

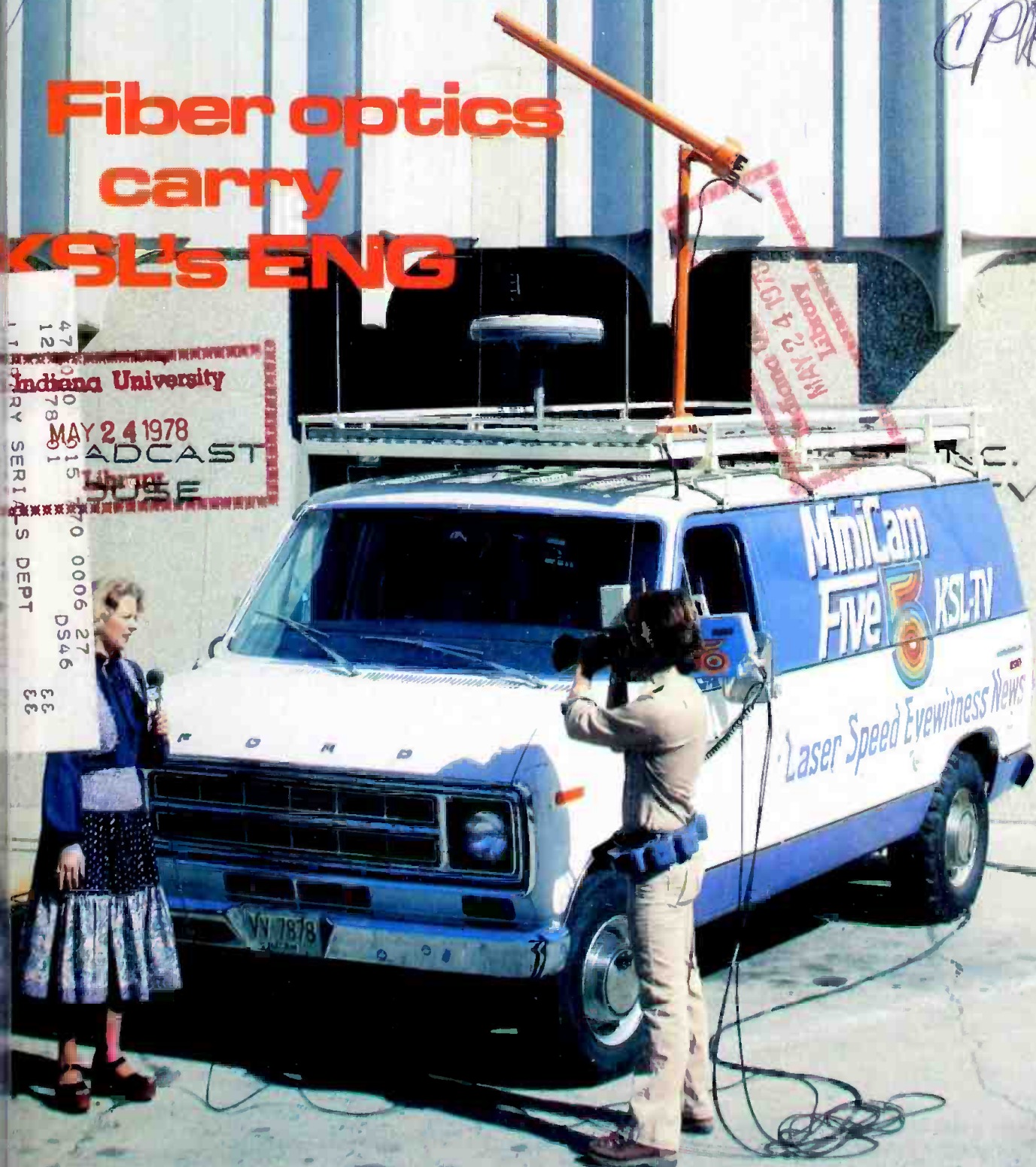
# Broadcast<sup>®</sup> engineering

ay, 1978/\$2.00

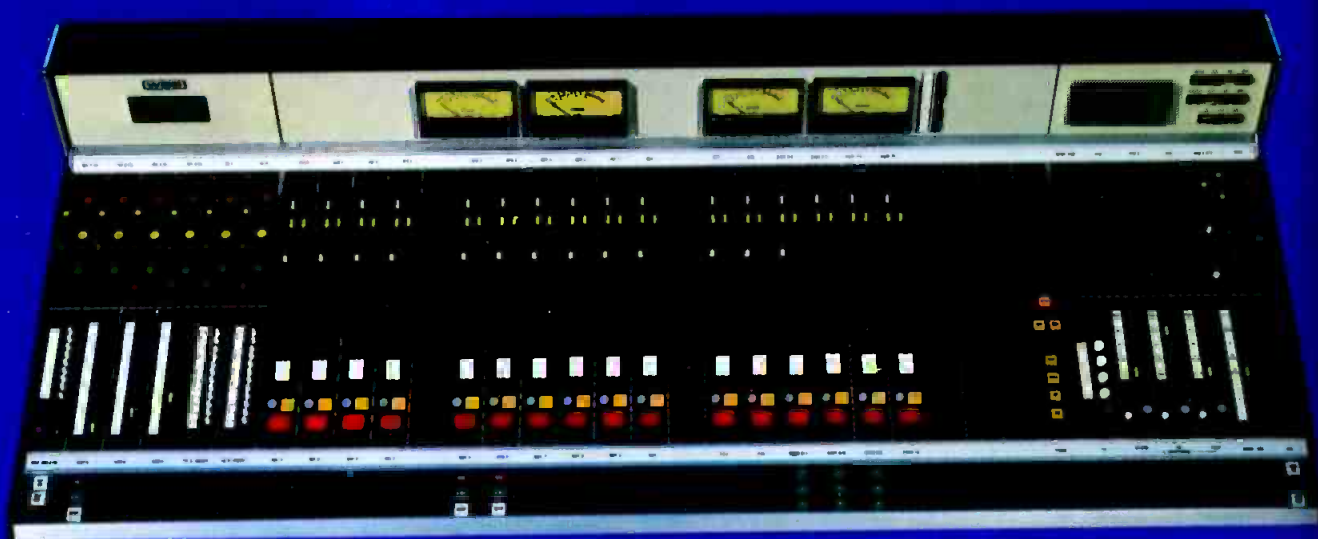
CPR

Fiber optics  
carry  
KSL's ENG

47  
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Indiana University  
MAY 24 1978  
BROADCAST  
LIBRARY  
SERIALS DEPT  
DS46  
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A visit to digital's numberland  
Multi-tower directional antennas



## AM Stereo by Ward-Beck.

Something special has happened to radio. Now, for the first time, there are operator-oriented radio consoles designed in the Ward-Beck tradition.

We take pride in introducing the new WBS R1200 and R2000 Radio Programming and Production facilities, assiduously engineered for AM and FM, assembled AM stereo ready.

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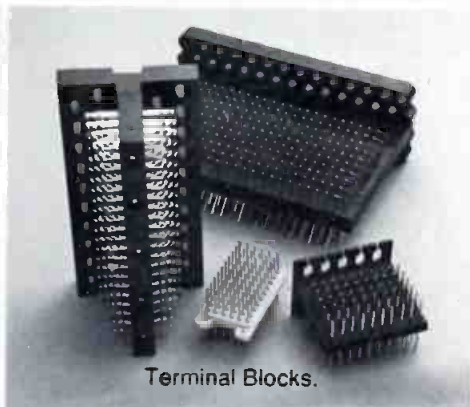
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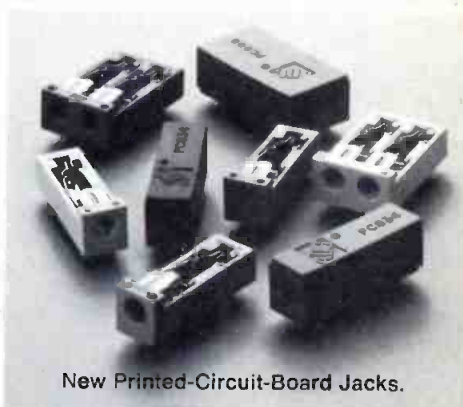
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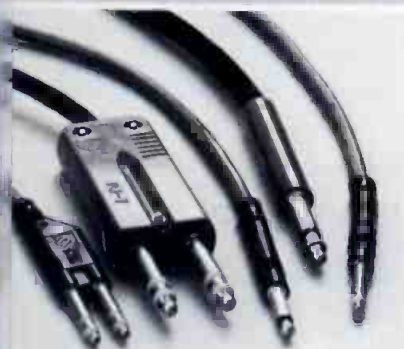
Bantam, Long-frame & Coax Jacks.



Terminal Blocks.



New Printed-Circuit-Board Jacks.



Bantam & Long-frame Patch Cords.



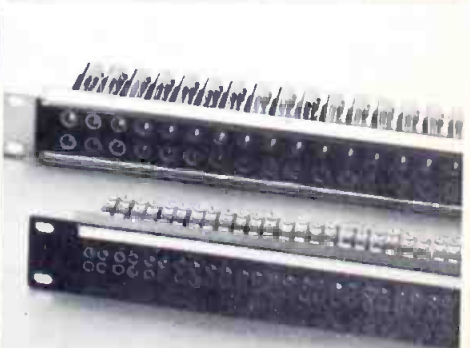
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Assembled Panels.

# BROADCAST<sup>®</sup>

## engineering

The journal of the broadcast-communications industry



page 34

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### About the cover

KSL-TV news team, Shelly Osterloh and Skip Erickson, send ENG crews to top of 26-story building by microwave and down to the studio by fiber optic cable. (Photo courtesy of KSL-TV.)

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BROADCAST ENGINEERING



# E-MEM\*

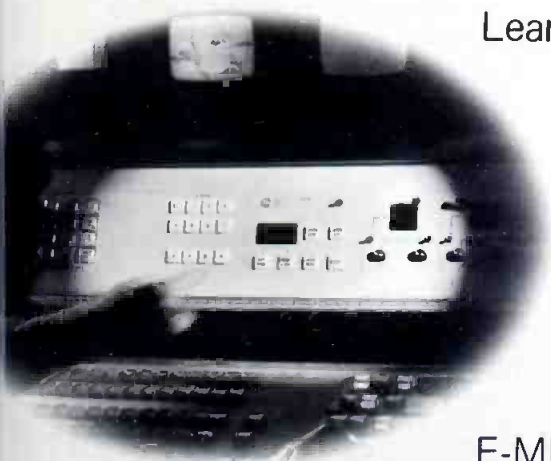
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# DIRECT CURRENT FROM D.C.



May 1978/By Howard T. Head & Harold L. Kassen

## Loud Commercials Revisited

The Field Operations Bureau of the Federal Communications Commission has issued a report worth reading. The number is FCC/FOB 78-01 and the title is "Evaluating Loud Commercials (An Experimental Approach)". In summary, a study of 178 television commercials indicated that, in the opinion of the commission's staff, 34.3% of the commercials were loud, 51.1% were moderate, and 14.6% were quiet. The report contains a comprehensive discussion of loudness and its problems and would be a worthwhile addition to any technician's library. The test procedures used are subject to question so that the results may not truly reflect precise answers. Nevertheless, the commission's staff hopes the report will create some incentive on the part of industry to see the correct answers.

## Commission Takes Novel Approach to Setting Technical Standards

In a departure from established practice, the commission has called for a debate among technical experts on revising the Technical Standards governing the maximum permissible noise figure of UHF television broadcast receivers. The matter arose as the commission was preparing to act on a petition by the Council for UHF Broadcasting (CUB) asking that the present maximum figure of 18 dB at UHF be lowered to 14 dB.

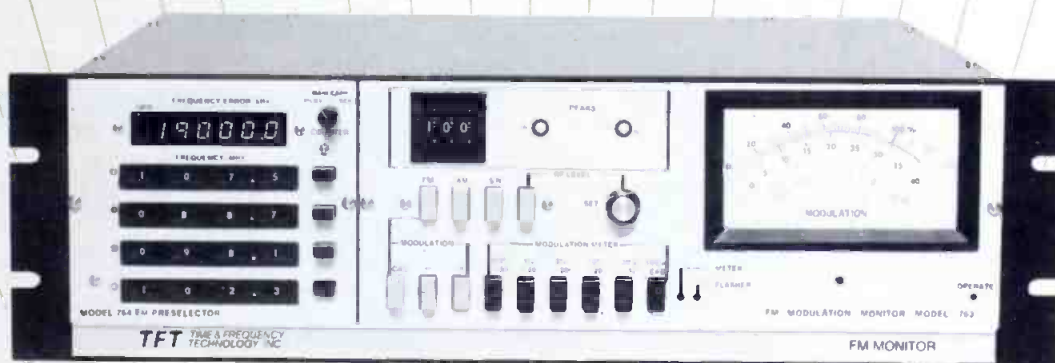
Ordinarily the commission relies on staff recommendations in adopting rules changes of this sort. In this case, however, the commission felt that more advice should be sought from outside experts and set up a panel discussion which would feature debates between proponents of even further reductions and those who felt that the 14 dB figure was just about right, or maybe a little bit too much.

It remains to be seen whether this approach of stimulating technical development through "forensic engineering" will prove particularly fruitful.

*continued on page*

BROADCAST ENGINEERING

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Now TFT gives you FM modulation monitoring that's so precise you can modulate your FM transmitter to the absolute legal limit—in absolute confidence. TFT monitors give you fast, unambiguous readings with an accuracy of one percent. And they can be tailored to your needs and budgets.

Our Model 763, for example, is an economical way to get precise measurement and make proof of performance measurements. It connects directly to your transmitter. Or, if you want off-the-air capability, add our optional Model 764 Preselector. It gives you frequency synthesized tuning and digital readout of carrier and sub carrier frequency errors. And, our Model 765 gives you everything the Model 764 does, except frequency readouts.

What's more, both Preselectors give you a fast, precise fix on how your modulation measures up to the competition. With either one, you can tune in other FM stations, one-at-a-time, and monitor their modulation off-the-air.

In addition, the Model 764 gives you the ability to preprogram up to four stations via thumbwheel switches. One of them can even be yours. Then, by simply pushing a button, you can monitor any one of the four off-the-air.

No matter which kind of system you choose, you'll get all the quality features that have made TFT the industry standard.

- Stereo and SCA add-on capability
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For a demonstration of how TFT can take the risk out of high modulation, ensure full FCC compliance and give you a calibration of your competitive position, call or write.

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# DIRECT CURRENT FROM D. C.

*continued from page 4*

## More Restrictive FM Translator Rules Proposed

The commission has proposed to amend the Rules governing FM translators to prohibit any primary FM station from establishing or supporting any FM translator station which would extend primary service beyond FM stations' 1 MV/M contours. Present Rules permit such extensions, although these are limited to cases where the area to be served by the translator does not receive any other primary (1 MV/M FM service.

The proposed new Rules would involve no change in the present practice of permitting community groups not connected with the FM licensee to establish FM translator stations at any desired location.

## Novel Use of FM SCA

The commission has granted an experimental license in Pittsburgh, Pennsylvania, to field test an electric utility load management system under development in that area. Multiple subcarrier transmissions would be employed to effect selective "load shedding" at times when demands on the utility exceed the amount of primary electric power available.

Ordinarily operation of this sort, which is really multiple-address point-to-point rather than broadcasting, would not be permitted by broadcast station. In this case, however, the commission has made an exception because of the importance of energy management to the nation's economy and welfare.

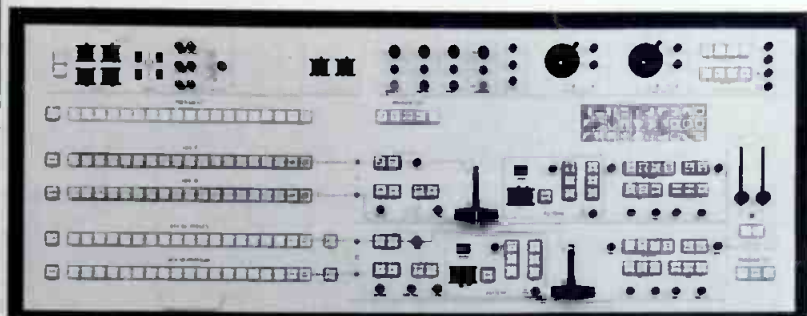
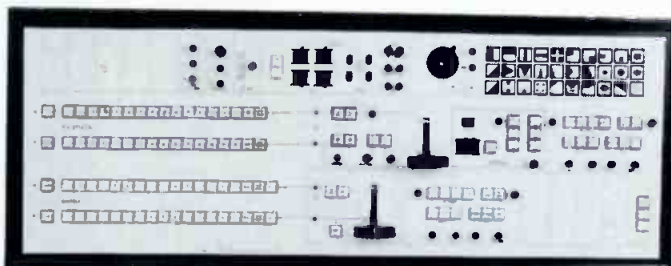
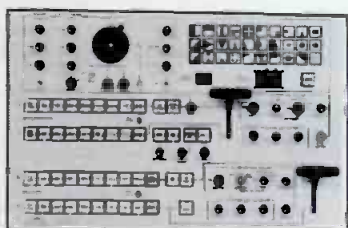
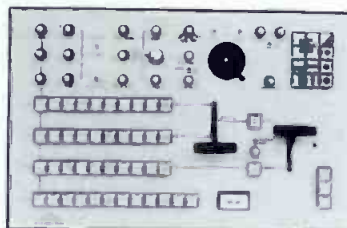
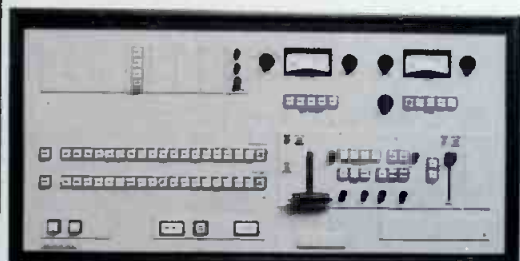
## Short Circuits

The commission is proposing a rule to require that broadcast stations respond "promptly and accurately" to FCC correspondence and inquiries...Broadcast and cable forfeitures (fines) may now run as high as \$20,000 for each offense compared with the previous limit of \$10,000...The commission has announced to all concerned that although it type accepts speed measuring radar equipment, such performance does not address the accuracy of indicated measurements.

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American Data manufactures a complete line of professional production, distribution, and master control switching systems for NTSC, PAL, and PAL-M standards.

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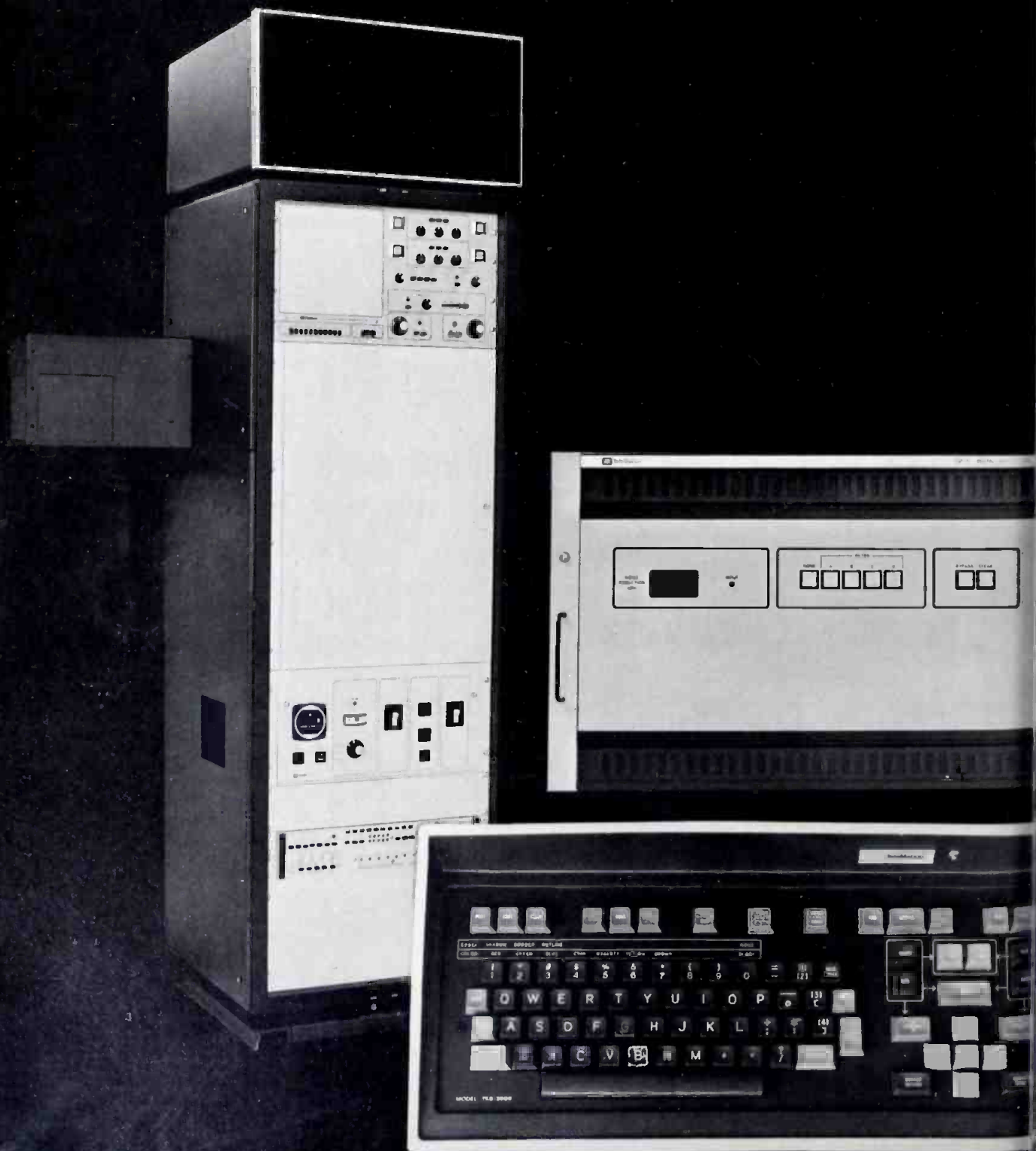
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# New from TeleMatio



## Introducing a state-of-the-art

From input to output, the new Compaq 1000 features a state-of-the-art noise reduction amplifier that uses a charge-coupled device (CCD) to significantly lower the signal-to-noise ratio of the subcarrier to 10 dB, reducing the maintenance of the system.

## A graphics system with a

Everyone who uses a graphics system knows the frustration of having to use the fonts they need. With the new Compaq 1000, you can use the fonts they need. The new Compaq 1000 features a removable cartridge that you can load and put it in the system in seconds. And, with the new Compaq 1000, you can load another cartridge in seconds. And, with the new Compaq 1000, you can load another cartridge in seconds.

What else is new with the new Compaq 1000? Including weather-resistant, now in use in PAL and

## A digital video recorder

The new Compaq 1000 features a digital video recorder (DVR) that can be used to record and playback video. The DVR is a state-of-the-art digital video recorder that can be used to record and playback video. The DVR is a state-of-the-art digital video recorder that can be used to record and playback video. The DVR is a state-of-the-art digital video recorder that can be used to record and playback video.

## Storage.

The new Compaq 1000 features a storage system that can be used to store data. The storage system is a state-of-the-art storage system that can be used to store data. The storage system is a state-of-the-art storage system that can be used to store data. The storage system is a state-of-the-art storage system that can be used to store data.

Fonts! More fonts are now available, including weather-resistant, now in use in PAL and

## A microprocessor-controlled

The new TVS/TA3000 is a microprocessor-controlled system that can be used to control a television. The TVS/TA3000 is a microprocessor-controlled system that can be used to control a television. The TVS/TA3000 is a microprocessor-controlled system that can be used to control a television. The TVS/TA3000 is a microprocessor-controlled system that can be used to control a television.

## switcher.

The new TVS/TA3000 features a switcher that can be used to switch between different channels. The switcher is a state-of-the-art switcher that can be used to switch between different channels. The switcher is a state-of-the-art switcher that can be used to switch between different channels. The switcher is a state-of-the-art switcher that can be used to switch between different channels.

## A telecine camera that

A new optics kit allows the TCF-3000 to be used as a telecine camera. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film.

## quickly and easily

The new TCF-3000 features a quick and easy setup. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film. The TCF-3000 is a state-of-the-art telecine camera that can be used to capture video from film.

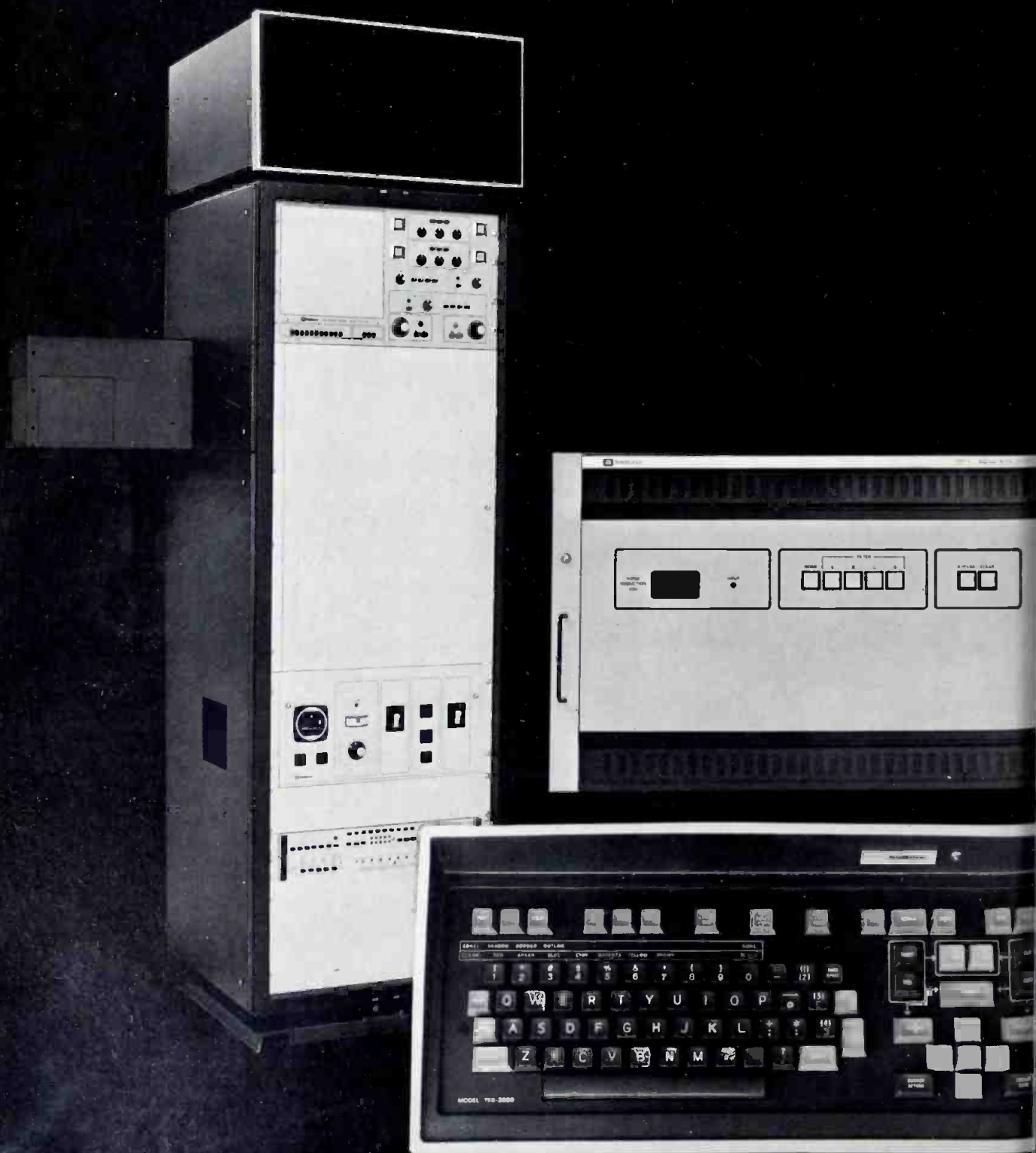
For more information about the new Compaq 1000, please contact TeleMation, Inc., P.O. Box 1000, Lake City, MN 55001.

Its circle 1000 is the only one of its kind. For more information, call (801) 972-8000.

For more information about the new Compaq 1000, please contact TeleMation, Inc., P.O. Box 1000, Lake City, MN 55001. Its circle 1000 is the only one of its kind. For more information, call (801) 972-8000.



# New from TeleMatio



### **Introducing a state-of-the-art digital noise filter that costs less.**

From input to output, the 8-bit TDF-1 represents an entirely new approach to digital noise reduction. At the input, we've included a full, broadcast-quality processing amplifier that completely regenerates incoming sync pulses. The TDF-1's charge-coupled device (CCD) memory offers the same high performance as RAM systems at a significantly lower cost. We've also increased the video sampling rate from three-times-subcarrier to four-times-subcarrier for greater bandwidth and resolution. And maintenance of the TDF-1 is made simple by a built-in diagnostic system.

### **A graphics system with off-line archival storage.**

Everyone who uses an electronic graphics system has their own artistic requirements. With the new Compositor I™ memory system, each of your clients (or departments) can use the fonts they like and logos they need to create up to 999 graphics on a low-cost, removable cartridge disk. At the end of their taping session, they simply take out the cartridge and put it on the shelf. The next user (such as your news department) can then load another cartridge containing different fonts, logos, and pages and be on line in seconds. And, with the new dual disk system, you can copy directly from one cartridge to another.

What else is new with Compositor I? Fonts! More than 40 fonts are now available, including weather symbols, graph characters, and foreign fonts. And Compositor I's are now in use in PAL countries.

### **A microprocessor-controlled distribution switcher.**

The new TVS/TAS-1000 Distribution Switcher microprocessor option can be programmed to perform salvo switches of multiple crosspoints simultaneously. Eight (or more) different salvos can be loaded into the system's memory and previewed by the operator before the live switch is executed, virtually eliminating the possibility of error. Other new control options include X-Y panels, where the source is selected with one button and the destination with another, and category-number selectors, where the input is selected by a name key (such as "VTR," "Camera," "Studio," etc.) and a number key.

### **A telecine camera that replaces GE units quickly and easily.**

A new optics kit allows the TCF-3000 Broadcast Color Film Camera to replace GE 240 and 240-format cameras without so much as moving a projector or changing a lens. The TCF-3000 also gives you true hands-off color balance and color correction, automatically correcting poor-quality film without disturbing balance or gamma tracking of good film. This long term operational stability is made possible by unique, temperature-compensated sampling and control techniques. The TCF-3000 has several other advantages over competitive units, such as lower noise, more detail in black, and superior color separation. And a fully-remotable six-vector color corrector is available as an option.

For more information about these TeleMation products, circle one of the numbers below or contact:  
TeleMation, Inc., P.O. Box 15068, Salt Lake City, Utah 84115. Phone: (801) 972-8000.

For More Details on TDF-1 Circle (24) on Reply Card

For More Details on Compositor 1 Circle (25) on Reply Card

For More Details on TVS TAS-1000 Circle (26) on Reply Card

For More Details on TCF-3000 Circle (27) on Reply Card



# industry news

## Orrox signs agreement with Vidtronics

Under terms of an exclusive licensing agreement between Orrox Corporation and Vidtronics Company Inc., CMX (a division of Orrox) will manufacture and market Videola™, a system which collects time code and other information from an edit controller and converts it into a CMX-compatible edit decision list. Videola can interface easily with thousands of existing edit controllers such as Convergence, EECO, Sony,

TRI, and others.

Vidtronics is a large production and post-production facility whose major output is prime-time television programming; CMX is a manufacturer and supplier of editing systems.

Jack Calaway, Vidtronics' vice president of research and development, developed Videola to fill the need for a low-cost bridge between simple time code or back-space

editing and the more versatile computer-assisted CMX editing systems in Vidtronics' own facility.

Videola allows any television operation with any type of edit controller to output a CMX-compatible edit decision list, including wipe, fade, dissolve, and key information. The system allows editing totally by picture (or sound), and the CMX decision list is accumulated accurately and automatically.

## Novel filming techniques used in documentary

An extraordinary one-hour documentary was shown in evening prime-time by the CBS TV Network. The documentary featured pictures never before seen of the heart and bloodstream. The unusual film footage was by director/photographer Robert Elfstrom.

Elfstrom is a motion-picture film-

maker whose credentials include several major TV documentary film series. In this documentary, "The Red River," a triple bypass heart operation is seen performed by a famous heart surgeon.

Elfstrom's hand-held and other filming techniques with a "Frezzi-Flex" FR-16 motion picture camera provided TV viewers close-ups of

the "operating field," showing detailed procedures only surgical operating teams see in operating rooms.

The FR-16 16mm Frezzolini Electronics Inc. motion-picture camera was "customized" to Elfstrom's particular requirements, as are all FR-16s purchased by other film makers.

## Television news photography winners announced

Despite a record number of entries at this year's Television News Photography Competition, held recently at Arizona State University, no one went home a winner in the general news category—an outcome which raises the question, Why?

According to the judges, winners in this category were not chosen because many entries featured reporters who were on-camera at a sacrifice to story continuity and content. Perhaps stations now featuring personality-oriented news will take this as a reminder that the purpose of the news is to present the story, not the reporter.

While the producers of general news began pondering next year's competition, however, the judges were awarding KTVY-TV in Oklahoma City, Oklahoma, "Top Television Station of the Year" honors for the excellent use of photography in its day-to-day news coverage.

There were more than 700 entries

in this year's contest, with 305 television news photographers participating. All three major networks as well as 183 television stations were represented. In addition, two Canadian stations submitted entries.

Winners in the competition, sponsored by the National Press Photographers Association, Eastman Kodak Co., Cinema Products, the Department of Mass Communications at ASU, and Angenieux Corp. of America, will be honored at the NPPA convention and business meeting scheduled for July 2 in Seattle, Washington.

Winners include (listed in order of finish):

Spot News—"Anti Shah Demonstration," Ken Resnick, WTTG-TV, Washington, D.C.; "Fire Victims Profile," Bob Phillips, WDTN-TV, Dayton, Ohio; and "Hostage," Jack Parker, WTTV, Indianapolis, Indiana. Karl Suchman of WHO-TV, Des Moines, Iowa, received an

honorable mention for "Fire Rescue."

Feature—"A Trip to the Bank of Gossamer Wings," Terry Morrison, NBC-News, San Francisco; "Women's Crews," Scott Gibbs, KPIX-TV, San Francisco; and "Mondo Eggo," Henry Kokojan, NBC-News, New York.

Sports—"The Fan," Hunter Bloch, WPLG-TV, Miami, Fla.; "Rainbow High," Paul Fine, WJLA-TV, Washington, D.C.; and "Wrestling," John Baynard, WBTV, Charlotte, N.C.

Minidocumentary—"Marines in Arms," Terry Morrison, NBC-News, San Francisco; "Yosemite Summer," Terry Morrison, NBC-News, San Francisco; and "Flint Hills Women," Larry Hatteberg, KAKE-TV, Wichita, Kan.

Documentary—"Catch A Rising Star," Paul Fine, WJLA-TV, Washington, D.C. There was a tie for second place: "Tutankhamen Live"

*continued on page 1*

# CP-16/A Cameras and Angenieux Zoom Lenses... Winning Combinations at Unbeatable Prices!

Put a lid on ever-escalating equipment costs with spectacular savings on camera/lens combinations from Cinema Products.

Upgrade your TV-newsfilm operation. Retire your antiquated 16mm cameras and lenses (whatever their condition), and trade up to the standard of the industry — CP-16/A news/documentary cameras, with a choice of four of the finest Angenieux lenses available:

Angenieux 9.5-57mm AV30 zoom lens. The lightweight, ultra-fast (T1.9), wide-angle 6×1 zoom lens permits close focusing at 24" from the film plane.

