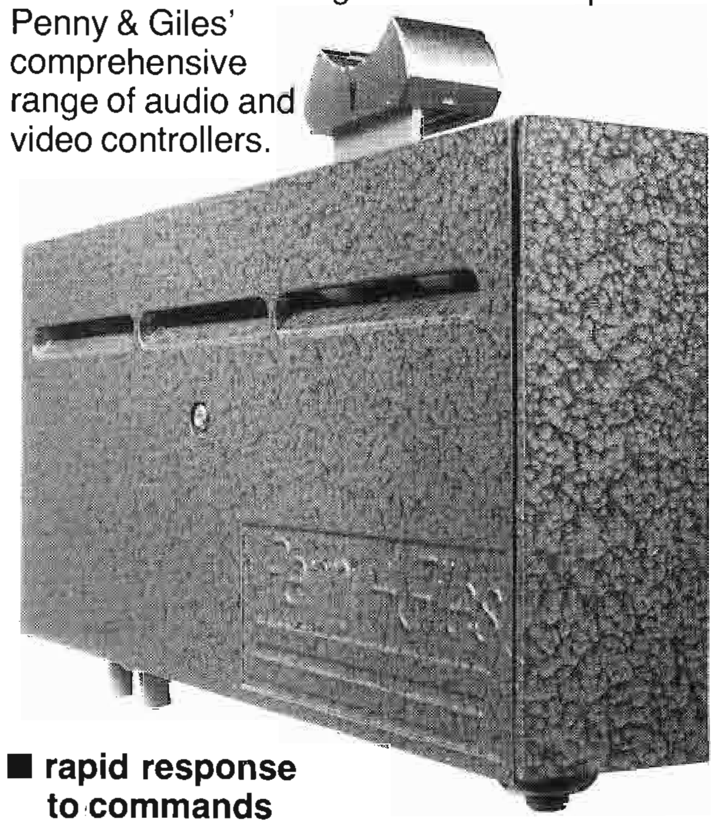

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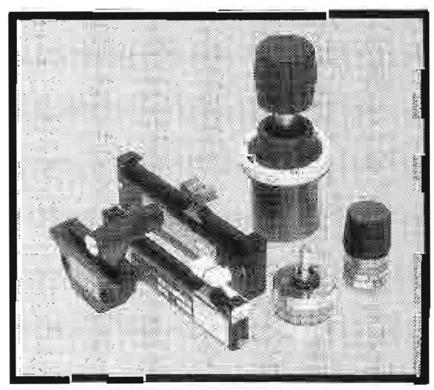

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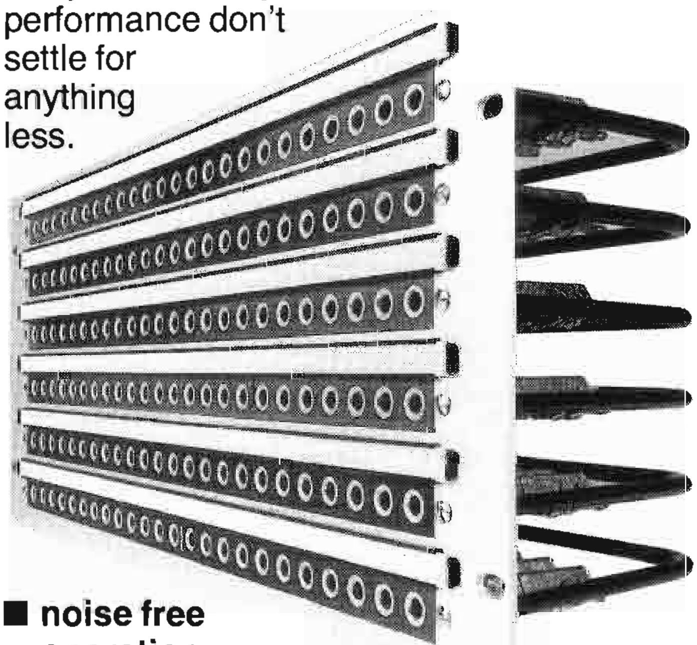

