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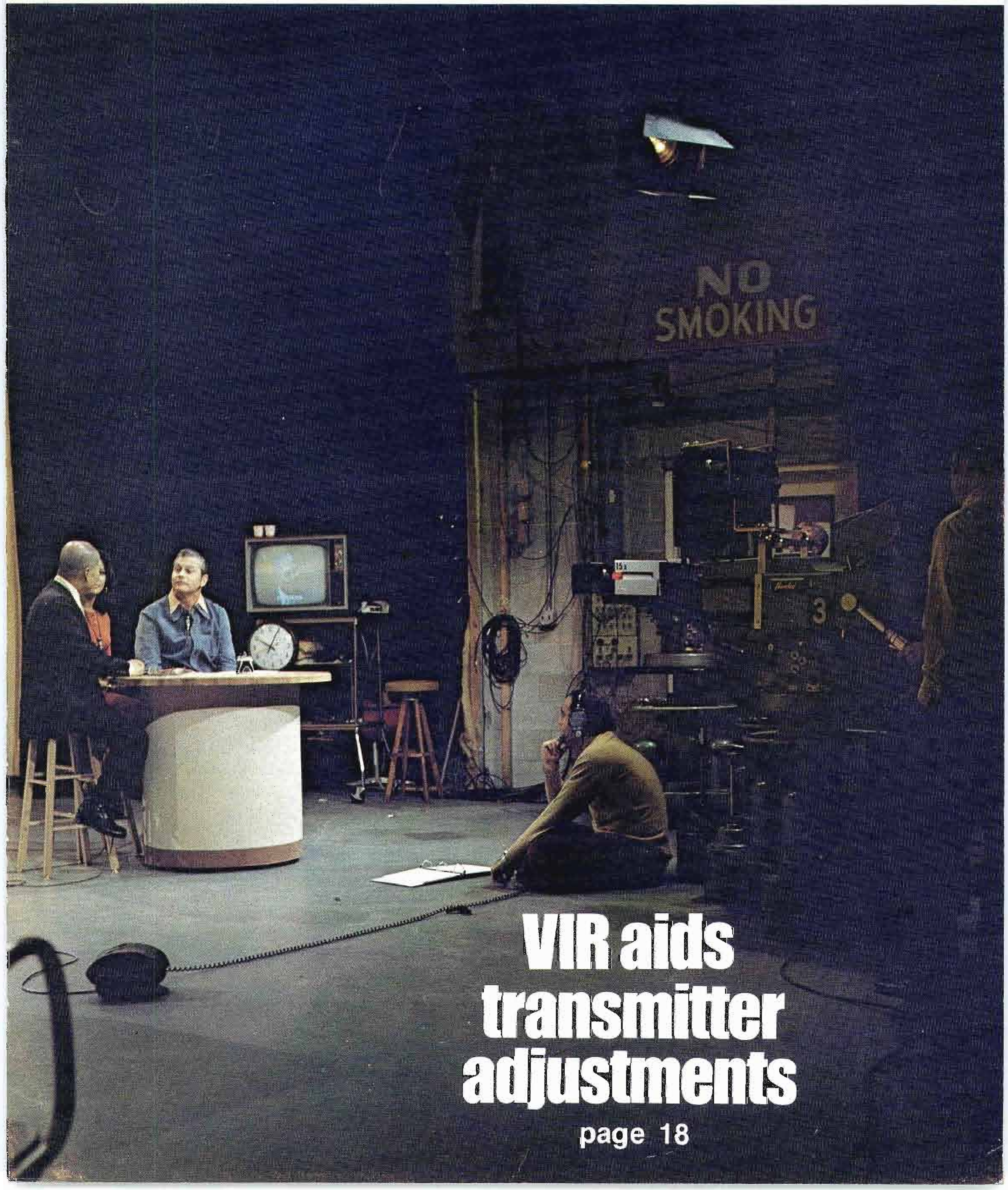
February, 1975/75 cents



BROADCAST ENGINEERING®

The journal of the broadcast-communications industry *February, 1975* *Volume 17, No. 2*

18 VIR signals aid transmitter adjustments ...A report on how one station is using these signals and special equipment to eliminate adjustments and get consistent color. **Archie Brusch.**

26 Challenging test tapes and records...BE runs a series of tests looking for ways to improve signal quality by test tapes and test records. The article includes notes on equipment and test tape and record distortion. **Dennis Ciapura.**

36 Avoid confusion with status lights... BE's maintenance editor describes a number of situations where status lights would aid station operations. Includes examples of circuits connections in typical applications. **Pat Finnegan.**

42 Digital math workshop...Last part in a series of articles on digital math that are designed to help engineers understand digital circuits. This last part includes a number of test exercises and answers. **Harold Ennes.**

About the cover

The cover photo was taken at WCVB-TV, Boston. The key is color, and our article on page 18 tells how the VIR signal can be used to keep color adjustments under control. (Photo courtesy Philips Bdcst. Equip. Corp).

Departments

Direct Current 4
News 8
SBE Journal 12
Cable Engineering CE-1
People In The News 48
New Products 49
Ad Index 58
Classified Ads 59

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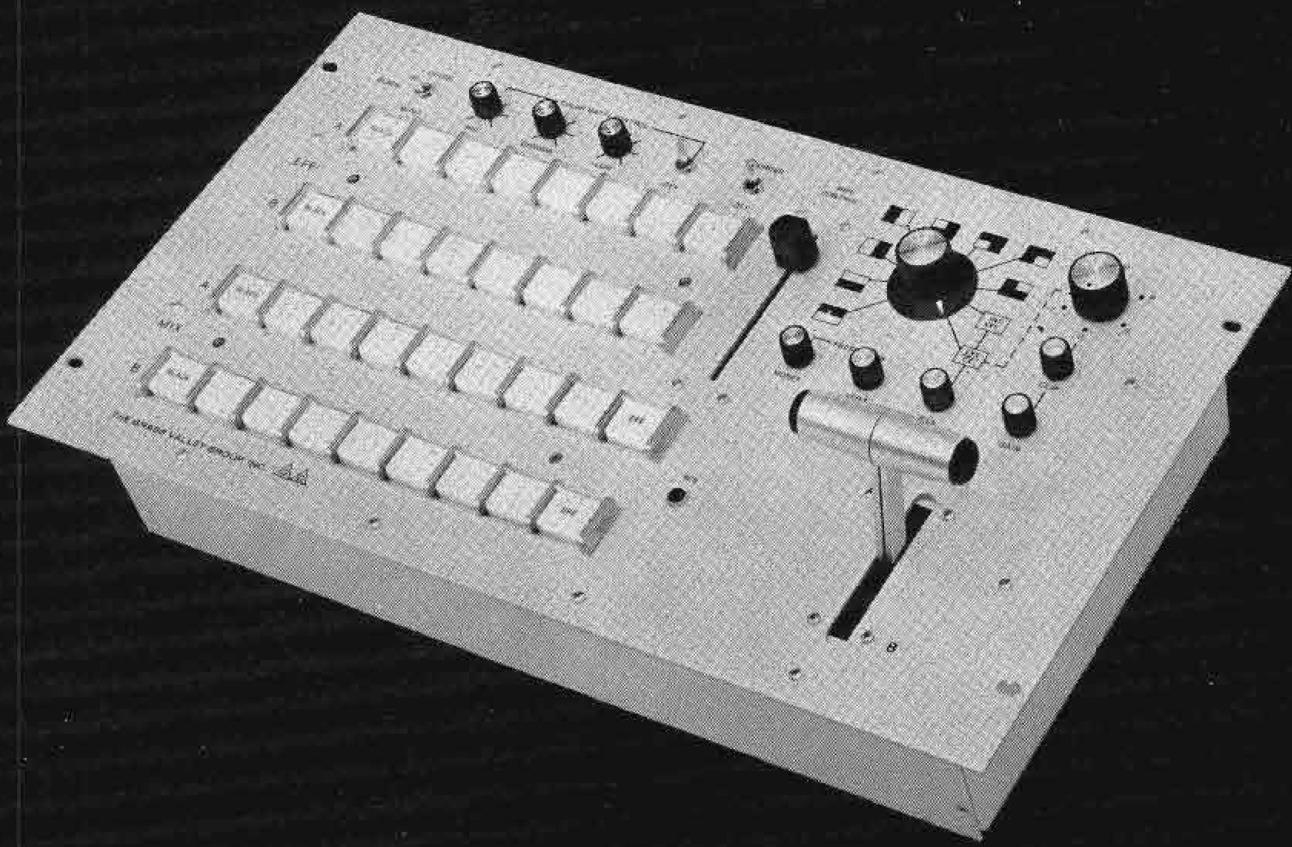

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DIRECT CURRENT FROM D.C.

February, 1975 / by Howard T. Head

Home Radio Warning System Selected

The White House Office of Telecommunications Policy (OTP) has announced a new policy respecting home radio warning systems for communicating attack or disaster warnings directly to the general public. Under the new policy, the National Weather Service VHF/FM forecasting and warning system (weather radio) will be the only Federal Government radio system employed for this purpose.

This system incorporates a special tone-alert signal. Already on the market are home receivers which can be activated automatically by this tone signal at the option of the receiver owner. OTP has expressed the hope that mass production of these receivers will bring the cost "within the reach of every American Citizen."

The National Weather Service transmitters operate either on 162.4 MHz or 162.55 MHz generally with a power of 1000 Watts. A service range of 40 miles is expected. There are 70 stations now in operation in the larger metropolitan areas with a network of 350 stations ultimately planned. The completed system is expected to make coverage available to 90% of the U.S. population. The projected cost of the completed system is around 3 million dollars, and the target date for completion is the end of 1977.

The new OTP policy does not affect the existence or operation of the Commission's Emergency Broadcast System (EBS). EBS will continue in operation, but OTP considered it to be unsuitable for a national attack and disaster warning system, since even its target response time of five minutes was considered inadequate, and as a practical matter, EBS response times are often much longer, even when the system works.

Commission Criticized on Operator Exams

The North Carolina Association of Broadcasters (NCAB), in a recent filing with the Commission, has told the FCC that its operator's study guide does not adequately prepare students for the actual examination for a Third Class Operator's permit. Stating that "fundamental fairness requires that there be a reasonable correlation between the official study materials" and the

(Continued on page 6)

None for the money...

or even MORE money, compare with the Sparta Studio/Remote Audio Control Centers. They are classed by themselves in providing **complete** production-and-remote broadcast facilities, as we discovered when we tried to measure up "competing" units. Which is probably why even our competitors sometimes buy them!

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☑	☐	Muting standard

Sparta AC155B/ ASC305B	Any Other Maker?	
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For More Details Circle (3) on Reply Card

(Continued from page 4)

examination, NCAB pointed out that in the last eleven months, 107 of 125 North Carolina applicants had failed the test for the Third Class permit. The Association went on to say that "this is a matter of particular concern to broadcasters who are trying to seek out and extend new employment opportunities to minorities."

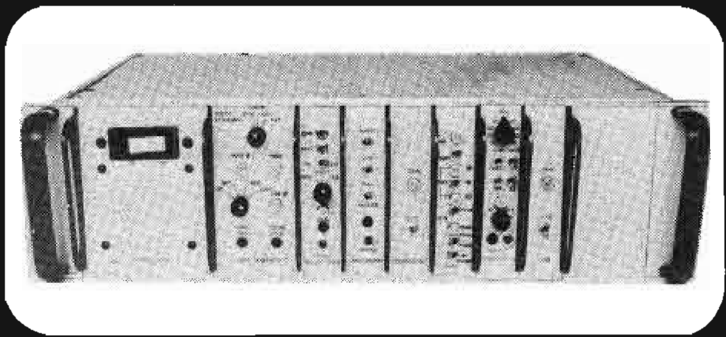
New TV Propagation Curves Still in Limbo

As the case nears its entry into its second decade, the Commission continues to debate the matter of the adoption of new field strength vs. distance curves to be employed in predicting the coverage areas of TV broadcast stations. Although it has long been known that the "official" curves contained in the Commission's broadcast Rules predict service ranges for UHF TV stations generally larger than are ordinarily realized in actual practice, the Commission and the broadcasting industry have been unable to agree on replacements for the curves which are now part of the Broadcast Rules and Regulations.