Angenieux 12-240mm AV30 zoom lens. The ideal 20×1 zoom lens for any situation requiring wide-angle as well as telephoto coverage, such as sports events, political gatherings, etc.

Angenieux 12-120mm AV30 DA zoom lens. The outstanding 10×1 zoom lens with Automatic Iris Control.

Angenieux 12-120mm AV30 zoom lens. The "workhorse" of the television news gathering industry.

## Free 3XL-IAZ Magnetic Head

CP-16/A cameras (with built-in Crystasound amplifier) included in this offer are supplied with a 3XL-IAZ magnetic record head — featuring individual record and playback azimuth adjustment — at no extra charge.



**Trade-in any 16mm camera and lens  
for the following CP-16/A camera/zoom lens packages:**

**1** CP-16/A (Code 1C272)  
with 3XL-IAZ  
Magnetic Head  
and Angenieux 9.5-57mm  
AV30 Zoom Lens  
**LIST: \$9695**  
**SAVE: 2295**  
**PAY: \$7400**

**2** CP-16/A (Code 1C272)  
with 3XL-IAZ  
Magnetic Head  
and Angenieux 12-240mm  
AV30 Zoom Lens  
**LIST: \$13665**  
**SAVE: 3065**  
**PAY: \$10600**

**3** CP-16/A (Code 1C272)  
with 3XL-IAZ  
Magnetic Head  
and Angenieux 12-120mm  
AV30 DA Zoom Lens  
(Automatic Iris Control)  
**LIST: \$10810**  
**SAVE: 3160**  
**PAY: \$7650**

**4** CP-16/A (Code 1C272)  
with 3XL-IAZ  
Magnetic Head  
and Angenieux 12-120mm  
AV30 Zoom Lens  
**LIST: \$9110**  
**SAVE: 1660**  
**PAY: \$7450**

## Also Available

Trade-in any 16mm camera (no matter how old), and move up to a brand new CP-16/A for the incredibly low price of \$4650. You'll save \$1120 off list!

Please call your local CP-16 dealer for special trade-in prices and savings on standard CP-16 camera/zoom lens combinations.

## Special Two-Year Warranty and Free "Loaner"

This special offer is covered by an extended two-year factory warranty on all mechanical and electronic components when you purchase your camera from your authorized local CP-16 dealer.

Your local dealer will also provide you with a free CP-16 "loaner" for any down time on a warranty-covered repair.

**Offer Good Through June 30, 1978**

So, don't wait. See your local CP-16 dealer now. And save!



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Forever," Jim Tolhurst, WWL-TV, New Orleans; and "Africa's Defiant White Tribe," Richard Norling, NBC News, New York.

"Catch A Rising Star" and "Yosemite Summer" received special awards for editing excellence. In addition, the Angenieux Award for Creative Cinematography went to "Catch A Rising Star."

Larry Hatteberg, KAKE-TV, Wichita, Kan., was named "Television News Photographer of the Year."

## World's largest routing switcher goes to NBC

In 1979 the world's largest routing switcher will be delivered to NBC by NEC America Broadcast Equipment Division.

How large is the largest commercial service switcher? The TKA105 will incorporate 40,500 cross points configured as 150 inputs by 270 outputs.

A 120-inputs by 60-outputs section of the switcher will be used for distribution of NBC's 1980 Summer Olympics coverage in Moscow.

When the equipment is returned from the Olympics, the complete switcher will be installed at the NBC Burbank studios.

According to NEC's R. Dennis Fraser, the switcher is valued at \$3 million. Bumping the technology, the TKA105 uses newly developed LSI cross-point technology and four discrete digital audio channels.

The purchase agreement was signed by Jack Kennedy, NBC's operations and engineering vice president.

## Fiber optics exposition

The first fiber optics and communications exposition to be held in the United States is scheduled for September 6-8 at Chicago's Hyatt Regency O'Hare Hotel.

FOC '78, sponsored by Information Gatekeepers Inc., is being held to meet the needs of the producers, innovators, designers, and users of fiber optic systems, components, and materials.

The exposition will include exhibits, technical sessions and panels, financial sessions, intensive short courses, and live demonstrations.

For more information, contact: Information Gatekeepers Inc., 167 Corey Road, Suite 212, Brookline, MA 02146.

## Ampex named supplier for XXII Olympics

Ampex Corporation has been granted the exclusive right to supply videotape records, slow-motion disc recorders, and magnetic recording tape for the XXII Olympic Games to be held in Moscow in 1980.

The decision resulted from an agreement between the organizing committee for the 1980 Olympics and the Soviet State Committee for Radio and Television, which also gives Ampex the right to use the official emblem of the games in conjunction with the designation "Official Supplier."

## State broadcasters get tips on fighting taxes

State broadcaster associations can now obtain a primer to help them prevent state and local taxation of their revenue and property.

The booklet, compiled by the NAB, is designed to familiarize broadcasters with the growing trend by states and localities to view broadcast stations as an answer to their fiscal problems. It reviews various taxes and Constitutional issues, offers policy arguments, urging rejection, and presents

continued on page 11

## log entries

June 6-9—More than 80 delegates from Asian and Pacific countries, the U.S., and Canada are expected to attend the *Third Asian-Pacific Television Conference*, to be held at San Francisco State University. The theme of the conference is "Satellite Communication for the Asian Pacific Region: Effective Message Formulation and Message Distribution Through Television." For more information, contact: Dr. Herbert Zettl, Broadcast Communication Arts Department, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132.

June 8-11—The spring meeting of the *Missouri Association of Broadcasters* will be held at the Kansas City Marriott, located at KCI airport. The meeting is being held in conjunction with the Kansas Association of Broadcasters.

June 15-16—The *Oregon Association of Broadcasters* will hold its 37th annual spring conference at Salishan Lodge in Gleneden Beach. Registration fee is \$65 for OAB members and \$75 for nonmembers. This fee includes all business sessions and meetings, as well as some meals. For more information, contact: OAB, P.O. Box 3236, Eugene, OR 97403.

June 20-22—Discussion of the latest technology, devices, and system applications for modulators will be the highlight of the *13th Pulse Power Modulator Symposium*. It is being held at the Statler Hilton, Buffalo, New York.

June 21-24—The 43rd annual convention of the *Florida Association of Broadcasters* will be held at the Colony Beach & Tennis Resort, Longboat Key, Sarasota, Florida.

June 23-24—The *Radio Television News Directors Association* is conducting a board meeting at the Atlanta Hilton, Atlanta.

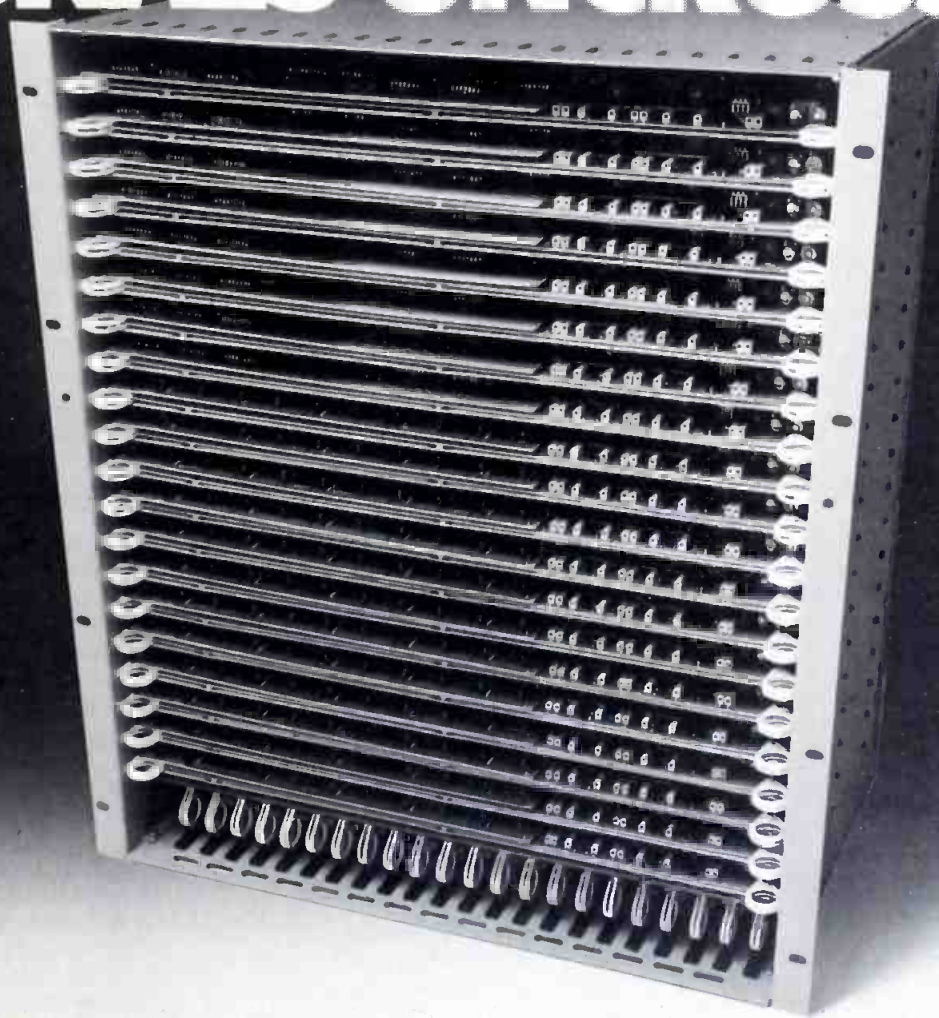
June 26-28—The University of California, Santa Barbara, is the site of the 36th annual *Device Research Conference*, sponsored by the IEEE Electron Devices Society. The conference is a forum for work of a basic or exploratory nature in all areas of device research and technology. Areas of emphasis include the various optoelectronic disciplines (e.g., semiconductor lasers and devices for optical communications), imaging, high-speed devices, etc.

July 14-15—The 21st annual *Motion Picture Laboratories (MPL) Seminar*, produced in conjunction with the Nashville Section of the SMPTE, is being held in Memphis, Tennessee. For further information, contact: Barbara Holley, MPL Inc., Box 1758, Memphis, TN 38101.

July 16-21—All subjects in the electric power area will be covered at the summer meeting of the *IEEE Power Engineering Society*, scheduled for Los Angeles.

July 16-28—The NAB's 11th *management development seminar for broadcast executives*, to be conducted at the Harvard Business School, will focus largely on the role of the general manager; emphasis will be placed on management leadership and decision making.

# GET YOUR SIGNALS UNCROSSED.



No matter how complicated your radio operation is, we can unsnarl your signals and send them on their way, with one of our off-the-shelf Switcher series.

For example, many broadcasters use our over cost 15X or RX Series Switchers to switch out signals to their VTR machines. By providing instant access to signals at the touch of a button, difficult editing jobs are accomplished in the spot and, during the Vertical Interval.

And to minimize system downtime we've designed our Series 20X and 40X Switchers for optimum reliability and capability. Most have a microprocessor in every channel to eliminate total system failure if the logic system malfunctions. And you can replace a channel

module without shutting down the entire system.

For audio use, our solid-state Series AX Switchers make the old fashioned patch panel a thing of the past.

All 3M Routing Switchers can be built to nearly any input/output capability, with vertical interval switching and can be operated by many types of controls.

Studio operation is getting more complex every day. You can't fight it, so why not switch? Switch to 3M Routing Systems.

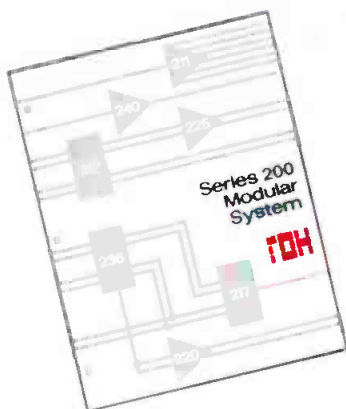
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## news

continued from page 12

status report on broadcast-related taxes.

Erwin Krasnow, NAB senior vice president and general counsel, said recently, "Taxes on the sale and/or purchase of broadcast advertising have already been enacted in several states, and similar bills are being considered elsewhere. Many states and municipalities have begun to interpret their existing tax laws in new ways so as to include previously exempt broadcast-related activities. In short, the chances are better than ever that radio and television stations soon may be liable for substantial new tax levies. This trend is expected to continue, but it is not inevitable."

### IEEE offers microprocessor seminars

The educational activities board of the Institute of Electrical and Electronics Engineers (IEEE) is offering several seminars on microprocessors this summer. Three-day seminars are scheduled for June 8-10, Princeton; June 15-17, Chicago; June 22-24, Washington, D.C.; June 28-30, Montgomery, W. Va.; and July 20-21, Nashville, Tenn.

### Mutual to open regional headquarters in Dallas

The Mutual Broadcasting System is establishing a Southwest regional headquarters in Dallas. It has been announced by C. Edward Little, Mutual president.

This marks the first time Mutual has established network facilities outside of Washington, D.C., location of Mutual's world headquarters. The Dallas operation will be fully manned and equipped, and be able to feed the full Mutual network as easily as the Washington studios, according to Little.

The new regional headquarters, which Little calls a "mini network," will include a sales department, station relations, accounting, engineering, traffic, production, continuity, as well as fully-staffed news and sports departments.

"The Mutual Dallas operation will be equipped to handle every aspect of network programming—everything needed to take care of network broadcasts from Dallas on a regular basis," Little said.

The opening of the Dallas head-

quarters comes shortly after Mutual signed a four-year agreement with the Dallas Cowboys to broadcast the Cowboys' games over a nine-state network, to be called the Dallas Cowboys Radio Network.

### Thomson-CSF to equip Iranian TV

The National Iranian Radio and Television (NIRT) authority has awarded Thomson-CSF a contract to supply the color TV equipment for several regional stations.

Thomson-CSF has worked in close collaboration with Iranian administrations for more than 12 years equipping most of the Iranian network of high-power transmitting stations and virtually all of Iran's TV channels.

A contract for the turnkey supply of the entire radio system for Teheran's shortwave station was awarded to Thomson-CSF earlier.

### FCC studies reasonable access provision

The reasonable access provision—Section 312(a)(7) of the Communications Act—providing the FCC with the power to revoke a station's license for willful or repeated failure to allow reasonable access to or permit purchase of reasonable amounts of air time by a legally qualified candidate for federal office on behalf of his candidacy, has been opened to inquiry.

Adoption of guidelines or rules to ensure that political candidates for federal elective office receive reasonable access on radio and TV will result if it is determined that the policy is inadequate, and new specific requirements are necessary to aid stations in complying with the policy.

The FCC said its general policy is to defer to the reasonable, good faith judgment of stations in determining what constitutes reasonable access. The commission has attempted to strike a balance between the rights of federal candidates and the obligations of broadcasters to present political as well as other types of programming.

Although it reviews individual complaints to determine whether the station has used reasonable good faith, the commission has developed some basic guidelines as to what Section 312(a)(7) requires. For instance, federal candidates are entitled to program time during prime time in the absence of special

continued on page

## Cetec Sparta Showcase:

### First-quality broadcast components joined in a first-quality studio system

That's a Centurion II 12-mixer stereo console up front, the centerpiece of a custom Sparta grouping that's handsome, functional, and compact.

Start with Centurion II — more than 200 stations have already. One great reason is that when AM stereo arrives, you're ready right now. If 12 mixers and 36 inputs aren't enough, you can add one or two extender panels of 6 mixers each — to a maximum of 24 mixers and 72 inputs! You can have either rotary or slide pot controls — or even some of each. And of course Centurion II is solid state all the way.

Put it in its place — along with Sparta's fine family of turntables, tape cart and remote control equipment — and complement it with

sleek, low-profile furniture designed just for broadcast operations. And there you have it — a custom studio system at less than custom prices.

Of course, you can mix and match. That's the beauty of the big Cetec Sparta line — multiple choices in equipment and studio layout.

Outstanding full-color Sparta catalogs are just off the press. Write for them today, or telephone Andy McClure (805) 968-1561.



**Cetec Broadcast Group**

The Broadcast Divisions of Cetec Corporation  
75 Castilian Drive, Goleta, California 93017



# There are few things in life as durable as a Scully

**Take our new, rugged 250 Recorder/Reproducer for instance.**

The die-cast Scully 250 will take on all assignments. For portable needs, just plug in the mic preamps for news, sports, or whatever. Solve your studio needs and use only 19¼" of rack space. Configurations include full or half track mono, two or quarter track stereo. The 250 is loaded with lots of other Scully professional features, including full front access for easy alignment.

For Reproducer needs only we've designed the compact Scully 255... same Scully dependability, engineering, and durability... perfect for your automated system.

Prices? Much less than you'd expect.

The 250/255... another classic performance by Scully.

For complete details, write or call Scully Recording Instruments, Division of Dictaphone Corp., 475 Ellis Street, Mountain View, California 94043, (415) 968-8389 TLX 34-5524.



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**Recording Instruments**  
*For classic performance.*

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circumstances, such as a large number of candidates.

The commission also indicated that a station has the option of offering either free or paid time, or a combination of the two, and that the reasonable access provision applies to noncommercial as well as commercial stations. However, the FCC said it had declined to recognize a candidate's right to a particular length of program time or a specific air time.

## Ivey purchases Bogner antennas

Bogner Broadcast Equipment Corporation has announced the sale of three UHF and two VHF high-power antennas to Ivey Communications Corporation. The antennas will be installed in the U.S. and in Latin America, where Ivey Communications is supplying major components of television systems.

## Broadcasters challenge government restraint

A cry for an enlightened era of government encouragement rather than restriction in the broadcast industry was voiced by Donald P. Zeifang, senior vice president for government relations of the National Association of Broadcasters.

Speaking at the Indiana Broadcasters Association's spring conference, Zeifang cited the broadcast industry as the object of stifling government regulation, frustrating competitive use of the billion-dollar technology created, ironically, by the "best broadcasting system in the world."

He added that "while more and more Americans rely upon the broadcast media for news and information, the government steadfastly refuses to abandon its position of discrimination against the broadcast media in the application of full First Amendment freedoms. Zeifang called for government to "keep up with the times," which are dictating a trend away from "regulation and reliance upon the judgment of bureaucrats."

He indicated it is wrongly assumed that the media not only is the bearer of bad news, but is responsible for it; rather, the growing mistrust of government is the fault of government as usual. In conclusion,

continued on page 16



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the new breed of  
video professional,  
the new breed of  
professional video from  
JVC.**



# If you're a video professional today, you're a tougher customer than ever. So JVC's rugged professional line delivers the quality and features you demand at prices you want to pay.

We know you've got a lean new attitude about the video equipment you buy, no matter how long you've been in the business. Or whether you're in broadcasting... a sophisticated corporate A/V operation... a top production house... or building your first video capability.

And that attitude is, with all the people vying for your video dollar, you want more state-of-the-art technology in equipment

that costs you less to own and maintain.

JVC's attitude is basic too. We build in engineering innovations—we don't add them on later. And we do it first. Which means you enjoy better picture and sound quality, easier operation, and sophisticated features you may not even find in equipment selling for twice the price.

For instance:

**You wanted faster performance and greater accuracy in 3/4-Inch video editing.**

**And JVC's new CR-8500LU Recorder/Editor System offers bi-directional fast/slow search from approximately 10 times to 1/20 time, with editing accuracy to  $\pm 2$  frames.**

It's a new generation of 3/4-Inch VCR editing—the fastest, surest way to get the frame-by-frame accuracy you need.

But JVC's CR-8500LU is still priced well below its closest performing competition.

With a single unit, you can edit with full functions and broadcast quality. Even if you don't happen to have special technical knowledge.

With a complete editing system of two CR-8500LU units and the new RM-85U Control Unit, you can perform the most advanced editing feats at approximately 10 times actual speed, then stop on a single frame.

Here's how the CR-8500LU gives you that kind of precision

- **Frame to frame editing** is made possible with the capstan servo/built-in rotary erase head/blanking switcher frame servo design. A design that also ensures true assemble and insert editing with no distortion at the edit points. Plus horizontal sync phase compensation to minimize timing error at the editing points.

- **Variable speed auto-search** lets you perform both high speed and low speed search. You can search at approximately 10 times in fast forward or reverse to find edit points faster. Or slow speed search at 2 times, 1 time, 1/5 time and 1/20 time. Or use the special auto-speed shift feature to automatically slow you down from 2 times, real time, 1/5 time, 1/20 time.

- **Automatic pre-roll** enables you to pre-roll tape between edits, with an automatic on/off switch. Which can come in especially handy during successive assemble edits using camera signals.

- **Self-illuminated control buttons**, allowing easy identification of the operation mode.

- **Full logic control** for direct mode change without pressing the stop button.

- **Remote control** of all operations, with the optional remote control unit RM-85U.

- **Audio level control with meters**, preventing over-level recording without audible distortion, with attenuator. Also, manual audio level controls let you adjust the audio recording level by checking the level meters.

- **Auto/Manual selection for video recording level control**, adjustable by the automatic gain control circuit or manually by referring to an independent video level meter.

- **RF output** to connect an external drop-out compensator.

- **Patented color dubbing switch** for stable color multi-generation dupes.

- **S.C./sync input connector** allows connection of time base corrector and allows for two second pre-roll.

- **Chroma level** can be controlled man-

ually for convenient connection to an external system.

- **Built-in comb-filter** for playback (switchable on-off).

- **Servo-lock indicator** to check the transport condition.

- **Counter search mechanism**, permitting Auto-Search of a particular section of the tape.

- **Solid construction for easy maintenance**: both side panels, top and bottom panels are detachable for easy access to the inside.

- **Tracking control meter** for maximum

tracking adjustment.

- **Heavy fan motor** for better circulation.

All that with one editing unit. But when you combine two editing units with our new RM-85U automatic editing control unit, you'll enjoy all the benefits of a total-performance system.

Starting with the kind of control JVC's RM-85U can give you:

- **Independent LED time counters** player and recorder, read out edit point minutes, seconds and frames.

- **Edit-in and edit-out automatic control**. Four built-in memories let you control edit-in and edit-out points of the player and recorder. And once start and ending points are determined, accurate editing is memory-controlled automatically.

- **Edit shift control** allows frame-to-frame edit point correction.



time indicated for each insert edit by LED display.  
 • **Preview mode available**, for "earsals" of actual edits.  
 • **Edit-in point search mechanism**. After edit, a Return button rewinds the tape automatically to the edit-in point, so easier to check edit conditions.  
 • **Auto-shift search mechanism** to step in the tape speed automatically, and for quick and accurate location of the edit point.  
 • **Safe safety guard circuit**. Because using the unit in the still-frame mode can actually cause damage to tape or video heads, a tape safety guard circuit places the unit into the stop mode automatically.

**demanded more versatility in a moderate-priced, broadcast-quality camera.**  
 And JVC's value-packed CY-8800U goes with you from studio to location.

Our CY-8800U offers a lot more picture quality and stability that compares favorably with units costing as much. Thanks to JVC's technology, the CY-8800U camera, offering



three  $\frac{3}{4}$ " magnetic focus, magnetic deflection Plumbicon\* or Saticon\*\* tubes offer total flexibility. And a rugged die cast chassis in front and back to hold up under the toughest conditions.

With the **Basic** configuration, it's a compact ENG/EFP camera that's completely self-contained. No CCU required. Easy to operate, simply to plug into our CR-4400LU/CR-4400U

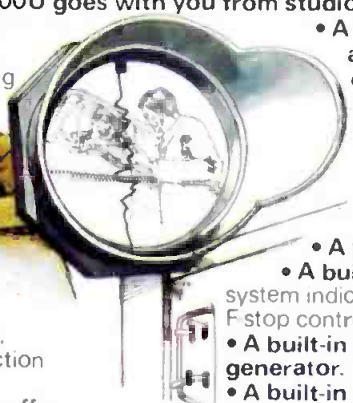
portable recorder, with optional cables available up to 66 feet. With the **Studio** configuration it's a working studio camera. Just add the CY-8800U remote Synchronizing unit and large screen, top mounted viewfinder. And as for big-ticket features, we've got what the others would let you add

if it is left in the still-frame mode for more than 10 minutes.

- **Selective editing modes**—assemble editing, insert editing for audio channel-1, audio channel-2 or video.
- **Versatile editing capability** offering techniques like "edit-in/out," pre-roll, and automatic pre-roll.

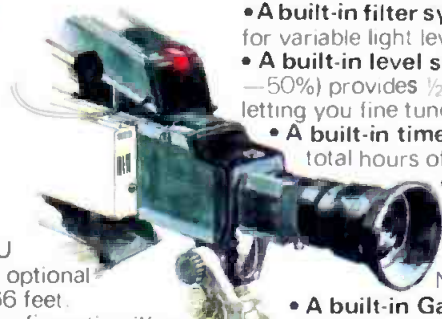
You'll find that nothing in its price class performs anywhere near the CR-8500LU/RM-85U videocassette editing system. And that you'd have to spend a lot more on the competitive unit that offers many of the same features.

That's what we mean by giving video people more of what they want, for less than they expect to pay.



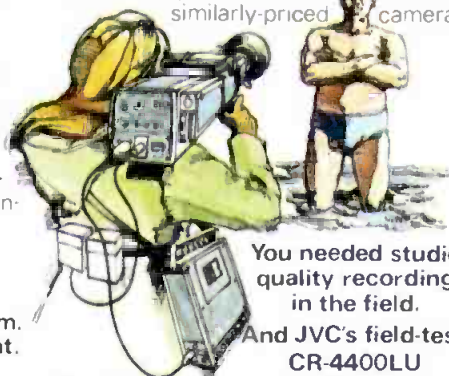
- **A built-in 1.5 Inch adjustable electronic viewfinder** for the convenience of the operator.
- **A built-in battery warning system.**
- **A built-in tally light.**
- **A built-in VSI—video system indicator** for precision F stop control.

- **A built-in color bar generator.**
- **A built-in +6dB, +12dB sensitivity switch** for low light level applications.
- **A built-in auto white balance.**
- **A built-in fast warm-up capability.**
- **A built-in electrical color temperature adjustment** for different applications (variable from 3000°K to 10,000°K).
- **A built-in filter system** (neutral density) for variable light levels.
- **A built-in level switch** (+50%, 0, -50%) provides  $\frac{1}{2}$  F-stop adjustment, letting you fine tune for added contrast.
- **A built-in time lapse meter** to show total hours of camera use.
- **A built-in intercom system** for studio applications.
- **An RGB output**, and NTSC encoding (Y, I, Q).
- **A built-in Gamma control** to fine tune gamma level.
- **An AC Adaptor**—standard.
- **Lightweight—17.4 lbs.—portability.**
- **Optional 12-to-1 zoom lens** with automatic iris and power zoom.



- **Built-in horizontal and vertical contour correction circuits.**
- **Signal-to-noise ratio of 49dB, F 4/3000 lux.**
- **Resolution of 500 lines at center.**
- **Return video** in the viewfinder.
- **A built-in -G circuit** for registration.
- **Minimum illumination F 1.9/300 lux** (+6dB switch on).
- **A comfortable hand grip** to stop and start the recorder. With a switch to operate iris control and a switch for return video.
- **A built-in CCU.**

And that adds up to a lot more features than you'd find in similarly-priced cameras.



You needed studio quality recording in the field.

And JVC's field-tested CR-4400LU

**Portable Videocassette Recorder** with automatic editing lets you bring your recording/editing capability wherever you need to shoot.

If you spend time on location in either ENG or EFP applications, you need a portable video system that can shoot, edit, and give you something to show in no time flat. Without awkward equipment hassles.

JVC's CR-4400LU is the one to take along when you can't bring a studio.

Because it's the lightweight machine with heavyweight features:

- **Weighs in under 27 lbs.** So you can take it anywhere, and assemble edit on the spot. You enjoy total flexibility. Complete freedom. Fast results.
- **AEF (Automatic Editing Function)** gives you clean assemble edits.
- **Built-in, full color recording and playback circuitry.** No need to buy an adaptor.
- **Low-power consumption** that lets you operate on a miserly 13.5 watts, for longer battery life. A multi-purpose meter checks battery, audio, video and servo levels for precise control of all functions.
- **Flexibility to record with the CY-8800U** or other high quality color cameras.

So if you need a field-tested recording system with the features you want at a price you can afford, check out our CR-4400LU Portable Videocassette Recorder.



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 \*\*registered trademark of Hitachi Corp.

**JVC's new breed of professional video.  
Backed by an old tradition of JVC quality  
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For the past fifty years, more and more professionals have turned to JVC for innovative equipment they can count on to perform.

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**JVC Professional Video.  
The tough new breed.**

**JVC**  
JVC INDUSTRIES COMPANY  
DIVISION OF US JVC CORP.

Continued from page 16

declared, "It will only be a conscious, positive initiative by the business community in general and broadcasters in particular that will bring about a change in government attitudes and policies."

## A Americom handles Voyager mission

A Americom will provide communications service for the interplanetary Voyager mission, giving scientists and the public a new look at the outer solar system. The deal by the National Aeronautics and Space Administration calls for a band data satellite communications links to support the decade-long Voyager mission.

Two 56 kilobits-per-second simplex channels and a duplex (two-way) 56 kilobits-per-second channel will carry full time transmissions between the Goddard Space Flight Center in Greenbelt, Maryland, and the Jet Propulsion Laboratories in Pasadena, California. Telemetry and other data from the Voyager spacecraft will be picked up in Madrid, Spain, and transmitted to Goddard. High-speed data will then be forwarded to TPL via RCA satellite computer analysis. The system becomes operable beginning May 1978.

## NAB urges adoption of AM stereo standards

The National Association of Broadcasters has urged the FCC to adopt AM stereo standards as soon as possible, based in part on the widespread interest in the system.

In its filing with the FCC, the NAB stated that the Office of Telecommunications also recognizes that AM stereo "could potentially in-

crease the attractiveness of the AM service to the general public, stimulate the production and sales of receiving equipment for use in motor vehicles and homes, and generally increase competition in the aural service."

The NAB pointed out that tests have shown no significant technical difficulties in AM stereo. In addition, the FCC was reminded that additional AM channels are not required because AM stereo "does not require additional spectrum space, but takes advantage of an existing redundancy in the present AM transmissions."

However, the NAB said the effect of skywave propagation on AM stereo reception may require special study, and suggested that the commission consider retaining a consultant to make theoretical and engineering studies of the proposed systems.

## Easier filing for royalties needed

The Copyright Royal Tribunal has been requested to make it as simple as possible for broadcasters to receive royalty fees from cable television systems.

The request from the National Association of Broadcasters pertains to the new copyright law that became effective January 1, requiring cable systems using broadcast programs to pay royalties.

The request for clarification of the actual payment procedure included suggestions to require stations to retain affidavits at the station stating the programs for which they claim royalties recorded; to devise a standardized form requiring minimal information; and to require initial short claim form (call letters, city of license and licensee) for the July 31 deadline, with full form due November 27 since broadcasters will not have access to cable systems' accounting statements prior to the July date.

Complete news coverage of the 1978 NAB convention will appear in the June issue of

# BROADCAST engineering

In addition, NAB coverage will include a summary of exhibits and a look at new products.

# foot ball special

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An important message from top management will soon be seen by all employees, whether they're in the home office, the branch offices or offices overseas. At the same time, a manufacturer decides his 450,000 volt generators, a bit too large to take along to sales demonstrations, are small enough to take along on tape. A large retailer trains the staff at four branch stores simultaneously. A real estate investor takes a tour of prospective California property from his office in New York. And a couple watch a new boat take the waves from a showroom miles away from water.

This is what industry can do through video communications. It's also why Panasonic brings you Omnivision II™ VHS™, the world's first two-hour ½" video cassette system with industrial strength.

## What is "industrial strength"?

The answer is simple: Durability, reliability, global adaptability and the kind of meaningful performance features and options industry requires. But industry also requires economy. That's why Omnivision II decks are available in two cost-efficient models. The NV-8300 player/recorder with VHF and UHF tuners.

And for situations that require only playback, there's the even more economical NV-8150 player. Both with a combination of features not found in any other ½" industrial system.

## Industrial strength performance.

For outstanding picture quality, both Omnivision II decks have direct-drive video head cylinders for low jitter and excellent stability. And for precise and steady tape speed, both use a capstan servo system. Combine this with patented HPF™ video heads and the results are what you'd expect from Panasonic: Horizontal resolution of 300 lines in black and white, 240 lines color and a superb S/N of 45 dB. There's also the kind of durability and strength you expect from Panasonic. That's why all the critical components and mechanical parts of both decks are mounted on an annealed aluminum die-cast chassis.

## Tape economy.

Omnivision II tape cassettes are less expensive, smaller, easier to store and more economical to mail than ¾" tapes. They also give you twice the playing time on a video cassette half the size of a ¾" cassette.



NV-8300 player/recorder.

# Industrial strength video. from Panasonic.

Not only can you spend more time recording and playing, you'll also spend less money on tape. Omnivision II cassettes are also compatible with all other VHS systems.

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Recording one video tape with Omnivision II is simple enough. Making as many copies as you need is just about as easy, with independent duplication facilities in certain key areas in the U.S.

For multinational corporations, both Omnivision II decks will operate anywhere in the world where there's a power supply of 120 volts and AC frequency of either 60 or 50 Hz.

And for even greater international flexibility, no modification is required when Omnivision II decks are used in countries with other AC line voltages.

Simply add an inexpensive step-down transformer, and wherever Omnivision II decks are used, fluctuations in AC line frequency won't affect them, because both use DC motors.

Both decks also have a VTR/TV antenna switch, automatic shutoff at the end of the tape, BNC and Pin output connectors and more. With the NV-8300

you also get a built-in digital clock timer for recording when you're not there.

## Industrial strength options.

Omnivision II decks are available with the kind of options you require for your special communications needs. Like an RF modulator for playback on most TV receivers. A remote pause control. Black and white and color cameras. Monitors. And Panasonic 30, 60 and 120 minute VHS cassettes.

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For more information write: Panasonic Company, Video Systems Division, One Panasonic Way, Secaucus, N.J. 07094.

In Canada, contact Panasonic Video Systems Department, 40 Ronson Drive, Rexdale, Ontario M9W 1B5.

CAUTION: Unauthorized recording of copyrighted television programs, films, video tapes and other materials may infringe the rights of copyright owners and be contrary to copyright laws.

# Panasonic VHS

Omnivision II™



NV-8150 player.

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[www.americanradiohistory.com](http://www.americanradiohistory.com)

# people in the news

## Manufacturers/Distributors

The promotions of **Peter Waldeck** to vice president of international marketing at Cinema Products Corp., and **Gary Gross** to vice president of national marketing, was announced by **Ed DiGiulio**, president. With Cinema Products since 1971, Waldeck was responsible for developing the worldwide network of distributors and dealers of the firm's 16mm and 35mm professional motion picture equipment line. Prior to joining the firm in 1975, Gross served in the U.S. Navy for 20 years, gaining extensive experience in all phases of motion picture production.

**Nicholas G. Makris** has been appointed director of business affairs at Imero Fiorentino Associates Inc. He comes to the firm with extensive experience, having served as production controller for the Children's Television Workshop in New York, in addition to prior business endeavors.

**Jay Kuca**, now sales engineer of the Grass Valley Group, was formerly chief engineer in the telecommunications department of Wright State University. **John White** is the new South Central sales manager of the Grass Valley Group. Prior to this position, White was sales representative for RCA in Minneapolis.

**David H. Buckler** was named director of sales for the Telesystems division of Chyron Corp. Buckler has been involved in sales for the corporation since 1973, and became Eastern region sales manager for Chyron in 1974.