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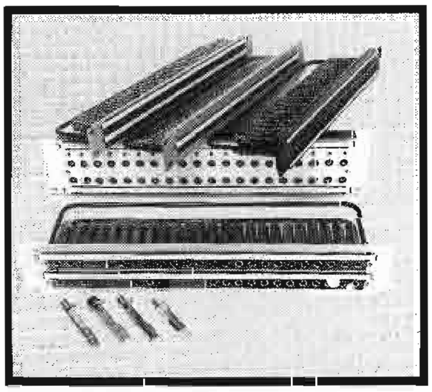

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computer with a spare RS-232 port. The user is spared the task of programming for specific VTR characteristics such as ballistics, capstan bump routines and remote implementations. The V-LAN protocol is not language- or computer-type dependent. The V-LAN uses a high-speed data communications link for bidirectional real time communications between VSIO computers. A standard RG-59 coax cable with BNC connectors is used to connect all VSIO units on the V-LAN. The VSIO unit is a small self-contained Z-80-based computer. The V-LAN developers kit consists of the complete protocol documentation, a 5¼-inch MS-DOS disk with working sample to source code, one V-LAN transmitter unit and one VSIO receiver unit for a VTR.

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Cardioid microphone

Bruel & Kjaer has introduced the Type 4011 prepolarized condenser microphone, with a first-order cardioid directional characteristic. It combines a flat on-axis frequency response with a uniformly smooth off-axis phase and frequency response.

Brüel & Kjær's Type 4011 Cardioid Microphone

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Compact recorder series

Otari has introduced the MX-55, a series of compact, ¼-inch tape recorders. The series includes full-track, 2-track NAB or DIN stereo, and a 2-track with center-track time code. It also is available as a 2-track with or without time code in a desktop overbridge cabinet style. The transport features a dc quartz PLL capstan motor with user-selectable speed pairs of 15/7.5ips or 7.5/3.75ips and is controlled from an external synchronizer with 9,600Hz frequency servo control. A 7-digit tape timer with a 4-memory minilocator is included as a standard feature. Additional features include ±20% vari-speed, sel-rep (sync) for overdubbing and monitor loudspeaker.

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Standby power source unit

Sola has introduced the SPS/R standby power source that features a transfer time of 1ms and full ac power conditioning capabilities. Equipped with an electronic regulator, the unit is suited to protect electronic equipment from all types of ac power problems including line noise, voltage irregularities and brownouts, as well as blackouts. The unit is available in 500VA, 1,000VA and 1,500VA outputs with 60Hz units rated for input/output of 120Vac. The front panel is equipped with red and green solid-state (LED) lamps that indicate operating and fault conditions. The front panel also contains an output power switch that enables the user to shut off all ac power from the four receptacles on the back of the cabinet.

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Suppressor

Transtector Systems has introduced the ACP 10,000 line of silicon solid-state transient overvoltage suppressors. The suppressors feature 5ns response time with a low clamping point and a suppression capability up to 1.8MW.

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Microwave links

TFT has introduced its model 8600 aural microwave link systems, which comply with Part 94 of the FCC Rules. The 8600 6W discrete microwave system is designed to operate from 944.5MHz to 951.5MHz, as well as 952MHz to 960MHz.

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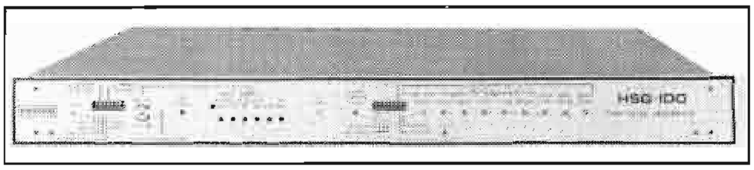
Video and audio switcher and sync pulse generator

HEDCO has introduced the following products:

- The TWS100/200 12x1 audio-video switcher features video only or stereo audio only, as well as audio-follow-video formats. One front panel controls the separate video and audio sections. The control panel can be detached or looped through to both chassis depending on the application. Other features include relegendable push buttons on the front panel, bridging video inputs, four isolated 75Ω video outputs, balanced bridging audio inputs, four isolated 600Ω audio outputs and 8-hour crosspoint retention during power failures. Its wideband video specs are suitable for HDTV.
- The HSG100 NTSC source sync pulse generator can be used stand-alone or as a slave generator. It provides consistent SCH, blackburst output, two outputs for subcarrier, sync and blanking as well as one output for burst flag, horizontal drive and vertical drive. Features include high-stability phase-locked crystal oscillator and low power consumption of 20VA.