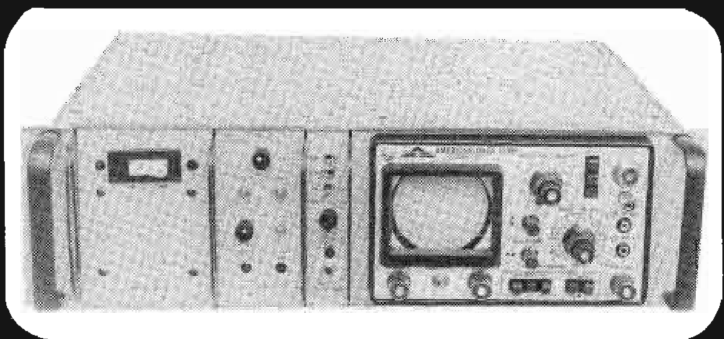
A family of curves developed in 1965 was objected to by broadcast engineers on the grounds of inaccuracy, and these curves were revised a year later, although in the face of some continued objection. About this time, TV broadcast licensees woke up to the fact that almost all stations would have their coverage contours shrunk by the use of the new curves, and the UHF stations would be much more seriously affected by this reduction. Even this realization generated little concern, since most TV stations rely on audience surveys to determine actual viewing.

The increasing penetration of CATV systems, however, caused many stations to take a closer look at the matter, since the coverage and non-duplication rights of broadcasting stations carried on cable systems are established in terms of the coverage contours. In the hope of making the new curves more palatable to broadcasters, the Commission proposed in 1971 to make a further change in the contour distances, by redefining the values of field strength required to provide a given grade of TV broadcast service. These proposed changes likewise ran into industry opposition.

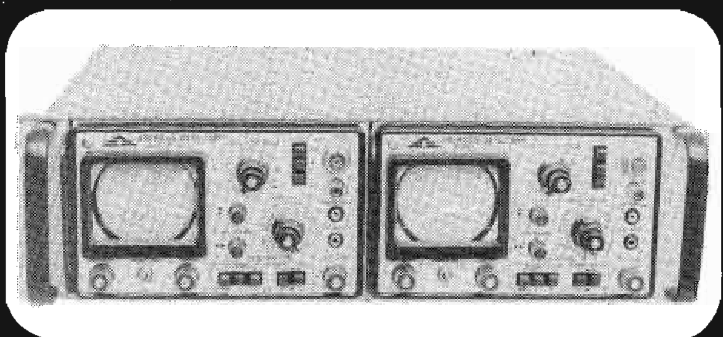
FCC Chairman Dick Wiley is anxious to clear up all pending cases, including this one, and the debate at the Commission continues. Broadcast stations, especially those on UHF channels, want maximum carriage and non-duplication rights from cable systems, while cable systems would prefer to exercise their own option as to which stations are carried. The Commission has considered a possible substitution of a system of fixed mileages to determine carriage and non-duplication rights, but this proposal has also run into disagreement. At this writing, the Commission has tabled the matter, still hoping to find some solution that will fly.



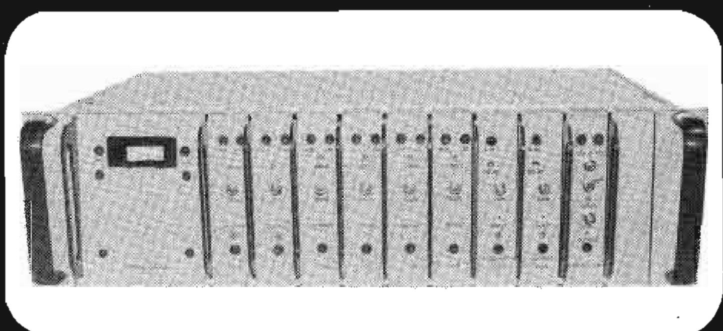
MASTER VIT TEST SETS



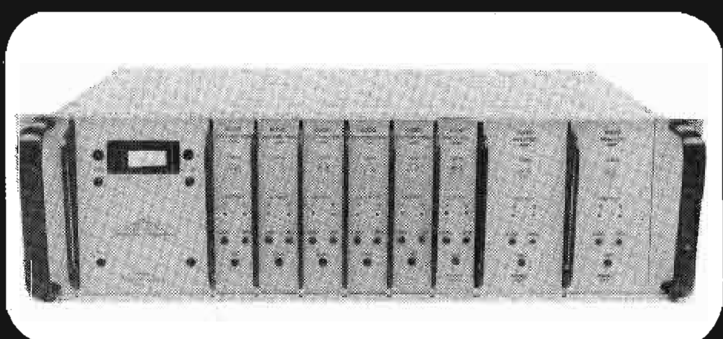
COMBINATION TEST SETS



WAVEFORM MONITORS



DISTRIBUTION AMPLIFIERS



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1114	Pulse Distribution Amplifier
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INDUSTRY NEWS

TV cameramen form societies

TV cameramen will be pleased to learn that there is an organization prepared to give special attention to them: The American Society of TV Cameramen, Inc. As reported in an earlier edition, there is also a second group called The Guild of Television Cameramen. This later group is headquartered in England.

Unfortunately, most cameramen around the world, as well as in the U.S., have not been aware of these two organizations. Now it appears, as a result of publishing something on the existence of the Guild, that the two apparently have common goals. Since there is now communication between the two, it may result in a melding of the two into an international organization.

For further information on the American Society, we suggest U.S. cameramen correspond directly with Robert Zweck, ASTVC President, Box 1189, Radio City Station, New York, N.Y. 10019.

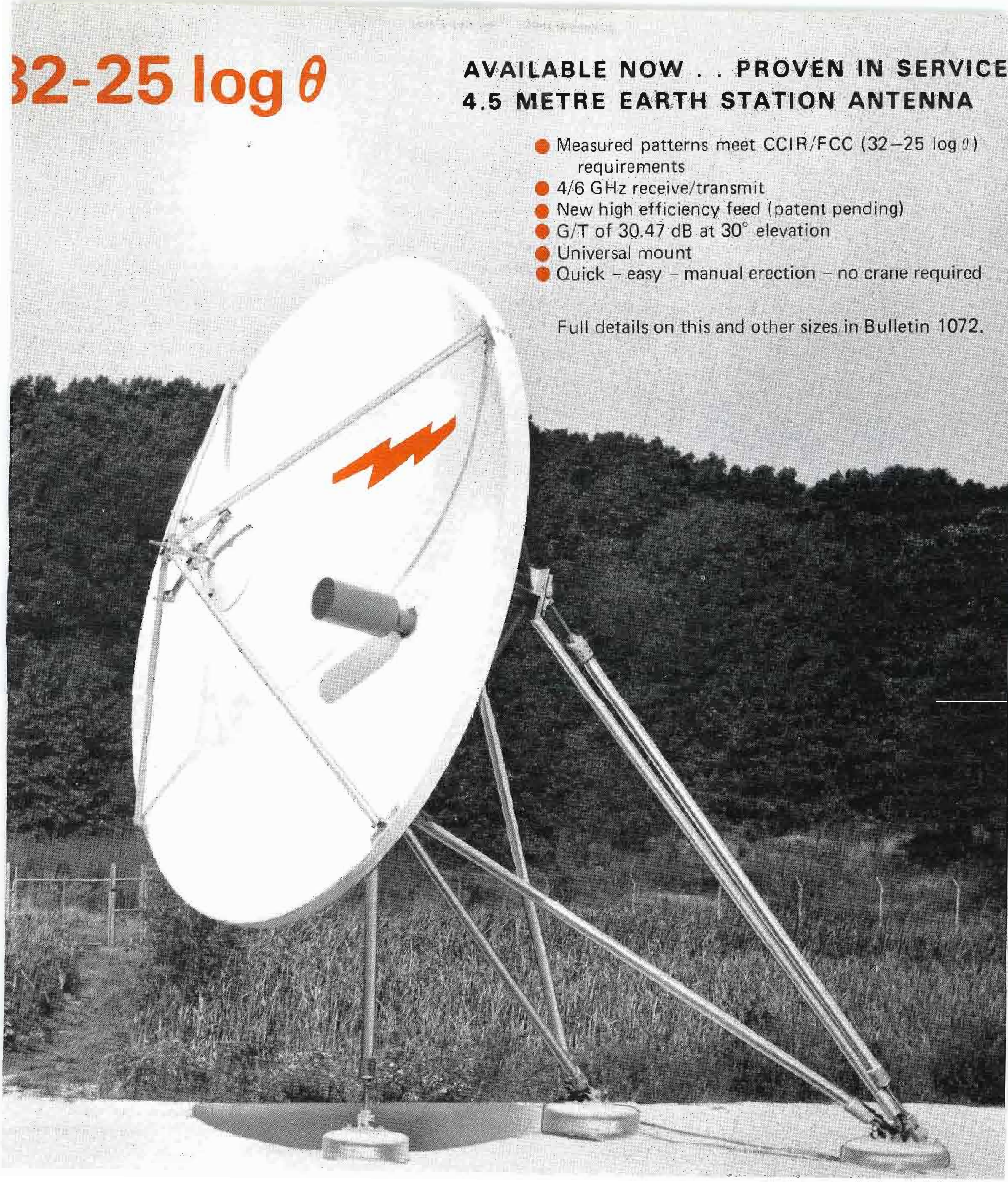
Remote services could be problem

The NAB has vigorously opposed a request by business and educational radio to share the 450 and 455 MegaHertz bands presently allocated for broadcasting's remote pickup services.

In comments urging the Federal Communications Commission to dismiss the proposal, NAB said it's an effort "to wrest additional frequencies" essential to high-quality broadcasting merely "to satisfy the nebulous demands of the Land Mobile Services."

NAB said the business/education radio filing "is fraught with ambiguities, half-truths and, above all, a total lack of understanding as to the intended purpose of the Remote Pickup Broadcast Service."

"Remote pickup frequencies are a programming tool and not a business convenience," it said.



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"Operation Re-regulation"

NCTA will sponsor two "Operation Re-regulation" conferences for cable operators and representatives of Congress and federal agencies in March.

Expanded versions of the NCTA Legislative Conferences held the past two years, the conferences are designed to acquaint law makers and policy makers with cable industry positions on current legislative and regulatory issues.

Cable operators from the Eastern half of the country will attend the first conference, March 2-4. Operators from the Western states will attend the March 16-18 meeting. Both conferences will be held at the L'Enfant Plaza Hotel in Washington, D.C.

NAB asks for fee refund

The National Association of Broadcasters is demanding that the Federal Communications Commission refund to broadcasters millions of dollars in annual fees.

Its filing with the FCC points that the Supreme Court held that its decision invalidating annual fees for cable television also applied to broadcasters; that the FCC itself conceded this in cancelling fees for cable, and argued that failure to refund broadcast fees would constitute "arbitrary and invidious discrimination."

NAB's petition said that in view of the Supreme Court decision and FCC's announced intention to refund cable fees, broadcasters are entitled to "equal treatment" under the law.

NAB also noted that the high court held that regulated industries also perform a public service and should only be assessed for the benefits they derived and the assessment of annual fees meant that "CATV's and **other broadcasters** would be paying not only for benefits they received but for the protective services rendered to the public."

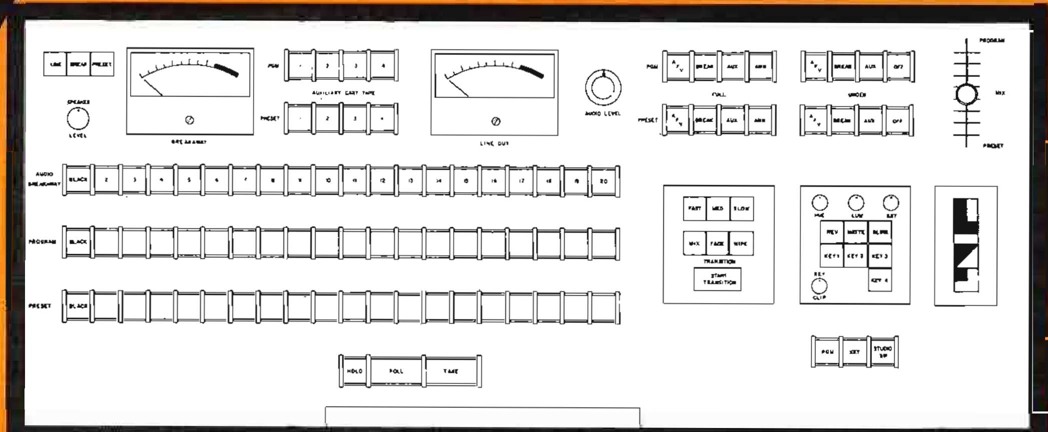
The NAB petition said the FCC itself "conceded the impropriety of the existing annual broadcast fee" by noting that the Supreme Court ruling "raised certain basic questions" about its schedule of annual fees.