MAKRIS



KUCA



BUCKLER

**Steve Brant** joined Tektronix as a video sales engineer, based in the Indianapolis, Indiana, field office.

CCA Electronics Corp. announced the appointment of **Carroll Ogle** as the firm's broadcast products manager. Ogle was district sales manager for broadcast products at RCA for six years.

Also announced at CCA was the promotion of **James Ehrmann** to the position of controller. And, **Anthony**

*continued on page*

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SONY CVM-1720

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Cost: \$950

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SONY KV1204

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Cost: \$571

SONY KV1711D

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Cost: \$691

Electro-optical isolators available for  
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Weigh all the options before you send your crew out for that ENG assignment. Will that lower-priced monitor/receiver your technical crew is using have that SONY performance and reliability? Too heavy you say... or maybe too expensive. Do yourself a favor... install a Video Aids electro optical isolator in a Sony receiver. In less than 30 minutes you have a high quality color monitor while still retaining the receiver function. You only add 8 ounces to the receiver's total weight instead of the typical 12 to 18 pounds most monitor/receivers add. Try it... not only will you like that solid reliability and performance... you'll save money... and your crews will love you for not having to carry those heavy monitor/receivers. Yes, weigh all the options before you make your decision...

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## people in the news

continued from page 24

Tierno assumes additional responsibilities as assistant treasurer in the areas of systems, controls, and procedures.

Alan K. Jensen, instrumental in the development of CEI's CEI-310 field production television camera system, was recently appointed as the firm's president. Previously, Jensen served as executive vice president for CEI.

E. L. Persons was appointed as Telemation's customer service manager, retaining his previous responsibilities as quality assurance manager. Prior to joining Telemation, Persons was with Beehive International.

Randy Wilson assumed the position of director of technical marketing for KLH Research and Development Corp. Wilson was a manager at Federate Electronics.

The appointment of Joseph T. Consalvi as vice president of finance and treasurer of CCA Electronics Corp. was announced by Jason S. Fox, president.

As manager of planning for California Microwave Inc., Nick Peterson will be responsible for coordinating the annual profit planning process and assisting in developing the company's strategic and long-range plans. Prior to joining California Microwave, Peterson was with Memorex as manager of financial analysis.

Coyle Dillon, vice president of sales at United Medical Corporation, joined ADDA Corp. recently as a sales representative for the nonbroadcasting video applications.

Ampex International announced the appointment of Ronald Ballintine as general manager, based in Redwood City, California. Ballintine is succeeding his former position as area manager of Europe, Africa, and the Middle East by Richard Sirinsky.

Paul H. Fletcher, who joined Micro Consultants last fall, is now the manager of the firm's new Southeast branch office in Atlanta.

Grant M. Smith was named assistant vice president and general manager of the Sony Technology Center. Also, Barnett E. Guisinger was appointed director of technology for the technology center.

## Radio/Television

Kryn Peter Westhoven, 20, was recently selected as WJB-FM public relations director for the 1978 winter semester at Brookdale Community College in Lincoln, N.J. Westhoven, a broadcast major at Brookdale, has worked at WJB-FM for more than a year.

Norman J. Avery is the new chief engineer of WENE/WMRV in Endicott, New York. Avery previously was the chief engineer at WEJL/WEZK in Scranton, Pa.

continued on page 25

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# The Sony BVH series.

## Consider the accomplishment.

Two years ago, 1" helical-scan recording was just a gleam on the broadcast horizon.

Now, there's the new SMPTE Type C Standard.

We're kind of proud of that. From the start, Sony Broadcast was a leader in the 1" revolution. We pioneered many of the technical innovations incorporated into the 1" helical-scan VTR. And it's good to be part of a movement so beneficial to the broadcast industry.

How does our new SMPTE Type C machine differ from the more than one hundred BVH-1000's already in use across the nation? Frankly, very little.

And we're proud to be able to offer you SMPTE-standard 1" machines that maintain all the unique advantages of the Sony Broadcast equipment already in the field.

**Consider the advantages.** Advantages like BIDIREX, which gives you full bi-directional search capability in both shuttle and jog modes. And that means 100% post-production creative freedom, with all the ease and flexibility of 35mm film techniques.

Advantages like the incredible economy of the 1" tape format. Far lower acquisition costs. Smaller size, so you save valuable studio space. Lower maintenance costs. Plus major savings in 1" videotape alone.

Advantages like three high fidelity audio tracks. Color framing, to maintain perfect timing continuity during editing and animation

sequences. And more.

**Consider the possibilities.** Think about the local programming capabilities that open up with the BVH-1000 and portable BVH-500. Capabilities quad can't match. With an economy that leaves film far behind.

Think about creating your own documentaries. Taping your own commercials. Think about taking 1" tape out into the field, then bringing it home and going directly on the air without the need for converting to another format.

Think about the kind of panoramic production once possible only on film. And think about what single-camera film editing techniques will mean to your creative effort.

**Consider the source.** There's one more thing you should think about as you consider the move to 1".

The source of your equipment.

And when you consider Sony Broadcast, you'll find benefits no other source can give you.

Like our years of experience in research, engineering, and production of advanced video systems.

And access to a complete family of professional video equipment from a single manufacturer. With the kind of reliability and performance only a single manufacturer system can guarantee.

The BVH Series, from Sony Broadcast.

All things considered, it's quite an accomplishment.

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**people  
in the news**

.....  
continued from page 26

Richard W. Osborne, station manager at WKXI Concord, N.H., since 1969, has been named general manager. Also, James J. Jeannotte, a veteran of 1 years at WKXL, has been appointed to the newly created position of assistant manager and operations director.

Robert Hauck joined KORK, Las Vegas, as chief engineer for both the AM and FM stations. He was employed as assistant chief engineer at KORK-TV. KORK is owned by the Donrey Media Group.

Tampa Bay Area Broadcasters Inc. has elected Larr Whitney, general sales manager at WTVT-TV, a president. In addition, Tom Watson, WLCY Radio, is vice president; Ted Moore, WRBQ Radio, is the new secretary; and Jim Tomlin, WTOG-TV, was elected treasurer. The new board of directors includes Don Boyles, WSUN Radio; Ed Winton, WWBA-AM/FM; Gene Danzey, WRXB Radio; Frank Celebre, WDAE WJYW; and Stan Raymond, Jr., WTAN/WOKF.

**18 Elected to NAB  
radio and television boards**

Eighteen prominent broadcasters throughout the nation have been elected to the National Association of Broadcasters' board of directors. Those elected will serve on either the radio board or the television board for two-year terms effective June 1978.

Elected to the radio board are William O'Shaughnessy, president, WVOX/WRTN, New Rochelle, N.Y.; Carl V. Venters, president, WPTF/WQDR, Raleigh, N.C.; Adrian L. White, owner-general manager, KPOC-AM/FM, Pocatonton, Ark.; Michael O. Lareau, executive vice president-general manager, WOOD-AM/FM, Grand Rapids, Mich.; Rober M. McKune, president-general manager, KTTR/KZNN, Rolla, Mo.; Pat Murphy, vice president-general manager, KCRC/KNID, Enid, Okla.; Roy A. Mapel, general manager-secretary/treasurer, KIML, Gillette, Wyo.; Jack Willis, vice president-general manager, KHEP-AM/FM, Phoenix, Ariz.; Cullie M. Tarleton, vice president-general manager, WBT-AM/FM, Charlotte, N.C.; Herbert W. Hobler, president, WHWH/WPST, Princeton, N.J.; Walter L. Rubens, president-general manager, KOBE/KOPE, Las Cruces, N.M.; and J. T. Whitlock, general manager, WLBN, Lebanon, Ky.

Elected to the television board are Forest W. Amsden, vice president-general manager, KGW-TV, Portland, Ore.; W. Frank Harden, president, State Telecasting Company, Columbia, S.C.; Robert King, executive vice president, Capital Cities Communications, Philadelphia, Pa.; Mark Smith, general manager, KLAS-TV, Las Vegas, Nev.; Leonard A. Swanson, vice president-general manager, WIIC-TV, Pittsburgh, Pa.; and Walter M. Windsor, general manager, WFTV, Orlando, Fla.



Scotch 479 Master Broadcast

## SCOTCH IS FIRST IN BROADCAST. GIVE OR TAKE AN INCH.

Scotch® has been state of the art in broadcast videotape for more than twenty years. It's an industry-wide fact that nobody knows tape like 3M.

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Like superior color noise and signal-to-noise. And nobody gives you better RF output.

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When you come to that new format, you'll have an old friend.

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# FCC cuts base meter requirements

By Bob Jones

Strange as it may sound, the FCC has now officially gone on record saying that all directional AM stations who have met the new Section 73.68 (b) requirements with an approved directional antenna sampling system can remove the RF meters from the base of each tower.

As most readers of **Broadcast Engineering** will recall from my May 1976 article on an "approved sampling system," those licensees who installed such a system were excused from the routine observation and logging of base-current meters. Up to now, the FCC had not stated that the meters could be physically removed from the tower bases.

In his letter of February 27, 1978, Rosco E. Long, chief of Policy and Rules Division of the Broadcast Bureau, pointed out to my associate Doug C. McDonnell:

"By virtue of Section 73.68(b) of the Commission's Rules, stations with approved directional antenna sampling systems complying with Section 74.68(a) are no longer required to routinely observe and log the individual base currents in the array elements. However, paragraph 64 of the Report and Order released February 12, 1976, in Docket No. 19692 states in part that 'the capability for measuring base currents should be retained to facilitate the measurement of base currents for test purposes or to permit the reading of these currents during any period the antenna monitor system is inoperative.' "

## Removal and storage

Each chief can now remove all his base current meters and store them in a warm, dry transmitter room. Hopefully, they will be far removed from lightning damage. It has been my experience that unused meters hold their calibration much better when stored indoors, than when left at a tower base.

At one station that was utilizing an approved sampling system, we found the number three tower base meter half full of water. It seems as if nobody had read base currents in six or seven months. The roof began to leak, and the leak just happened to be directly over the meter. Needless to say, we didn't get the correct meter reading at that tower.

## Single meter ideas

One suggestion is to just keep a single meter that can be carried around from tower to tower as necessary. This approach has several distinct advantages.

First, you need to keep fewer meters in stock. Second, by using a single meter you don't need be concerned about comparative calibration with all the other base current meters in your system. If the on meter is off, all the readings will be off by the same amount.

When using a single meter, you still have to be concerned about compliance with Section 73.1215 of the Rules.

## Meter jacks needed

Section 73.58 of the Rules sets forth the commission requirements for indicating instruments, including R thermocouple-type ammeters. Part (b) allows a station to use a suitable jack and plug arrangement.

However, when you do choose to use a jack and plug, the contacts shall be made of silver and capable of operating without arcing or heating. The contacts also are required to be protected against corrosion. This means the contacts must fit tight or be cleaned regularly.

It is also important that when the meter is inserted into the antenna circuit, or removed, that its presence does not interrupt the transmission of the station.

The Rules further require that when not in use, the meter(s) be labeled and identified as to the tower the plug into. Obviously the RIs would expect them to be stored in a location that is readily available for use. A prudent chief would certainly exercise care in handling each meter to prevent damage or impairment in accuracy.

## Final thoughts

The FCC is continuing in its efforts to catch up with the state-of-the-art in the field of broadcast engineering. This approach to simplifying meter care and maintenance makes a lot of sense. So now you can get out and get unplugged.



## “The CEI-310 is the best field production camera we looked at.”

“And we looked at every 2/3” production camera on the market,” says Don Barros of Southwest Producer’s Service, Inc. of Dallas. Southwest Producer’s is one of the country’s newest, best equipped production houses.

He adds: “We like everything about the CEI-310 — size, weight, mobility and range, simple operation, stability, and reliability.”

“And the electronics unit has all the features we need for the sophisticated production work we do.”

“We also like the modularity of the system. We were able to buy just what we needed — one portable unit,

one modified studio setup, and one full studio system with an 8-inch viewfinder. Any time we have to, we can quickly reconfigure any of these cameras from studio to portable and vice versa.

“But after all, a television camera is judged by the pictures it makes,



and the CEI-310 is far superior to everything else we looked at. The colorimetry is superb and it performs beautifully under all kinds of light conditions. Never before have we had so many compliments from our clients on the appearance of their commercials.

“In short, we think we’ve got the world’s best field production camera.”

Isn’t it time you looked into the new CEI-310, the camera that’s changing the look of field production? Call your local CEI representative now. Or get in touch with us directly at 880 Maude Avenue, Mountain View, California 94043, (415) 969-1910.

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# CEI

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# KSL scores ENG first with fiber optic link

By Ron Merrell



On March 8, 1978, KSL-TV (Salt Lake City) began transmitting ENG material from its microwave receiving station atop the Beneficial Building through a 1700-foot fiber optic cable to its studios a block away. This event marked the first commercial broadcast use of a fiber optic video transmission link as an operational part of an ENG system.

Up to now, the word on fiber optics has been only of successful installations in cable TV and telephone systems.

The fiber optic cable carries a modulated light beam, which is reconverted to a video signal in the KSL studios. And as BE has pointed out in previous articles (December issues, 1976 and 1977), the advantages of fiber optics are that it takes up much less cable space, provides high quality because there is no line loss and frequency limitation, and the light beam is not affected by any type of interference. The quality at the receiver is virtually identical with that at the transmitter under all weather and environmental conditions.

To update our coverage of fiber optics, BE interviewed KSL-TV's director of engineering, William Loveless. Here's how it went:

**BE:** We know that KSL is a pioneer in broadcast applications of new technologies. So, was the KSL involvement with fiber optics strictly a "let's see what it's like" decision, or was fiber optics seen as a definite answer to an old problem?

**WL:** Early in the spring of 1977, the engineers at KSL-TV became aware of the many advantages of fiber optic cables over metallic cables. These advantages included the complete immunity from crosstalk and common mode ground potential between buildings; the very wide transmission bandwidth and resulting lack of equalization required; the fact that the fiber optic cables' attenuation is insensitive to temperature changes; and, the small cable size and weight compared to metallic cables.

About this time, our KSL studio microwave path was being blocked by new building construction and we had to relocate a number of remote pickup, STL and intercity relay stations from one building to another. We made the decision that spring to include a fiber optic cable in the 1700-foot run of metallic video, audio and control cables, based up on the promise of this future technology, as video fiber optic links were not then available.

**BE:** Why fiber optics over conventional links?

*continued on page 3*

# How to get a three-motor, direct-drive, isolated-loop deck. And save \$5,500.



Ingenuity of design can be fascinating for its own sake, but when it results in a product of demonstrable excellence, as with this tape recorder, one can only applaud...

The review is from *Modern Recording*. The tape deck is Technics RS-1500US. And the ingenuity of design that *Modern Recording* and *Audio* have praised in recent issues is Technics' advanced "Isolated Loop" tape transport with a quartz-locked, phase-control, direct-drive capstan.

By isolating the tape from external influences, Technics has minimized tape tension to an unprecedented 80gms. Eliminating virtually all signal dropout. While reducing modulation and wow and flutter to a point where conventional laboratory measurement is seriously challenged. A considerable achievement when you realize Technics RS-1500US is priced substantially below its professional counterpart. \$5,500 below.

Electronically, too, Technics has provided the ultimate in professional control and performance. A separate microphone amplifier. Record amplifier. Mixing amplifier. And three-way bias/equalization. While IC full-logic function controls permit absolute freedom in switching modes.

Compare specifications and prices. Then you'll realize there's no comparison. **TRACK SYSTEM:** 2-track, 2-channel recording, playback and erase. 4-track, 2-channel playback. **FREQ. RESPONSE:** 30-30,000Hz,  $\pm 3\text{dB}$  (-10dB rec. level) at 15ips. **WOW & FLUTTER:** 0.018% WRMS at 15ips. **S/N RATIO:** 60dB (NAB weighted) at 15ips. **SEPARATION:** Greater than 50dB. **RISE TIME:** 0.7 secs. **SPEED DEVIATION:**  $\pm 0.1\%$  with 1.0 or 1.5mil tape at 15ips. **SPEED FLUCTUATION:** 0.05% with 1.0 or 1.5mil tape at 15ips. **PITCH CONTROL:**  $\pm 6\%$ . **SUGGESTED RETAIL PRICE:** \$1,500.

Technics RS-1500US. A rare combination of audio technology. A new standard of audio excellence.

\*Technics recommended price, but actual retail price will be set by dealers.

## Technics Professional Series

by Panasonic

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## Fiber optic link

continued from page 34

**WL:** The fiber portion of the system provides almost unlimited bandwidth with no equalization required. The electronics portion of the system limits the bandwidth to 10 MHz with a signal-to-noise ratio of 6 dB. The fiber system greatly exceeds the NTC7 TV network specification provided by metallic cable systems.

**BE:** I understand there are four fiber lines in the cable at KSL. How will the other lines be used?

**WL:** We ordered a two-strand fiber optic cable from Times Wire & Cable Company, but because of a delivery schedule problem at Times, a six-strand cable was substituted. At present only two of the six strands have optical links attached. One of these is used to connect the KSL ENG microwave receiver to the studio.

The optical and metallic links are all interchangeable by patching the video signals at each end.

**BE:** Is fiber optic line splicing still a problem?

**WL:** Yes! At KSL, each end of the .00055-inch diameter cable fiber and the end of the link fiber optic pigtail were inserted into opposite ends, down the center of a three-drill-rod-splice and clamped. These splices may be replaced with fiber optic connectors when they become available.

**BE:** Are there minimum and maximum input signal levels for video signals?

**WL:** The Telemet 4210 fiber optic link system was designed to handle a cable loss of up to 15 dB. With a 62 dB signal-to-noise ratio, our 1700-foot fiber cable represents 5.2 dB loss. The optical receiver video output level is adjusted for standard 1-volt output while feeding 1 volt into the optical transmitter. The optical fiber is not sensitive to signal level or temperature.

**BE:** Will the line losses limit the use of fiber optics in broadcasting?

**WL:** Our Times fiber optical cable is rated at 10 dB per KM, and we have 0.52 KM length. I understand future optic cables with only 2 dB per KM loss are possible.

**BE:** How good is the video signal on the fiber optic cable when it arrives at the studio?

**WL:** Without standard video test equipment, we cannot measure the difference between the test signal generator output and the fiber link output.

**BE:** Are the advantages of fiber optics strictly technical? Or are costs a major consideration?

**WL:** In our prototype fiber optic system, the costs were less than metallic cable systems, with superior performance from the fiber system.

**BE:** What support equipment is needed for video transmission via fiber optic lines?

continued on page

BROADCAST ENGINEERING



# Introducing a monitor with beauty and brains.

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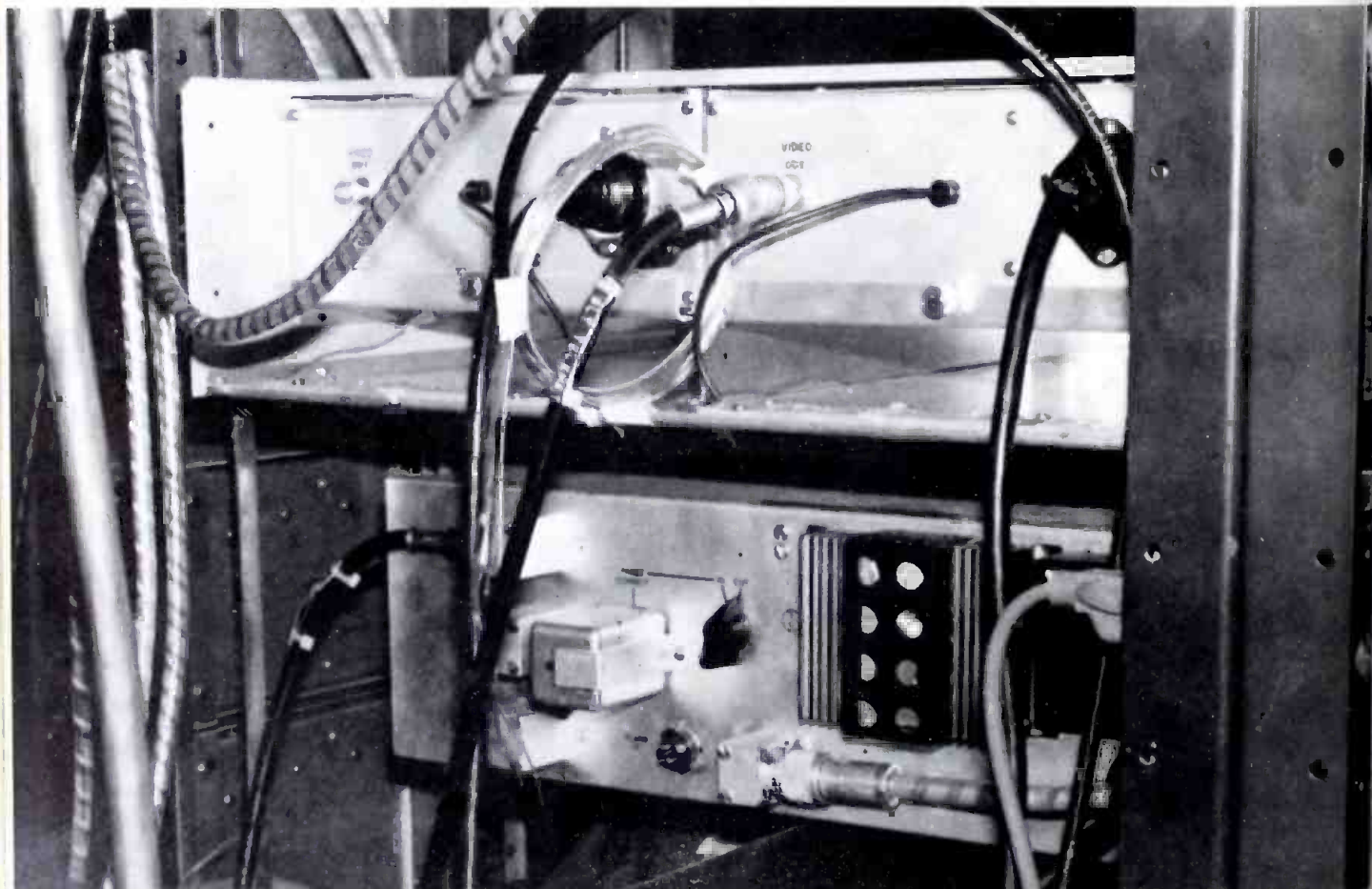
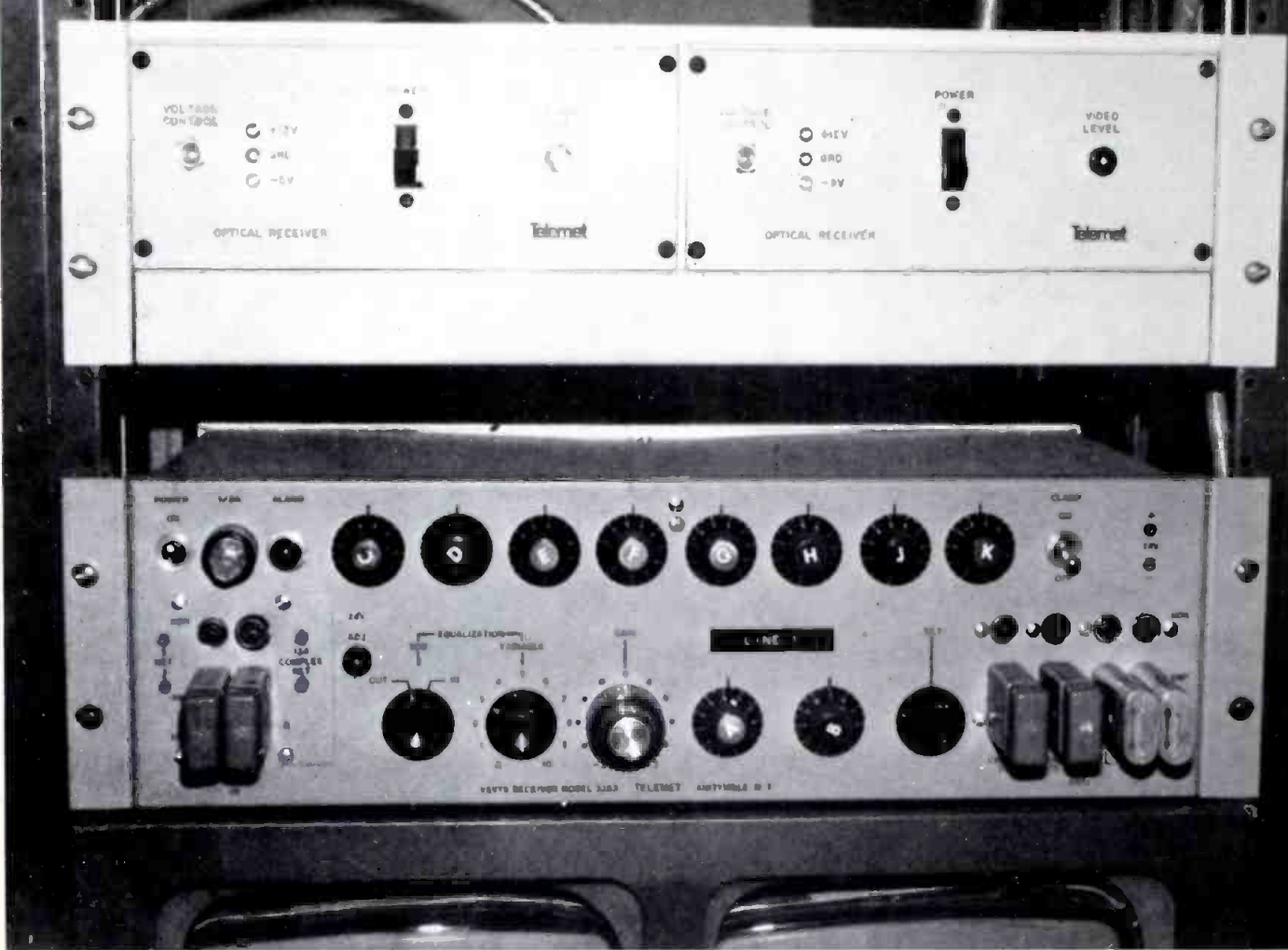
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\*Optional



upper left photo shows the optic receiver mounted above the metallic cable receiver. The optic receiver was shown at the convention by Telemet. The lower left photo shows the back side of the rack with pigtailed to cable splices. They are taped to the back edge of the chassis. Photos courtesy of KSL-TV)

## Fiber optic link

Continued from page 36

**Q:** The same as metallic—a standard video test signal generator and waveform monitor or scope for setting levels.

**A:** Are there any plans for fiber optics inside the studio? And can fiber optics be used for audio?

**Q:** Until future studio equipment has optical connectors as standard items, the conventional metallic cables will continue to be used for short runs in the studio. Audio is no problem on optic cables, but it seems to me to be a mismatch on signal audio circuits for interface costs and bandwidth. Thousands of audio channels can be carried on one optical fiber if the multiplexing equipment was used.

**A:** The Times Wire & Cable fiber optic cable installed in the KSL-TV link is about the diameter of RG-58U. While the fibers are the thickness of a human hair, they ride in an acrylate sheath. In the cable used at KSL-TV, the six fibers are placed around an aramid center strength member, and then covered by a braider and a polyethylene jacket.

Aside from the advantages we've already covered, fiber optics offers complete ground isolation and protection against ground loops, no short-circuit loading, and the elimination of crosstalk. While it may not be important to broadcast uses, it does eliminate signal tapping possibilities.

### FO system at NAB

The Telemet video transmission system Loveless mentions (model 4210) was exhibited at the recent NAB convention in Las Vegas. It consists of an optical transmitter and receiver. No complex amplifiers, equalizers, phase correctors, pre-correctors or post-correctors are needed. Surprisingly, only when cable lengths run into thousands of feet is amplification necessary.

The Telemet system is specified as a 10 dB loss system, meaning that with 10 dB cable attenuation between transmitter and receiver there would be 1-volt peak-to-peak video output from the optical receiver with 1-volt peak-to-peak to the optical transmitter. Output impedance from the receiver is 74 ohms. The 60 Hz tilt is adjustable to zero, and the envelope delay is less than 10 nanoseconds.

### Who needs fiber optics?

Undoubtedly, fiber optics will make further inroads of the video market. But don't forget that its audio potentials are equally impressive. Meanwhile, this new product area will not fall into the category of the more thing that solves a problem we didn't know we had. It's an intriguing alternative for manufacturers and broadcasters. But for a station such as KSL-TV (who already is using infrared for site-to-van links), it was a natural way to go. □

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# What others promise, the Ikegami HK-312 has been delivering for 2 years.

The Ikegami HK-312 is a high-quality broadcast studio color television camera with unusual capability. In addition to delivering superb pictures, it can be easily interfaced with a microprocessor-computer control unit that automatically performs a complete camera set-up in 45 seconds or less. This is not a vague promise, it's what the HK-312 computer has been doing at leading stations such as WABC, WGBH, WLS, KABC, and KGO. They've put the HK-312 and its computer through the testing and evaluation wringer—the HK-312 cameras you buy today are based on two years of on-air field experience and incorporate the suggestions of a variety of users.

By itself the HK-312 is a state-of-the-art camera with Ikegami performance, quality and reliability.

**Performance** designed-in by the engineering group responsible for the well-known Ikegami HL-33, HL-35, HL-37, and HL-77.

**Quality** assured by 30-mm Plumbicon® tubes, preamps furnishing a signal-to-noise ratio of -53 dB minimum, precise video signal processing, and an excellent detail corrector. For the very cleanest first-generation VTR masters a -3 dB gain control delivers pictures with virtually invisible noise.

**Reliability** built into every HK-312 and verified by complete testing before delivery.

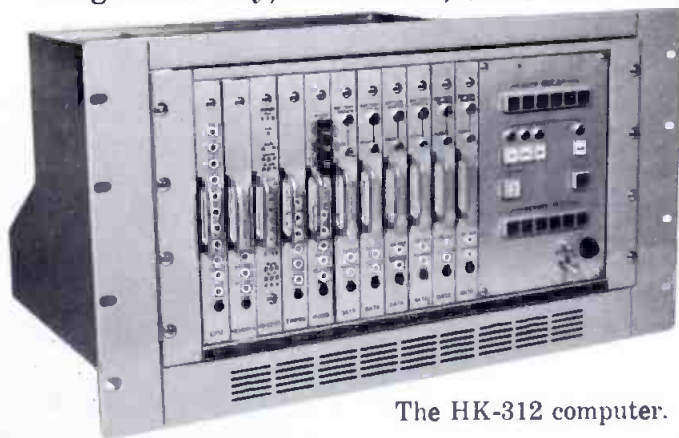
The computer is available for instant integration and operation. Plug it in and the HK-312 camera can be automatically interrogated and set-up to produce an essentially perfect picture: aligned, registered, skew-gamma-flare-corrected, black-balanced, color-balanced, set-up completely and double-checked in about

45 seconds. A single computer can sequentially serve up to six HK-312 cameras. A single push-button starts the entire sequence; the computer can be programmed to skip any camera or any function.

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The HK-312 computer.

## Ikegami

Circle (77) on Reply Card

# ENTERING AND LEAVING NUMBERLAND

**Ever  
weighed  
yourself?**

**You've been  
digitized!**

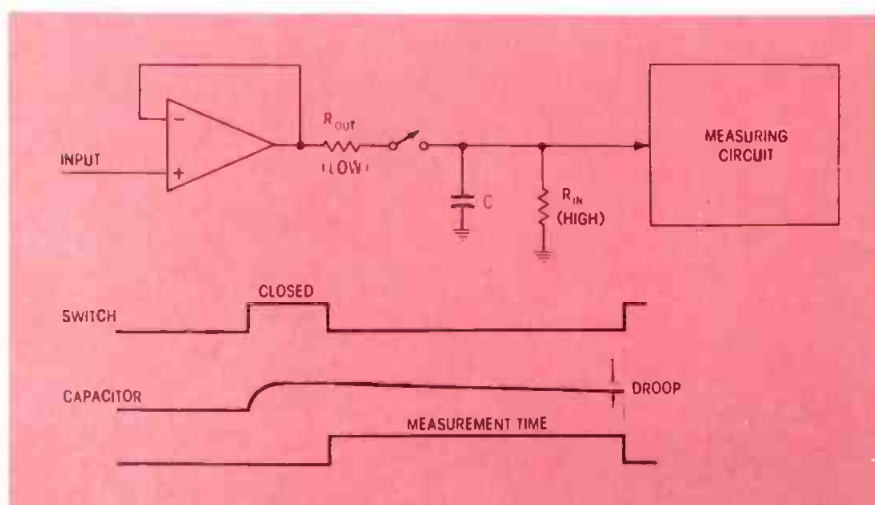


Figure 1 Basic Sampling Circuit.

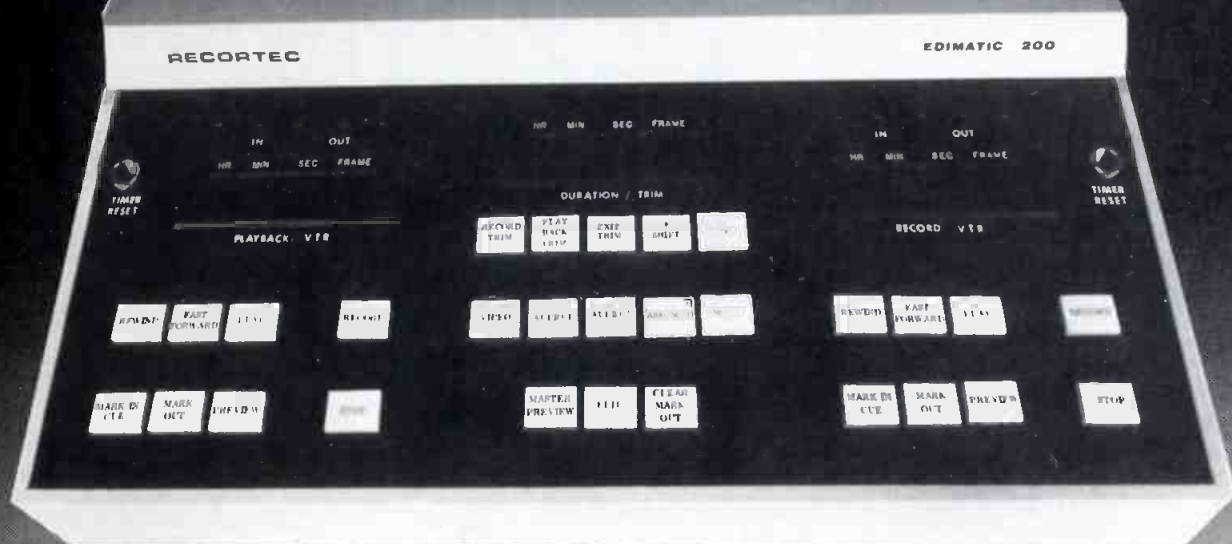
by E. Stanley Busby, Jr.

There are two kinds of things in this world: things you can count and things you can't.

Counting things, like the pages of this magazine, is exact. It is 1 pages; not one less nor one more. The weight of this magazine is another matter. Let's say it actually weighs 314.159625 grams. It's doubtful anyone could determine this and be sure he's right. You could probably find out that it is surely greater than 314.159 and less than 314.160, but who cares? Even the Swiss post office is happy knowing to the nearest gram.