HSG100 NTSC sync pulse generator

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Companion printer

Leader Instruments has introduced the model 100P, a companion printer for the combination digital multimeter/storage oscilloscope. The printer provides a hard copy of stored waveforms. The storage oscilloscope section is equipped with a 3MHz maximum sampling rate, 10mV sensitivity and an autorange mode that automatically sets the time base. There is an on-screen display of setting conditions that include sensitivity, time base, triggering, slope and sync. Other features include roll mode, pretrigger view and a memory that allows storage of three waveforms with their setting conditions. The autoranging DMM offers ac and dc measurement functions, resistance and a low ohm mode to provide a lower test voltage for in-circuit resistance measurements. The printer and DMM/storage oscilloscope are portable.

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People

BE names new TV technical editor
By Jerry Whitaker, editoral director

We at **Broadcast Engineering** endeavor to lead the industry and our readers with the most up-to-date and accurate technical information available. This not only takes dedication, but a special staff having hands-on experience facing the challenges, frustrations and needs of engineers and managers. Toward this end, we are proud to welcome Rick Lehtinen to fill the position of TV technical editor. Lehtinen replaces Ned Soseman, who is editor of our sister publication, **Video Systems**.

Lehtinen will share editorial responsibilities with Carl Bentz, special projects editor, and Brad Dick, radio technical editor. Lehtinen brings to **BE** a strong background in video technology, satellite uplink operations and the engineering of computer graphics systems.

Lehtinen comes to **BE** from Salt Lake City, where he was a senior engineer for KSL-TV. While at KSL, Lehtinen worked on the design and construction of the new Broadcast House at Triad Center.

Prior to KSL, Lehtinen was employed by KBYU Broadcast Services, Provo, UT, as a master control and tape room operator, transmitter remote-control operator and cable-TV head-end operator.

Lehtinen entered electronics in his home state of Washington, working in the timber industry as a mobile radio repair technician. Shortly thereafter, he began searching for a side of electronics that didn't require squirming in the mud installing radios in log trucks. Accordingly, he sought the then required first class license, receiving it just prior to beginning at KBYU.

While at KSL, Lehtinen developed an interest in computer graphics, and was retained to construct the facilities of Visual-Izatt Productions, an independent graphics company in Salt Lake City. While there, he installed one of the first image transfer systems using an Ethernet LAN to link graphics systems of different manufacturers.

In 1983, Lehtinen wrote his first article for **Broadcast Engineering** magazine. He has contributed regularly since then, including several field reports and the "Strictly TV" columns for January and February of this year.

Correction

The "Satellite Technology" column on waveguide components (see page 14 of the February issue) contained a formula for calculating VSWR that was in error. The corrected formula should read: VSWR = $(V_{out} + V_{ref}) / (V_{out} - V_{ref})$. We regret any inconvenience this may have caused.

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Interested in ordering article reprints out of this or another issue?* Reprints can be excellent learning tools for your technical staff and great marketing tools for your sales staff. Call or write Cynthia Sedler at Intertec Publishing Corp., P.O. Box 12901, Overland Park, KS 66212; (913) 888-4664.