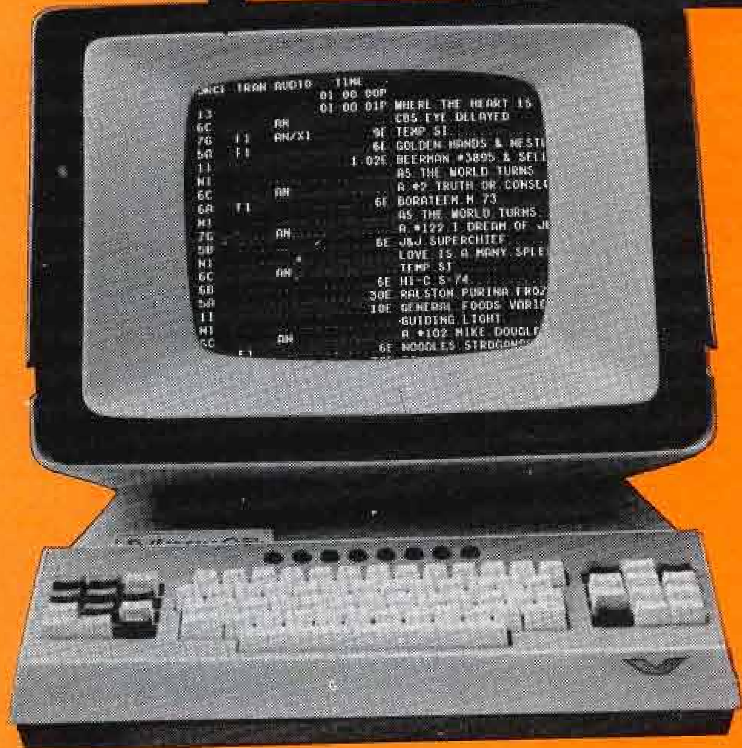
"Since the standard utilized by the Commission in setting the cable fees was arbitrary and unlawful," NAB's petition said, "the same would hold true for that upon which the broadcast fee was premised.

"A disparate treatment between the cable and broadcasting industries...would invoke evidence of arbitrary and invidious discrimination.

"NAB submits, therefore, that as a result of the NCTA (Cable) decision and the determination to refund annual cable fees, the Commission is now obligated at law to respond to broadcast petitions for annual fee refunds in a like manner."

VIMAX 27





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SOCIETY OF BROADCAST ENGINEERS, INC
P O Box 88123 Indianapolis, Indiana 46208

Broadcast Engineering magazine provides this means whereby the members of the Society of Broadcast Engineers can report on SBE chapter meetings, announce future events, and have articles, papers, and other technical and nontechnical items published.

Chapter chairmen should see that information on meetings and other news is sent promptly, as soon as it is available, to the SBE Editor, Joe Risse, P.O. Box 131, Dunmore, Pa. 18512. Include photographs whenever available; preferred photograph size is 8 x 10, but smaller sizes are also usable.

The deadline for submitting copy to the SBE Editor is the 25th of the second month preceding publication.

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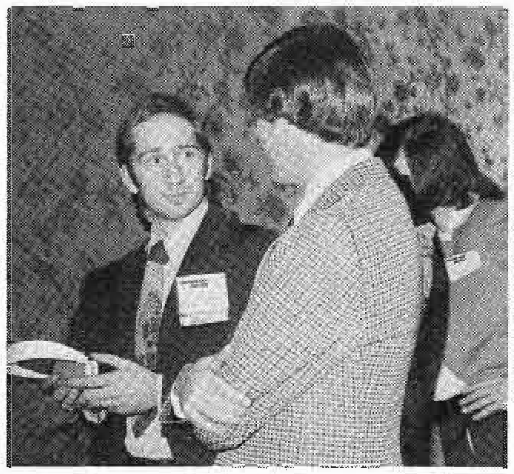
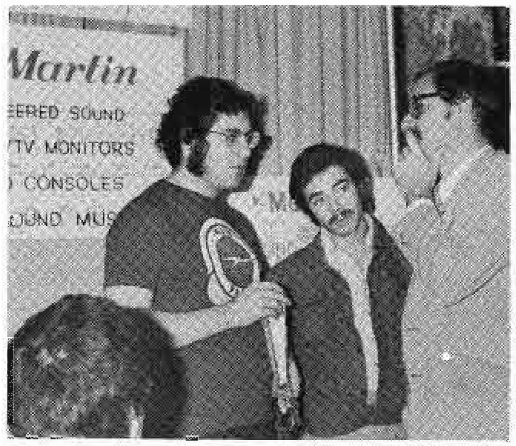
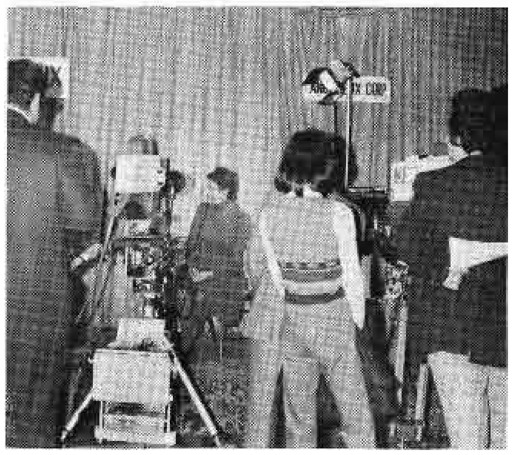


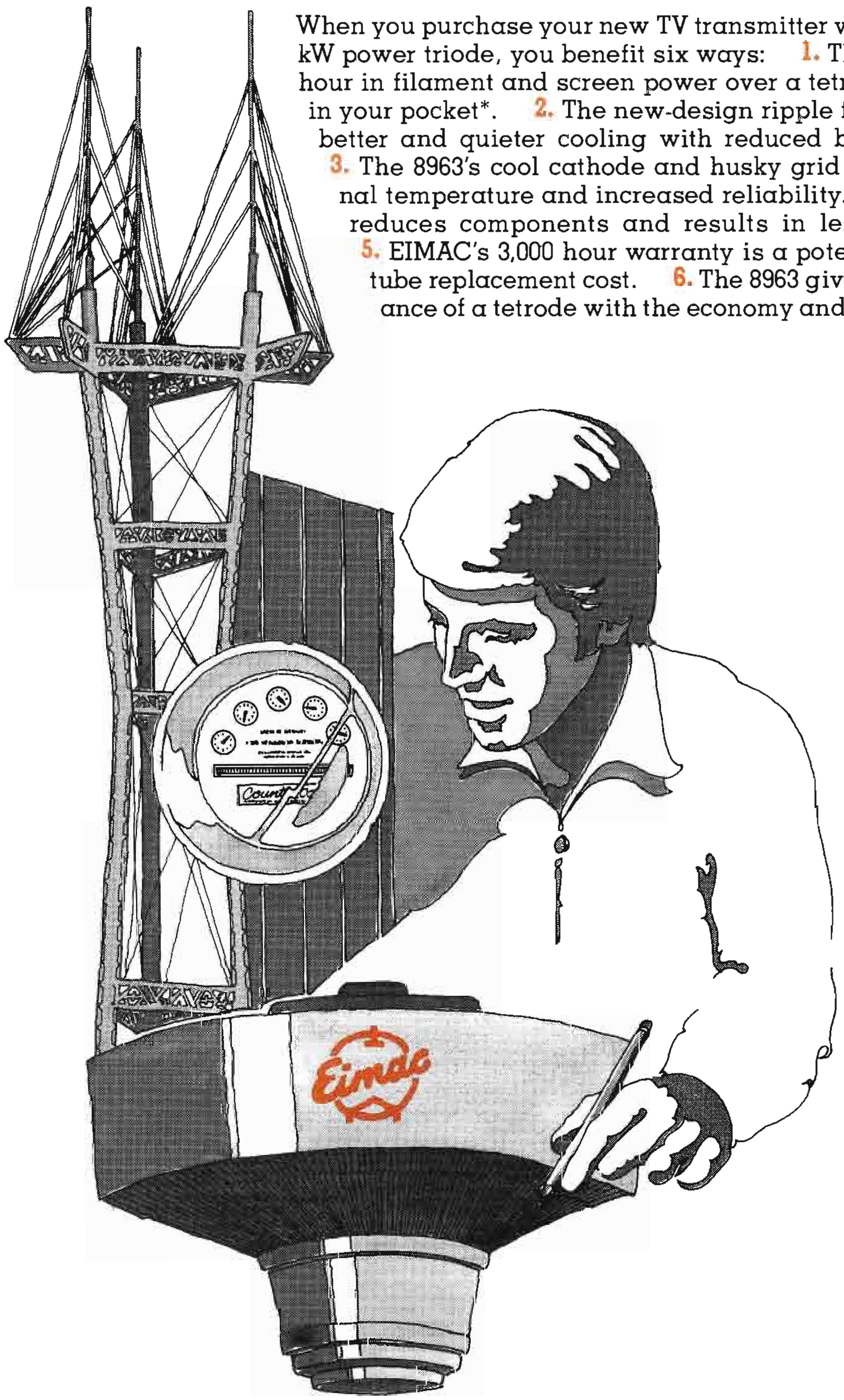




These pictures were taken at the mini-convention sponsored by the New York Chapter. SBE has been successful with their mini-convention mainly because the Chief Engineer - the chief buying influence - heads the list of attendees. However, these conventions also have included key sessions with industry heads covering important industry issues.

TV Station Executives...

EIMAC's 1975-model 8963 TV triode saves you money six ways.



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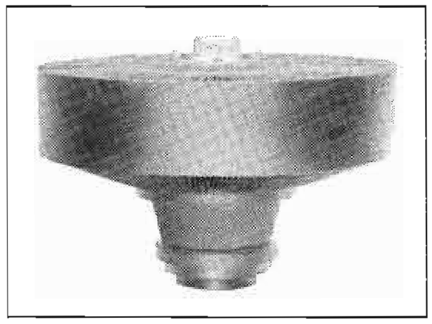

Put dollars in your pocket and enjoy improved transmitter reliability with the EIMAC 8963. For complete details, ask your TV equipment distributor or write EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070. Or contact any of the more than 30 Varian/EIMAC Electron Device Group Sales Offices throughout the world.

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*Based on an 18 hour transmitting day at 3¢ per kWH—and rates are going up (Business Week, Oct. 5, 1974).

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SBE

(Continued from page 12)

Chapter Reports

Chapter 1: Binghamton, N.Y.
Chairman: Bill Sitzman, Jr.
Tyrone, N.Y. 14887

On December 10th, optional dinner at the Ramada Inn was followed by a meeting at WBNG-TV, Binghamton. Bob Raboin, Supervisor, End User Sales, Amperex Corp., demonstrated the Plumbicon camera tube plus other innovations of the Amperex and North American Philips Co., in the video field. Chairman Sitzman thanked Doug Colborn for having presided over the previous meeting while the chairman was recuperating from loss of voice.

Ususally the chapter meets on the 2nd Tuesday at the Owego, N.Y. Treadway Inn. For further information on future meetings phone (607) 273-2970.

Chapter 15: New York, N.Y.
Chairman: John M. Lyons
Woodside, N.Y. 11377

The December 12th meeting was held at the Cowboy Restaurant, 60 E. 49th St. Morley Kahn and Mike Faulkner of Dolby Laboratories, New York, discussed the reduction of net FM pre-emphasis when Dolby type encoding is simultaneously employed. The technique was demonstrated and applications were reviewed.

For information on future meetings in New York call Chairman Lyons at (212) 335-1600.