*continued on page 4*

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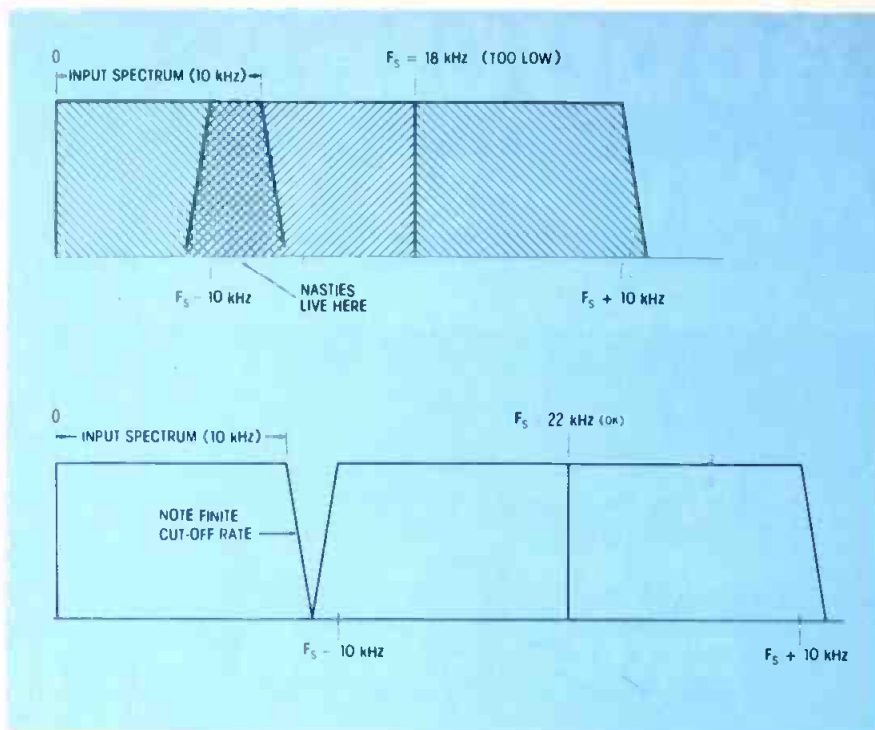


Figure 2 Upper diagram shows what happens if sampling rate is too low.

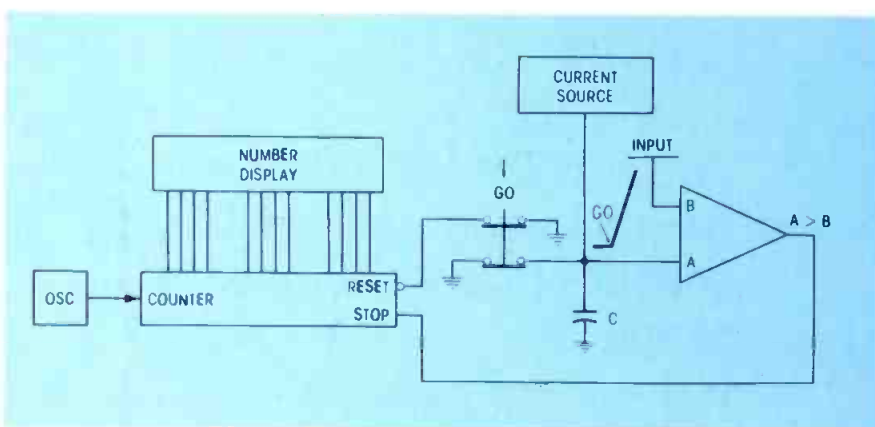


Figure 3 Indirect A/D digitizes the time needed to charge C to exceed input voltage.

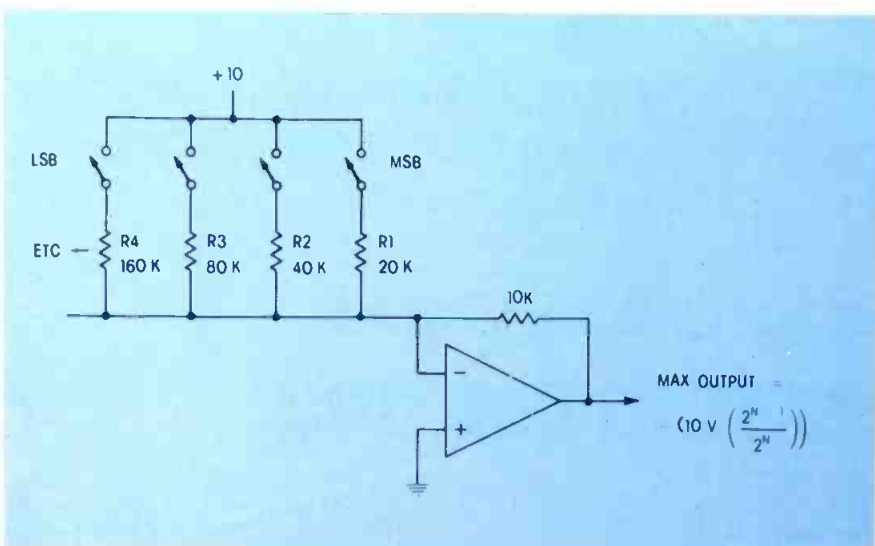


Figure 4 Simple D/A uses binary-weighted resistors.

Sometimes the extent to which you can describe a value with number is limited by the accuracy of the instrument used to measure it. More often, as in the case of the post office, it is limited by practical consideration: the need to know.

## How close, how quick, how often?

If you wanted to record for history the weight of **Broadcast Engineering** each month, you must consider two things: to what accuracy and over what range. If the weight is always less than 1,000 grams and you are only concerned with the nearest gram, then three digits will do. To record to the nearest tenth gram, four digits are needed. To a hundredth gram, five digits. Using binary numbers, ten bits will do for up to 1,024 grams, a one gram resolution. Eleven bits can resolve to  $\frac{1}{2}$  gram, 12 bits to  $\frac{1}{4}$  gram, etc.

To measure anything takes time. If the thing being measured is under your control and will hold still long enough (like a bag of flour), there is no problem. If it varies, and you are interested in recording the variations, two new considerations appear. If you wait too long between measurements, you might miss something, and if the variation is fast enough that it changes while the measurement proceeds, the measurement will be wrong.

Figure 1 shows how an electrical signal can be made to hold still while being measured. The procedure goes: close the switch long enough for the capacitor to charge up, then open the switch to prevent further change, and measure the voltage across the capacitor.

The time constant of the capacitor and the total of the amplifier output and switch resistances must be small enough that the capacitor can follow a rapid change without lagging too far behind. And, the capacitor must be large enough that its charge does not significantly dribble away through the input impedance of the measuring circuit. This calls for amplifiers with very low output impedances, measuring circuits with a very high input impedance, and a compromise capacitor.

How fast to repeat the measurement? Figure 2 shows the sampling rate as if it were a modulated

continued on page 44



## when cost is more important than price

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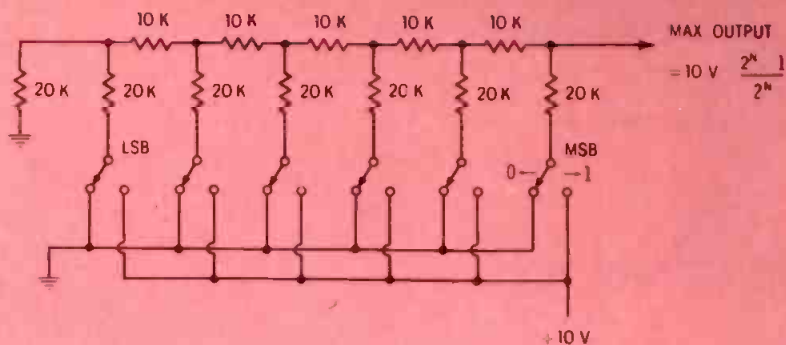
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# STUDER



Figure 5  
Ladder attenuator  
requires only 2/1  
resistor range.



## Numberland

continued from page 44

carrier. If a frequency of more than  $F_s/2$  were to be sampled, the lower sideband would land down amongst the signal frequencies. Audio people would hear a "birdie," video people would see "moire," and to others, it's an "aliasing component."

In theory, if a "brick wall" filter having infinitely steep cut-off was used to limit the modulating frequencies to  $F_s/2$ , you could sample at exactly twice the signal bandwidth. You can imagine a brick wall filter but you can't build one, so the sampling rate is always chosen to

be greater than twice the signal bandwidth. In systems with analog input and output, and digital in the middle, bandwidth-restricting filters are used before digitization and after reconstruction. (For those who know about "sub-Nyquist" sampling, please note the phrase "signal bandwidth" as opposed to "signal frequency.")

**How far is it to the airport?**

**Answer: 30 minutes.**

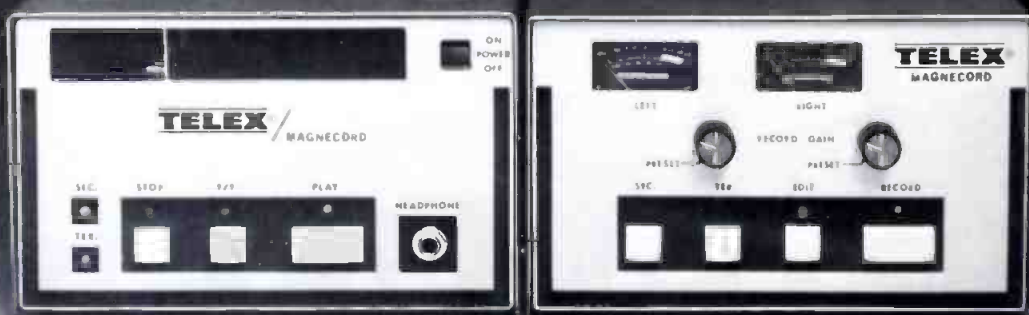
Probably the simplest method of converting a voltage to a number

(analog-to-digital or "A/D") is the indirect method used in most digital voltmeters. Figure 3 shows one elementary approach. To measure, a short circuit is removed from the capacitor, and at the same time, a counter (usually a BCD counter in bench instruments) is started from zero. The capacitor charges linearly until its voltage exceeds the voltage to be measured. The counter is then stopped and its contents displayed.

This requires that the current source, capacitor, and counting

continued on page 41

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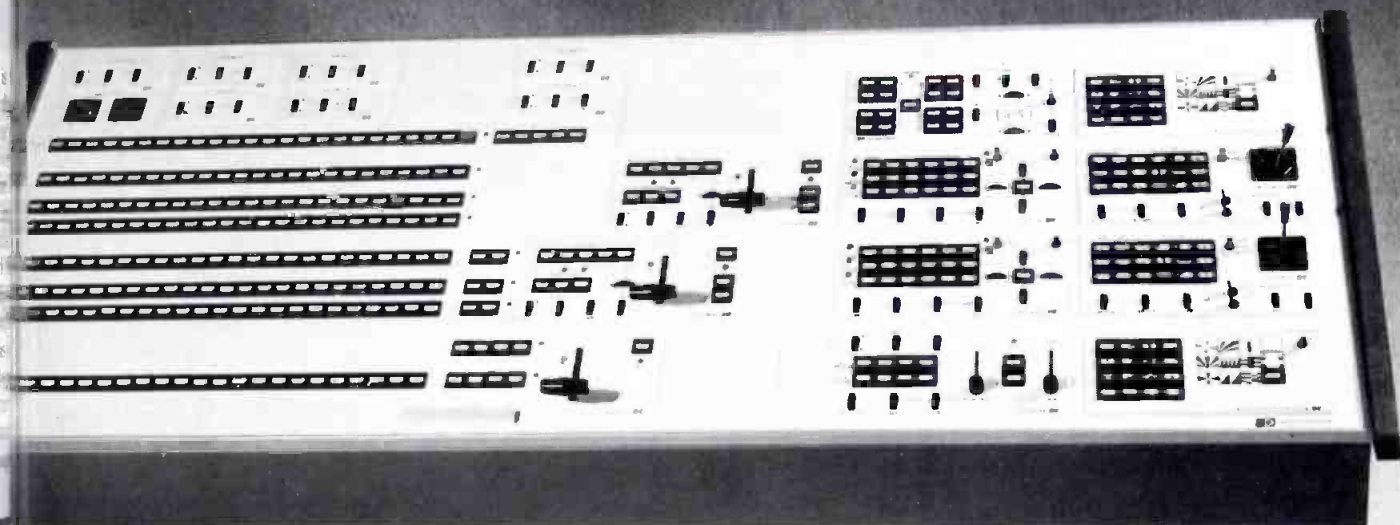
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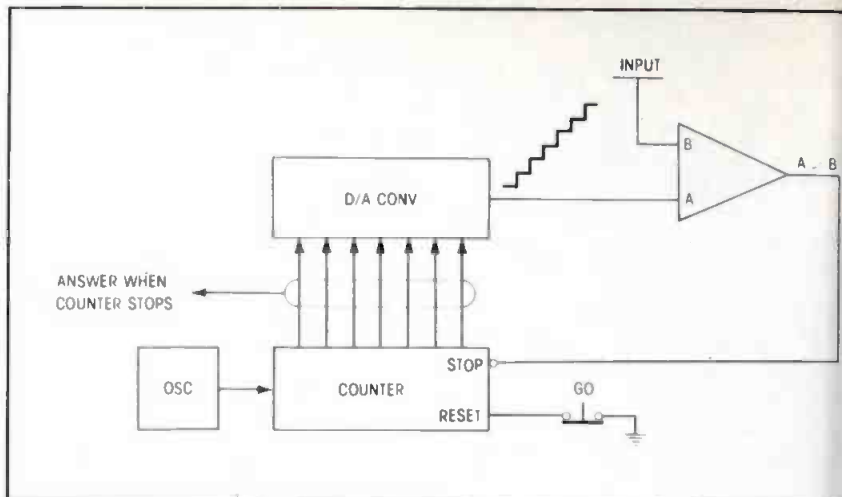


Figure 6 Counting A/D stumbles along until it trips over the answer.

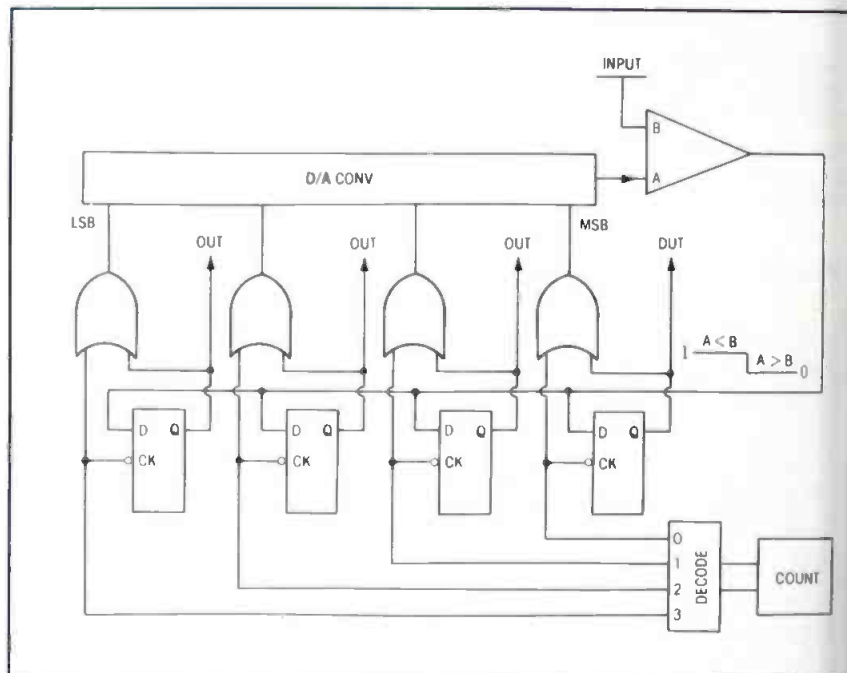


Figure 7 Successive approximation A/D employs memory to good advantage

## Numberland

*continued from page 46*

frequency have good long-term stability. There are a number of schemes used to reduce these stringent demands, some of them ramping the capacitor up and down as many as four times. By doing this, the accuracy requirements are concentrated in the reference current source and the instrument can be caused to "zero" itself before each measurement. For digitizing audio or video signals to any usable resolution, this method is too slow.

### Let's start at the output

A/D conversion is often accomplished with the same circuit used

to convert a number to a voltage (digital-to-analog or "D/A"). Figure 4 shows the simplest D/A circuit.  $R_1$ , when connected, furnishes current into the amplifier which is responsible for  $1/2$  full-scale output.  $R_2$  is responsible for  $1/4$  full-scale output.  $R_3$  for  $1/8$  and so on.

Adding one more resistor doubles the resolution. It has a problem even with moderate resolution, resistor values cover an enormous range.

This makes it very difficult to maintain their two-to-one ratio over a range of temperatures, even with

*continued on page*

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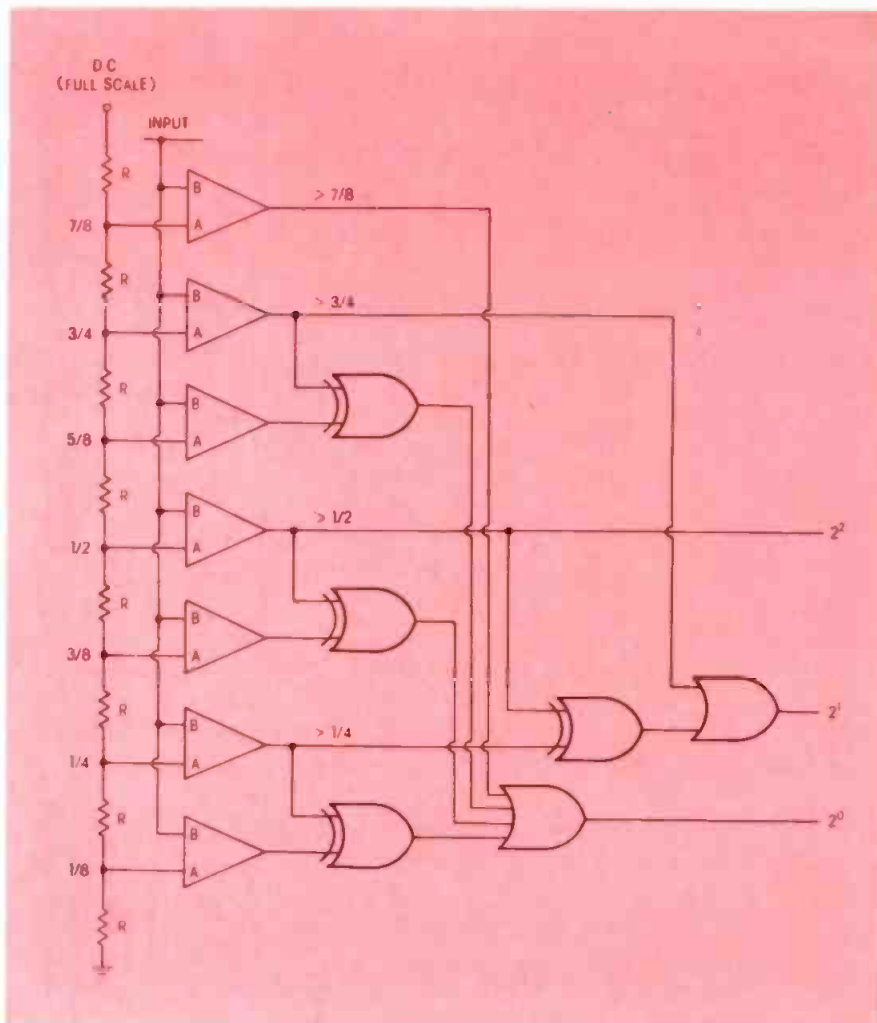


Figure 8 "One-look" A/D uses many comparators. Logic develops binary output number.

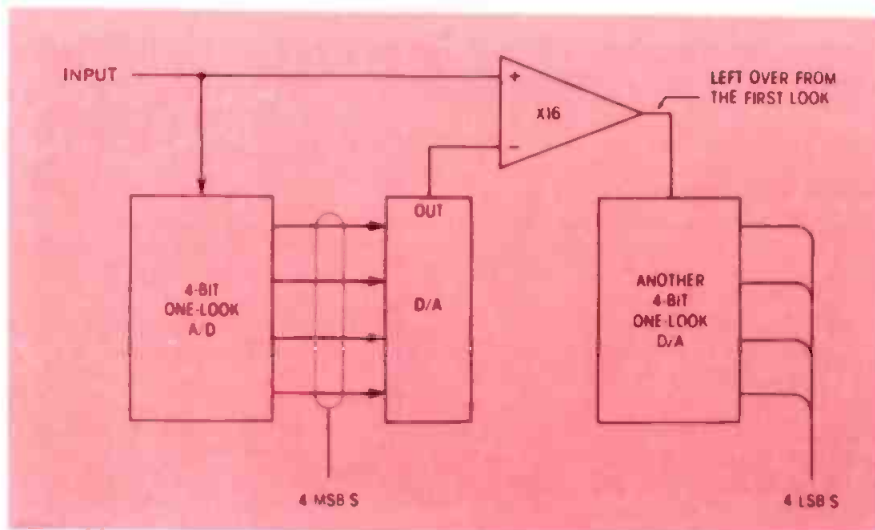


Figure 9 Compromise A/D, used for video and other high-speed applications.

they are encapsulated into the same package.

Figure 5 shows how a ladder attenuator can be used. The least significant switch produces a small output, not because it is a small current supplied through a high resistor, but because it has to traverse the entire attenuator and loses half of itself at each step.

## Try it on for size

Figure 6 shows how a D/A can be used as an A/D. A counter which starts at zero drives a D/A whose output is compared to the input being measured. The D/A output increases one step at a time. When it exceeds the input, the counter is stopped and the number read from it. In the worst case (full scale) it is slow, because it must step through each intermediate value in turn.

A very popular method is illustrated in Figure 7. The most significant bit (responsible for  $1/2$  full scale) is turned on and the D/A output compared with the input. If the D/A output is too much, this bit is turned off and if not it is latched on. The next bit ( $1/4$  full-scale) is turned on and tested to see if it should be kept or not. In this way only  $N$  tests are necessary to make  $N$  tests for an  $N$  bit A/D instead of  $2^N$  tests for the counter type. It is adequately fast for digitizing audio frequencies, but not for video.

## Let's do it all at once

Figure 8 shows the fastest approach of all. To conserve space the illustration is for a three-bit A/D. One look at the input sample yields an answer. Its problem is that it requires  $2^N - 1$  comparators for  $N$  bits. An eight-bit digitizer would require 255 comparators. It has been done for digitizing video where time is very short. There are better ways.

## When time is short...

Television video is normally sampled at three or four times the subcarrier frequency. In PAL countries this means as little as 56 nanoseconds to do a measurement.

The method used in many digital time base correctors is shown in Figure 9. Fifteen comparators in a "one-look" configuration examine the input sample and split out the four most significant bits of the product. These four bits are applied to a D/A whose output is subtracted

continued on page

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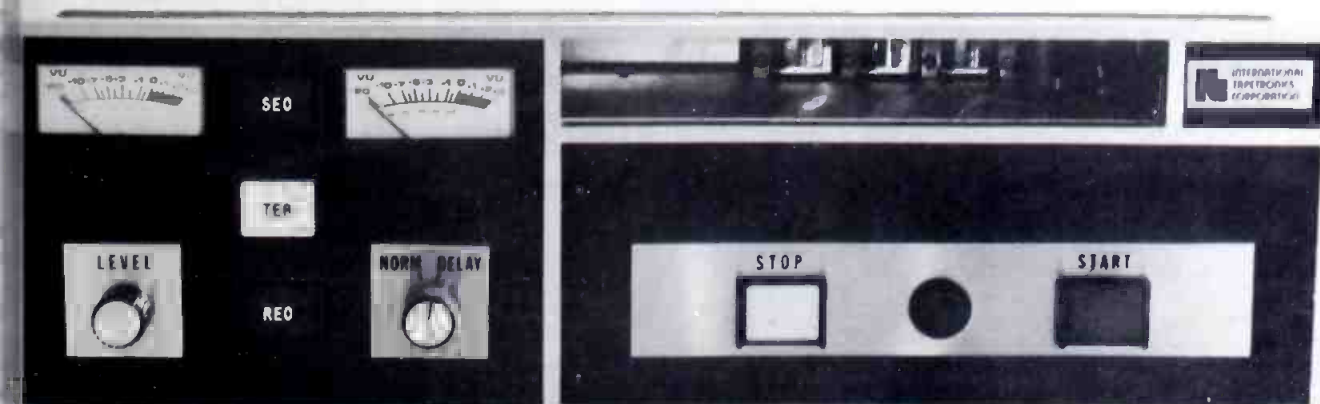
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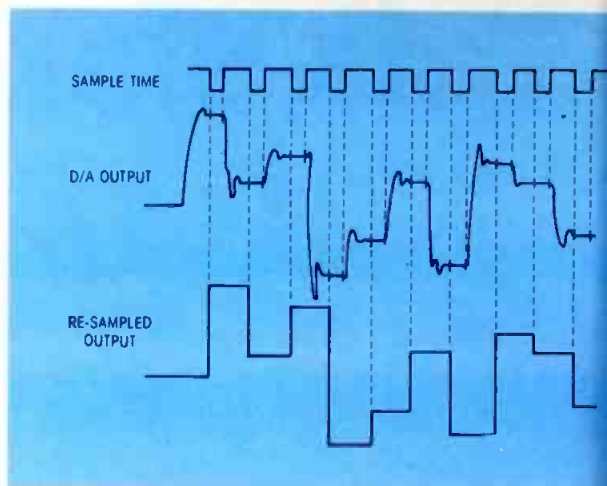
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**Figure 10**  
Resampling (as in  
Figure 1) ignores  
nasty transients.

## Numberland

*continued from page 50*

from the input sample. The remainder is amplified 16 times and applied to an identical four-bit one-look A/D to yield the four least significant bits.

### Stepping over the snit

D/A circuits take time to settle down after the input number is changed. As their output moves from one value to another, they are likely to produce nasty transients. The fast component of the transients will be smoothed by the output low-pass filter, but the average of all these ragged edges does not necessarily equal zero and this can produce undesirable effects in the output analog signal. A solution is to re-sample the D/A output as shown in Figure 10, capturing it only after it has become stable. It's like opening the curtains only when the sun is out.

There is a loss of amplitude at high frequencies of the same form as that produced by a playback head gap or an optical scanning slit on a film projector. The loss (in dB) is:

$$20 \log_{10} \sin(x)/x \text{ where } x =$$

$$\frac{\pi \times \text{frequency}}{\text{sampling rate}} \text{ radians}$$

In practical systems it is usually less than three dB and easily equalized.

### Different kinds of noise

You may hear the term "quantizing noise" bruited around. It is not a noise in the sense that it sizzles in the background when nobody is talking. It stems from the fact that in converting a signal to a number, it is done with deliberately limited accuracy.

The final output is then only an approximation to the input. A large spectrally pure input sine wave emerges as a large sine wave accompanied by some low-level trash spread throughout the spectrum. The magnitude of this trash is halved for each added binary bit of resolution. It occurs only in the presence of a signal. It is similar to the "asperity noise" or "modulation noise" of an audiotape recording.

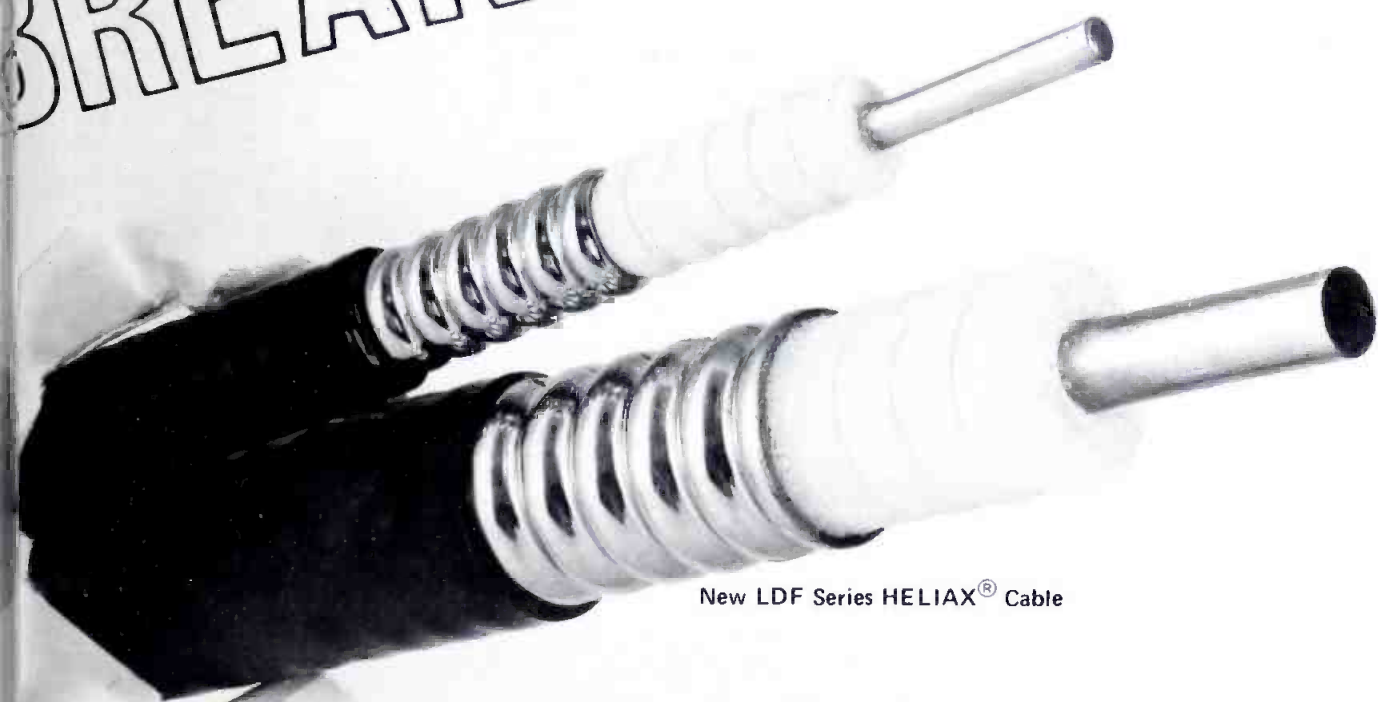
Idling noise is more like random noise. If an amplifier somewhere has a little DC offset, its output (with zero input) can present to the A/D converter a voltage midway between step N and step N+1. Added to this the inevitable thermal noise in all amplifiers, and the A/D sometimes says N and sometimes says N+1. The output varies accordingly.

The peak amplitude of the garbage is one step. It can be minimized by adding to the input signal a square wave at  $F_s/2$  having an amplitude of  $1/2$  step. This tends to concentrate this noise at a frequency which will later be removed by the output low-pass filter. This added signal is called "dither."

It would seem that adding more bits of resolution is the answer to all ills. It is if you can afford it. For N bits, memory cost is at least proportional to N and the cost of A/D's and D/A's tends to vary as  $2^N$ . More accuracy also takes more time.

Analog systems tend to distort large signals; digital systems manage the small ones. There are so many peculiarities about video signals and about the way we hear things that allow some tricky exploitation of the advantages of a digital signal system, but that's the subject of another article.

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# DIRECTIONAL ANTENNA BASICS

Part 5/By Bob Jones, Consulting Engineer, La Grange, Illinois and Facilities Editor for BE.

As is the case with three-tower patterns, there are two basic methods of computing four-tower designs: the addition method and the multiplication method. As you might suspect, there are special cases here, too. One new factor which comes into play with any four-tower pattern is tower placement. You can have all four towers in a straight line (the so-called in-line array), or in the form of a parallelogram.

The general equation (1) for a four-tower pattern is the same as that of a three-tower pattern, plus one more term. This is shown below (Equation 1):

$$E = Kf(\Theta) [1.0 \angle 0 + E_2 \psi_2 + S_2 \cos \Theta \cos (\Theta - \delta) + E_3 \angle \psi_3 + S_3 \cos \Theta \cos (\Theta - \delta) + E_4 \angle \psi_4 + S_4 \cos \Theta \cos (\Theta - \delta)]$$

As with the use of computers in Chapter 3, I have written in the Greek letter to represent the shift from

the reference bearing on each tower. If all towers are in a straight line, then  $\delta = 0$ .

In designing four-tower patterns one usually looks at the end result as being the product of two or three two-tower patterns or the sum of two two-tower patterns. Because of this I'll first show an example of an addition method for an in-line array, then the multiplication method for a parallelogram pattern. Keep in mind both methods apply to each type of tower configuration.

## Four-tower addition formula

In using this method you first must calculate the pattern of each of the individual two-tower patterns to be added. The negative and positive signs are added appropriately to each lobe. These  $\pm$  signs must be carefully observed when the two patterns are added. For an example I used the WTAQ nighttime

*continued on page*

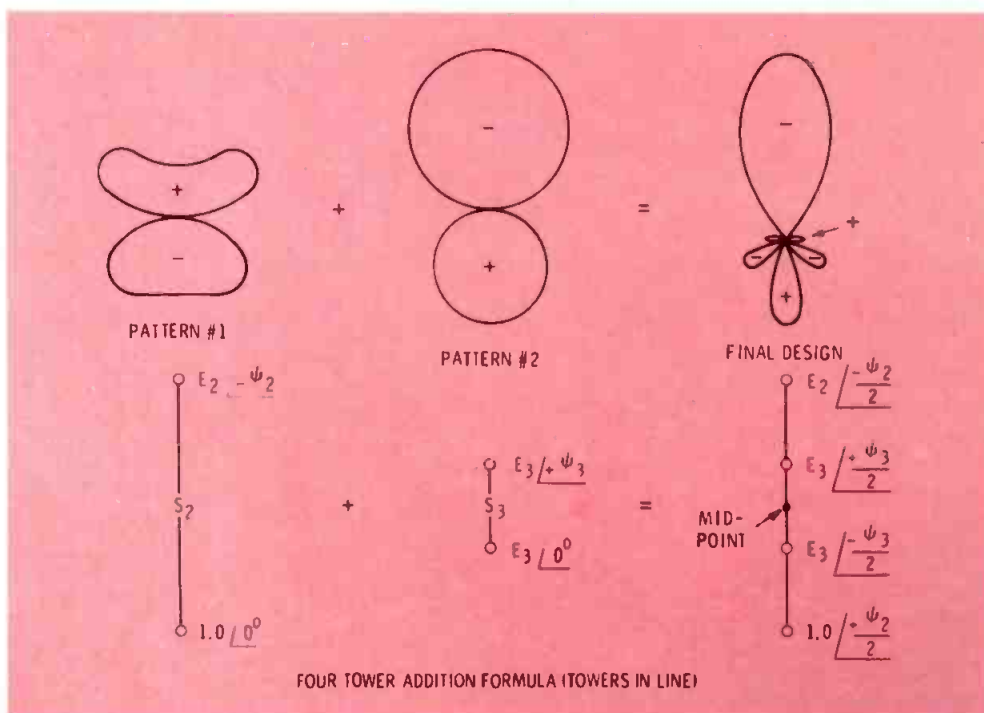


Figure 1

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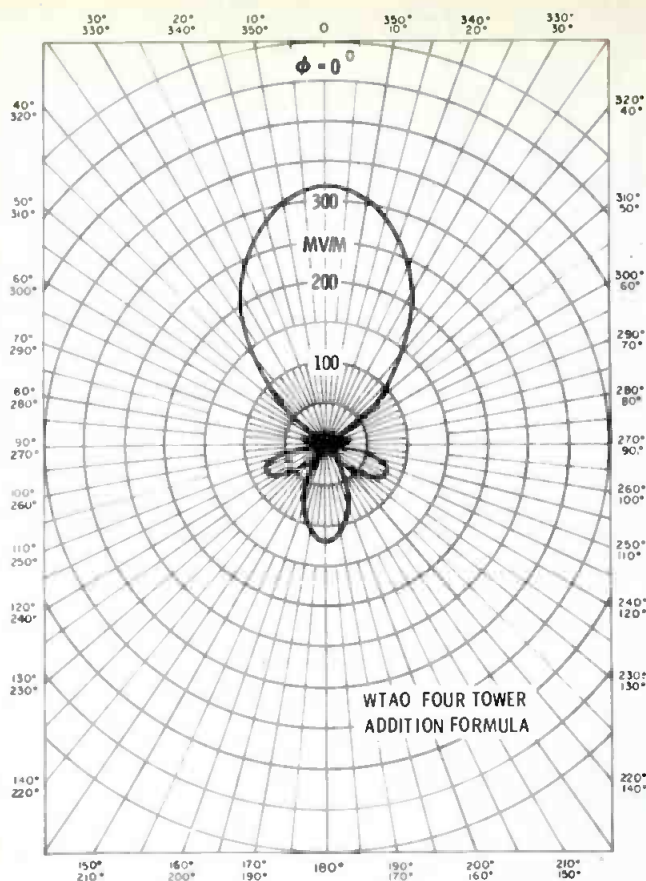


Figure 2

## Antenna basics

continued from page 54

pattern, consisting of a two-tower 90° spaced cardioid and a 270° spaced four-leaf-clover pattern. Figure 1 shows how each pattern looks, as well as the end result. The calculated data is in Table 1.