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Telemet	102	43	516/436-7260
Telemetrics Inc.	38	19	201/427-0347
Television Equipment Associates, Inc.	332	126	914/763-8893
Television Technology Corp.	75	42	303/465-4141
Telex Communications, Inc.	308	221	612/887-5550
Tennaplex Systems Ltd.	212	144	301/561-1999
Tentel	208	139	800/538-6894
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TFT, Inc.	287	205	408/727-7272
Thermodyne International Ltd.	246	174	213/603-1976
Thomson Video Equipment	195	123	203/324-1320
Thomson-CSF/DTE	279	200	203/324-1320
Thomson-CSF/LGT	245	173	203/324-1320
Time Service Systems, Inc.	200	127	416/764-7720
TMD, a Will-Burt Co.	160	81	216/682-7015
Topaz, Inc.	247	175	619/279-0831
Toshiba Corp.	269	192	
Total Spectrum Manufacturing, Inc.	31	18	914/268-0100
Townsend Broadcast Systems	213	146	800/531-5232
United Ropeworks (U.S.A.) Inc.	216	149	215/368-6611
United Video	186	111	800/331-4806
Utah Scientific Inc.	158-159	80	800/453-8782
Varian	122-123	65	415/592-1221
Varian	39	20	415/592-1221
Varian	169	91	415/592-1221
Varian VCT Ltd.	217	150	415/592-1221
Vid Video	190	147	800/826-2035
Video Accessory Corp.	338	248	303/443-4950
Video Int'l Development Corp.	319	231	516/842-1815
Videotek, Inc.	119	61	602/997-7523
Videotek, Inc.	117	59	602/997-7523
Vinten, W. Ltd.	282-283	202	818/767-0306
Ward-Beck Systems Ltd.	BC		416/438-6550
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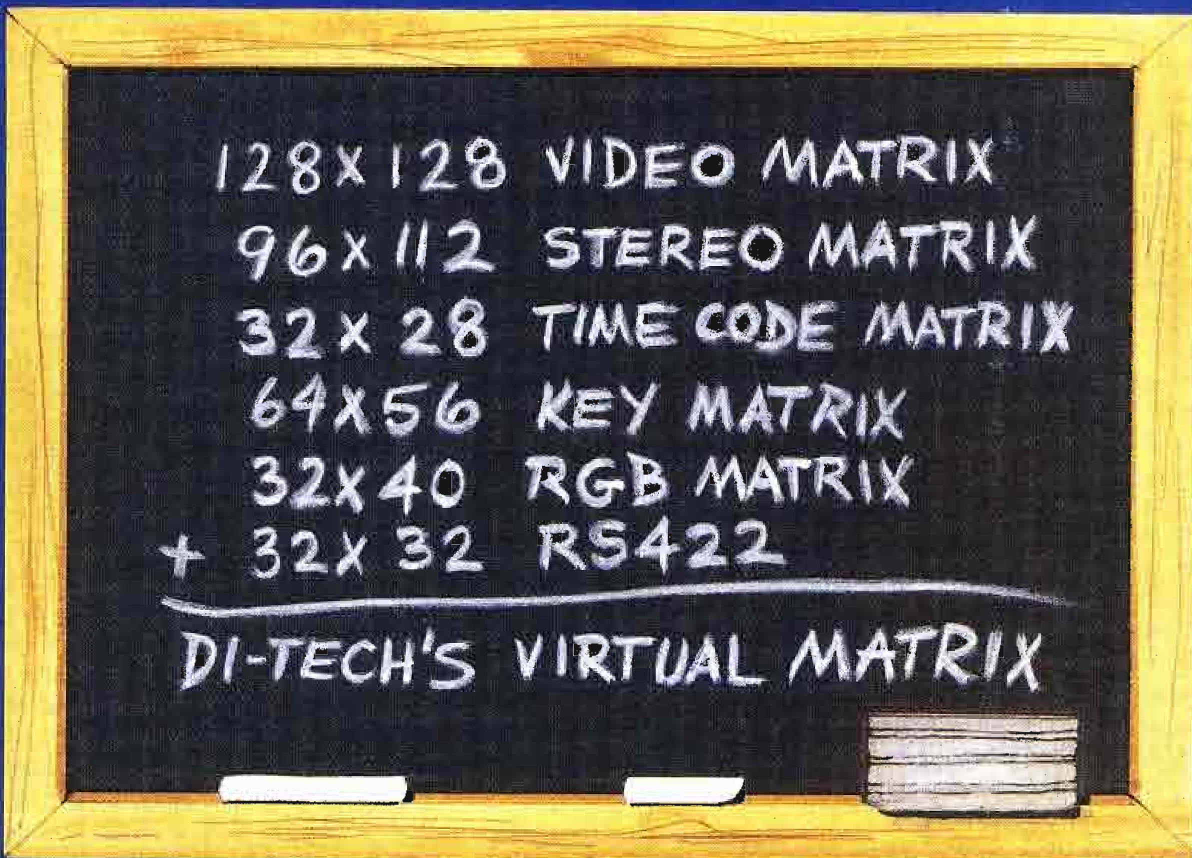

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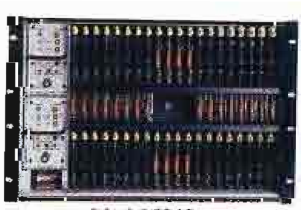

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