Chapter 16: Seattle, Wash.
Chairman: Harry Lewis
Seattle, Wash. 98125

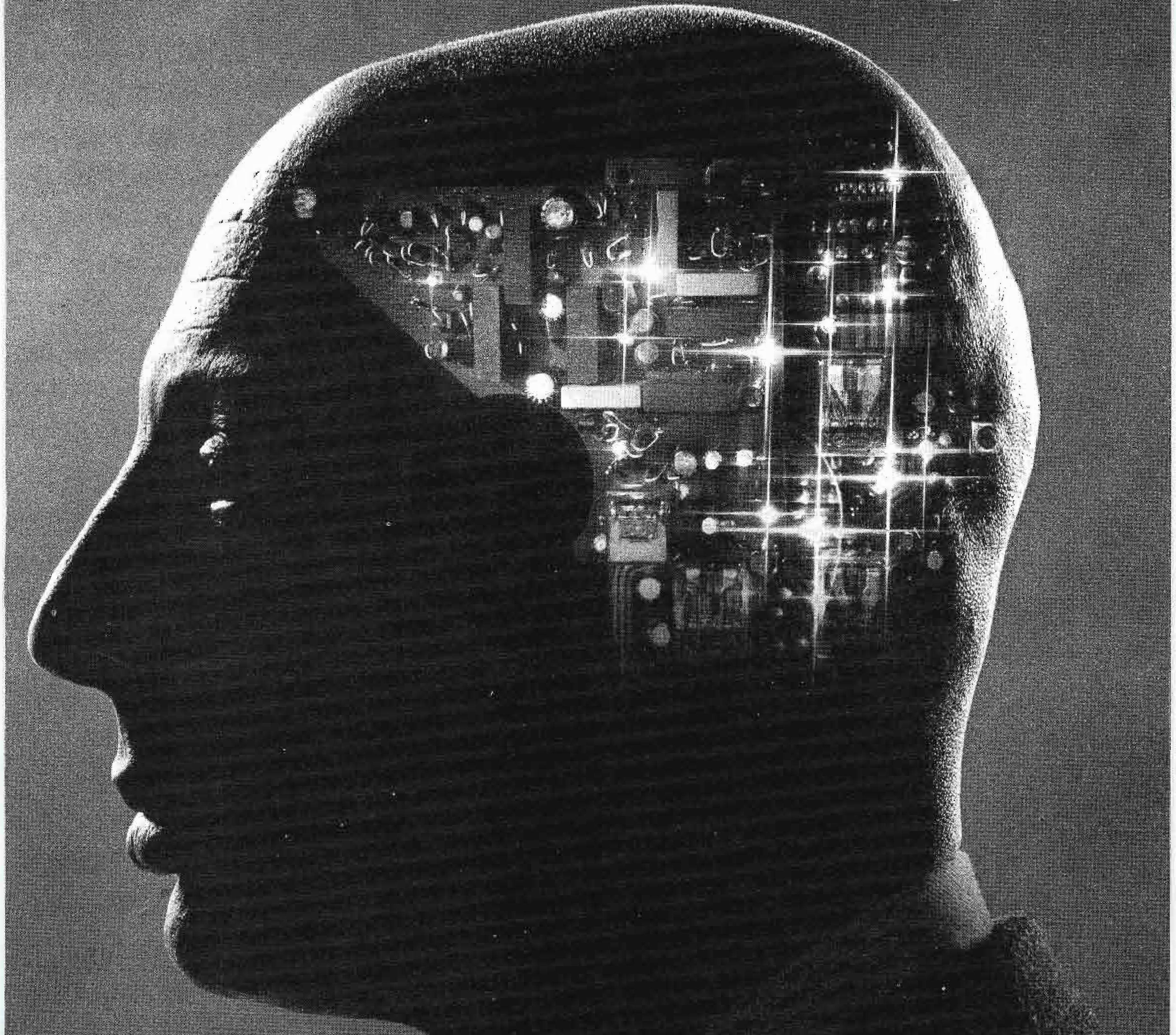
The December 11th meeting, held in the Downstairs Banquet Room, featured Russ Williams, Ampex Regional Sales Engineer, who demonstrated and described the AMPEX AVR-2 modular portable quad videotape recorder.

Chapter 17: Minneapolis-St. Paul, Minn.
Reorganization Under Direction of:
Joel Humke, St. Paul, Minn.
Reynold Lark, Egan, Minn.

Editor's Note: Thanks to Engineers Humke and Lark, Chapter 17 is on the way back to becoming one of the largest and most active. Arrange-

(Continued on page 16)

Can a chief engineer afford to think only like an engineer?



Put a good picture on a TV set.

That's always been the first thing a chief engineer has to think about.

But it doesn't seem to be the only thing anymore.

Today, more and more chief engineers are thinking more and more like station managers.

They have to. They've got staff meetings to go to, they've got equipment to buy, they've got cameramen to keep happy, they've got program directors to keep happy.

Now they've got this whole new thing of electronic journalism to think about. How can their station adapt.

Most agree the way to do that is with one of those little portable color videotape systems. The ones they also agree don't quite stack up to film.

Well, we agree too. They don't. Not on a studio monitor anyway.

But what about the guy sitting at home in front of his TV set? He doesn't know how many scanning lines a studio monitor has or how many his TV set has.

All he knows is that he sees the news or he doesn't.

If there was a fire downtown at 4 o'clock and he hears about it on the radio driving home, he wants to see it at 6 o'clock. Instead of hearing about it. Again.

And if one station can get that kind of news on the air consistently, chances are the guy at home will be watching that one station. Consistently.

And chances are that station will be using the Akai VTS-150, the portable color videotape system that's being used by more stations in more states than any other system.

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SBE

(Continued from page 14)

ments are being made for a meeting place and technical speakers. Contact either one of the above to learn when the next meeting will be held, and where.

Chapter 20: Pittsburgh, Pa.
Chairman: Henry R. Kaiser
Pittsburgh, Pa. 15212

The December 19th meeting, held at Buddies Upstairs, was a general discussion meeting which included seating of newly elected officers: Chairman Jim Hurley, Vice Chairman Jack Cvetic, and Secretary-Treasurer Frank Davis.

The November 5th MiniVention was reviewed and it was generally felt that this event was most successful. A repeat for next year was planned for discussion in the early future. The encore was being urged by a number of the exhibitors.

Chapter 21: Spokane, Wash.
Chairman: T. O. Jorgenson
Spokane, Wash.

Featured speaker, Frank Coile, Chief Engineer of KWSU, discussed Translators in Eastern Washington for Educational Television on November 18th at the usual luncheon meeting at the Castle Restaurant. Mr. Coile suggested that the group hold at least one meeting in Pullman, Washington in 1975.

Chapter 22: Central N.Y.
Chairman: Mort Miller
Syracuse, N.Y. 13214

The December 19th meeting, held at the Northway Inn, Syracuse, was chaired by Hugh Cleland, program director. The program started with a 20-minute videocassette, courtesy of WCNY, on using and taking measurements with the Tektronix 520 Vectorscope. Following that, the meeting was open to a general engineering exchange or open discussion on problems, solutions, new developments, and FCC regulations.

Chapter 25: Indianapolis, Ind.
Chairman: Don Morgan
Indianapolis, Ind. 46217

Chairman Morgan presided over the November 19th meeting at the I. U. Dental School. The Tek Corp., demonstrated Broadcast Signal measurements. Tektronix Engineers Paul Raymond, Juan Moore, and Roger

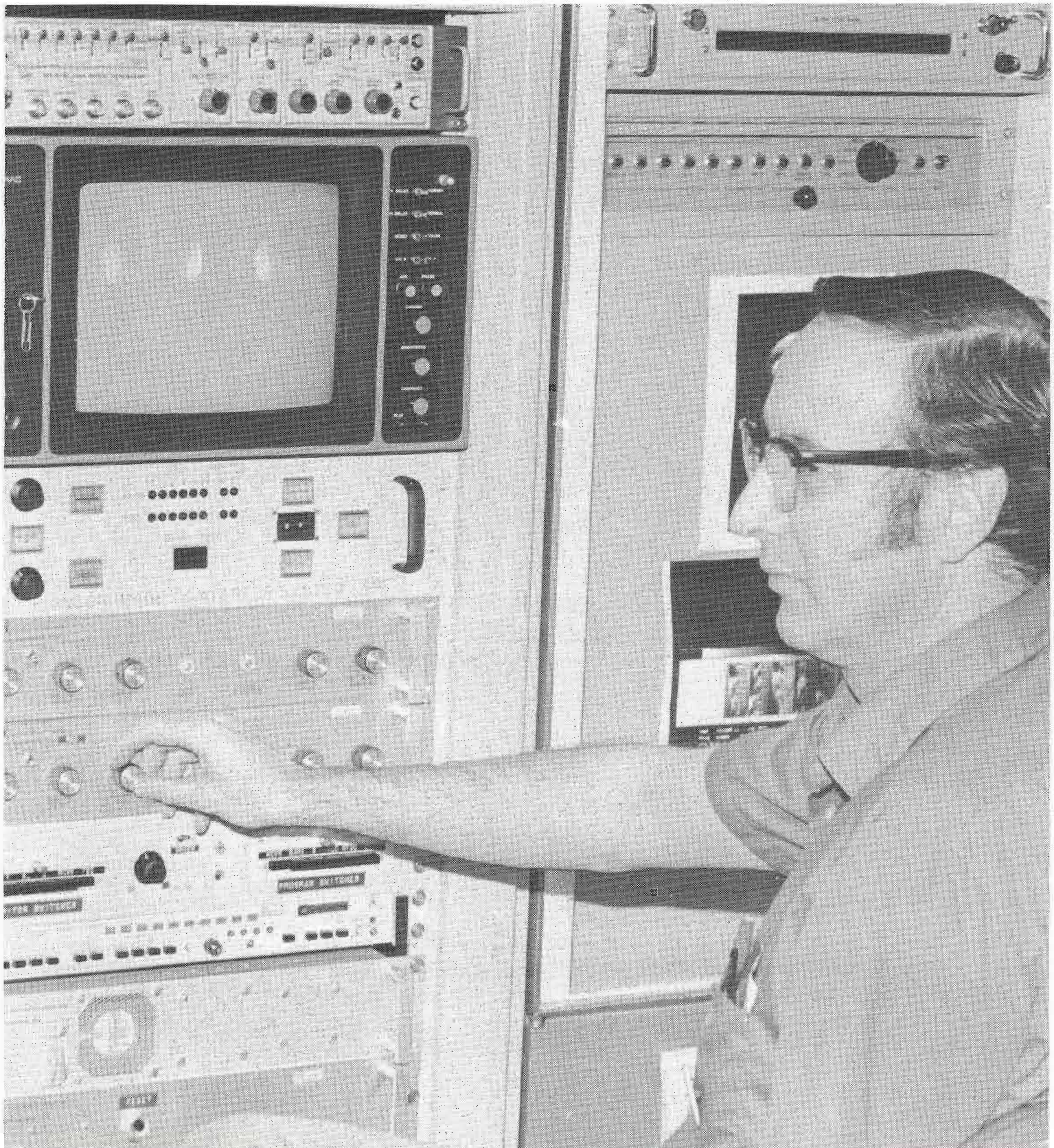
(Continued on page 55)

FEBRUARY, 1975

CABLE ENGINEERING

In this issue...

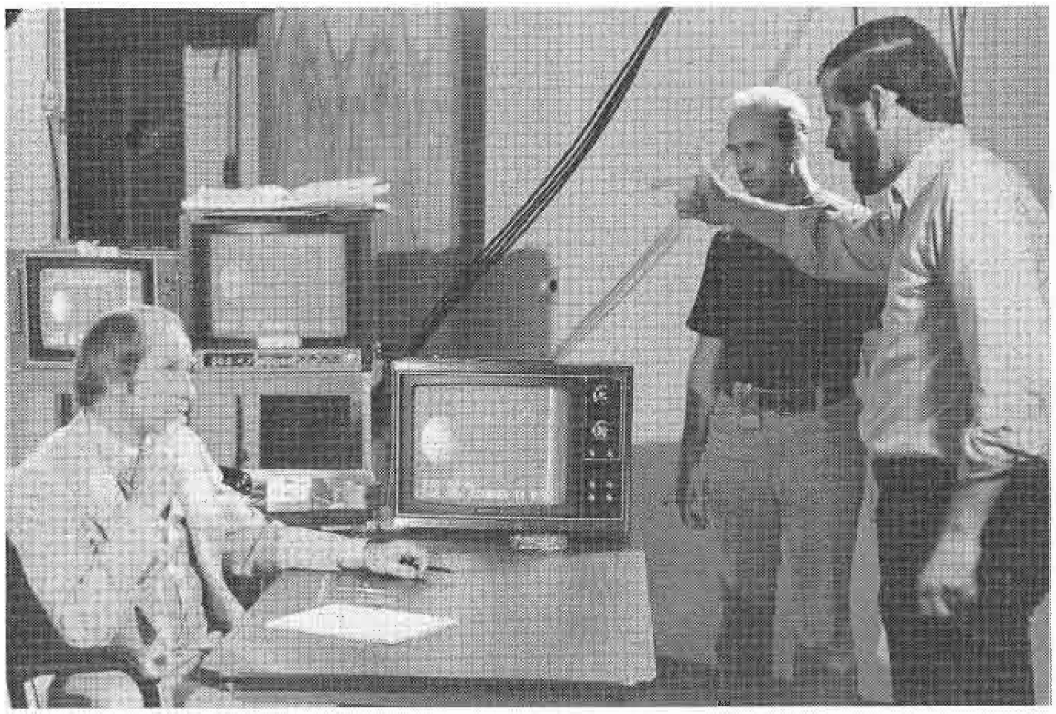
Cable TV takes on Jupiter Flyby CE-2



Cable TV takes on Jupiter

By Joe Roizen

(Photos by Donna Roizen)



Apollo astronaut Al Worden takes directions from Larry Sturges. Program coordinator George van Valkenberg looks on.