The lobes to the north on each are (+), so they add. To the sides and the back these lobes are of opposite signs, hence they cancel. Keep in mind that you can vary not only the individual pattern nulls of each two-tower pattern, but also the relative amplitude of each tower, hence the null depth. In the final four-tower design the nulls are determined not by the location of the nulls in the two-tower patterns but by the bearings at which the (+) and (-) lobes are of equal magnitude, for only at those points will cancellation occur. Although this is an awkward method, it is still in common use.

### Four-tower multiplication formula—parallelogram

This method is similar to the addition form, except you multiply the two-tower patterns. For this example I've chosen two two-tower patterns that will combine in a parallelogram shape. The close-spaced pattern is a familiar 90° super cardioid. For the wide-spaced array I've chosen a 200° spaced figure eight, with

continued on page 57

TABLE 1  
FOUR-TOWER ADDITION FORM

$$E = Kf\Theta \left[ E_2 \frac{\Psi_2}{2} + \frac{S_2}{2} \cos \emptyset \cos \Theta + E_3 \frac{\Psi_3}{2} + \frac{S_3}{2} \cos \emptyset \cos \Theta \right]^*$$

We Substitute:  $E_2 = 1.0$ ,  $\frac{\Psi_2}{2} = -76$ ,  $\frac{S_2}{2} = 135$ ,  $E_3 = 2.1$ ,  $\frac{\Psi_3}{2} = 97$ ,  $\frac{S_3}{2} = 45$

$$E_T = K [1.0 \cos (-76 + 135 \cos \emptyset) + 2.1 \cos (97 + 45 \cos \emptyset)]$$

| A           | B                    | C      | D        | E           | F        | G            | H     | I      | J     |
|-------------|----------------------|--------|----------|-------------|----------|--------------|-------|--------|-------|
| $\emptyset$ | $135 \cos \emptyset$ | B-76   | $\cos C$ | $45 \cos A$ | $97 + E$ | $2.1 \cos F$ | D+G   | $H^2$  | MV/M  |
| 0           | 135.0                | 59.0   | .515     | 45.0        | 142.0    | -1.655       | 1.140 | 1.2990 | 321.0 |
| 10          | 132.9                | 56.9   | .546     | 44.3        | 141.3    | -1.639       | 1.093 | 1.1950 | 306.0 |
| 20          | 126.8                | 50.8   | .632     | 42.3        | 139.3    | -1.582       | .960  | .9220  | 270.0 |
| 30          | 116.9                | 40.9   | .756     | 38.9        | 135.9    | -1.508       | .752  | .5660  | 214.0 |
| 40          | 103.4                | 27.4   | .888     | 34.5        | 131.5    | -1.392       | .504  | .2540  | 141.7 |
| 50          | 86.8                 | 10.8   | .982     | 28.9        | 125.9    | -1.231       | .248  | .0620  | 69.6  |
| 60          | 67.5                 | -8.5   | .989     | 22.5        | 119.5    | -1.034       | .045  | .0020  | 6.2   |
| 70          | 46.2                 | -29.8  | .868     | 15.4        | 112.4    | -.800        | -.068 | .0050  | 19.2  |
| 80          | 23.4                 | -52.6  | .607     | 7.8         | 104.8    | -.536        | -.071 | 0.0050 | 19.5  |
| 90          | 0.0                  | -76.0  | .242     | 0.0         | 97.0     | -.256        | .014  | .0002  | 4.0   |
| 100         | -23.4                | -99.4  | -.163    | -7.8        | 89.2     | .029         | -.134 | .0180  | 37.5  |
| 110         | -46.2                | -122.2 | -.533    | -15.4       | 81.6     | .307         | -.228 | .0510  | 64.0  |
| 120         | -67.5                | -143.5 | -.804    | -22.5       | 74.5     | .561         | -.243 | .0590  | 68.8  |
| 130         | -86.8                | -162.8 | -.955    | -28.9       | 68.1     | .783         | -.172 | .0290  | 48.2  |
| 140         | -103.4               | -179.4 | -1.000   | -34.5       | 62.5     | .969         | -.031 | .0010  | 8.5   |
| 150         | -116.9               | -192.9 | -.975    | -38.9       | 58.1     | 1.109        | .134  | .0180  | 38.6  |
| 160         | -126.8               | -202.8 | -.921    | -42.3       | 54.7     | 1.213        | .292  | .0850  | 81.5  |
| 170         | -132.9               | -208.9 | -.875    | -44.3       | 52.7     | 1.273        | .398  | .1580  | 111.8 |
| 180         | -135.0               | -211.0 | -.857    | -45.0       | 52.0     | 1.293        | .435  | .4950  | 122.0 |

\*Half angle formula added to a second half-angle formula.

K = 281.5, RMS = 136

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small side lobes. These are shown in Figure 3, and the data used to calculate them in Table 2. The question now is, how does one go from the design values of the respective two-tower patterns to the final four-tower values?

If you assume one corner of the parallelogram as the reference tower (1.000  $\angle 0^\circ$ ), then the nearest tower has the same phase and field ratio as that of the close-spaced ( $90^\circ$ ) pattern. Likewise, the closest wide-spaced tower has the same values as that of the

*continued on page 6*

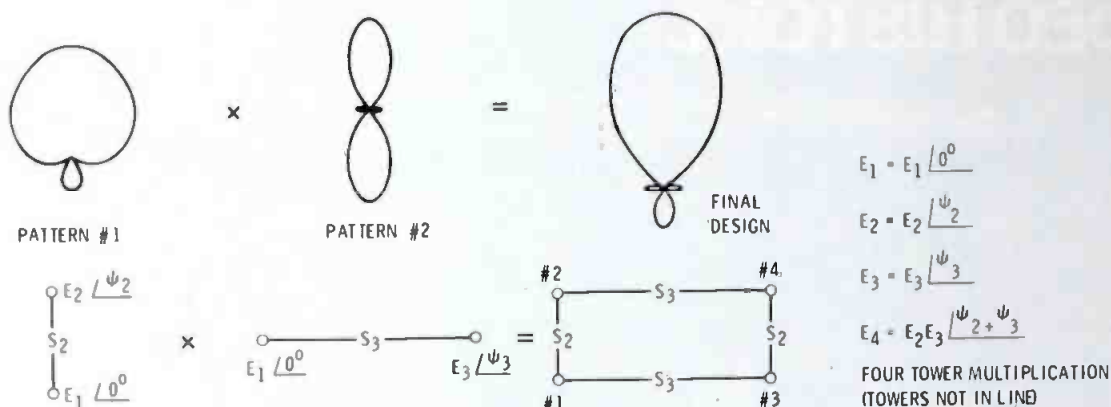


Figure 3

TABLE 2  
FOUR-TOWER MULTIPLICATION METHOD, PARALLELOGRAM

$$E_T = K f(\Theta)$$

$$\left[ \left( E_1 + E_2 \angle \psi_2 + S_2 \cos \theta \cos \Theta \right) \cdot \left( E_1 + E_3 \angle \psi_3 + S_3 \cos \Theta \cos (\theta - \delta) \right) \right]$$

Where

$$E_1 = E_2 = E_3 = 1.0, \psi_2 = -116.4, S_2 = 90^\circ, \psi_3 = 0^\circ, S_3 = 200, \delta = -90$$

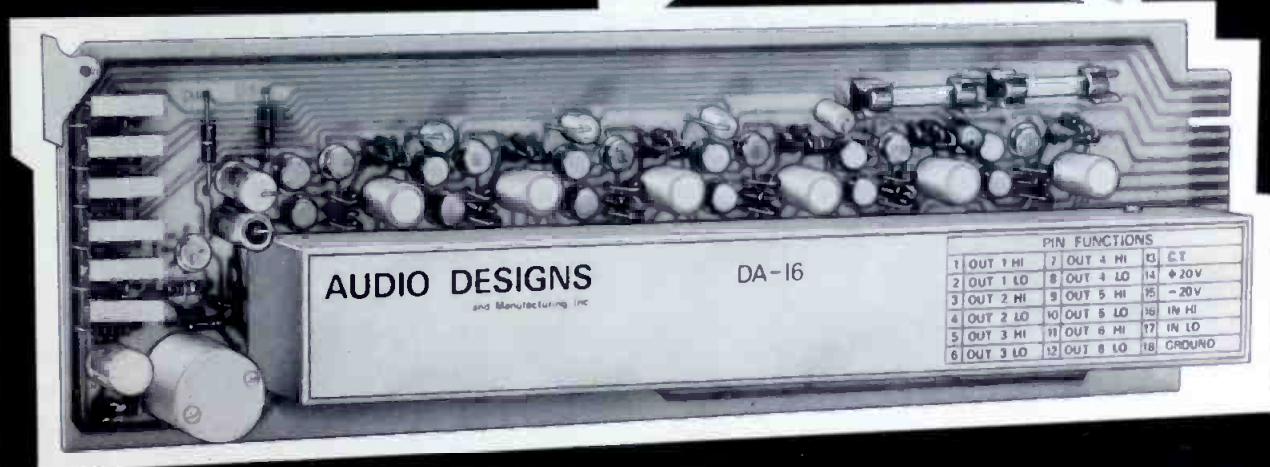
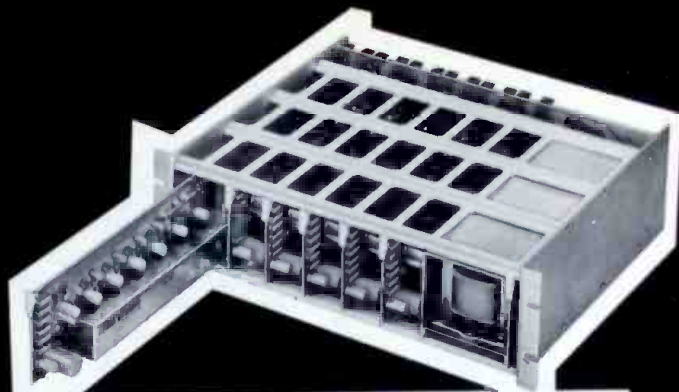
Substituting

$$E_1 = K \left[ \left( 1 + \cos (-116.4 + 90 \cos \theta) \right) \cdot \left( 1 + \cos (0^\circ + 200 \cos (\theta - 90)) \right) \right]^{1/2}$$

| A        | B           | C         | D        | E       | F      | G            | H        | I       | J          | K         | L     |
|----------|-------------|-----------|----------|---------|--------|--------------|----------|---------|------------|-----------|-------|
| $\theta$ | $90 \cos A$ | $B-116.4$ | $\cos C$ | $1 + D$ | $A-90$ | $200 \cos F$ | $\cos G$ | $1 + H$ | $E \cos I$ | $J^{1/2}$ | MV/M  |
| 0        | 90.0        | -26.4     | .896     | 1.896   | -90    | 0.0          | 1.000    | 2.000   | 3.7920     | 1.947     | 497.0 |
| 10       | 88.6        | -27.8     | .885     | 1.885   | -100   | -34.7        | .822     | 1.822   | 3.4340     | 1.853     | 472.0 |
| 20       | 84.5        | -31.9     | .849     | 1.849   | -110   | -68.4        | .368     | 1.368   | 2.5290     | 1.590     | 405.0 |
| 30       | 77.9        | -38.5     | .783     | 1.783   | -120   | -100.0       | -.173    | .827    | 1.4740     | 1.214     | 309.0 |
| 40       | 68.9        | -49.5     | .649     | 1.649   | -130   | -128.5       | -.622    | .378    | .6230      | .789      | 201.0 |
| 50       | 57.8        | -58.6     | .521     | 1.521   | -140   | -153.2       | -.892    | .108    | .1640      | .405      | 103.0 |
| 60       | 45.0        | -71.4     | .319     | 1.319   | -150   | -173.2       | -.993    | .007    | .0090      | .096      | 24.4  |
| 70       | 30.8        | -85.6     | .077     | 1.077   | -160   | -187.9       | -.990    | .010    | .0110      | .104      | 26.5  |
| 80       | 15.6        | -100.8    | -.187    | .813    | -170   | -196.9       | -.957    | .043    | .0350      | .187      | 47.7  |
| 90       | 0.0         | -116.4    | -.445    | .555    | -180   | -200.0       | -.939    | .061    | .0340      | .184      | 46.9  |
| 100      | -15.6       | -132.0    | -.669    | .331    | -190   | -196.9       | -.957    | .043    | .0140      | .119      | 30.3  |
| 110      | -30.8       | -147.2    | -.841    | .159    | -200   | -187.9       | -.990    | .010    | .0016      | .039      | 9.9   |
| 120      | -45.0       | -161.4    | -.948    | .052    | -210   | -173.2       | -.993    | .007    | .....      | .019      | 4.8   |
| 130      | -57.8       | -174.2    | -.995    | .005    | -220   | -153.2       | -.892    | .108    | .....      | .023      | 5.9   |
| 140      | -68.9       | -185.3    | -.996    | .004    | -230   | -128.5       | -.622    | .378    | .0015      | .039      | 9.9   |
| 150      | -77.9       | -194.3    | -.969    | .031    | -240   | -100.0       | -.173    | .827    | .0260      | .160      | 40.8  |
| 160      | -84.5       | -200.9    | -.934    | .066    | -250   | -68.4        | .368     | 1.368   | .0900      | .300      | 76.5  |
| 170      | -88.6       | -205.0    | -.906    | .094    | -260   | -34.7        | .822     | 1.822   | .1710      | .414      | 105.6 |
| 180      | -90.0       | -206.4    | -.896    | .104    | -270   | 0.0          | 1.000    | 2.000   | .2080      | .456      | 116.3 |

K = 255, RMS = 196

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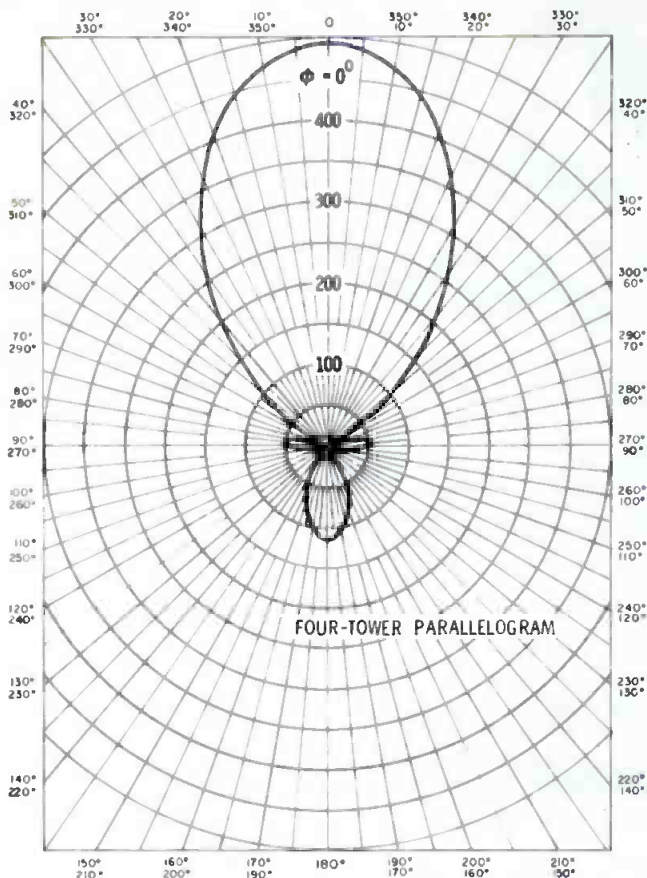


Figure 4

## Antenna basics

continued from page 58

200°-spaced pattern. The opposite corner tower has the multiplication of the two-corner tower. Thus we have (Equation 2):

$$2 = E_1 \angle \psi_1 \quad 4 = E_1 \times E_2 \angle \psi_1 + \psi_2$$

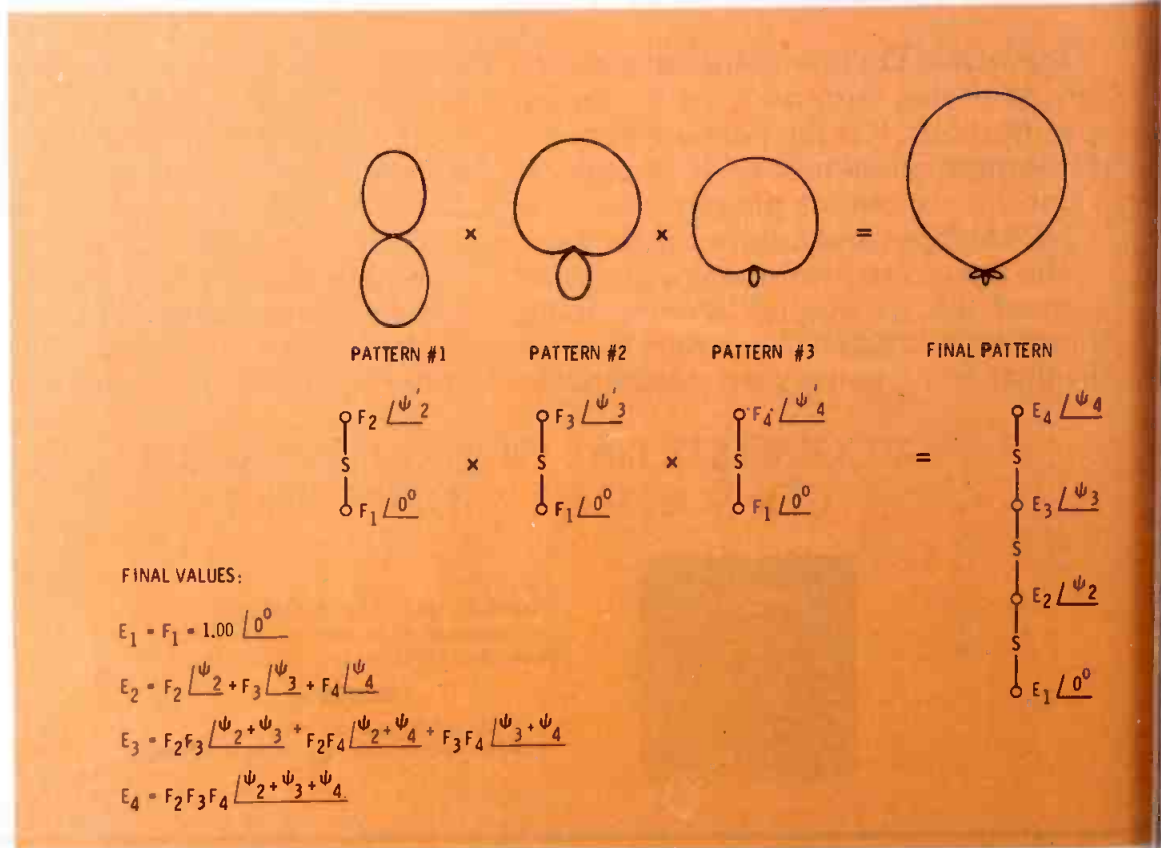
Another version of the four-tower multiplication method is that of the in-line array, where one more term is added to Equation 1 of the three-tower formula in Chapter 4. This can be written as (Equation 3):

$$E = Kf(\theta) \sqrt{\left[ \frac{1+M_1^2}{2M_1} + \cos(\psi_1 + S \cos \theta \cos \phi) \right]} \times$$

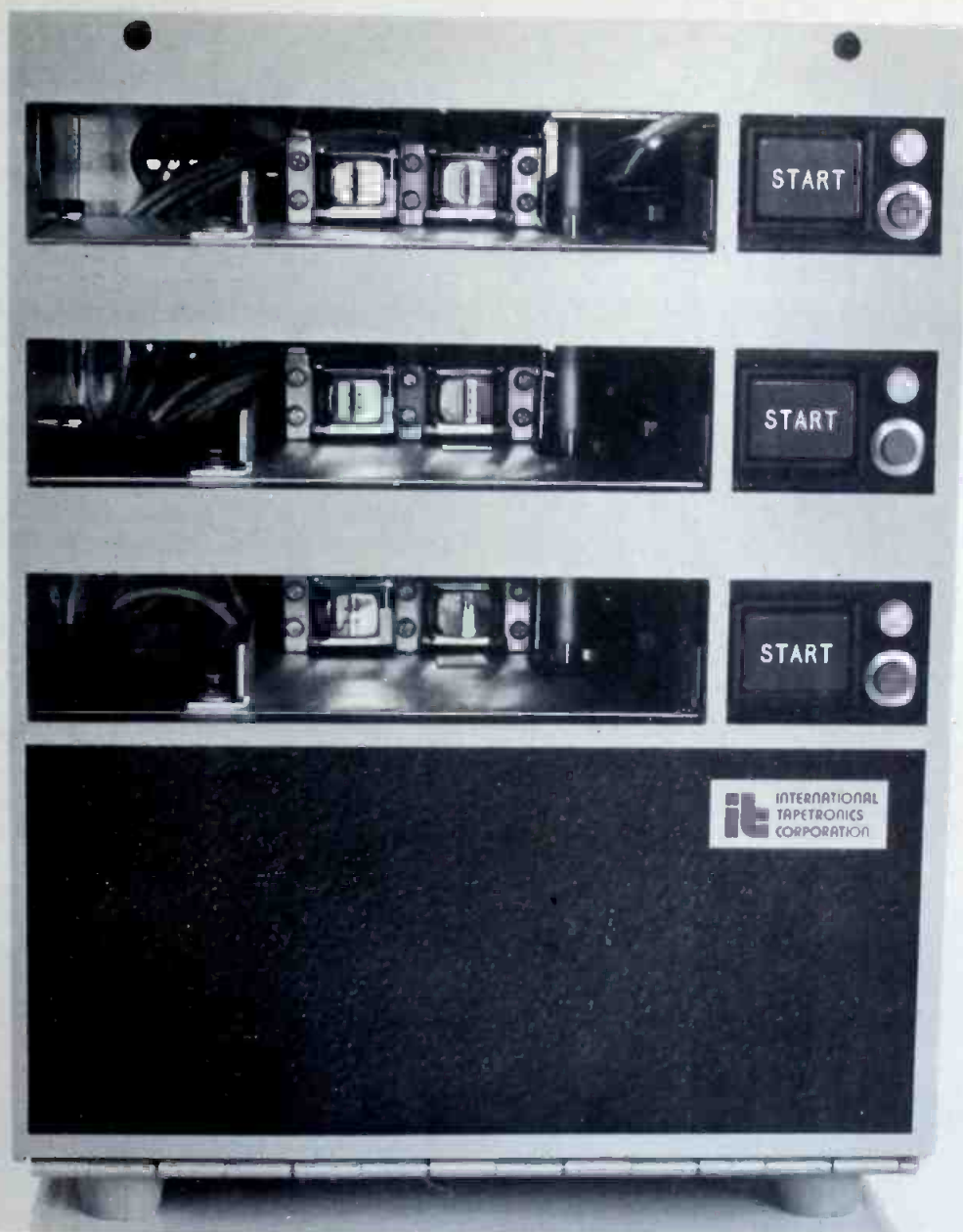
$$Kf(\theta) \sqrt{\left[ \frac{1+M_2^2}{2M_2} + \cos(\psi_2 + S \cos \theta \cos \phi) \right]} \times$$

$$\left[ \frac{1+M_3^2}{2M_3} + \cos(\psi_3 + S \cos \theta \cos \phi) \right]$$

continued on page 6



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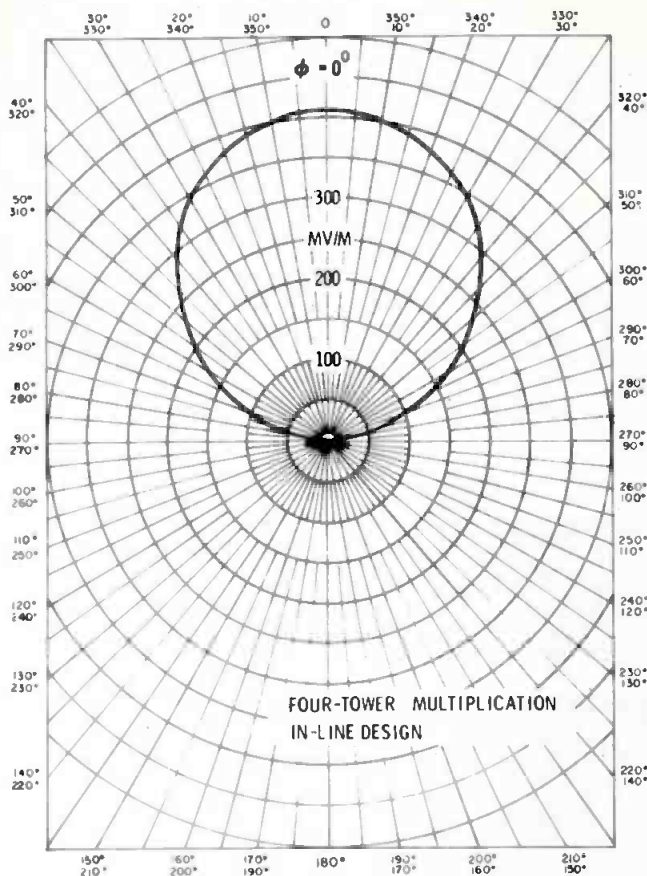


Figure 6

## Antenna basics

continued from page 60

### Four-tower multiplication in-line

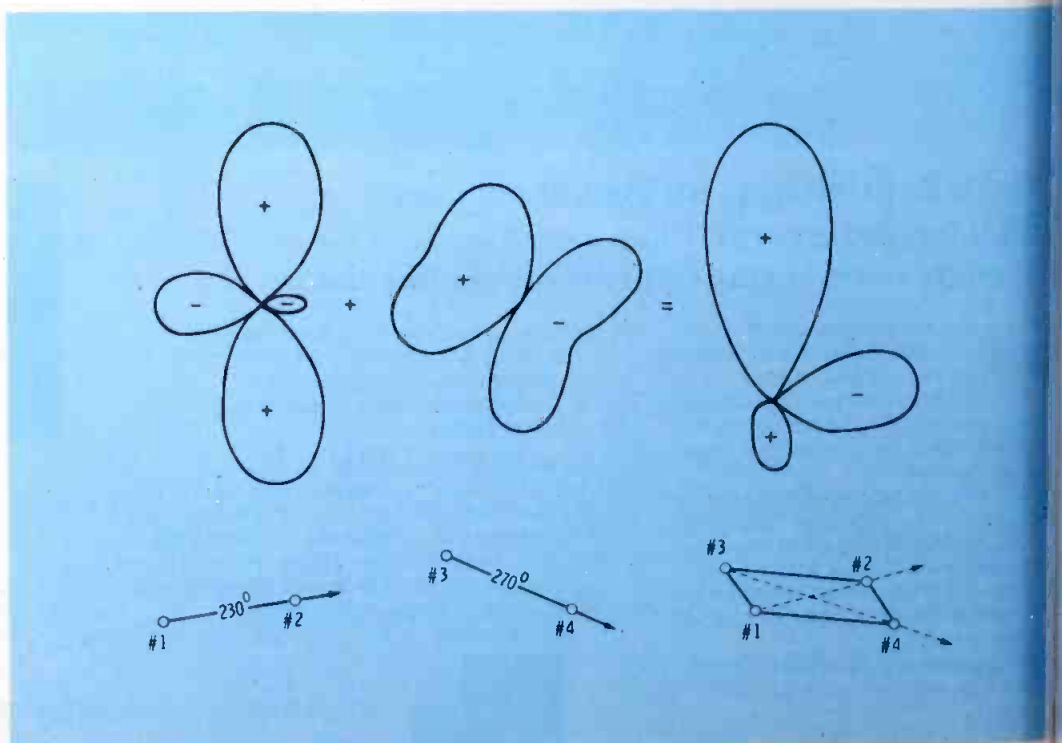
Equation 3, above, shows the formula to be used. For an example I've taken Figure 4 of Chapter 4 and added one more two-tower design value, having null  $155^\circ$  True. This will produce three pairs of nulls in the final pattern (shown in Figure 3). The end result is that both sides as well as the rear arc of the pattern are well suppressed. All useful energy is directed into the major lobe.

Figure 5, at the bottom, sets forth the method by which the design engineer determines the final operating current ratios and phase angles of each individual tower. In this method the letter E represents the "design" values of each of the pairs that go to make up the final four-tower pattern.  $F_1$  is assumed to be equal to 1.00 with an angle of  $0^\circ$ .

As a final thought I'll show how separate two-tower designs can be added together at about mid-point. WTAC's pattern represents one designed by this approach. Figure 7 shows the two individual shapes with assigned values of (+) and (-) for the respective lobes. Keep in mind that wherever lobes have equal signs the respective magnitudes add, and where opposite, they subtract. At any bearing where the

continued on page 61

Figure 7



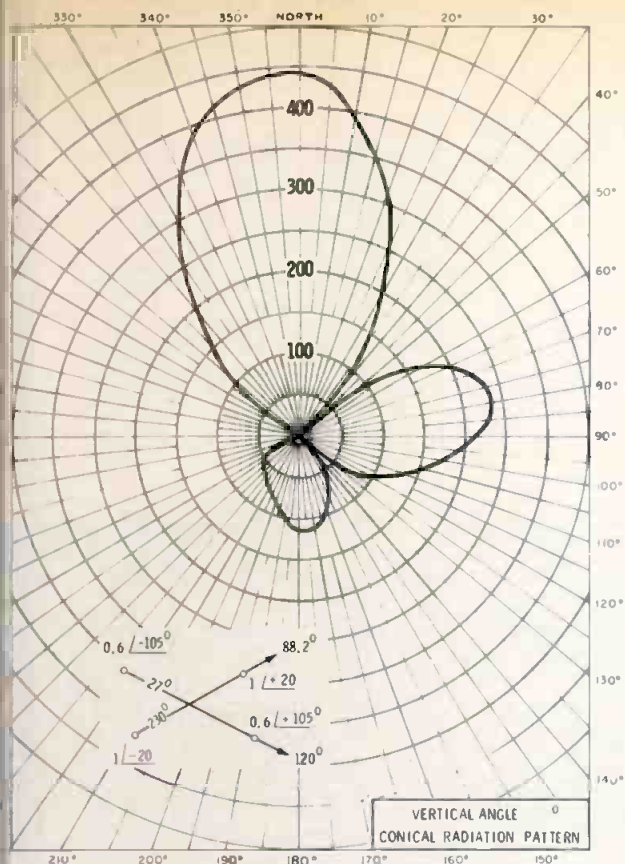


Figure 8

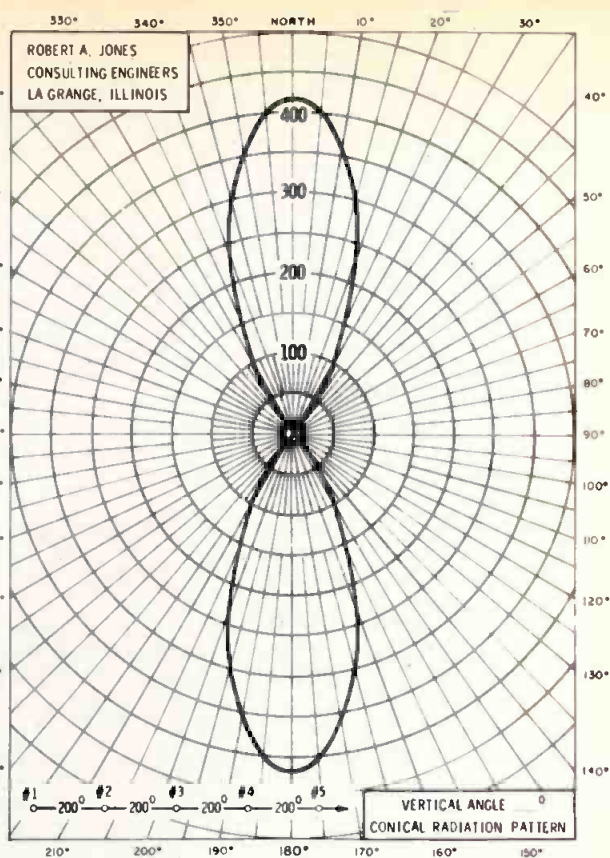


Figure 9

TABLE 3  
FOUR-TOWER MULTIPLICATION  
METHOD, IN-LINE

$$E = K f(\theta) \left[ \left( \frac{1 + M_2^2}{2M_2} + \cos(\psi_2 + S \cos \theta \cos \Theta) \right) x \right. \\ \left. \left( \frac{1 + M_3^2}{2M_3} + \cos(\psi_3 + S \cos \theta \cos \Theta) \right) x \right. \\ \left. \left( \frac{1 + M_4^2}{2M_4} + \cos(\psi_4 + S \cos \theta \cos \Theta) \right) \right]^{1/2}$$

| A        | B        | C       | D     | E      | F    | G         | H     | I      | J     | K     | L      | M                | N     |
|----------|----------|---------|-------|--------|------|-----------|-------|--------|-------|-------|--------|------------------|-------|
| $\theta$ | 90 cos A | B-116.4 | cos C | 1 + D  | A-90 | 200 cos F | 1 + G | B-98.4 | cos I | 1 + J | E+H+K  | L <sup>1/2</sup> | MV/M  |
| 0        | 90.0     | -26.4   | .896  | 1.000  | -90  | 0.0       | 1.896 | -8.4   | .989  | 1.989 | 3.7710 | 1.9420           | 408.0 |
| 10       | 88.6     | -27.8   | .885  | .976   | -100 | -34.7     | 1.885 | -9.8   | .985  | 1.985 | 3.6510 | 1.9110           | 401.0 |
| 20       | 84.5     | -31.9   | .849  | .904   | -110 | -68.4     | 1.849 | -13.9  | .970  | 1.970 | 3.2930 | 1.8140           | 381.0 |
| 30       | 77.9     | -38.5   | .783  | .791   | -120 | -100.0    | 1.783 | -20.5  | .937  | 1.937 | 2.7320 | 1.6530           | 347.0 |
| 40       | 68.9     | -49.5   | .649  | .641   | -130 | -128.5    | 1.649 | -29.5  | .870  | 1.870 | 1.9770 | 1.4060           | 295.0 |
| 50       | 57.8     | -58.6   | .521  | .467   | -140 | -153.2    | 1.521 | -40.6  | .759  | 1.759 | 1.2490 | 1.1170           | 235.0 |
| 60       | 45.0     | -71.4   | .319  | .293   | -150 | -173.2    | 1.319 | -53.4  | .596  | 1.596 | .6160  | .7850            | 165.0 |
| 70       | 30.8     | -85.6   | .077  | .141   | -160 | -187.9    | 1.077 | -67.6  | .381  | 1.381 | .2090  | .4580            | 96.2  |
| 80       | 15.6     | -100.8  | -.187 | .037   | -170 | -196.9    | .813  | -82.8  | .125  | 1.125 | .0340  | .1840            | 38.6  |
| 90       | 0.0      | -116.4  | -.445 | 0.000  | -180 | -200.0    | .555  | -98.4  | -.146 | .854  | 0.0000 | 0.0000           | 0.0   |
| 100      | -15.6    | -132.0  | -.669 | -.037  | -190 | -196.9    | .331  | -114.0 | -.407 | .593  | .0070  | .0850            | 17.8  |
| 110      | -30.8    | -147.2  | -.841 | -.141  | -200 | -187.9    | .159  | -129.2 | -.632 | .368  | .0080  | .0910            | 19.1  |
| 120      | -45.0    | -161.4  | -.948 | -.293  | -210 | -173.2    | .052  | -143.4 | -.803 | .197  | .0030  | .0550            | 11.5  |
| 130      | -57.8    | -174.2  | -.995 | -.467  | -220 | -153.2    | .005  | -156.2 | -.915 | .085  | .0002  | .0140            | 3.0   |
| 140      | -68.9    | -185.3  | -.996 | -.641  | -230 | -128.5    | .004  | -167.3 | -.975 | .024  | .....  | 0.0078           | 0.0   |
| 150      | -77.9    | -194.3  | -.969 | -.791  | -240 | -100.0    | .031  | -176.3 | -.998 | .002  | .....  | 0.0070           | 0.0   |
| 160      | -84.5    | -200.9  | -.934 | -.904  | -250 | -68.4     | .066  | -182.9 | -.998 | .002  | .0001  | .0110            | 2.3   |
| 170      | -88.6    | -205.0  | -.906 | -.976  | -260 | -34.7     | .094  | -187.0 | -.993 | .007  | .0006  | .0250            | 5.3   |
| 180      | -90.0    | -206.4  | -.896 | -1.000 | -270 | 0.0       | .104  | -188.4 | -.989 | .011  | .0011  | .0330            | 6.9   |

K = 210, S = 196

## Antenna basics

continued from page 62

TABLE 4  
FOUR-TOWER PARALLELOGRAM BY ADDITION

$$E = Kf(\Theta) \left[ \cos\left(\frac{\Psi_1}{2} + \frac{S_1}{2} \cos \Theta \cos \phi\right) + M \cos\left(\frac{\Psi_2}{2} + \frac{S_2}{2} \cos \Theta \cos \phi\right) \right]$$

Where  $\Psi_1 = -20^\circ$ ,  $S_1 = 230^\circ$ ,  $M = 0.7$ ,  $\Psi_2 = 105^\circ$ ,  $S_2 = 270^\circ$

| A      | B         | C       | D     | D           | F         | G     | H       | I     | J     | L              |
|--------|-----------|---------|-------|-------------|-----------|-------|---------|-------|-------|----------------|
| $\phi$ | 115 cos A | B-10    | cos C | $\phi-3.18$ | 135 cos E | F+105 | 7 cos G | D+H   | $I^2$ | K <sub>W</sub> |
| 0      | 115.00    | 105.00  | -.259 | -31.8       | 114.7     | 219.7 | -.461   | -.720 | .518  | 214.4          |
| 10     | 113.25    | 103.30  | -.230 | -21.8       | 125.3     | 230.3 | -.383   | -.613 | .376  | 182.6          |
| 20     | 108.00    | 98.00   | -.139 | -11.8       | 132.2     | 237.2 | -.326   | -.465 | .216  | 138.5          |
| 30     | 99.60     | 89.60   | .007  | -1.8        | 134.9     | 239.9 | -.301   | -.294 | .086  | 87.6           |
| 40     | 88.10     | 78.10   | .206  | 8.2         | 133.6     | 238.6 | -.313   | -.107 | .011  | 31.9           |
| 50     | 73.90     | 63.90   | .440  | 18.2        | 128.2     | 233.2 | -.359   | .081  | .007  | 24.1           |
| 60     | 57.50     | 47.50   | .676  | 28.2        | 118.9     | 223.9 | -.432   | .244  | .060  | 72.7           |
| 70     | 39.30     | 29.20   | .873  | 38.2        | 106.1     | 211.1 | -.513   | .360  | .130  | 107.2          |
| 80     | 19.90     | 9.90    | .985  | 48.2        | 89.9      | 194.9 | -.579   | .406  | .165  | 120.9          |
| 90     | 0.00      | -10.00  | .985  | 58.2        | 71.1      | 176.1 | -.598   | .387  | .472  | 115.2          |
| 100    | 19.90     | -29.90  | .866  | 68.2        | 50.1      | 155.1 | -.544   | .322  | .104  | 95.9           |
| 110    | -39.20    | -49.30  | .652  | 78.2        | 27.6      | 132.6 | -.406   | .246  | .061  | 73.2           |
| 120    | -57.50    | -67.50  | .383  | 88.2        | 4.2       | 109.2 | -.198   | .185  | .034  | 53.1           |
| 130    | -73.90    | -83.90  | .106  | 98.2        | -19.3     | 85.7  | .045    | .151  | .023  | 44.9           |
| 140    | -88.10    | -98.10  | -.141 | 108.2       | -42.1     | 62.8  | .274    | .133  | .018  | 39.6           |
| 150    | -99.60    | -109.60 | -.335 | 118.2       | -63.8     | 41.2  | .452    | .117  | .014  | 34.8           |
| 160    | -108.00   | -118.00 | -.470 | 128.2       | -83.5     | 21.5  | .558    | .088  | .008  | 26.2           |
| 170    | -113.25   | -123.25 | -.548 | 138.2       | -100.6    | 4.4   | .598    | .050  | .003  | 14.9           |
| 180    | -115.00   | -125.00 | -.574 | 148.2       | -114.7    | -9.7  | .591    | .017  | .000  | 5.1            |
| 190    | -113.25   | -123.25 | -.548 | 158.2       | -125.3    | -20.3 | .562    | .014  | .000  | 4.2            |
| 200    | -108.00   | -118.00 | -.470 | 168.2       | -132.1    | -27.1 | .534    | .064  | .004  | 19.0           |
| 210    | -99.60    | -109.60 | -.335 | 178.2       | -134.9    | -29.9 | .520    | .185  | .034  | 55.1           |
| 220    | -88.10    | -98.10  | -.141 | -171.8      | -133.6    | -28.6 | .526    | .385  | .148  | 114.6          |
| 230    | -73.90    | -83.90  | .106  | 161.8       | -128.2    | -23.2 | .551    | .657  | .432  | 195.6          |
| 240    | -57.50    | -67.50  | .383  | 151.8       | -118.9    | -13.9 | .583    | .966  | .933  | 287.7          |
| 250    | -39.20    | -49.30  | .652  | 141.8       | -106.1    | -1.1  | .600    | 1.252 | 1.568 | 372.7          |
| 260    | -19.90    | -29.90  | .866  | 131.8       | -89.9     | 15.1  | .579    | 1.445 | 2.088 | 430.3          |
| 270    | 0.00      | -10.00  | .985  | 121.8       | -71.1     | 33.9  | .498    | 1.483 | 2.199 | 441.6          |
| 280    | 19.90     | -9.90   | .985  | 111.8       | -50.1     | 54.9  | .345    | 1.320 | 1.742 | 393.0          |
| 290    | 39.20     | 29.20   | .873  | 101.8       | -27.6     | 77.4  | .131    | 1.004 | 1.008 | 309.7          |
| 300    | 57.50     | 47.50   | .676  | 91.8        | -4.2      | 100.8 | -.112   | .564  | .318  | 167.9          |
| 310    | 73.90     | 63.90   | .440  | 81.8        | 19.3      | 124.3 | -.342   | .098  | .010  | 29.2           |
| 320    | 88.10     | 78.10   | .206  | 71.8        | 42.1      | 147.1 | -.504   | -.298 | .089  | 88.7           |
| 330    | 99.60     | 89.60   | .007  | 61.8        | 63.8      | 168.8 | -.589   | -.582 | .339  | 173.3          |
| 340    | 108.00    | 98.00   | -.139 | 51.8        | 83.5      | 188.5 | -.593   | -.732 | .536  | 217.9          |
| 350    | 113.25    | 103.25  | -.230 | 41.8        | 100.6     | 205.6 | -.541   | -.771 | .594  | 229.6          |

14.897

$$K = \frac{191.5 \text{ MV/M}}{\sqrt{\frac{14.897}{36}}} = 297.8$$

**TABLE 5**  
**FOUR-TOWER FIGURE EIGHT**

Formula:

$$E = Kf(\Theta) \left[ \left( \frac{1 + M_1^2}{2M_1} + \cos(\Psi_1 + S \cos \Theta \cos \emptyset) \right) \times \right. \\ \left. \left( \frac{1 + M_2^2}{2M_2} + \cos(\Psi_2 + S \cos \Theta \cos \emptyset) \right) \times \right. \\ \left. \left( \frac{1 + M_3^2}{2M_3} + \cos(\Psi_3 + S \cos \Theta \cos \emptyset) \right) \right]^{1/2}$$

Assumptions:

$$M_1 = M_2 = M_3 = 1.0, \Psi_1 = +7^\circ, \Psi_2 = -7^\circ, \Psi_3 = 0^\circ, S = 200^\circ, f(\Theta) = 1.0, \Theta = 0^\circ$$

| A           | B         | C      | D        | E      | F        | G        | H      | I     | L        |
|-------------|-----------|--------|----------|--------|----------|----------|--------|-------|----------|
| $\emptyset$ | 200 cos A | B+7    | 1+ cos C | B-7    | 1+ cos E | 1+ cos B | D•F•G  | H     | K•I      |
| 0           | 200.0     | 207.0  | 0.109    | 193.0  | 0.026    | .060     | 0.000  | 0.000 | 0.0 MV/M |
| 10          | 196.9     | 203.9  | 0.086    | 189.9  | 0.015    | .043     | 0.000  | 0.000 | 0.0      |
| 20          | 187.9     | 194.9  | 0.034    | 180.9  | 0.001    | .009     | 0.000  | 0.000 | 0.0      |
| 30          | 173.3     | 180.3  | 0.000    | 166.3  | 0.028    | .007     | 0.000  | 0.000 | 0.0      |
| 40          | 153.2     | 160.2  | 0.059    | 146.2  | 0.169    | .107     | .001   | .033  | 4.9      |
| 50          | 128.5     | 135.5  | 0.287    | 121.5  | 0.478    | .377     | .052   | .227  | 33.8     |
| 60          | 100.0     | 107.0  | 0.708    | 93.0   | 0.948    | .826     | .554   | .744  | 110.9    |
| 70          | 68.4      | 75.4   | 1.252    | 61.4   | 1.478    | 1.368    | 2.530  | 1.591 | 237.2    |
| 80          | 34.7      | 41.7   | 1.747    | 27.7   | 1.885    | 1.822    | 6.000  | 2.449 | 365.1    |
| 90          | 0.0       | 7.0    | 1.993    | -7.0   | 1.993    | 2.000    | 7.944  | 2.818 | 420.3    |
| 100         | -34.7     | -27.7  | 1.885    | -41.7  | 1.747    | 1.822    | 6.000  | 2.449 | 365.1    |
| 110         | -68.4     | -61.4  | 1.478    | -75.4  | 1.252    | 1.368    | 2.530  | 1.591 | 237.2    |
| 120         | -100.0    | -93.0  | 0.948    | -107.0 | .708     | .826     | .554   | .744  | 110.9    |
| 130         | -128.5    | -121.5 | 0.478    | -135.5 | .287     | .377     | .052   | .227  | 33.8     |
| 140         | -153.2    | -146.2 | .169     | -160.2 | .059     | .107     | .001   | .033  | 4.9      |
| 150         | -173.3    | -166.3 | .028     | -180.3 | 0.000    | .007     | 0.000  | 0.000 | 0.0      |
| 160         | -187.9    | -180.9 | 0.001    | -194.9 | 0.034    | .009     | 0.000  | 0.000 | 0.0      |
| 170         | -196.9    | -189.9 | .015     | -203.9 | 0.086    | .043     | 0.000  | 0.000 | 0.0      |
| 180         | -200.0    | -193.0 | .026     | -207.0 | .109     | .060     | 0.000  | 0.000 | 0.0      |
|             |           |        |          |        |          |          | 26.216 |       |          |
|             |           |        |          |        |          |          | x 2    |       |          |
|             |           |        |          |        |          |          | 52.432 |       |          |

$$K = \sqrt{\frac{180}{52.432}} = 149.1$$

magnitudes are of opposite sign and equal in magnitude, the final pattern will contain a null. For example, at 47° and 122° are nulls in the final pattern. Figure 8 is a polar plot of the final pattern, with the calculations shown in Table 4.

As a comparison of the degree of major lobe gain I have taken the basic figure eight patterns of Chapter 2 (two-towers) and added a fourth tower to produce the design shown in Figure 9.

Table 5 is the step-by-step computation used to calculate this design. Forward gain is achieved by opening the arc of the pattern minima. Or, in other words, by narrowing the beam. The top of the major lobe has been increased from 304.9 to 381.6 MV/M

to 420.3 MV/M. From a two-tower to a four-tower you have gained:

$$\frac{420.3 \text{ MV/M}}{304.9 \text{ MV/M}}$$

Or a ratio of 1.378. This relates to an equivalent power increase of 1.900 times.

If it is assumed that the two-tower pattern had 1 kW of power, this would require increasing the transmitter power into the two-tower to 1.90 kW in order to equal the 1 kW signal you would get off the tip of the four-tower pattern. Thus doubling the number of tower almost doubles the effective power. □

# BROADCASTING IN PARADISE: On the air from the Grand Bahamas

George Ferguson (standing), ZNS-3 chief engineer, keeps a vigilant eye on Kirk Russel, morning man and production manager.

By Dennis Ciapura

While many engineers spend lazy summer weekends mentally transporting their spirits to the sandy shores and soft breezes of some remote Caribbean island, there is at least one engineer whose daily routine is that fantasy come true. His name is George Ferguson and his island lies about 100 miles east of South Florida in the Bahamas. He is the chief engineer at ZNS-3 in Freeport on Grand Bahama Island.

Although you could spend days walking the miles of Grand Bahamas' secluded beaches, just watching the blue ocean curl ashore, the spell is easily broken if you travel inland. You'd find the bustling town of Freeport with its luxurious hotels, casino, and International Bazaar. And right in the middle of it all is ZNS-3, or ZETA-NESH-THREE, as many of the island residents call it.

Despite the relaxed atmosphere of Grand Bahama, ZNS-3 is as busy a radio station as any of its mainland cousins. To better understand how and why the station operates, let's first take a look at how the station came to be located in Freeport to begin with.

When the Bahamas received its independence from Great Britain in 1973, the authorities decided to establish a northern service of radio Bahamas on Grand Bahama Island. Work on the station began at a feverish pace in order to have the facility ready to go on the air for the Independence Day celebration. The station was to start out as a modest installation with plans to improve in the future, not unlike the birth and childhood of most U.S. stations which have gone through a series of modifications.

A 1,000-watt Harris transmitter was located in a trailer similar to the ones used for construction offices, and a center-fed horizontal dipole antenna was erected. While this installation was designed to be a temporary facility that could easily be upgraded and relocated later, it was built well enough to serve the island community for a number of years. It's still on the air in that form today, although plans for a new 5 kW station and a conventional vertical antenna system are being considered.

ZNS-3 operates on a frequency of 810 kHz and covers the island fairly well, considering the relatively low power and the length of the island (which is in excess of 100 miles). The studios are located in an office complex in downtown Freeport, with Telco links to the transmitter on the edge of town. Incidentally, for those readers who enjoy working with telephone companies, Ferguson has two Telco outfits to deal

*continued on page 68*



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## Grand Bahamas

continued from page 66

with: one local telephone company in Freeport and one national telephone service.

### The only game in town

The station is on the air 24 hours a day. Since it's the island's only local broadcast facility, its operation is extremely important to the people of Grand Bahama. The only other signals received are radio and TV stations from South Florida which, of course, do not relate at all to the broadcast needs of the Bahamians.

While ZNS-3 was set up by the government and certain amount of funding comes from the government, the station sells commercials on a regular basis to local merchants in an effort to become economically self-sufficient. As a matter of fact, a staff arrangement at ZNS-3 is almost identical to the typical commercial stations in the U.S. There is a well-organized traffic and billing department in addition to the usual programming and engineering functions.

Since at one time or another almost all of Freeport's nearly 26,000 residents listen to the station (remember it's the only local game in town), a commercial on ZNS-3 is a pretty good advertising buy and the station seems to be doing quite well. Eventually, the studio and offices will also be relocated, but even the present setup (except for the antenna) is very similar to many small-market stations on the mainland.

The audio consoles and cart equipment are modern Harris solid-state units; Ampex tape decks are used for production duty. One of the station's biggest assets, however, is George Ferguson. Aside from being a very capable and experienced broadcast engineer, he is a good public relations representative for a station whose easy manner helps visitors feel comfortably impressed.

From 6 a.m. until 6:30 p.m., the station is locally programmed, featuring as much native Bahamian music as possible in a mix with popular U.S. titles. In this way, the station's programming is able to relate to the resident community while competing with the mainland stations for the tourists' attention. The balance of the around-the-clock programming comes from Nassau via the national telephone company to a point called 8 Mile Rock, east of Freeport. It is relayed from there by STL in the 160 MHz band to the station in Freeport.

### Problems in paradise

As you might expect, an island located out in the Atlantic Ocean can experience some incredibly violent weather. ZNS-3 is subject to the occasional wrath of nature that is the bane of broadcast engineers working in the tropics. Although no unusual maintenance problems exist at the station, when equipment does break down, repair is not always a simple matter because most replacement parts must come from the U.S. It's important to know just what to keep in stock. However, Ferguson reports that the equipment manufacturers have been very cooperative, keeping real problems to a minimum.

As you can see, while George Ferguson does have the opportunity to spend his days enjoying the pleasures of an island paradise (that we are left only to dream about), it is not quite the vacation it might first appear to be. Like the rest of us, Ferguson handles all the usual operation and maintenance problems that come with broadcast facilities, no matter where they're located...even in paradise.

# Q & RA or...

## Don't fly by the seat of your pants

---

By Raymond Miller  
Chief Engineer,  
KGWA, Enid, Oklahoma

---

Well, first of all what's Q & RA? It's a system to straighten out the mess you run in circles, scream, and yell" about. It's a technique that results when equipment "goes to fail" before maintenance and operators "fly by the seat of their pants" until chaos sets in.

So what does it mean, Q & RA, what is it? Quality and reliability assurance. I know, you've heard of it in big industrial applications, the military, assembly lines, etc., and it won't work in your station. You're right, it won't if you follow all the industrial ideas of application. The principle is good though, so modify it to fit the operation. We tried it in our thousand-watter, and after a couple of years it has made a real improvement. If you think you'd like to give it a whack, here goes.

The first thing to deal with is people, you and the boss. Everyone

must accept the idea of squawking the faults whether it is equipment, operators or managers that failed. That's easy. The hard part is that every individual must accept the fact that he can get written up for a mistake too. The equipment's defense mechanism is "the pervisity of inanimate objects" while people's defense mechanism is "excuses and rationalization." The former is fixed by parts replacement. The latter may be fixed with communication and understanding.

The other facet is that Q & RA applies to every function of broadcasting that directly affects air time. It starts in quality in hiring and ends at the emission of the antenna.

### Quality control

So let's talk about quality control (QC) now that everyone is willing to be a radio inspector (RI) as well as whatever hat or hats they have been wearing. Quality in job accomplishment is controlled by a system of defining the best way to do it. Too often this is verbal and

always changing in its basic form. Solve it with a set of **standard operating procedures (SOP)** for those jobs that are repetitive and on-going. Remember to write in a procedure plan to solve the special unexpected situations. SOPs for operator responsibility, operating log, maintenance log, remote control operation, operating parameters, preventive maintenance safety, license posting, equipment inventory, emergency program transmission, quality control (see Figure 1) to interpret FCC rules and define managerial expectations are vital to a healthy quality control application.

### Training goes a long way

Training is essential and the SOPs are fine but 100 to 1 says someone will read something into or out of them that you, in your wildest imagination, did not expect. So, from the provisional to the old timer, you have to get eyeball communication about how your station works and what the SOP is trying to

*continued on page 71*

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ENGINEERING

RADIO STATION  
KGWA  
STANDARD OPERATING PROCEDURE

SOP 116-15  
11 August 1976

### SUBJECT: QUALITY CONTROL

Purpose: To provide a system of inspection and correction of equipment defects.

GENERAL: The program consists of all facets of daily routines as observed by each Duty Operator, i.e. Program, Traffic, Remote Systems, Equipment and operating. This Standard Operating Procedure defines the method of Quality Control for the Engineering Department only. "KGWA Discrepancy Report" shall be used in all cases to report. (See atch #1).

ACTION: The person discovering an Equipment or Remote Systems discrepancy shall:

- Initiate "KGWA Discrepancy Report" by checking Equipment and/or Remote blanks, filling in the current date and signing (or initialing) the discovered blank.
- Annotate time and description of trouble.
- Place the Report on the Chief Engineer's desk. (During normal duty hours call it to his attention when malfunction is discovered.)

CORRECTION: The Engineering Department shall take the following actions to correct fault:

- Analyze the problem to determine troubleshoot technique.
- Troubleshoot and correct fault.
- If the trouble cannot be duplicated, enter "799" in the corrective action of "KGWA Discrepancy Report", date and initial that block.
- Should fault be found and replacement part consumed, complete the correction block and also make appropriate entry in the Historical Maintenance Record in accordance with SOP 116-6.

FILING: All "KGWA Discrepancy Report" forms, upon completion, shall be maintained in Engineering Department file number 116H-2 for a period of three years.

*Raymond L. Miller*  
Raymond L. Miller  
Chief Engineer

Atch:  
1. "KGWA Discrepancy Report" Form

Figure 1 Standard Operating Procedure.

| KGWA DISCREPANCY REPORT                     |                           |                                                                                                                    |
|---------------------------------------------|---------------------------|--------------------------------------------------------------------------------------------------------------------|
| PROGRAM _____                               | REMOTE _____              | EQUIPMENT <input checked="" type="checkbox"/>                                                                      |
| TRAFFIC _____                               |                           | OPERATING _____                                                                                                    |
| DATE: <u>13 May 74</u> DISCOVERED <u>BH</u> |                           |                                                                                                                    |
| TIME                                        | PROBLEM                   | CORRECTIVE ACTION                                                                                                  |
|                                             | <u>Sentry unit record</u> | <u>L-801 bad -</u><br><u>Temporary repair -</u><br><u>ordered check e.</u><br><u>on Order #</u><br><u>132574-1</u> |
|                                             |                           | DATE: <u>13 May 74</u> INIT <u>[Signature]</u>                                                                     |

Figure 2 Discrepancy Report.

Continued from page 69

Then get their feedback. Remember the only thing standard about broadcasting is that all are licensed—everything else is unique. Another quality control facet is operating technique. Every method of repairing requires an operator. He can act with the finesse of a broadcaster or a blacksmith. So use the time to impress on him or her the delicacy of the equipment, the value and repair costs if broken. Avil and hammer language might be to be used, but make the dent in understanding. It'll save engineering time and management money.

## The discrepancy report

Now the nuts and bolts of quality control. The discrepancy report is a central document (see Figure 2). You have to design one that is easiest for the operator to use, for engineering to show action and to fit in file system. Why have a "pink" write-up? Well, if you're like most of us, your title is chief engineer with a lot of "Hey, you" going that do not allow you to stand at the studio door waiting for an operator to show violent emotion at the failure of a piece of gear. So, the discrepancy report blanks are hanging on a clip in the studio he has put on his RI hat and write it

When you get in from the transmitter site, there it is. You've got a buck and can take care of it. Whether the operator who discovered it is still on duty or not. Don't forget to enter it on the historical maintenance record, if it's significant. At least keep it on file for whatever time period you desire. Quality control of equipment is pretty well defined now. One more thing—tell people you appreciate their help! If you get that "What, ain't" look every time a write-up shows up you'll find fewer discrepancy reports and a ration of surprises in the form of equipment breakdown call outs. On the other hand a smile and a thank you brings report of the QC system.

## Equipment reliability

Ok, what about reliability? Sure, everything wears out. But its quality whatever was designed and manufactured into it, can be exceeded. Preventive maintenance through diligent scheduled action is the heart of reliability. Start your schedule by designing a system. Three by five cards, one each month, will suffice for

listing what equipment is to be checked out on what month. Question is, how often? Most manufacturers' manuals will give you a clue as to what and how often preventive maintenance need be done. Use it.

Add other items as your own station experience dictates. Change time intervals as needed. Your usage of a particular piece of equipment may be such that more frequent maintenance action will prevent failure or, on the other hand, less usage would allow longer periods of time between performing

the scheduled inspection routines.

Initiate an equipment inspection and maintenance record (see Figure 3) for each piece of equipment that preventive maintenance is to be applied to. Decide each routine that is needed, number them as you describe them in the inspection routines column and then write in the frequency to be done after each routine. As the preventive maintenance actions are achieved enter the date, the number of the routine and initials in the space provided on the front side of the equipment

continued on page 72

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| EQUIPMENT                                  | SERIAL NO. | DATE   | INITIALS | DATE | INITIALS | DATE | INITIALS | DATE | INITIALS |
|--------------------------------------------|------------|--------|----------|------|----------|------|----------|------|----------|
| Taga Machine Type 280                      | 5605       |        |          |      |          |      |          |      |          |
| INSPECTION ROUTINES                        |            |        |          |      |          |      |          |      |          |
| 1. Clean Hubs, rollers and deming (weekly) |            | Mar 18 | 12       |      |          |      |          |      |          |
|                                            |            | Nov 14 | 12       |      |          |      |          |      |          |
| 2. Lube Capstan (Quarterly)                |            | Feb 15 | 12       |      |          |      |          |      |          |
| 3. Frequency Response (Annual)             |            | Apr 15 | 12       |      |          |      |          |      |          |
|                                            |            | Aug 15 | 12       |      |          |      |          |      |          |
|                                            |            | Nov 15 | 12       |      |          |      |          |      |          |
|                                            |            | Feb 16 | 12       |      |          |      |          |      |          |
|                                            |            | Apr 16 | 12       |      |          |      |          |      |          |
|                                            |            | Nov 16 | 12       |      |          |      |          |      |          |
|                                            |            | Feb 17 | 12       |      |          |      |          |      |          |
|                                            |            | Apr 17 | 12       |      |          |      |          |      |          |
|                                            |            | Nov 17 | 12       |      |          |      |          |      |          |
|                                            |            | Feb 18 | 12       |      |          |      |          |      |          |

Figure 3 Inspection/Maintenance Record.

| DATE ENTERED | ENTERED BY | DISCREPANCY                | NUMBER   | CORRECTIVE ACTION                        | DATE CORRECTED | CORRECTED BY |
|--------------|------------|----------------------------|----------|------------------------------------------|----------------|--------------|
| 15 APR 1973  | Kaplan     | Receivers                  | —        | Installed                                | 15 APR 1973    | Kaplan       |
| 20 APR 1973  | Kaplan     | Recept. Hot                | —        | Installed Attenuator                     | 20 APR 1973    | Kaplan       |
| 13 MAY 1974  | Kaplan     | Won't Record               | 13054-1  | Exchanged Amp. and Recept. — Ordered VHS | 13 MAY 1974    | Kaplan       |
| 17 MAY 1974  | Kaplan     | Blue Frame Failed          | —        | 702 (1st component) — Soldered           | 17 MAY 1974    | Kaplan       |
| 24 MAY 1974  | Kaplan     | Lead cable # 13-530-1      | —        | Exchanged Amp. and Recept. — Soldered    | 24 MAY 1974    | Kaplan       |
| 24 MAY 1974  | Kaplan     | Speed Sensor               | —        | Replaced with                            | 24 MAY 1974    | Kaplan       |
| 24 MAY 1974  | Kaplan     | — 20db hum                 | —        | Replaced C-201 in P10                    | 24 MAY 1974    | Kaplan       |
| 20 MAY 1974  | Kaplan     | H. Crew roll-off 5th       | —        | Relabeled Head                           | 20 MAY 1974    | Kaplan       |
| 11 MAY 1974  | Kaplan     | Video (mechanical) in Pack | 128517-1 | Replaced Pack                            | 20 MAY 1974    | Kaplan       |

Figure 4 Maintenance Record

## Q & RA

continued from page 71

inspection and maintenance record.

Now remember those discrepancy reports that the operators have been handing you? Ok, turn the equipment inspection and maintenance record over (see Figure 4). That maintenance record is where you are going to find many interesting things. Things like pinch wheel life, trouble cures that the manufacturer never mentions in the troubleshooting charts, how often like troubles occur that you never thought of putting on the preventive maintenance schedule, and many others.

A word of caution. This composite maintenance record does not take

the place of the official maintenance log. The maintenance record is better engineering management tool simply because all the troubles and cures are documented in one place for the life of the equipment instead of strung throughout the official maintenance logs.

Quality and reliability techniques are taken care of but what about assurance? Well, don't sit back and wait! The only way it'll come is by devotion to reporting discrepancies, fanatical adherence to the PM schedules and good engineering practices on every installation, repair or replacement action. The one day, when assurance comes you realize you are not hearing the dreaded phrase "Due to technical difficulties..."

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# Studio construction

# PRELIMINARY PLANNING

Part 1/by Peter Burk

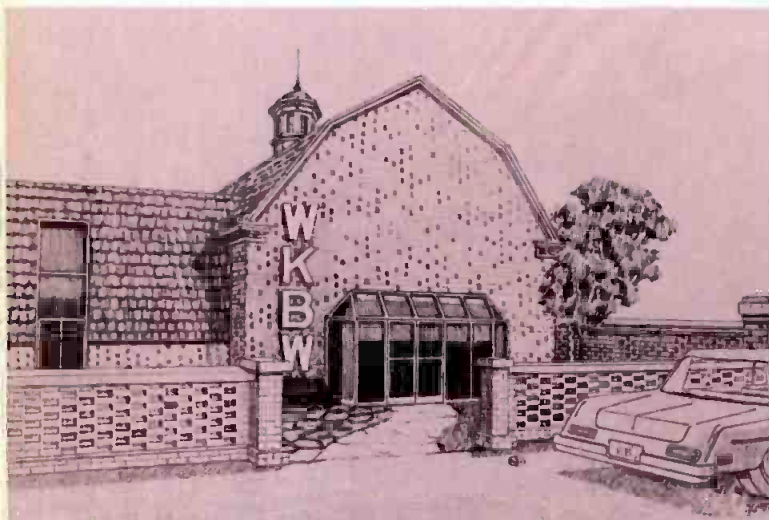


Figure 1 New studios for WKBW, Buffalo, are being constructed in this turn-of-the-century carriage house. The addition on the left and the entire inside of the structure are totally new construction, with the flavor of wood and old brick retained to tie the building together with its surroundings in an historically significant neighborhood.

One of the nicest challenges facing a broadcast engineer is the opportunity to construct new facilities. Unlike many of our responsibilities, building new studios is a tangible and highly visible achievement.

Ten years from now, no one will say "Remember how station WWII sounded in 1978?" But ten or even twenty years from now, the person responsible for the technical installation of new facilities will be remembered, one way or another.

For the next few months, **Radio Workshop** will focus on modern broadcast studio construction. If you've got a building project coming up in the future, or even a minor remodeling project at your station, stay with us. We'll try to make it easier for you to be remembered in the right way.

## WKBW Studios

Throughout this series, we'll use the new WKBW studios in Buffalo, New York (Figure 1), to illustrate some of the techniques discussed in the **Workshop**. This facility is presently under construction, and provides a convenient example of one approach to modern broadcast facilities. Every station has a slightly different method of operation, so it's not likely that the same approach would work for your station. How-

ever, you may find some of the basic ideas useful in planning your new facility.

## Choosing a site

As in most things, choosing the best location for a radio station is loaded with compromise. Some of the general considerations are the same as for any other type of service business: adequate floor space, sufficient parking, compatible neighborhood, proximity to the business community, cost of real estate.

Some special technical considerations must also be entered into the formula:

Is the proposed site in the flight path of an airport? If low flying jet aircraft will pass overhead frequently, special acoustical construction will be required.

Is the site next to a busy thoroughfare or railroad? Again, consider the amount of acoustical treatment necessary to keep the noise and vibration out of the studios.

Is the power source for the area reliable? It's a fact of life that the utilities provide more reliable service in some areas than others. Find out as much as you can from the utility. If your site is at the end of a long above-ground feed or, for some other reason, is less than ideal, you'll have to consider the additional cost (and space requirements) of an auxiliary generator and voltage regulators.

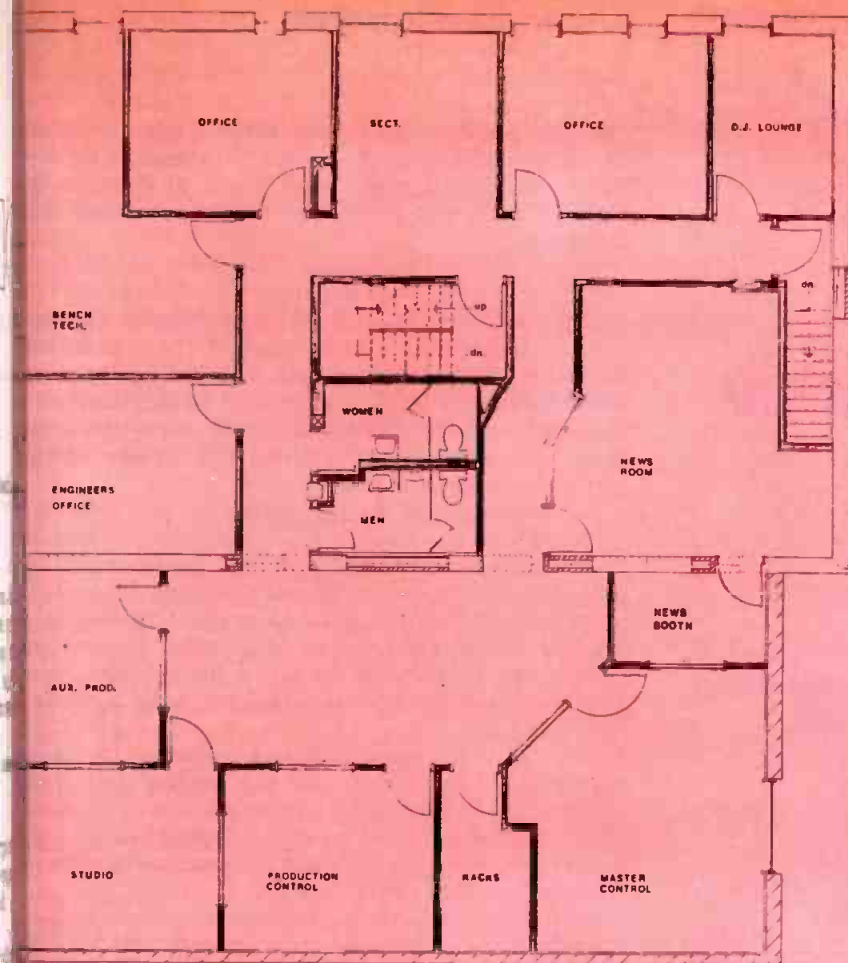
Do you have line-of-sight from the studio site to the transmitter? If your transmitter is located some distance away, having a microwave shot from the studio can be quite important, especially if you're building stereo facilities. Also consider suitability for remote pickup antennas if you're into RENG.