The largest and most mysterious planet in our solar system which has fascinated terrestrial astronomers for several hundred years is Jupiter. Ground observations have established the size, rotational period, and other topographic features. But in an effort to ever refine our knowledge of our own solar system, NASA launched two space vehicles in the past 32 months which were targeted to go around Jupiter and send back signals relating to that planet's atmosphere, magnetosphere, radiation belts, and other scientific details.

While the measurements of Jupiter's specific characteristics are of interest to specialists in the scientific fields involved, the aspect of the Pioneer 10 and 11's fly-by that most intrigued and amazed television viewers all over the world were the actual images of the planet returned from the satellite by a television camera that must easily be the most sophisticated (and expensive) color TV camera to date. The statistics regarding the problem of sending back any signals at all are impressive. Pioneer 11's transmitter, generating an 8-watt output, sent its electromagnetic radiation through 450 million miles to space, a distance so great that even at the speed of light (186,284 miles per second) it takes 42 minutes for the signal to arrive at earth.

Holding Down The Noise

Since the earth is rotating, three separate ground stations located in Goldstone, California, Madrid, Spain, and Canberra, Australia are used to constantly track the space vehicle with parabolic disk antennas measuring 210 feet in diameter. By the time the 8-Watt signal reaches earth, it is at an infinitesimally miniscule level, in order of a quadrillionth of a watt, or in electrical terms minus 153 dB.

To amplify this signal without inserting additional system noise, the amplifiers at the ground stations use masers operating at 7° K, a temperature achieved through the use of liquid nitrogen and needed to slow down atomic activity within the solid-state devices used for separating this minute signal from background interference. If distance is not enough, there is a further problem that when the spacecraft approaches the planet and achieves periapsis it must go through severe radiation which may

Flyby Continues On Page CE-4

Management Highlights

Cable, community college television, and local educational institutions scored a significant plus in providing over a million viewers in the San Francisco Bay Area with television access to a momentous event that unfolded itself over a five day period and which received only cusory coverage from the national networks. If there was ever an example of the advantages that are available to the viewer through intelligent use of a cable system, this was probably one of the prime ones.

NASA's exploration of our own solar system through the Pioneer series of space vehicles, which carry television cameras that send back pictures of our neighboring planets, is one of space technology's greatest achievements that is unfortunately eclipsed by the more dramatic Apollo missions that involved human passengers. From a technical standpoint, the problems of sending back television images and other scientific data from distances approaching six astronomical units are phenomenal.

The average viewer getting his evening dose of national news was given only a few minutes of highly condensed pictorial reporting during the peak activity period near periapsis. Obviously, much more was going on at NASA's Mission Control as Pioneer II began sending back reams of information while it was in the proximity of Jupiter. Scientists, who had designed and were conducting the on-board experiments, all gathered at Moffett Field to explain what was happening to science editors and other experts attending the press briefings.

NASA's desire to publicize this event and to also record and distribute later led to a unique opportuinty where literally hours of fascinating program material obtained through interviews with the assembled experts were made available over microwave lengths to the local cable companies, TV equipped community colleges, educational stations, and museums. At least, the population in this area had a picture-window view of an historical and technological space success which the rest of the nation saw only through the dim porthole of restricted prime time.

affect the performance of the unit significantly and may even damage it beyond recovery.

Television viewers throughout the United States were given relatively short news briefs about the Pioneer 11 Jupiter fly-by by science reporters such as Roy Neal and Jules Bergman which limited reporting of this significant event to a mere few minutes of national network time. That is deplorable when one considers the amount of time allocated to murder, mayhem, and military activities instead of to a positive accomplishment of this kind. Viewers in the San Francisco Bay Area, however, who were connected to cable television or those willing to visit local community colleges, educational institutions such as the San Francisco Arch Diocese and museums like the Exploratorium, were able to see extended coverage of the whole project through a very unique TV system set up by NASA at their Ames Research Center in Moffett Field.

Press briefings during the critical days of the Jupiter fly-by were conducted with full color coverage and permitted viewers to listen to the scientists and project leaders who explained the progress of the spacecraft and the state of the data being received. Press representatives could ask questions and received direct responses from such noted scientists as James van Allen, who discovered the radiation belt around earth which is named after him, and Dr. Guido Munch of the California Institute of Technology, who has conducted the infrared radiometer measurements of Jupiter's net heat energy output which may solve one of the greatest mysteries as to whether Jupiter is actually radiating more heat than it receives from the sun.

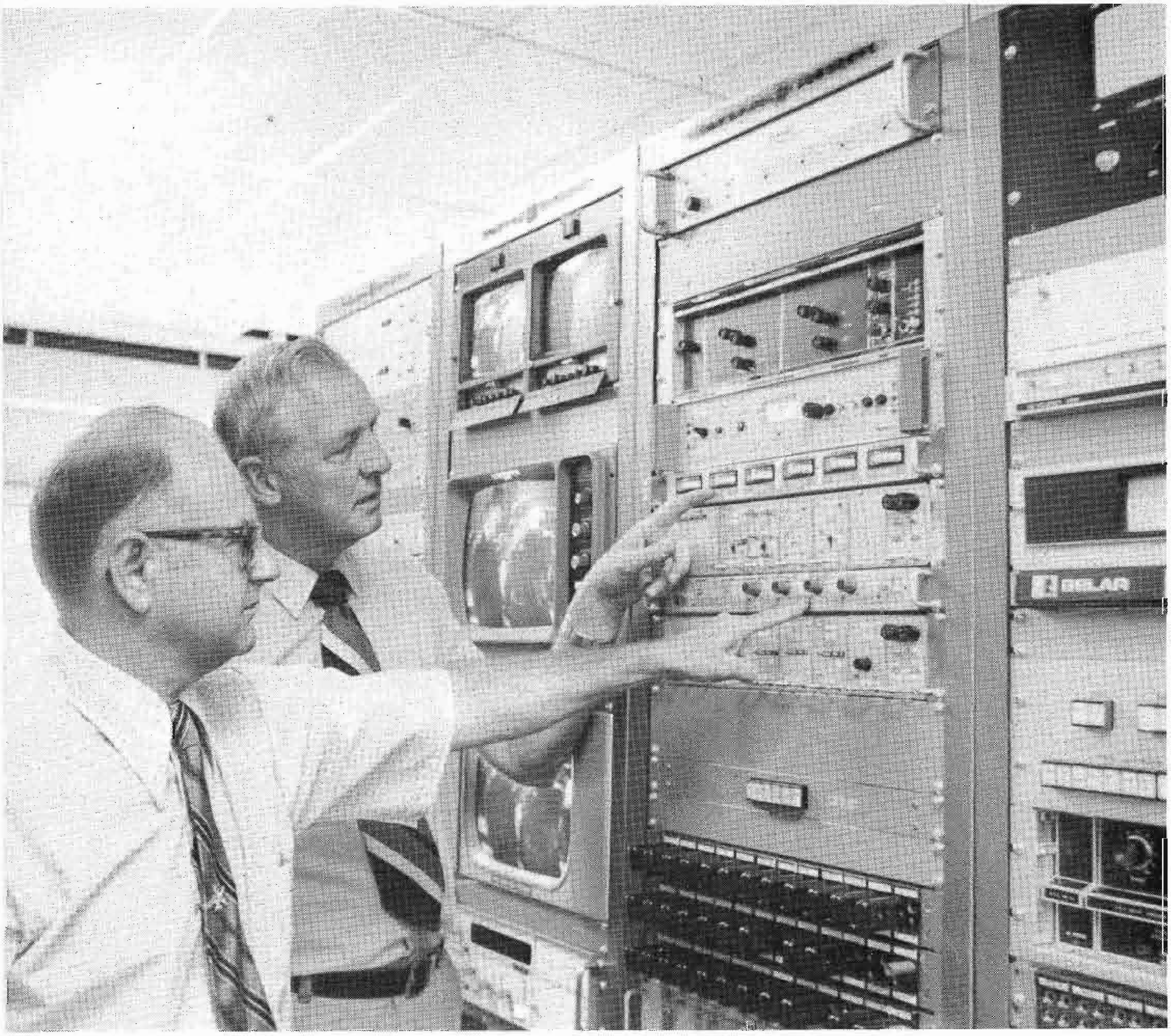
The combination of the pictures being generated by the imaging photopolarimeter on Pioneer 11, with its ever closer views of Jupiter and those coming from the press center or the studio, were constantly being recorded in U-Matic and one-inch format on a pair of Sony and two IVC 800 series machines. It was possible therefore to either feed live signals of the events at NASA out to the viewers that were hooked into the system and to repeat these programs at more convenient time (one press conference was after midnight) through the use of VTR playbacks that went through digital time base correctors in order to make them broadcast stable. If the national networks needed locally prerecorded Jupiter images to overlay on their commentary, the VTR machines with the correctors could be used for that purpose.

Public interest in this television solar system spectacular was obviously high since the San Francisco Exploratorium reported that they had 10,000 visitors go through to view the special monitors they had set up for this purpose. The local cable companies figured that they were reaching 200,000 homes as far south as Monterey and potentially a million viewers. Obviously, this is one of the areas where cable TV can provide a unique service to the community by bringing high interest information to local subscribers of an event which regular commercial television cannot or will not assign much time to.

The method by which the images are returned from Pioneer 11 is in itself worthy of description. The imaging photopolarimeter, which was conceived by Dr. Tom Gehrels of the University of Arizona and built by the Santa Barbara Research Center is a most unique TV camera weighing nine and half pounds, using 2.2 Watts of power and employing a one-inch telescope as its lens to scan celestial bodies in our solar system. The IPP consists of a dichroic image splitting system that divides the light coming through its lens into red and blue components. Two super-sensitive photo diodes generate electrical signals proportional to light intensity which are stored in the camera's EC memories in the sequential fashion they are received from the stepping action of the lens system as it scans in increments across a controlled angular position of up to 141 degrees. Since the spacecraft itself spins approximately once every 12 seconds, the combined spin/scan motion produces the two dimensional requirements for creating an image.

VIR helps automate transmitter adjustments

By Archie Brusch, KATU, Portland, Ore.



The three units of the 1440 are shown installed in the rack at KATU. CE William Vandermay is pointing to the small meter panel, while Assistant CE Archie Brusch points to the control panel. Top position in the rack goes to the heart of the device.

In March, 1971, the five Portland, Oregon television stations were involved in an actual on-air test of the VIR signal. Stations KATU, KOIN-TV, KGW-TV, KOAP-TV and KPTV were activated during the experimental period with KOIN-TV acting as the originating station. Through the cooperation of Pacific Northwest Bell and associated AT&T companies, the signals were sent through a 1,000 mile loop to simulate a typical transmission circuit, then back to Telco and fed to the various stations involved in the test. The tests were supervised by members of the BTS committee and representatives from interested engineering firms and television consultants from throughout the USA were in attendance, observing and serving as judges of the test results.

Pre-selected color slides with an assortment of APL's, color saturation and hues were transmitted both with and without the VIR signal. When the VIR signal was sent, each transmitter operator adjusted his phase, chroma amplitude, luminance amplitude, black level, etc., for an optimum recovered demodulated VIR signal. The group of skilled observers at the receiving site then made color and quality judgments on the signals from the four stations transmitting (unfortunately, disaster struck and the KOIN-TV towers fell the previous morning so their transmitter could not participate).

Judgments were made with and without VIR adjusted signals. VIR adjusted signals showed a definite improvement in picture quality, and perhaps to be expected, showed that the worse the picture degradation before VIR, the more significant the improvement as seen with VIR.

At the receiving site, all four channels were optimized on a carefully engineered receiving system. All color receivers were made identical as to light output, color balance, etc., and the transmitters involved had been optimized previously.

It was at this test site that the first hint of the concept to use the VIR as a reference in order to electronically automate transmitter adjustments came to our attention. This gives you a little of the background of the VIR signal, where it originated, and how it was officially field-tested in Portland.

A new and useful device for video control is the Tektronix 1440 Automatic Video Corrector. KATU, Channel 2, an ABC affiliate in Portland, Oregon, has been operating a 1440 since April of 1974, in conjunction with our RCA TT-30FL Parallel Television Transmitter, with such interesting results that we felt we should share our experience with other stations.

Your Transmitted Signal

Basically, the 1440 can be used in two entirely different applications, as shown in Figure 1. First, in open loop operation, it could be used to automatically adjust incoming video from various sources such as a network feed or a remote feed. We do not use the device in this manner. At KATU, we have installed the 1440 in a closed loop circuit at the transmitter.

The VIR signal is added to the program signal at the studio Master Control output. It traverses the STL and transmitter. A Telemet 4501 Demodulator recovers the video signal, including the VIR signal, from the transmitter's output feed line and feeds it back to the 1440.

The 1440 also receives the video signal from the STL and introduces compensatory changes in this signal as it is being fed to the transmitter. These changes or pre-distortions are determined by the distortions suffered by sync, burst and the VIR signal as recovered by the demodulator and fed back to the 1440's other video input.

Correcting Errors

The 1440 can correct; sync amplitude, burst amplitude, and set-up, picture modulation depth, chrominance to luminance gain errors, and burst to chroma phase errors.

The first three errors are subject to FCC tolerances, and the last two directly affect saturation and hue errors in the received picture. The 1440 now uses the VIR as a standard to rebuild the signal **as it appears at the transmitter output coax feed line** in the following manner: the SYNC GAIN is adjusted to exactly 40 points, and stays at 40 points, even with soft tubes which are stretching and compressing the sync level with APL changes. There is no compromise, no question, you get a clean 40 points—no more, no less.

The BURST GAIN is also controlled to exactly 40 points—no more, no less, just as sync gain is held constant. When viewing the recovered signal through the demodulator on the Tektronix 529 waveform monitor, flipping the RESPONSE knob on the 529 to HIGH PASS gives you a presentation of burst and Chrominance Reference Bar that you can lay a straightedge across.

Because the chroma of the burst should be matched exactly to the phase of the Chroma Reference Bar, the 1440 does just exactly that. When viewing the line 19 VIR signal on the 520 Vectroscope, the phase displacement is negligible and the lengths of the vectors match exactly, even under severe APL conditions.

Working on the same philosophy, the 1440 now turns its attention to the CHROMA itself. If the sample from line 19 VIR tells the 1440 that the CHROMA is down 5 points at the transmitter output line, then it adds enough CHROMA GAIN to bring it back up to 40 points.

The VIR signal includes a chrominance reference of 40 points. This is modulated on a 70 point pedestal. This chroma reference will suffer both differential gain and differential phase distortions in the transmitter.

When the amplitude and phase are restored by the 1440, a lot of wrong looking faces look right again.

The 1440 corrects burst amplitude to 40 points, independently of its chroma gain correction, so if there is a lot of differential gain in the system, flesh tones and your burst are both correct. You will know when this is happening but your viewers will not.

Turning its attention now to the portion of the VIR which rides at 50 points on the recovered waveform (Luminance Reference), our electronic smartbox now either shifts the overall video gain up or down as needed and lays that portion of the VIR signal exactly on 50 points.

While doing all of the above, the device is also eyeballing the set-up on the recovered VIR signal, and lays it exactly where you want it. Want 7.5 points? You get 7.5 points!

As any transmitter engineer will confirm, if you had manually adjusted the above parameters as previously described, you would spend the next ten minutes carefully going over and over the same set of adjustments, each time correcting to smaller and smaller errors, until your eye said, "it's o.k." The 1440 makes the corrections fast and simultaneously. Once presented to the signal to be corrected, it corrects all six items mentioned in the discussion above—in about 300 milliseconds. It does not just start to correct in 300 milliseconds, it completes the job in 300 milliseconds. As a result, the variation in transmitter power output is negligible and needs little or no attention.

Figure 2 shows the classic VIR signal, and the points involved in the previous discussion are all marked for clarification. With this information, you will better understand the method used by the 1440 to correct to the VIR, which is used as the "standard" by the device.

Physical Layout

Physically, the entire system including the meter panel and control panel consists of three units. The latter two are sold as an accessory. The 1440 itself (without the two accessory units) occupies 3½ inches of panel space and all cabling and fittings occupy about 19 inches of depth. This unit is mounted on slide rails and may be pulled out for service, using a simple adaptor. The panel simply contains an on-off switch, a fuse and four LED indicator lights telling which of the four modes the 1440 is operating in.

One of the accessory units contains six sensitive zero center meters in a 1¾ inch panel. Total depth, including cabling, is about 11 inches. The other accessory unit contains external adjustments, some in the form of pots with knobs, others are recessed controls with screwdriver and adjustment slots. More about both of these units later in greater detail. The three units described are interconnected by two 36-conductor cables with blue ribbon connectors.

An unusual bonus is the ability of the transmitter engineer to use the meter panel to do many things. If your incoming video is normal, you can assume (we find) that the 1440 is functioning perfectly, therefore, you can make ratio adjustments on things like sync, set-up, master gain, chroma, burst gain, etc., by simply adjusting the transmitter control and watching for the 1440 meter on that function to cross the ZERO mark.

The zero center meters show the corrections being applied to video in order to produce the classical VIR signal at transmitter output. Take sync gain for instance. If your transmitter is in reasonable shape, and the incoming signal ratio is correct, and you note that the 1440 sync gain meter is, say at +10, then you can safely run your sync gain on your transmitter (if it has one) to return the meter to zero and you will find that you have optimized your transmitter, which can then be confirmed by flipping the 1440 out of the circuit into its bypass mode.

The above illustration actually has occurred at KATU several times because we are remote controlled from the studio and it is easy for the remote operator to run up sync (or make other adjustments) not realizing that he is doing so. The 1440 corrects for this error, but the maintenance man can then eyeball the meter panel and reset sync for zero reading knowing he is returning the transmitter to normal adjustment.

Another very useful function of the 1440 is to observe the SYNC GAIN meter during varying APL. When your transmitter tubes are near the end of their useful life, sync will bounce with varying APL. As long as the 1440 will control (read on scale), you know that you are safe in keeping the tubes in the socket, thus extending their life. You also have a built-in tube checker for rejecting them. We also

use it to observe the condition of our driver tubes, final amplifiers, etc., as follows.

We can supply the RF sample signal to our demodulator from several strategic points by using a cross point switcher with high grade coaxial relays and commercial 6 dB pads terminating each line coming from the sample points. The most important sample point is the output of the Vestigial Sideband Filter, and the recommended sample point to feed your demodulator which then feeds its own video into the 1440 for a closed loop corrective sample.

Let us assume there is some sync stretch in our transmitter. We know this just by glancing at the SYNC GAIN meter on the meter panel. (Although the signal being broadcast is still perfect.) Let us say it is reading -15. Now, we have a terrific service instrument at our fingertips. Simply select the sample coming from Transmitter A (remember, our Parallel transmitters are twins) and see if the meter goes back to normal. If it does, you have just given Transmitter A a clean bill of health. So, we then select the sample from Transmitter B final stage. This shows (in this case) the -15 reading. Having followed the abnormal reading to Transmitter B, we wish to know if it is the final tube or the driver tube. So, we select the next sample from the driver stage output. If we find the meter still reading abnormally at -15, the trouble is probably in the stage just preceding our sample, which is the driver. Should the meter read normal on this stage, however, the trouble is obviously in the final amplifier stage.

It appears then, that we have a built-in servicing system, thanks to the combination of the 1440 and our selective RF sample points, thus reducing maintenance time. Your imagination should by now be showing that you can find the source of frequency response trouble. This can be done during air-time, thus providing a dynamic servicing instrument for use on the air, with little or no effects to the viewing public. While I am sure that Tektronix did not intend for the 1440 to turn into a "Transmitter Checker," that is the way it has turned out at KATU!

Modes Of Operation

As mentioned, the 1440 operates in one of several different modes of operation. Let us take a look at them. First, it can be manually bypassed with a lever switch on the control panel. This gives you a look at your system without the correcting efforts of the 1440 and is a useful service function.

In the manual control, the knobs on the front of the control panel become the controls for an excellent in-line, manually operated processing amplifier without the automatic correcting abilities previously described.

The most important mode is the VIRS control position. In this mode, the 1440 is using the VIR signal from line 19 as seen at the transmitter output sampling point through the demodulator, and controlling the signal automatically.

When VIRS Is Not Present

Pre-set mode is also very important. Assume that the VIRS is not present on the programming material. What then? Simple! The electronic brain inside the box says, "I see no VIR, therefore I command the circuitry to proceed to the PRESET mode." Now a different set of screwdriver adjust-type controls have been pre-set to match what the 1440 was doing on VIR control, and when the unit flips to this pre-set condition, no one out there in TV-land is aware of it. True, dynamic corrections are not now taking place, however, the pre-set controls are set for optimum and unless your transmitter develops severe trouble during pre-set mode, you are in good shape. Why drop the VIR? Let us talk about that a bit.

We face several problems at KATU that are perhaps not normal. First, we are operating by remote control from the studio. FCC requires that the operator at this control point (studio, in our case) be able to adjust all ratio and power levels. Second, we are operating two Parallel transmitters (RCA TT-30 FL) into a combiner and the 1440 must control both transmitters.

How about this legal requirement? Let us say the 1440 is functioning on VIR control and the remote operator decides to change sync level. He pushes the correct buttons on the Moseley remote system to run the sync level higher, but the 1440 recognizes an abnormal situation and automatically starts cranking the sync back down! In other words, the 1440 will defeat each and every function that it is capable of controlling, as far as the operator at the remote end trying to adjust things.

To solve this problem, provisions are made to drop the VIR where it is inserted at the studio. The absense of the VIRS then places

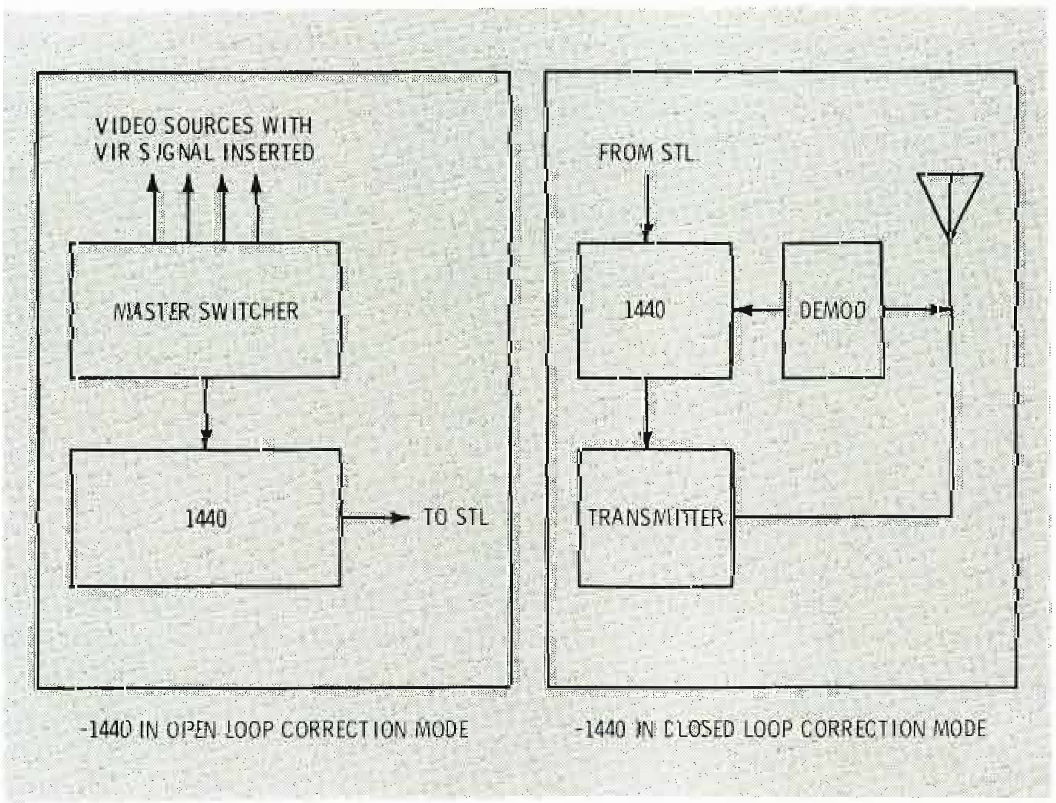


Fig. 1 Open and closed loop operation.