## Sharing

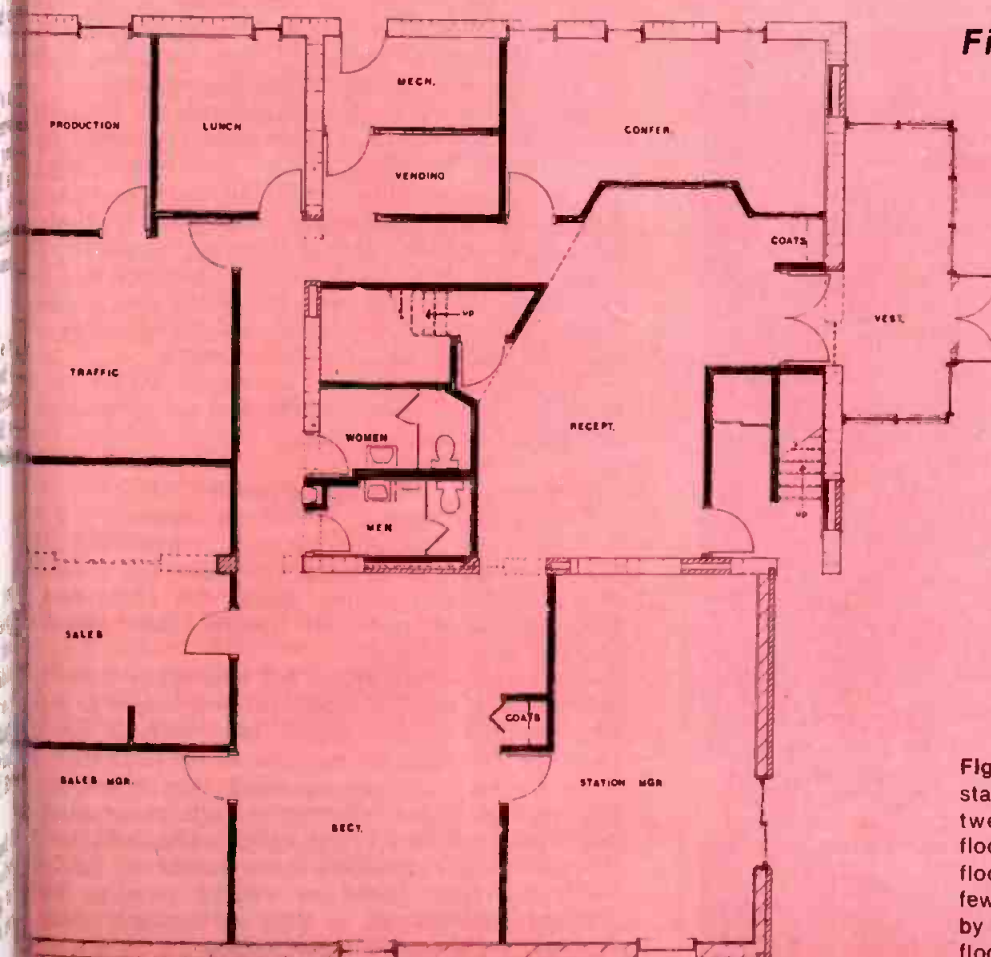
If you're considering an office building (or an building shared with other tenants), there are some additional points to consider. Make sure that the tenants adjacent to your space are compatible with your operation. A medical clinic, for instance, might produce unwanted RF radiation from older diathermy equipment. (A clause in the lease stipulating that other tenants comply with Part 15 of the FCC Rules is a good general precaution.)

In one case, an FM studio was constructed in an office building with a health spa immediately above. It took special acoustical treatment in the ceiling to keep Mantovani free of the sound of fifty fat people running in place!

*continued on page*



**Second floor**



**First floor**

**Figure 2** Floor plans for the station show the division between business offices (first floor) and operations (second floor), compromising so that the fewest people will be affected by the stairway between the two floors.

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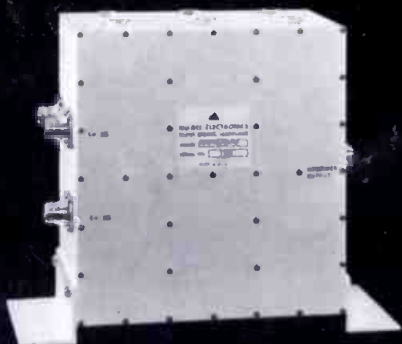
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## Studio construction

continued from page 74

Office buildings may pose several other problems. Air-conditioning probably won't be adequate (and will be too noisy) and might even be set to shut down at night. After-hours access to the building will be a necessity, too.

### Experts

Many studios are built without benefit of expert help in specialized areas. Some of them even work well. If you've got a lot of faith in your contractor, you might be able to build a successful facility without an architect or other professionals. If you'd like a little more assurance that everything will go according to plan, let the experts help.

An architect will do a lot more for you than draw up plans and specifications. In fact, the real value of his services comes during actual construction. The architect will supervise the work as it progresses, and make certain that the finished product resembles the original plans. He'll be on your side, too, when it comes time to account for all of those little changes that you thought of after the job was already in progress.

Generally, the architect can arrange to have a mechanical engineer lay out the heating and cooling system, but be careful! Frequently the ME doesn't fully understand the special considerations of a broadcast studio. In a future column, we'll show you what to look for besides hot air.

One other expert is frequently overlooked—the acoustical consultant. His services will cost less than you might think. In fact, he might save you several times his fee by helping you select a more cost-effective method of producing the desired acoustical results. He'll work closely with your architect to come up with the best cost/performance compromise.

Your architect may recommend an acoustical consultant or may even profess to be competent in the field himself, but check for yourself before you say yes. Broadcast studios aren't the same as churches and high school auditoriums. Find someone that has done small studios—they're treated differently than large concert halls. Actually, the country is full of acoustical consultants and engineers, but many of these people are skilled at industrial noise and vibration control, and not studio design.

Whether you employ an acoustical expert or not, you'll find lots of useful information on acoustics in subsequent Workshop column.

### The jigsaw puzzle

Once a site has been tentatively selected, it's time to see how the people will fit into the available space. Whether the studio is being built from the ground up or being fit into existing space, the rules are the same: **Make it work for people, then solve the mechanical problems.**

This may sound obvious, but how many times have you been in a building where the people had to put up with needless inconveniences daily because the floor plan was designed for mechanical convenience? This is not to say that you shouldn't take advantage of obvious mechanical efficiencies such as locating the men's room adjacent to the ladies' room. Just don't let the mechanical considerations dominate. An extra hundred dollars spent on copper pipe to put a drinking fountain in a more convenient place is probably a reasonable compromise.

Before you start on a floor plan, decide how much space is required for each person or task. You have to know how big the pieces are before you try to fit them into the puzzle.

Next, draw a traffic flow diagram for your operation. Connect "bubbles" that represent people or work areas with traffic lines that indicate the interaction between areas. Use variable line thicknesses to indicate the relative amount of traffic between areas. As you fit the pieces into the puzzle, your traffic flow diagram will help you make the ever present compromises in areas where the fewest people will be affected.

As you fit the rooms together, don't forget to allow for wall thickness, especially in the studio area. Acoustical construction may require some walls to be as much as twelve inches thick.

### Studio layout

A good studio plan for today's broadcaster will bear the resemblance to broadcast studios of the past generation. Frequently, automation must be incorporated, and even in a live operation the tasks are divided between people and rooms differently than in the past. In the air studio, announcers are usually running a board, answering telephones, and controlling the transmitter. In addition, room must be allowed for as many as several thousand cartridges instead of a small bin of records. In short, planning new studio layouts should be done with an open mind. One past concept that seems to reappear frequently is the idea that the studios should all be in visual contact with each other. In some cases, it's necessary, but don't get carried away. Providing good acoustical isolation is tough enough without making the walls 50 percent glass. The control room and production room, for instance, probably don't need to have visual contact. In fact in most cases, it should just be another distraction. Notice in Figure 2 that the production room and master control are separated by a rack room. This is not only convenient from a technical standpoint, it provides a natural sound barrier between the two rooms.

Sound locks are another concept left over from an earlier day. With the rushed pace of most modern stations, sound locks serve more as people obstacles than sound barriers. If your staff is typical of most, the sound lock doors would just get left propped open anyway, so why include them?

### Sizes and shapes

You probably already know how big you'd like each studio to be, but be careful about the shape of each room. You can spend many hours and dollars trying to correct the sound of a studio that was built to the wrong dimensions.

Avoid room dimensions that are nearly square. The frequency resonances are almost impossible to eliminate. Rectangular rooms are the most efficient from a utilization standpoint, but are not necessarily the best acoustically. If it's convenient to offset the floor or ceiling by ten degrees or so, the reflections will be more evenly distributed in the room.

### Coming soon

Future workshop columns will deal with acoustical treatment, equipment placement, wiring practices, heating and cooling systems. If you have a specific area you'd like to read more about, or if you'd like to share your solution to a particular problem, drop a line to the Radio Workshop editor. □

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## James Hurley elected SBE president

James E. Hurley of WTAE-TV, Pittsburgh, has been elected president of the Society of Broadcast Engineers for 1978. Hurley replaces Robert Wehrman of the Cox Broadcasting Corp., Atlanta.

Other newly elected officers include Howard Immekus, KCBS-

AM/FM, San Francisco, vice president; and James Grinnell, ABC-TV, Chicago, secretary-treasurer.

Members of the 1978 board of directors are Ron Arendall, WTHR-TV, Indianapolis; Morris Courtright, Jr., Rockwell/Collins Radio, Yuma, Az.; Steve de Satnick, KCET, Los

Angeles; P. J. Ford, WCLY-TV, Tampa, Fl.; Ralph Green, CBS Radio Network, New York; Ed Herlihy, KTLA-TV, Los Angeles; Albin F. Hillstrom, KOOL Radio-TV Inc., Phoenix; Robert Jones, consulting engineer, LaGrange, Ill.; Bill Powers, WSB-TV, Atlanta; and Ralph Thompson, Post Newsweek Stations, Washington, D.C. Ford, Hillstrom and Thompson were elected to second terms.

## NEW CHAPTERS

The society announces the addition of two new chapters to the list of active SBE chapters throughout the country.

**CHAPTER 14**—Connecticut Valley has finally become an active chapter because of the continued interest and efforts of charter member Carmine Iannucci, WTNH-TV, New Haven. He has made several attempts to get a chapter started in his area and now his long-time dream has come true. SBE is extremely proud of this kind of dedication and realizes this is the kind of member that keeps the society growing and progressing.

**CHAPTER 51**—Tri-Cities, Washington was organized under the direction of Dave Bauer, Kennewick. Bauer is another SBE member who has done an excellent job recruiting new members and organizing his group into the newest chapter.

SBE congratulates both these members for their accomplishments and is happy to have them aboard.

## CHAPTER REPORTS

### Chapter 1—Binghamton, New York

Barry Enders and Roger Williams of Tektronix spoke on digital video at the March 14 meeting, held in Owego. They discussed digital techniques and Tektronix's method of processing and measuring.

### Chapter 3—Kansas

The March 14 program, held in Wichita, was presented by chapter member Jay Zacharias of KPTS-TV and dealt with satellite earth receiving stations, such as the one recently installed at KPTS. A brief tour of the KPTS plant followed the meeting.

### Chapter 9—Phoenix, Arizona

The chapter met March 22 at Mountain Bell's studios in Phoenix. Wilbur Steinman, associate professor of engineering, Arizona State University, presented a program entitled, "Digital Electronics: Present and Future."

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#### Chapter 16—Seattle, Washington

At the March 8 meeting, Bob Letsch of the FCC presented a report on current FCC activities and introduced Bill Johnson, recently appointed director of FCC Region 5. Dave Christian, chief engineer at Pacific Lutheran University, led a discussion on radio and TV RF interference. He had some interesting observations and experiences related to increasing the power of an educational FM station from 10 watts to 40,000 watts with the transmitter located in an urban area.

#### Chapter 20—Pittsburgh, Pennsylvania

Hank Kaiser gave a report on FCC news at the March 16 meeting. In addition, Curt Gramlich, customer service engineer for AMPLEX, gave representation on the manufacture, care, and handling of audio and video magnetic tape.

#### Chapter 22—Central New York

The March 16 program was presented by Ross Kauffman, director of engineering, WCVB-TV, Boston. Kauffman is currently chairman of Chapter 11. He presented a discussion on frequency allocations, surveys, and record keeping of the data (a subject of increasing im-

portance to broadcasters as radio and television remote pick-up units proliferate). Kauffman spearheaded the frequency allocation coordination program in the Boston area.

#### Chapter 24—Madison, Wisconsin

The March 21 meeting was held at the WISC-TV transmitter. The program was an inspection of the new 18 kW Harrison transmitter and a demonstration of the surface acoustic wave filter method of vestigial sideband suppression. The SAW filter eliminates the "plumbing" commonly used for VSB attenuation.

#### Chapter 26—Chicago, Illinois

The meeting on March 30 was conducted in Lake Bluff for a program by Howard Knaack, president, Radio Aids. His subject, "It's Your Frequency—Thou Shall Not Stray," was an in-depth look at the world frequency measurement.

#### Chapter 28—Milwaukee, Wisconsin

The guest speaker at the March 21 meeting, held in the WTMJ studios, was Dennis Fraser of NEC America Inc. Fraser discussed the history of digital video and frame-store development, as well as digital video effects systems available now.

*continued on page 80*

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## SBE

continued from page 79

### Chapter 33—Southwestern Ohio

The March 9 meeting was held at WHIO Radio in Dayton. Steve Baughn, assistant chief engineer at WHIO Radio, explained and demonstrated how the Cox stations utilize the Tektronix 7L13 Analyzer to facilitate audio and transmitter adjustments, some difficult problems and how the 7L13 helped resolve them.

### Chapter 46—Baltimore, Maryland

The March 15 meeting featured a program by Dave Stuart of Kliegl. He gave a brief description of the Kliegl operation, then provided an interesting review of the new trend in lighting fixtures.

### Chapter 47—Los Angeles, California

Mike Zioli of Southern California Edison Company spoke on "The Flip Side of Your Breaker Box" at the March 15 meeting. Zioli also described the Los Angeles power distribution system and some of the "nasties" that can come down the line into your equipment.

### Chapter 48—Denver, Colorado

Dick Davis of NBS Time and Frequency Standards Lab presented a program on "Frequency Calibration Using the TV Color Subcarrier." He also explained the use of network TV programming as a frequency standard traceable to NBS.

### Chapter 49—Central Illinois

Chapter 49 met March 28 for a program presented by William Meintel, an engineer from the FCC Chicago field office. He discussed his function as a field inspector covering the entire communication field, from CB to broadcast stations. There was also a question and answer session.

### Chapter 50—Fort Collins, Colorado

Computer Image Corp. provided videotape demonstrating computer created animation at the March meeting, held at Colorado State University.

### NOTE:

Pat Satter of the national office announces that several of the new forming SBE chapters are progressing very well with their organization, and the society can expect some new active chapters in the near future. She will be happy to send information to anyone interested in receiving the name of the person to contact regarding chapter activities in your area.

## From blue bananas to bag tails

**Hell-o, goodbye**

The control room tape decks at WROK, Rockford, Illinois, not only play back prerecorded programs, but can record the telephone, network, or "air-check." In addition, the machines may be started by a digital clock for automatically recording network spots.

One Sunday, a former (you'll understand why he's former" in a minute) part-timer was playing a religious tape and chatting with friends on the phone instead of paying attention to his job. Sure enough, the recorder had been left on automatic start with the telephone input selected from a previous show.

It was normal until the tape deck kicked into record, erasing the church program and putting the phone conversation on the air. You can imagine the program director's surprise when the startled board realized something was amiss and bellowed, "What the hell is going on!" John Shepler, WROK, Rockford, Illinois.

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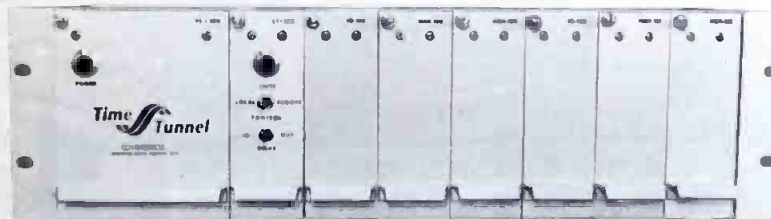


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## zoom in!

This is the official column of the American Society of TV Cameramen (ASTVC). The ASTVC can be contacted by writing to: P.O. Box 296, Sparkill, NY 10976. (914) 359-5985.

### Take 1...Advice to the Job-Worn

**[Editor's Note:** This article is from Gregg Suhm, graduate of UNC presently servicing as associate director of ASTVC's Plans & Services, and a veteran of the "job-seeking route."])

Making the big-time in the television industry is not as easy as you may have been led to believe, especially if you plan to come to New York.

I know that the usual plan is to make the rounds in the Big Apple and, as a result, save years at the smaller, more "insignificant" stations. But the fact is that the smaller stations provide the necessary experience to be considered in this very competitive job market. After all, other pilgrims have come, and are still coming to Mecca. It's not exactly an original idea.

Even if you are well-qualified, there are a lot of people who went

to some very fine TV-film schools right here in New York (such as NYU, Columbia, the New School).

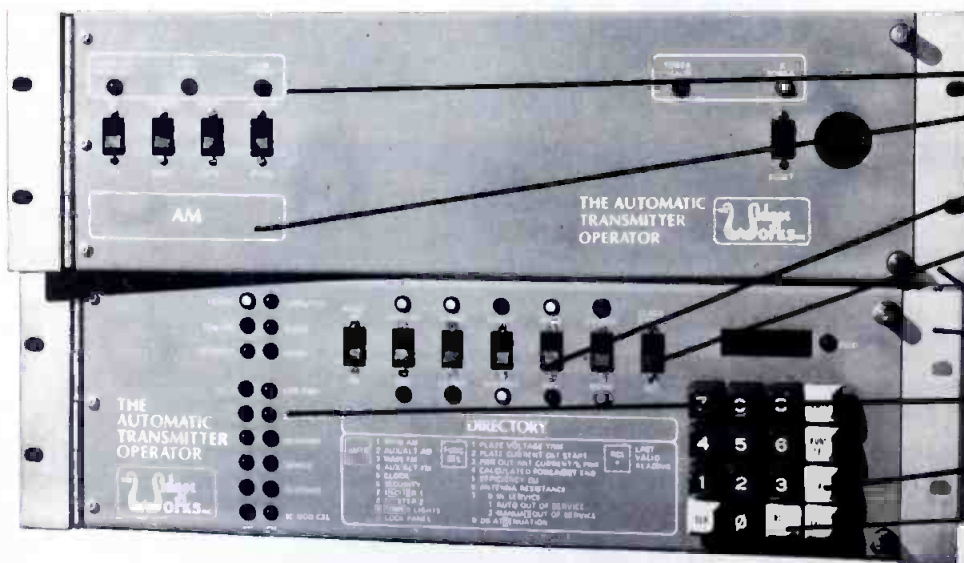
One sad fact is that a lot of the network operations have moved to the West Coast. In other words, the city that was once a Mecca for radio and television has lost its place at the head of the line.

An executive at NBC told me that if 36 openings came up in the spring, the vacation relief (VR) people who worked last year from April to November in VTR or as cameramen (etc.) would have to be offered the positions first, according to the NABET contract.

CBS hires year 'round (unlike NBC and ABC), but it's tougher year because they have the VR people from the other two networks to choose from. Well, what about the other stations in New York, such as Channels 5, 9, 11, and 13? Her again, a 1st Class FCC license is a must. As Karl Malden says, "Don't leave home without it!"

All in all, it would be better for the aspiring writer, producer, or director to start small and work up rather than look to New York City for those greener pastures. By the way, NYC doesn't have any pastures—a lot of muck and mire, but no pastures.

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# Station-to-Station

## Interfacing the TG2/EBS with an automation system

By Edd Monskie, Chief Engineer, WDDL/WNCE, Lancaster, Pennsylvania

I was looking for a circuit that could completely interface our Martin TG2/EBS generator with an automation system. We broadcast the tones as a source through the automation system rather than interrupt the program lines. The circuit would hopefully be compatible, simple, and inexpensive.

A remote state was already in the air, but getting the end-of-message auxiliary tone signal was the problem. Having someone manually switch out of the tones or let the source sense do the work was a copy. The following circuit filled the needs.

In the McMartin generator, pin 3 of IC7 (the timer) goes high for 22.5 seconds to time out the tones. I wanted to use the falling edge of that pulse to trigger a circuit. Using the 74123 IC seemed the easiest one to take. Other circuit ideas worked, but they also triggered on the rising edge of the 22.5-second pulse and that would confuse the automation.

On the 74123, you tie pins 2 and 3 together, use pin 1 as the input, and the output. Using pin 1, the IC generates a negative-going pulse on the output that triggers the 555 timer for 2.5 seconds. The high output pulse of the timer turns on Q1 and energizes K1. The NO contacts on

the relay send the end-of-message pulse to the automation.

R1 (10K) and C1 (.02) set the pulse width on the output of the 74123. They are not critical values as long as the pulse is long enough to trigger the 555. R2 (100K) and C2 (10 mfd) set the 2.5-second pulse on the 555 timer to close the relay contacts. You may need a longer time depending on your automation. The +5 and +12 voltages were easy to find in the McMartin, and there was plenty of empty space to fit a piece of PC board inside. All you have to do is bring the relay contact leads to the outside world. Also, if you tie pin 1 low and pin 3 high on the 74123, and use pin 2 as the input, it will trigger, but on the leading edge of a pulse (if that is easier to get to in your system).

The circuit should be compatible with almost any TTL tone generator and any automation system. You might find other uses for the circuit too. You can wire the generator in as another source, and program the test whenever you need it for the weekly test.

The circuit can be built probably for under \$10 if you buy everything. You might be lucky, as I was. The only part that wasn't on the shelf was the 74123. I had to buy that for 99 cents!

*continued on page 84*

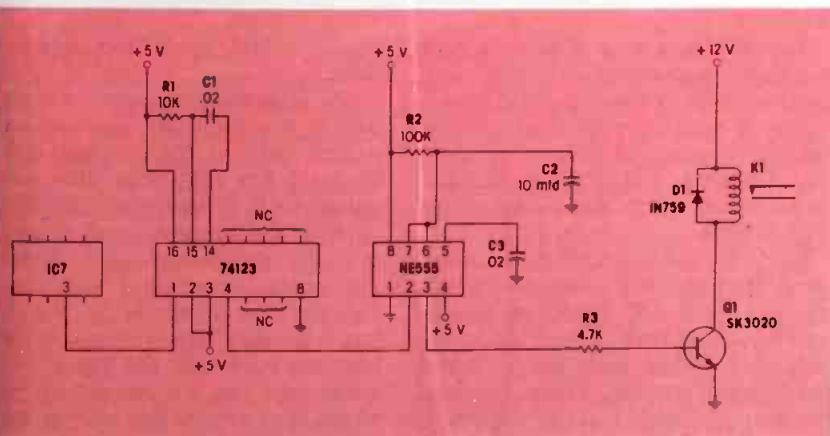
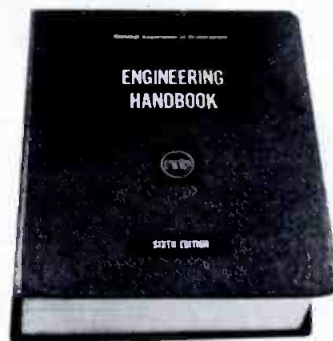


Figure 1

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The *Handbook* can also be purchased directly from the NAB at \$30 a copy for NAB members and \$45 a copy for non-members. Write to: *Station Services Dept.*, NAB, 1771 N Street, N.W., Washington, D.C. 20036.

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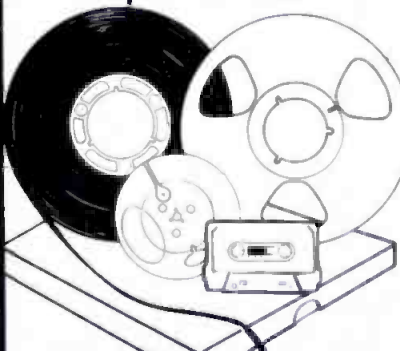
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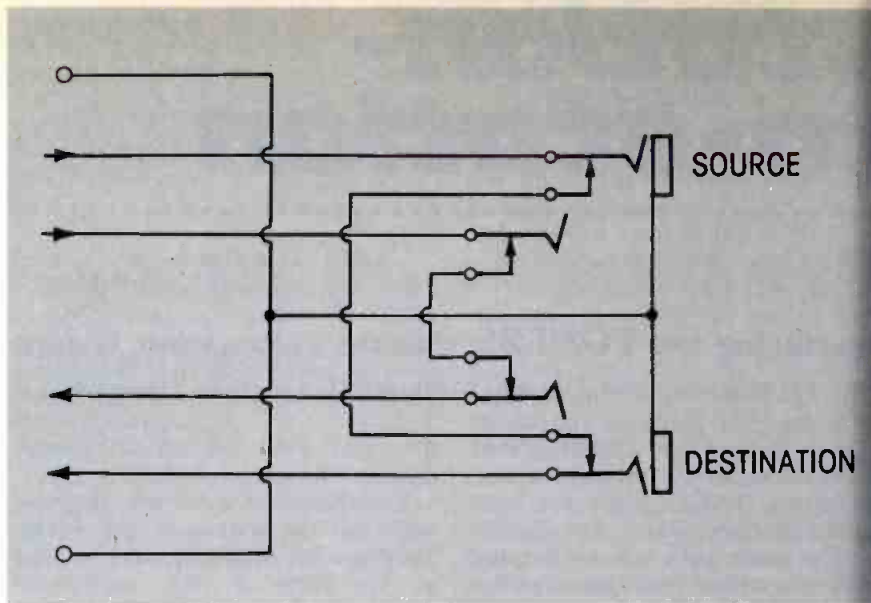


Figure 1

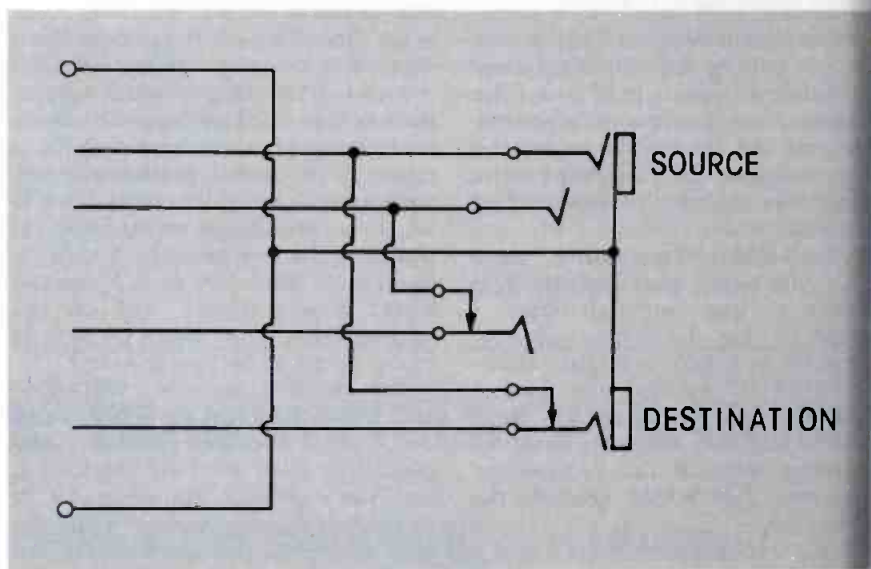


Figure 2

## Station-to-Station

*continued from page 83*

### Wiring patchbays for maximum flexibility

By James Sensenbach, Chief Engineer, KMWU, Wichita, Kansas

To allow maximum flexibility with minimum equipment, I wired our patchbays in a new (I think) way. Although I rarely want to cut off the normal connection when patching signal sources, I do want to cut that connection when patching signal destinations.

Our bays were wired in the usual short fashion—with normal circuits wired to the NC contacts on the patch jack at both ends. Putting the plug into either jack would break the normal circuit. This required the use of "multi" jacks (wired in parallel) to split a mono signal into stereo or to mix two stereo outputs

to mono and send them down two lines.

My improvement was merely to defeat the contacts on the signal source side of the normal circuit. Thus, plugs put into the source patch jack bridge the circuit, including the normal, and plugs put into the destination jack interrupt the normal circuit. I did this by shorting the contacts in the jack but when initially wiring the patch bay you wire both the signal source wires and the normal circuit wire to the jack where the source wiring is normally attached.

Advantages of this include using

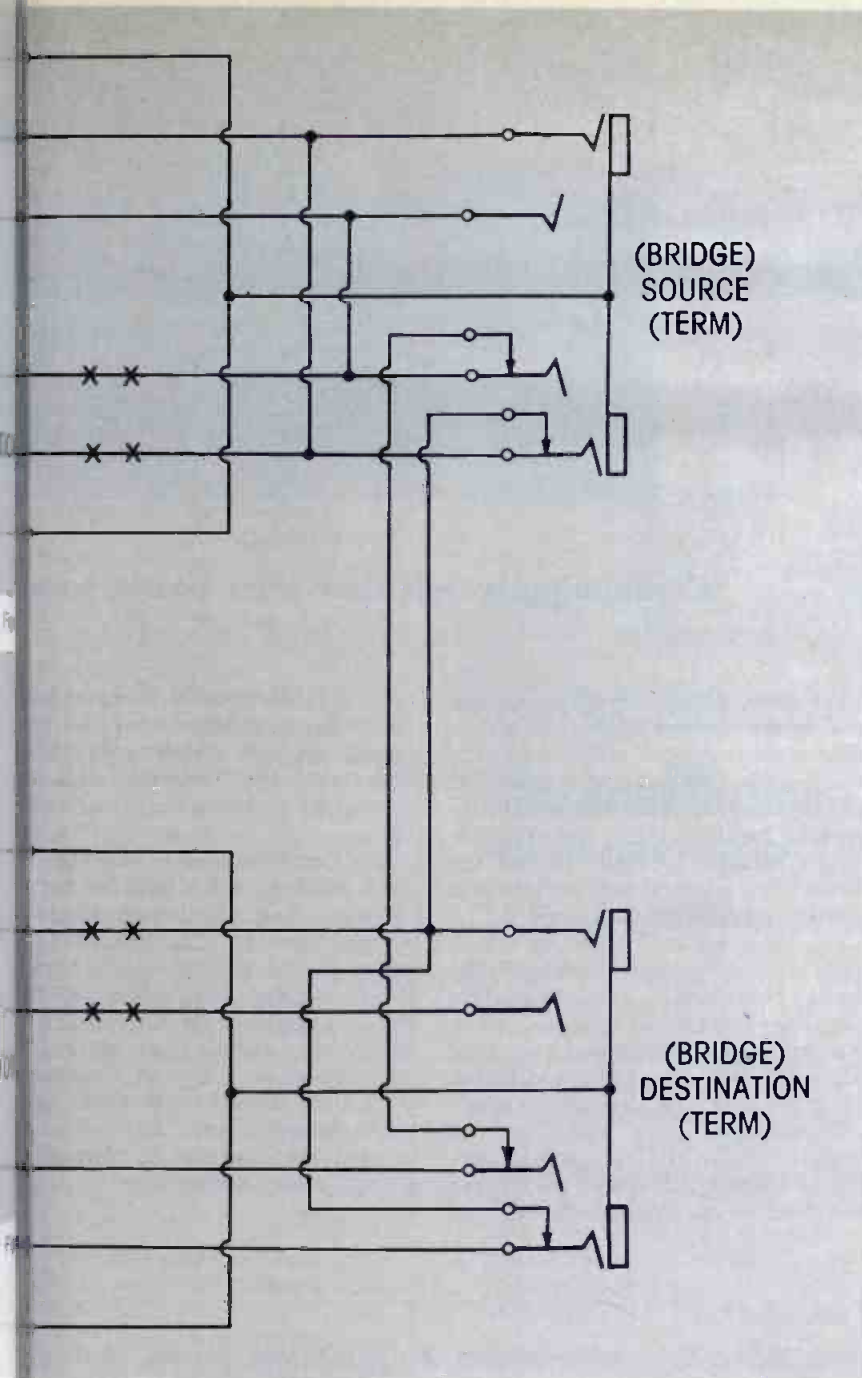


Figure 3

patchcord to split mono-to-stereo and stereo-to-mono mixes. It provides a bridging and a terminating access to each circuit through a patchbay without using four lines for each circuit. It allows the attachment of bridging test recording gear. It also eliminates the need for "multi" jacks. There are some tradeoffs. The most obvious is impedance mismatching. I've found this is not serious as long as you keep straight where the bridging inputs are and where the circuits are terminated. You may still need a "multi" set of patch jacks if you need a three-way

signal split or if you want to split a test input that does not normally come through a jack. You might also need the multi if you want to split mono to stereo where neither "stereo" line is normalled from the mono line.

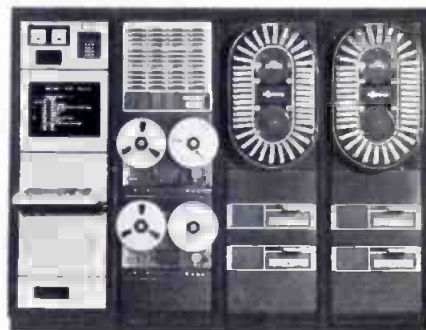
Although I find it hard to explain, it's easy to wire, and I think you can see that the tradeoffs are oriented to a broadcast station. I won't vouch for how well they work for a recording studio-type operation. They do come in very handy when working with telephone company program lines.

*continued on page 86*

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## Station-to-Station

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page 85

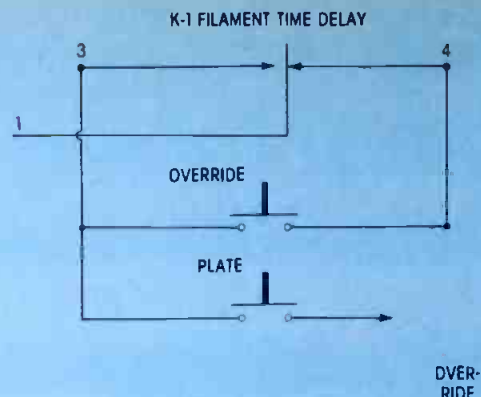


Figure 1

## Eliminating recycle time after power outage

By Alex Fraser, Chief Engineer, WVNH Radio, Salem, New Hampshire

We were plagued with numerous one to ten second power interruptions from the local utility company which have knocked our transmitter off the air with a three-minute recycle period. (The power company's excuses typically placed the blame on a squirrel getting into one of their sub stations.)

We have a CSI T-10-A rig which uses a three-minute filament time delay relay (K1) in its control circuitry. The circuit is closed when the relay is energized, making contact between pins one and three; when not energized, contact is made between pins one and four. A normally open SPDT switch was placed in circuit between pins three and four so that when closed, the

control circuit would be complete no matter which position the relay contactor is in. After relay K1 energized, the override switch normalled by the transmitter operator.

For the switch, I used a Switchcraft 84206-L which has the feature of being illuminated with either amber color in the normally open position, or green when closed. Power for the lamp was taken from the transmitter's 24-volt supply. The illuminated switch is an option, but one appreciated by the transmitter operators as it is located easily when needed; and the two colors remind the operator to normal the switch after K1 energizes.

### Editor's Note

In the January Station-to-Station column, Mark Wharton took exception to a comment in the June 1977 Radio Workshop concerning the use of a spectrum analyzer for official equipment performance measurements.

Wharton presented a valid method for computing THD from the spectrum analyzer display. This, however, is not the reason a spectrum analyzer is presently unacceptable for FCC measurements.