5 MILLION FEET OF FILM—ZERO MAINTENANCE!

RALPH G. WEISINGER, AWARD-WINNING CAMERAMAN-DIRECTOR, AVON PRODUCTIONS

This is the verbatim text of an unsolicited letter received from Mr. Weisinger, reproduced with his permission:

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Since we bought the machine we estimate that we have run 250,000 feet of original material thru the machine without a scratch, add to that 250,000 feet of workprint material, which was then cut down to approximately 35,000 feet of edited footage.

A conservative estimate of all this footage running back and forth, at up to 240 frames a second, for at least 125 round trips, gives us a rough figure of just under 5 million feet of film.

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Ralph G. Weisinger
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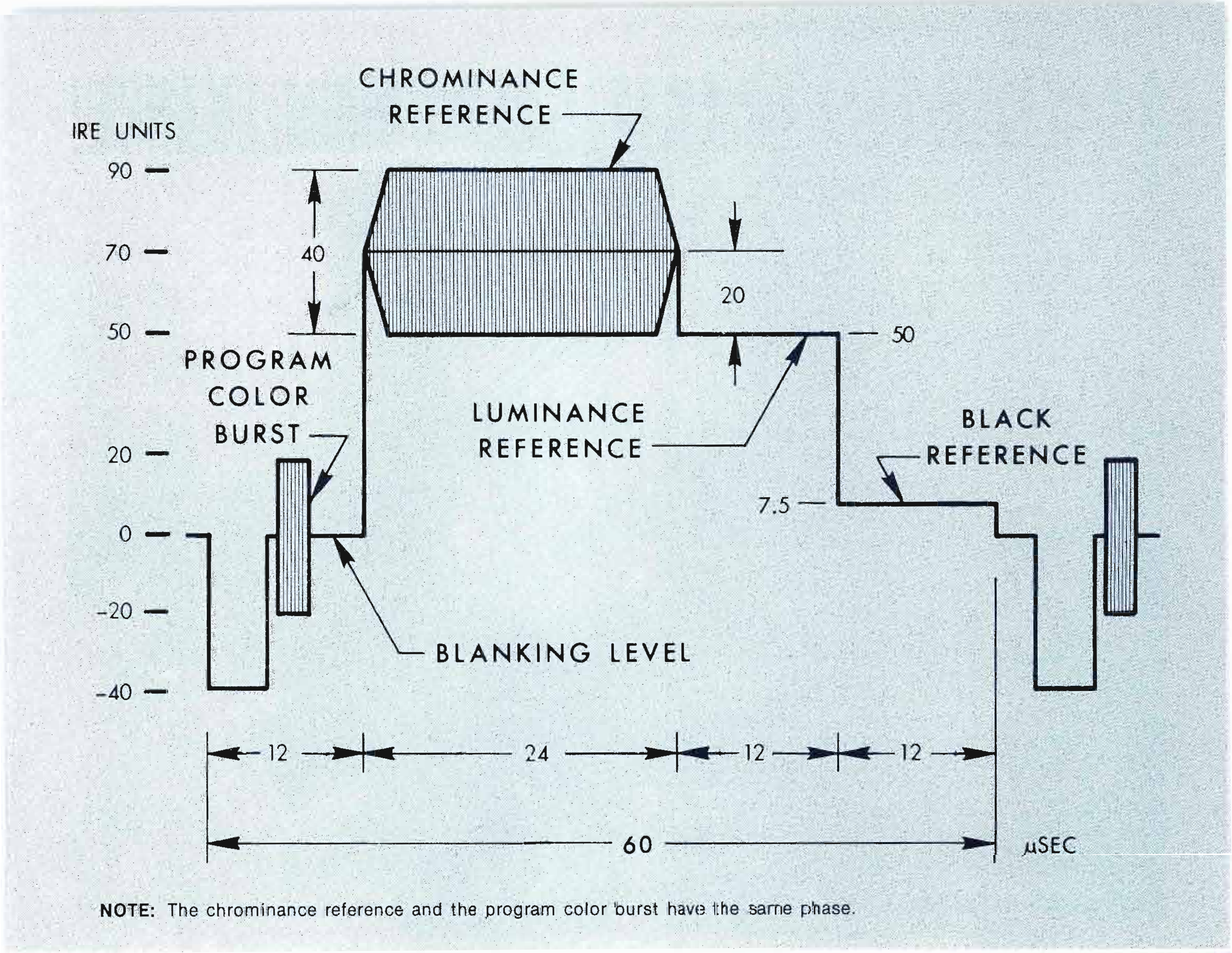

Fig. 2 The nominal vertical interval reference (VIR) signal.

the 1440 in its pre-set mode. This gives the operator complete and entirely legal control over the transmitter ratios, etc., should he need it. We never have needed it yet.

The VIR signal was originally intended to be a "quality key" that the show producer applied to his program at the point of origination. Then, at destination, if the burst phase is adjusted to be in phase with the VIR chroma reference, and the VIR amplitude points are used as standards, the operator at the transmitter (or studio) can make the program being broadcast look exactly like the originator intended it to look, despite its degradation along the way.

Until program producers become fully aware of the advantages of this system and technical details for application of the VIRS for transmission are worked out and standardized, it is advisable to DELETE the incoming network or other VITS and insert your own. At KATU, we insert VITS, (including VIRS, on line 19) of the vertical interval, using a Tektronix R149 waveform generator. This is the last operation that occurs to our studio feed and occurs at the point we feed the microwave STL. Thus, we have absolute control over the quality of VITS, including our VIR.

Now, upon occasion, after staying up all night to make sure your transmitter will pass the best of color programming, you will find that the station is transmitting black and white. We have a very popular series called "Movie Classics" and most of these old-timers are available only in black and white. What happens to our 1440 which depends on VIR during such programming? Well, if you do nothing, the 1440 will flip over to pre-set, which is good, but not dynamic. So, you insert the VIR signal without burst when on black and white and the 1440 then goes right on regulating monochrome parameters and doing the job of maintaining sync and video ratios and gain.

General Installation Information

It goes without saying that a chain is only as strong as its weakest link, and we have at least two important items as links in this chain besides the 1440. First, how about the transmitter? It must be reasonably clean as far as band pass and power making ability.

(Continued on page 56)

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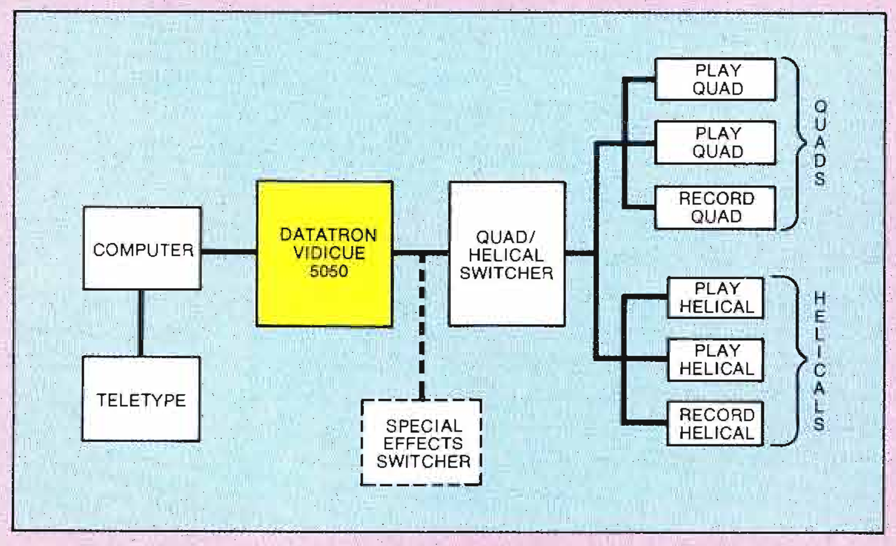

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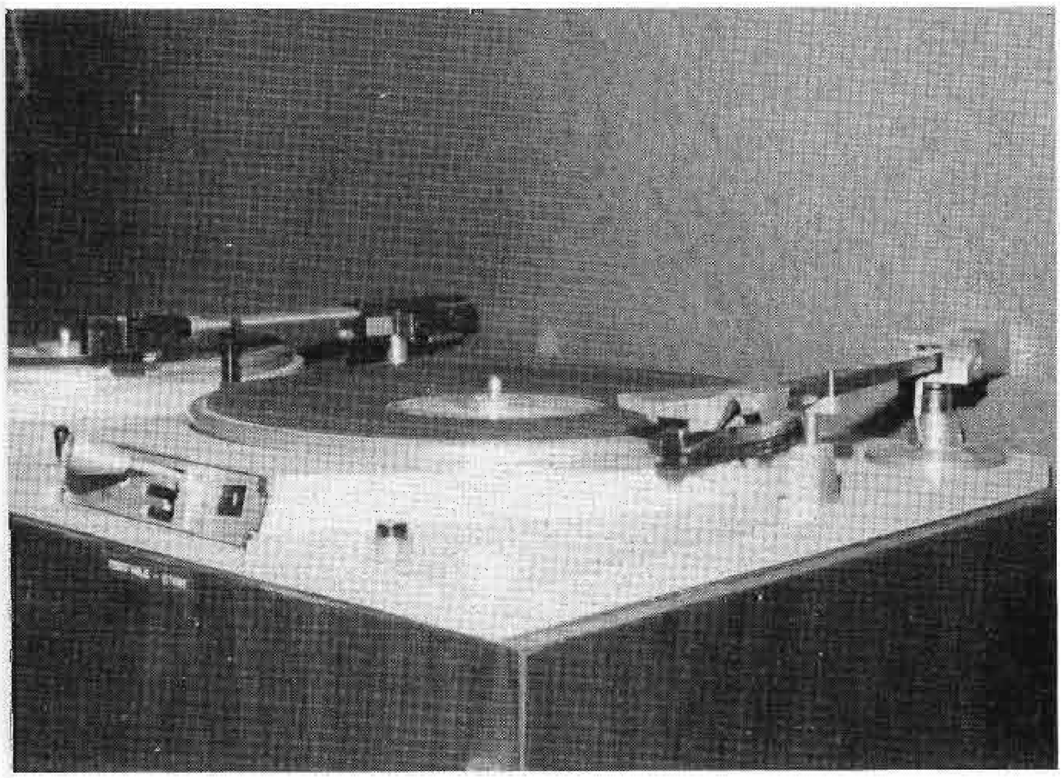
A challenge for test tapes and records

By Dennis Ciapura

Although electrons can be made to paint an audio analogy with near perfect precision, there comes a time when the program must be stored. Audio recordings on plastic disks and magnetic tapes are the most common storage mediums employed and it is here, at the electro-mechanical conversion, that the audio engineer meets his greatest challenge.

The broadcaster has his opportunity to share that challenge when it comes time to convert the mechanically stored program back to its electrical analogy for broadcast to the radio listener. Even if the broadcaster was to install a perfectly transparent cable link to each listener's home, the fidelity of the program would still depend upon the accuracy of reproduction that the tape or record playback systems at the station are capable of. That fidelity capability is best measured by testing the fidelity of test tape and record reproduction.

In the "bad old days" when recording standards for equalization varied as much as quad standards do today, the job of insuring accurate reproduction of every recording that came down the



Turntable system used in tests described.

Diane Ciapura inspects the $30 component that shapes the sound of a multi-million dollar radio station.

pike was often a frustrating one. With today's tape and record equalization pretty much standardized, the testing process for frequency response is quite simple and really takes very little time.

One area that is virtually unknown to broadcast engineers is that of tape deck and phono distortion testing. The reason that these tests aren't commonplace, despite the fact that the opportunity for audio disaster is very great when dealing with electromechanical conversions, is that the test materials are largely unavailable. Have you ever seen, much less used, a distortion test tape or record? How ironic it is, that most broadcasters can easily produce data and curves for the frequency response and distortion of every segment of their broadcast chain, except the very tape decks and/or phono reproducers that feed the audio into the system!

In our proof change survey series of articles, **Broadcast Engineering** proposed the use of standard test tapes and records for equipment performance measurements. Since very little experience in this area existed in the broadcast industry, we decided to pick the minds of some top people in the recording, test tape and record industries to see what types of test tapes and records are available now and what, if any, new types could be generated to widen the scope of transducer tests that could be done in the field. We were primarily interested in looking into the factors involved in producing low distortion test tapes and records that would be suitable for use as signal sources for the equipment performance measurements, as well as routine maintenance tools.

For our test tape investigation, we turned to Mr. John G. (Jay) McKnight, president of Magnetic Reference Laboratory in Palo Alto, California, who is currently serving as the chairman of the Measurements and Definitions Sub-committee of the N.A.B. Tape Cartridge Standards Committee, as well as many other advisor positions in this field. Jay is recognized as one of the world's top tape experts.