The rules require a measurement of modulation sensitivity. That is, at each frequency, you must show how much signal is necessary to produce a particular level of modulation. Unless your system happens to be perfectly flat, the spectrum analyzer display of response doesn't meet this requirement.

The spectrum analyzer is, indeed, a useful tool, but at least once a year you'll still have to resort to conventional techniques to satisfy FCC requirements.

Peter Burk

## New Products

This month's New Products section kicks off with just a few of the products introduced at last month's NAB convention. Next month, Broadcast Engineering will feature a complete NAB Wrap-up issue, a summary of the exhibits, discussion of new products, and comments on the convention itself. In the total NAB story, be sure to read the June Wrap-up issue.

### Search-to-cue accessory

A multi-point search-to-cue and timing accessory providing up to 20 cue storage capability for a variety of mixdown and over-dubbing operations has been introduced by Ampex Corporation.

The 10-button keyboard panel and a store control allow access to a total memory array. The keyboard stores up to 20 cues in memory and calls them as desired.

Three time displays show tape memory time, and keyboard time. (The time displays are separately available through the LED readout.) An additional display shows current cue reference. The main time display automatically returns the tape time upon finding the desired memory time.

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### Portable color camera

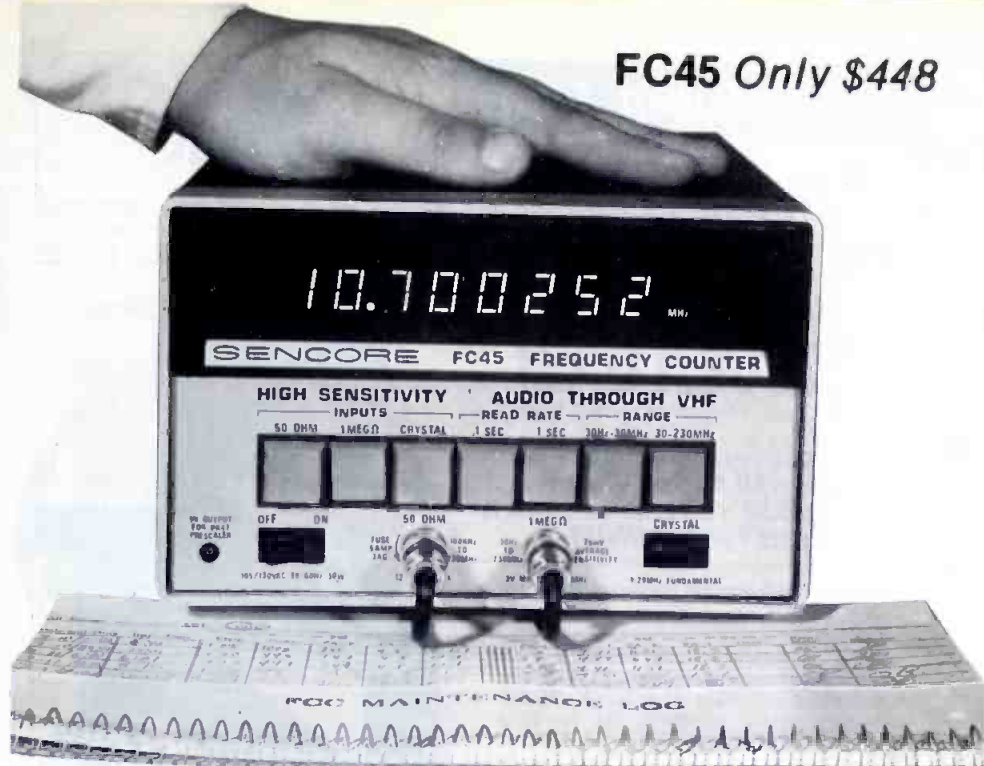
C's new CTC-5X portable color camera features a 1½-inch electronic viewfinder. The camera uses a 1-inch striped filter vidicon tube and will use any 1-inch C-mount

Other features include an omnidirectional condenser-type mike, a switch for activating portable external mike, front panel switch for activating portable TR, adjustable control for indoor or outdoor shooting, automatic light control for changing light, and EIA RS 170 sync.

The camera can be used with any NTSC compatible. The package includes the camera, the viewfinder, an AC power supply, 8-foot extension cable, and a removable hand grip. Optional accessories include a portable power supply, battery; a battery for DC power supply; a portable camera operator; and a 25-foot extension

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### And you can extend these FC45 reliable uses even further with...



**PR47 600 MHz Prescaler:** Extends FC45 from 230 MHz to 600 MHz by plugging into special FC45 power jack and inserting into input lead. \$125

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**PL207 "Snoop Loop":** RF pick-up loop with cable to avoid direct circuit connection. \$9.95

Write for 24-page FC45 Frequency Counter Sencore News or order instrument from: Sencore, Inc., 3200 Sencore Drive, Sioux Falls, South Dakota 57107

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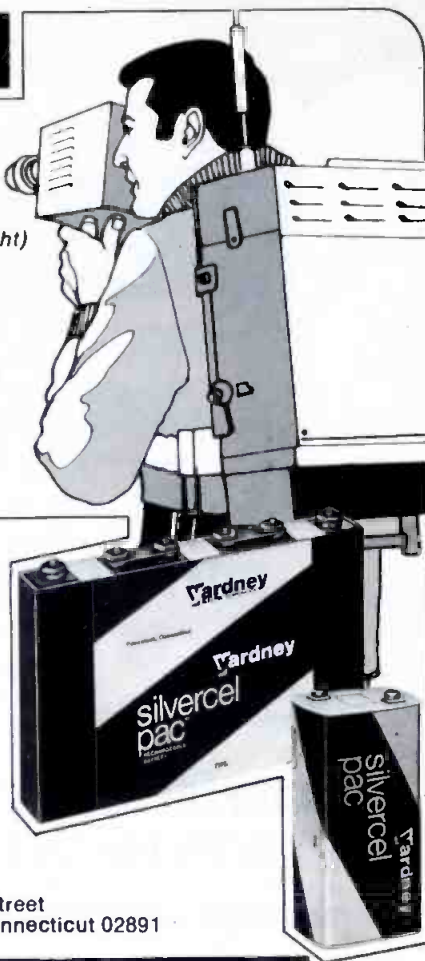
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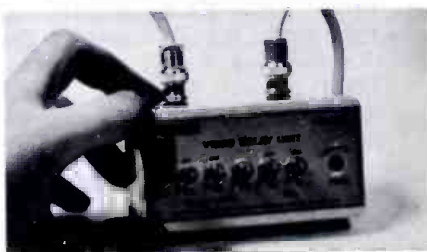
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| Stereo Cross Talk | —65 DB               |
| Noise             | —65 DB or less       |
| Response          | ±0.5 DB 30-15000 Hz. |
| Distortion        | Less than 0.5%       |

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## Video Engineer's Timing "Tool"



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The performance is suitable for full color timing and can be inserted directly into the video path without any extras. The equalizers are built inside the "UN360."

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— Video Delays priced from \$75

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## new products

continued from page 87

### Personal computing products

Heath Company has introduced a line of personal computing products for hobby, home, educational, and small business applications.

The product line is designed around two new computers, the H8 and the H11. The H8 is an 8-bit computer based on the popular 8080A microprocessor. It features a front panel with octal data entry and display, and a resident monitor with built-in bootstrap for one-button program loading or storage.

The H11 is a 16-bit computer using the Digital Equipment Corporation (DEC) LSI-11 with 4k memory, built-in backplane, and regulated switching power supply. System-compatible peripherals include CRT terminal; paper-tape reader/punch; serial and parallel interfaces; a "hard copy" printer terminal; and a cassette player/recorder.

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### Routing switcher

Vertical interval switching is available for Dynasciences' 8800 series routing switcher line.

The 8500 series modular system consists of a single rack housing up to six 12x1 plug-in modules. Each module contains both video and audio switching circuitry and has a self-contained power supply. Load through high-impedance inputs permit configurations of up to 12 channels without signal degradation.

The system can be expanded into larger configurations through the use of external video distribution amplifiers.

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### Video camera

Sony Corporation's new small-format color video camera utilizes large-scale, charge-coupled technology and a fourth-generation semiconductor.

Designed for wide application in ultra-high-density memories, signal processing, and logic circuitry, the CCD camera contains about 110,000 elements on a single chip, allowing size, weight, and power consumption reductions in current electronic equipment. The new camera measures 10.3mm by 0.1mm, with each element 36 micron millimeters by 13 micron millimeters, arranged in a 10x10 array.

BROADCAST ENGINEER

a matrix of 226 horizontal elements by 492 vertical elements, a total of 111,192 picture elements.

The CCD camera will contain three chips, and by utilizing Sony's proprietary spatial offsetting technique (which allows a doubling of horizontal resolution), provides for greatly increased picture resolution. Interline transfer organization, shielded channels, and SNO2 transparent electrodes made possible improvements in picture quality, resolution, sensitivity, and signal-to-noise ratio. As a result, greater than 280-line horizontal resolution and 700-lux minimum scene illumination (AT F2) are achieved.

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#### Frequency counter

Phillips Test and Measuring Instruments has introduced a new 100-MHz automatic frequency counter to complement its existing automatic counter with a temperature-compensated crystal oscillator. According to the company, the 6664-01 counter is particularly suitable in production testing, where maximum accuracy and a long stability time base is an essential requirement.

The unit can be used with a frequency generator to produce a constant readout.

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#### Frame synchronizer

The new VW-1 frame synchronizer from ADDA Corporation is designed to meet the need for high-quality, low-cost full-frame synchronizers. The VW-1 is a fourth generation, digital synchronizer with the ability to lock remote network, cable, and satellite feeds to station reference.

The synchronizer functions as a lock for heterodyne color U-matic order formats. The system will accept any NTSC-type standard with an optional freeze frame.

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#### 1-inch camera tube

A new 1-inch Plumbicon TV camera tube which will permit the use of portable cameras for EFP is available from Amperex.

Physically interchangeable with conventional 1-inch Plumbicon pick-up tubes, the S73XQ can be used in existing cameras with only minor circuit modifications. Its limiting resolution is 1,000 TV lines; modulation depth is 65% at 400 TV lines, a significant advance over previous 1-inch

continued on page 90

## the 3 WATT TRANSMITTER with 100,000 WATT CAPABILITY



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What McMartin has learned about performance and reliability from building full-power AM and FM transmitters, it has put into the "New Breed" RPU-1103 (150 MHz) and RPU-1403 (450 MHz) remote units.

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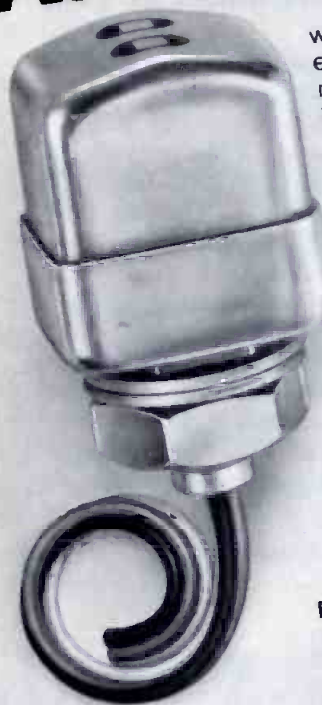
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## new products

continued from page 89

Plumbicon tubes. The increase in beam acceptance of its photocathode layer reduces signal decay lag, even at low light levels: decay lag at 50 msec is typically 2% of signal levels down to 50 nA.

Other technical advances in the S73XQ include an increase in beam reserve (resulting in reduced cometailing and blooming) and a low capacitance target contact that allows overall signal-to-noise ratio to be maximized. Another feature of the tube is a modified triode electron gun operating in a diode mode, improving the electron beam energy distribution uniformity, providing smaller spot size and better control over spot shape.

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### Videotape editor

Convergence Corporation is introducing their new ECS-100 series Superstick editing control system suitable for ENG, EFP, and commercial post-production. Because of their modularity of design, Superstick systems allow the start of a basic low-cost system, and expand to meet the needs for increased capability. They interface with most low-cost videocassette recorders, as well as the new 1-inch Type III teleproduction videotape recorder.

The system's new CUT/LAP allows for program fades and simulated dissolves from a single playback VCR, without adding a switcher or time base corrector. Other features include Liplock™ and pitch control, automatic return edit, auto tag, and ADR (automatic dialogue replacement).

The post-production version, the ECS-103, also gives SMPTE time code; A/B rolls; special effects; special edits; multiple source machine; CRT display of all edit data, and hard copy edit decision list for assembly; programmable automatic full automatic audio monitoring; and adjustable edit cycles.

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### Digital time base corrector

Consolidated Video Systems' new broadcast-quality, digital time base corrector is designed for heterodyne VTRs.

Called the CVS-516, the new TBC is compatible with current heterodyne VTRs. Standard features

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clude correction of chroma/  
luminance delay problems, a 3 dB  
chroma noise reduction, velocity  
compensation, and color dropout  
compensation. The unit also has  
WS's Gyrocomp circular memory.

Other features include a broad-  
cast stable gen lock sync generator,  
automatic VTR sync, and an ad-  
justable proc amp. Users can plug  
in an optional image enhancer/noise  
reducer printed circuit card which  
reduces luminance and chroma  
noise, and improves subjective reso-  
lution. A 16-line window plug-in is  
also available as an option.

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### Computer

The Cetec Schafer Series 7000  
incorporates a third-generation  
microprocessor (the Z-80) with a  
computer-grade CRT terminal as  
control center.

The basic sequential Series 7000  
system is supplied with a CRT  
terminal, 16 audio source capacity  
(the first nine are random selectable  
999 trays), and thousand-event  
memory. The system may expand to  
four separate CRT channels, up to  
1,000 events, and up to 64 audio  
sources.

Features include Plain English  
programming; programming error

detection; programming lookahead  
(19 program and 9 time events, with  
optional clock); multi-CRT capabili-  
ty; dual (music and voice) program  
busses; programmable source cards  
which are switch-selected to match  
various makes of audio sources;  
the six-source multi-cue system; and  
multi-level subroutine capability.

The series is field-expandable and  
upgradable, with computer ports for  
billing/traffic automated systems,  
telephone line remote connection,  
VEL, 'debug' module, modem, load/  
dump cassette system, etc.

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### News recording system

A News Recording System (NRS)  
developed for major radio stations  
and networks has been developed  
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NRS is a computer-logic system  
incorporating a series of Beucart  
audio cartridge tape recorder/pro-  
ducers and sequencing equipment to  
allow news to be recorded auto-  
matically from the UP or AP wire  
services.

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ing Beucart cartridge tape ma-  
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**BUILD YOUR OWN TV AND RADIO PRODUCTION EQUIPMENT.** Easy, inexpensive, (mostly IC). Plans or kits: Special Effects Generator, Automatic Logger, Vertical Interval Video Switcher, Solid State Lighting Board, Preset Audio-Video Board, Preset Lighting Board, Crystal Controlled Wireless Mikes with Matching receivers. Subsonic Tone Control for audio tapes, 8MM SOF Cameras and Projectors, Distribution Amplifiers (Sync. Video, Audio), Audio Control Boards (Studio & Remote) Proc-Amp with compensation and regeneration for adapting Helical Scan VTR's to broadcast standards. PLUS specialized correspondence courses in TELEPHONE Engineering (\$39.50), and Integrated Circuit Engineering (\$49.50). Plans from \$5.95 to \$15. SUPER CATALOG plus years updating of new devices Air Mailed \$1.00. Don Britton Enterprises, P.O. Drawer G, Waikiki, Ha. 96815. 5-77-32t

**HAVING CRYSTAL OR OSCILLATOR TROUBLE** or changing frequency on your TV, FM or AM transmitter? Call us for help at (817) 773-3901. Our many years in this field with crystals gives us considerable experience. We can probably save you time and money, and strictly first class. EDISON ELECTRONIC CO., Box 96, Temple, Tex. 76501. 3-78-3t

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**SAVE HUNDREDS OF DOLLARS** on high quality, dependable. American Made. MATV Head-Ends, V/V, U/V Converters, Camera Modulators at factory-direct prices. Send \$5.00 (or your MATV Installers Letterhead). "Information," Box 809, Boynton Beach, Fla. 33435. 1-78-e.o. 3

## EQUIPMENT FOR SALE

**FOR SALE—NEW UNUSED:** Complete System Television Transmitter Channel 10—192-198 MHz. Complete Television Transmitter System Channel 10—180-186 MHz-5 KW Visual 1.1 KW Aural including Filter Plexer 5 KW, Dummyload 5 KW, Filter Sets VHF Harmonic, Filter Video Low Pass - Kits Spare Tubes, Semi-Conductors - Complete Data including Operating Manuals, Schematics Parts Lists and Installation Drawings. Priced for quick sale. Contact Edw. Malavarca, Box 448, Dover, N.J. 07801, or call (201) 361-7200. 5-78-11

**RCA VTY MODIFICATIONS KITS** for TR4/22/50/60/61/70. Splicer (single-frame), TEP Interface, Time Code Edit Interface Kit, Audio Splice Timing Mod (Audio Insert Editor), Wideband Audio Amplifiers, most mod kits, some modules available. LAWHED, LTD., 388 Reed Road, Broomall, Pa. 19008, (215) 543-7600. 4-78-tf

## EQUIPMENT FOR SALE (CONT.)

RCA VTR update modification kits for TR4/22/50/60/61/70. Splicer (single-frame), TEP Interface, Time Code Edit Interface Kit, Audio Splice Timing Mod (Audio Insert Editor), Wideband Audio Amplifiers, most mod kits, some modules available. LAWHED, LTD. 388 Reed Road, Broomall, Pa. 19008 215/543-7600.

**DATATRON 5050 EDITOR** modified for 3 VTR's. Ideal way to break into time code editing. (216) 822-3770. 4-78-tf

**LIGHT PEN** Tektronix 4501 scan converter and homemade interface. (216) 822-3770. 4-78-tf

**TWO AKAI CAMERAS,** one with camera control unit, one with combination recorder CCU. Ed Risk, KSD-TV, (314) 421-5055. 5-78-2t

**AMPEX VR-660B,** \$375. Ampex Amtek, \$375. (213) 842-4506. 5-78-11

**FOR SALE:** Hitachi EA-103U Video Effects Switcher, SG108U Color Sync Generator, Concord 1/2" Color Player, Video Dist. Amp, equipment racks. One Way Productions, 1410 W. 13th, Eugene, Ore. 97402, Att. Dan Plaisted. 5-78-11

**CARTRIDGE LABELS:** New, non-smear pressure sensitive labels. Fits all cartridges. Comes white & 4 colors. Write for FREE sample—MASTER-TONE COMPANY, 1105 Maple, West Des Moines, Iowa 50265, (515) 225-6122. 8-77-tf

**BROADCAST CRYSTALS** for AM, FM or TV transmitters, frequency change, repair or replacement of oven types. Also vacuum types for RCA, Gates, Collins, etc. transmitters. Quality products, reasonable prices and better delivery! Don't be without a spare crystal. Frequency change and service for AM and FM monitors. Over 30 years in the business. Eldson Electronic Co., Box 96, Temple, Texas 76501. Phone (817) 773-3901. 12-74-tf

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**ONE SPOTMASTER 500B rack mt.,** \$400; one Sparta 800C RP, \$400; one Sparta 800C P, \$200; one Ampex 351 in roll cart, \$1200. Steve Evans, 4100 McCahill Rd., Chattanooga, Tennessee 37415. 5-78-11

## HELP WANTED

**IMMEDIATE OPPORTUNITY—First Class Engineer** for AM-FM and Music Service operation. Prefer Electronic Technician training with solid state and RF experience. Other broadcast experience helpful. EOE/M/F. Jesse Gilbert, KPET, P.O. Box 30, Lamesa, Texas 79331. 5-78-11

**STUDIO MAINTENANCE** and remote control engineer. Prefer VTR experience. If not, digital background helpful. First required. Equal opportunity employer. Write or call Richard Doyle, CE, KGGM-TV, Box 1294, Albuquerque, NM 87103, (505) 243-2285. 5-78-11

## HELP WANTED (CONT.)

### EMPLOYMENT OPPORTUNITIES (\$15,000-\$40,000)

Broadcast/Communications related openings at all locations coast to coast—all levels and disciplines. Engineering, Sales, Marketing, Management, Etc. Over 1,000 firms represented. To cover ALL your immediate job possibilities in the "unpublished market", send your resume with salary requirements now. No fee, confidential, professional. **KEY PERSONNEL, NATL HDOTRS.** Dept. B. South Main Towers, Wilkes-Barre, Penna. 18701 (717) 822-2196.

5-78-TF

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### ENGINEERING SUPERVISOR

For the candidate who can supervise technicians assigned to television production and maintenance. A solid technical background, FCC FIRST CLASS LICENSE and a minimum of 5 years of television broadcast experience is also required. Previous supervisory experience a real plus.

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Experience in studio broadcasting and an FCC FIRST CLASS LICENSE are required. A background in electronics is also desirable.

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**MAINTENANCE ENGINEER**—Chicago VHF station has an immediate opening for an experienced maintenance engineer to work at our studio location. We are seeking a person with a minimum of two years of technical training, four years maintenance experience and a 1st Class FCC License. Send your resume in confidence to: Larry W. Ocker, Director of Engineering, WTTW-TV/Channel 11, 5400 North St. Louis Ave., Chicago, Illinois 60625. An affirmative action/equal opportunity employer. 5-78-11

## HELP WANTED (CONT.)

**TELEVISION**—Immediate opening for First Class engineer who wants to grow with small UHF station. Experience helpful with UHF transmitter, RCA microwave, Sony studio and ENG equipment. Strong maintenance background a must. Send resume and salary history to Charles Smithley, Director of Engineering, KXIX TV, P.O. Box 1879, Victoria, Texas, 77901. 5-78-11

**TELEVISION**—CCTV Video Maintenance Technicians. Full Benefits. Greater New York, Suffolk County or New Jersey Area. Send resume to: VPC, P.O. Box 268, New Hyde Park, N.Y. 11040. 6-77-1t

**BROADCAST ENGINEER.** Duties—master control, transmitter, production & microwave operation, installation & maintenance. Rotating shifts. Requires 1st Class FCC license, quad & TV transmitter experience. Salary range, \$11,000 to \$13,554 per year. Contact Kirk, WDSE-TV, 210 Bradley Building, Duluth, MN 55802, (218) 727-8734. 5-78-11

**CHIEF ENGINEER**—established Motion Picture/TV sound recording studio has opening for Electrical Engineer with heavy experience in audio equipment, maintenance, modification, design, and fabrication. Confidential interview. Send resume and salary history. Photo Magnetic Sound Studios, 222 East 44th Street, New York City, N.Y. 10017. 3-78-3t

**VTR & PRODUCTION ENGINEERS**—Chicago VHF station has immediate openings for engineers experienced in the operation of VTRs, film chains, studio cameras, & video shading. We are seeking persons with a minimum of two years technical training, four years experience, & first class FCC license. Send your resume in confidence to: Larry W. Ocker, Director of Engineering, WTTW-TV, 5400 N. St. Louis Ave., Chicago, Illinois 60625. 5-78-2t

**TELEVISION MAINTENANCE ENGINEER**—Experienced with VHF transmitters and microwave. Beautiful western mountain location and excellent work facilities with an aggressive ABC affiliate. Send resume with references and salary requirements to Dept. 417, Broadcast Engineering, P.O. Box 12901, Overland Park, Kansas 66212. 4-78-2t

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## SITUATION WANTED

**SENIOR VIDEO & COMMUNICATION TECHNICIAN** seeking position in 2 year college or related school as instructor for TV mass media or related field. Will also do repair and maintenance of equipment. Six years of industrial digital and RF, 2 years of studio and equipment repair, 2½ years of business and electrical background. ¾ year work experience at Bucks County Community College, Bucks County, Newtown, PA as technical assistant, repair and maintenance of TV studio equipment and overseer of students in control room. Presently employed as Senior Digital Communications Technician with a corporation with yearly sales of 1.75 billion dollars. For complete resume, 1311 Barton Drive, Ft. Washington, PA 19034. 4-78-3t

**VIDEO/RF MAINTENANCE ENGINEER** seeks employment. Eight years' TV: Ampex, GE, Sony, Ikegami, IVC, Grass Valley, etc. Quad, helical, UHF XMTs, microwave, studio and portable cameras. In supervisory position; out of opportunities here. 31, single, will travel U.S. or abroad. 5-78-11

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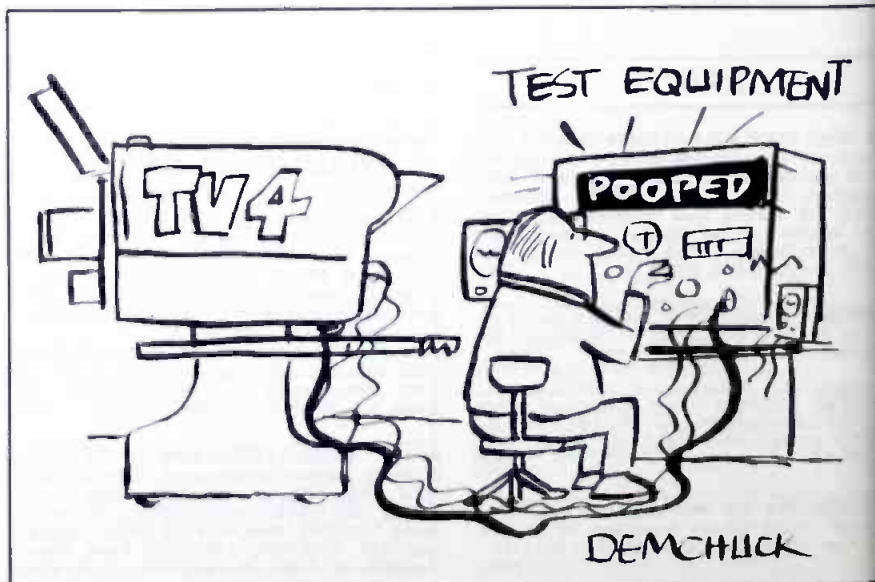
**New York, New York**—Stan Osborn, 60 E. 42nd St., Room 1227, New York, NY 10017, (212) 687-7240.

**Mountain View, California**—Dennis Triola, 2680 Bayshore Frontage Rd., Room 102, Mountain View, CA 94043, (415) 961-0378.

**London, England**—John Ashcraft & Co., 12 Bear St., Leicester Square, London, WC2H 7AS, 930-0525.

**Badhoevedorp, Holland**—John Ashcraft & Co., John J. Lucassen, Mfg., Slotweg 303, 1171-VG Badhoevedorp, Holland, 2968-6226.

**Tokyo, Japan**—International Media Representatives, Ltd., 2-29 Toranomon 1-chome, Minato-ku, Tokyo 105, Japan, 502-0656



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For issue of May 1978—Use until August 1, 1978

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Station or Company \_\_\_\_\_

Address/City \_\_\_\_\_

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| 13 | 25 | 37 | 49 | 61 | 73 | 85 | 97  | 109 | 121 | 133 | 145 | 157 | 169 | 181 | 193 | 205 | 217 | 229 | 241 | 253 | 265 | 277 | 289 | 301 | 313 |
| 14 | 26 | 38 | 50 | 62 | 74 | 86 | 98  | 110 | 122 | 134 | 146 | 158 | 170 | 182 | 194 | 206 | 218 | 230 | 242 | 254 | 266 | 278 | 290 | 302 | 314 |
| 15 | 27 | 39 | 51 | 63 | 75 | 87 | 99  | 111 | 123 | 135 | 147 | 159 | 171 | 183 | 195 | 207 | 219 | 231 | 243 | 255 | 267 | 279 | 291 | 303 | 315 |
| 16 | 28 | 40 | 52 | 64 | 76 | 88 | 100 | 112 | 124 | 136 | 148 | 160 | 172 | 184 | 196 | 208 | 220 | 232 | 244 | 256 | 268 | 280 | 292 | 304 | 316 |
| 17 | 29 | 41 | 53 | 65 | 77 | 89 | 101 | 113 | 125 | 137 | 149 | 161 | 173 | 185 | 197 | 209 | 221 | 233 | 245 | 257 | 269 | 281 | 293 | 305 | 317 |
| 18 | 30 | 42 | 54 | 66 | 78 | 90 | 102 | 114 | 126 | 138 | 150 | 162 | 174 | 186 | 198 | 210 | 222 | 234 | 246 | 258 | 270 | 282 | 294 | 306 | 318 |
| 19 | 31 | 43 | 55 | 67 | 79 | 91 | 103 | 115 | 127 | 139 | 151 | 163 | 175 | 187 | 199 | 211 | 223 | 235 | 247 | 259 | 271 | 283 | 295 | 307 | 319 |
| 20 | 32 | 44 | 56 | 68 | 80 | 92 | 104 | 116 | 128 | 140 | 152 | 164 | 176 | 188 | 200 | 212 | 224 | 236 | 248 | 260 | 272 | 284 | 296 | 308 | 320 |
| 21 | 33 | 45 | 57 | 69 | 81 | 93 | 105 | 117 | 129 | 141 | 153 | 165 | 177 | 189 | 201 | 213 | 225 | 237 | 249 | 261 | 273 | 285 | 297 | 309 | 321 |
| 22 | 34 | 46 | 58 | 70 | 82 | 94 | 106 | 118 | 130 | 142 | 154 | 166 | 178 | 190 | 202 | 214 | 226 | 238 | 250 | 262 | 274 | 286 | 298 | 310 | 322 |
| 23 | 35 | 47 | 59 | 71 | 83 | 95 | 107 | 119 | 131 | 143 | 155 | 167 | 179 | 191 | 203 | 215 | 227 | 239 | 251 | 263 | 275 | 287 | 299 | 311 | 323 |
| 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 | 192 | 204 | 216 | 228 | 240 | 252 | 264 | 276 | 288 | 300 | 312 | 324 |

Please check every section which applies to you.

## BUSINESS OR OCCUPATION

- ☐ A. AM Radio Station
- ☐ B. FM Radio Station
- ☐ C. TV Station
- ☐ D. ETV Station
- ☐ E. CATV Facility
- ☐ F. CCTV Facility
- ☐ G. Consulting Engineer
- ☐ H. Educational Radio
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- ☐ J. Distributor
- ☐ K. Government Agency
- ☐ L. Corporate Officer
- ☐ M. Technical Management/Engineering
- ☐ N. Other Management
- ☐ O. Other (specify) \_\_\_\_\_

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# BROADCAST engineering.

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Station or Company \_\_\_\_\_

Address/City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_ Phone ( ) \_\_\_\_\_

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| 13 | 25 | 37 | 49 | 61 | 73 | 85 | 97  | 109 | 121 | 133 | 145 | 157 | 169 | 181 | 193 | 205 | 217 | 229 | 241 | 253 | 265 | 277 | 289 | 301 | 313 |
| 14 | 26 | 38 | 50 | 62 | 74 | 86 | 98  | 110 | 122 | 134 | 146 | 158 | 170 | 182 | 194 | 206 | 218 | 230 | 242 | 254 | 266 | 278 | 290 | 302 | 314 |
| 15 | 27 | 39 | 51 | 63 | 75 | 87 | 99  | 111 | 123 | 135 | 147 | 159 | 171 | 183 | 195 | 207 | 219 | 231 | 243 | 255 | 267 | 279 | 291 | 303 | 315 |
| 16 | 28 | 40 | 52 | 64 | 76 | 88 | 100 | 112 | 124 | 136 | 148 | 160 | 172 | 184 | 196 | 208 | 220 | 232 | 244 | 256 | 268 | 280 | 292 | 304 | 316 |
| 17 | 29 | 41 | 53 | 65 | 77 | 89 | 101 | 113 | 125 | 137 | 149 | 161 | 173 | 185 | 197 | 209 | 221 | 233 | 245 | 257 | 269 | 281 | 293 | 305 | 317 |
| 18 | 30 | 42 | 54 | 66 | 78 | 90 | 102 | 114 | 126 | 138 | 150 | 162 | 174 | 186 | 198 | 210 | 222 | 234 | 246 | 258 | 270 | 282 | 294 | 306 | 318 |
| 19 | 31 | 43 | 55 | 67 | 79 | 91 | 103 | 115 | 127 | 139 | 151 | 163 | 175 | 187 | 199 | 211 | 223 | 235 | 247 | 259 | 271 | 283 | 295 | 307 | 319 |
| 20 | 32 | 44 | 56 | 68 | 80 | 92 | 104 | 116 | 128 | 140 | 152 | 164 | 176 | 188 | 200 | 212 | 224 | 236 | 248 | 260 | 272 | 284 | 296 | 308 | 320 |
| 21 | 33 | 45 | 57 | 69 | 81 | 93 | 105 | 117 | 129 | 141 | 153 | 165 | 177 | 189 | 201 | 213 | 225 | 237 | 249 | 261 | 273 | 285 | 297 | 309 | 321 |
| 22 | 34 | 46 | 58 | 70 | 82 | 94 | 106 | 118 | 130 | 142 | 154 | 166 | 178 | 190 | 202 | 214 | 226 | 238 | 250 | 262 | 274 | 286 | 298 | 310 | 322 |
| 23 | 35 | 47 | 59 | 71 | 83 | 95 | 107 | 119 | 131 | 143 | 155 | 167 | 179 | 191 | 203 | 215 | 227 | 239 | 251 | 263 | 275 | 287 | 299 | 311 | 323 |
| 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 | 192 | 204 | 216 | 228 | 240 | 252 | 264 | 276 | 288 | 300 | 312 | 324 |

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State \_\_\_\_\_ Zip \_\_\_\_\_ Phone ( ) \_\_\_\_\_

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| 13 | 25 | 37 | 49 | 61 | 73 | 85 | 97  | 109 | 121 | 133 | 145 | 157 | 169 | 181 | 193 | 205 | 217 | 229 | 241 | 253 | 265 | 277 | 289 | 301 | 313 |
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| 17 | 29 | 41 | 53 | 65 | 77 | 89 | 101 | 113 | 125 | 137 | 149 | 161 | 173 | 185 | 197 | 209 | 221 | 233 | 245 | 257 | 269 | 281 | 293 | 305 | 317 |
| 18 | 30 | 42 | 54 | 66 | 78 | 90 | 102 | 114 | 126 | 138 | 150 | 162 | 174 | 186 | 198 | 210 | 222 | 234 | 246 | 258 | 270 | 282 | 294 | 306 | 318 |
| 19 | 31 | 43 | 55 | 67 | 79 | 91 | 103 | 115 | 127 | 139 | 151 | 163 | 175 | 187 | 199 | 211 | 223 | 235 | 247 | 259 | 271 | 283 | 295 | 307 | 319 |
| 20 | 32 | 44 | 56 | 68 | 80 | 92 | 104 | 116 | 128 | 140 | 152 | 164 | 176 | 188 | 200 | 212 | 224 | 236 | 248 | 260 | 272 | 284 | 296 | 308 | 320 |
| 21 | 33 | 45 | 57 | 69 | 81 | 93 | 105 | 117 | 129 | 141 | 153 | 165 | 177 | 189 | 201 | 213 | 225 | 237 | 249 | 261 | 273 | 285 | 297 | 309 | 321 |
| 22 | 34 | 46 | 58 | 70 | 82 | 94 | 106 | 118 | 130 | 142 | 154 | 166 | 178 | 190 | 202 | 214 | 226 | 238 | 250 | 262 | 274 | 286 | 298 | 310 | 322 |
| 23 | 35 | 47 | 59 | 71 | 83 | 95 | 107 | 119 | 131 | 143 | 155 | 167 | 179 | 191 | 203 | 215 | 227 | 239 | 251 | 263 | 275 | 287 | 299 | 311 | 323 |
| 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 | 192 | 204 | 216 | 228 | 240 | 252 | 264 | 276 | 288 | 300 | 312 | 324 |

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