We Rolled Our Own

Before we attempted any further investigation, we decided to record our own distortion test tape on a broadcast type recorder to see what results could be expected before we proposed any standards for a production line product. After all, it would mean very little to propose that a standard test tape with less than 1 percent distortion be employed to test station deck performance if some basic limitation made such a tape impossible to produce. If, however, we could produce a suitable tape on relatively unsophisticated equipment, then it would seem logical to assume that a somewhat better product could be produced by a test tape manufacturer.

Our test machine was a Scully 280-2, which is a 2 track stereo record/play deck. We chose a speed of 7½ i.p.s. and Ampex 406 recording tape, so that a common mode of broadcast operation and an

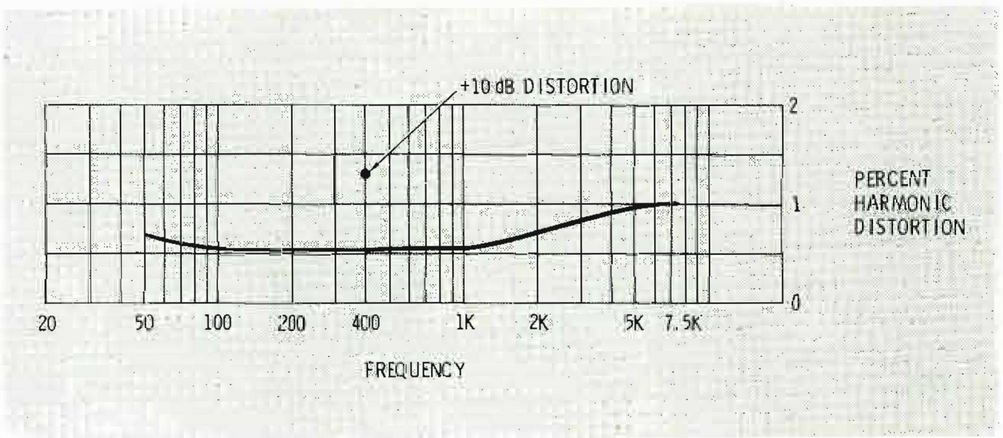


Fig. 1a Graph depicting distortion vs. recorded audio frequency for the sample tape.

SAMPLE DISTORTION TEST TAPE RESULTS

LEVEL	AUDIO FREQUENCY	CHANNEL 1	CHANNEL 2	AVERAGE
@ 0 dB	50	0.84	0.50	0.67
	100	0.65	0.45	0.55
	400	0.65	0.45	0.55
	1000	0.65	0.45	0.55
	5000	0.95	0.90	0.93
	7500	1.00	1.00	1.00
@ +10 dB	400	1.50	1.10	1.30
	400 Hz CLIPPING LEVEL	+16 dB	+16 dB	+16 dB
TAPE: AMPEX 406 (1/4") SPEED: 71/2 IPS RECORDER/REPRODUCER: SCULLY 380-2 (2 TRACK STEREO) REFERENCE LEVEL: 200 nWb/m				

Fig. 1b Detailed results of the tape distortion test.

easily attainable tape would be employed. No special or modified circuitry was used and the tape sample was selected at random.

Figure 1 illustrates the distortion vs. frequency response characteristics that we were able to attain. We ran the same series of measurements on each of the channels and averaged the results to obtain the data for the curve. The bias was adjusted for minimum distortion with 0 level referenced to 200 nWb/m fluxivity. In record preamplifier input level was adjusted to keep each tone at 0 level for a uniform playback output level. The same tests were performed on several other machines of the same type but with different test equipment and different engineers, so, we know that the results are not a fluke peculiar to one set of test conditions, as all of the results were very similar.

As you can see from the graph, mid-band values of around ½ percent are attainable and a 1 percent limit at the frequency extremes is reasonable. Even at a +10 dB level, the average distortion at 400 Hz is still only 1.3 percent and a +16 dB input was required to cause visible flatening of the waveform with the 406 tape. Figure 1b gives the individual distortion levels for each frequency. A 16 kHz toroid type low pass filter was used to eliminate supersonic bias components and weighed the measurements so that only audible components would be measured. Oscilloscope checks of the null type distortion meter output showed that the distortion consisted mainly of third harmonic. Measurements beyond the 7.5 kHz fundamental that we used would have been pointless because even the second harmonic of higher frequencies would fall outside of the bandpass of the ear, radio broadcast and our tests.

Figure 2 shows the bandpass characteristic employed and Figure 3 shows the test arrangement that we used, for those who wish to duplicate the procedure. No attempt was made to reduce the high frequency distortion by employing pre-distortion techniques. Most of the distortion takes place during the recording process, so, the use of pre-distortion would simply compensate for that distortion, thus insuring that the play-back measurements included play-back system distortion only.

Motional feedback methods have been used successfully for many years to reduce the inherent nonlinearity of disk cutters and even speakers. While motional feedback would not be possible with tape systems, the fact that a test tape is a series of single tones makes the pre-distortion process quite simple, since each tone could have its own individual compensation tailored to the record transfer characteristic at that frequency.

The next step in our test tape investigation was to consult with our tape expert, Jay McKnight, to see what his thoughts on the subject were. Although we knew that a distortion test tape with a "less than 1 percent" spec could be produced singly, we wondered if such a tape could be added to the series of standard test tapes produced by an existing commercial firm, and manufactured in normal quantities. After a discussion of the inherent system limitations that

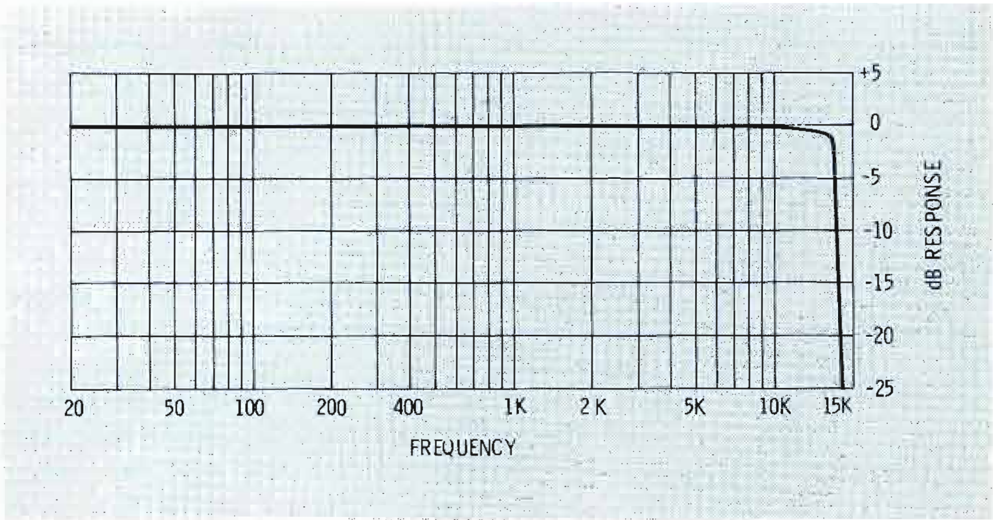


Fig. 2 Bandpass characteristics used for the distortion measurements.

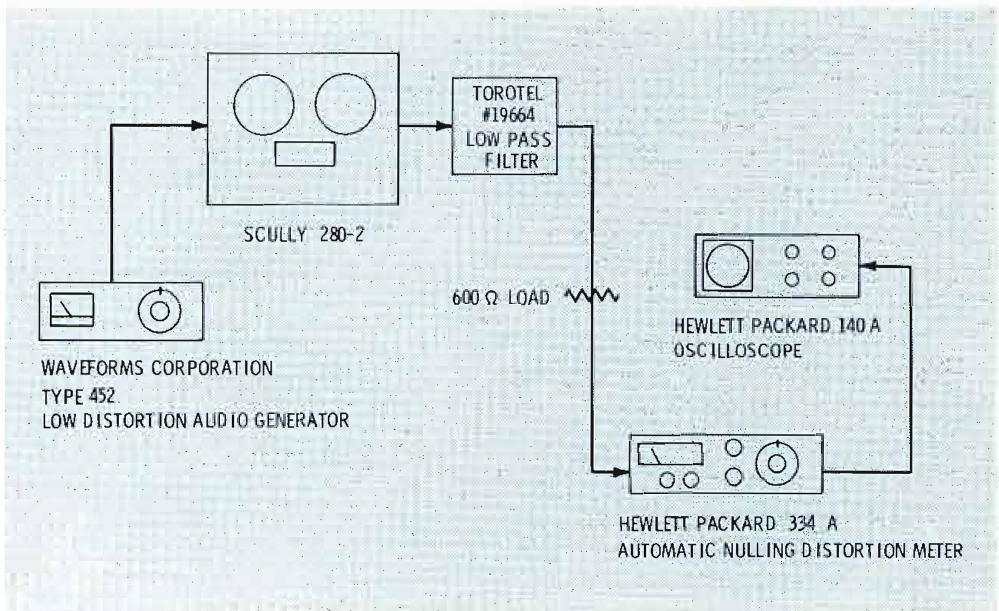


Fig. 3 Test equipment and recorder/reproducer used to produce the sample tape.

must be dealt with, and a review of what kinds of tests the engineers in the field could use, we asked Jay if in his opinion a tape with less than 1 percent harmonic distortion from 50 to 7500 Hz could be produced. As we expected, he said that it could.

A multi-track cartridge would be more difficult to produce because of the lesser tape width that can be recorded on for program tracks due to the portion occupied by the cue track, but it appears that a distortion test cart could also be produced. As a matter of fact, an appropriate type of tape could have been recorded on the Scully 280 that we used for our tests, and then loaded into a cart for use in playback distortion tests. Unplugging the cue pick-up head leads would prevent "stop" activation. Of course, a commercially made test cart would be cut in the standard track configurations and once again, pre-distortion techniques used to reduce the recording distortion.

Jay agreed that most of the distortion occurred during the recording process and that playback head linearity was not normally a problem. We checked the distortion of our test machine's play-back pre-amps and found it to be just over 0.1 percent. As a practical matter, when measuring tape system distortion below 1 percent, the smoothness with which the deck handles the tape can have as much affect on the measurements as the distortion components when using null type test equipment, because any speed fluctuation will change the frequency of the reproduced tone slightly. This causes the tone frequency to flutter about the center of the null frequency, thus adding some ambiguity to the meter reading. It is usually possible to catch a smooth stretch in which to make an accurate measurement, however, and if a tape deck has so much wow and flutter that distortion tests are difficult, a greater maintenance priority lies waiting in the tape

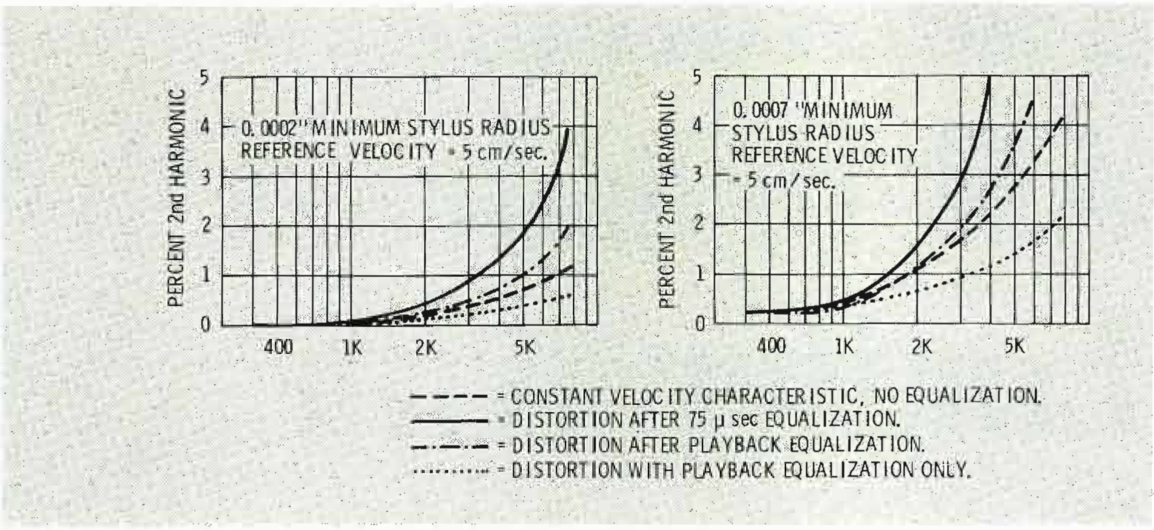


Fig. 4 These graphs show the calculated values of second harmonic that can be expected due to tracing error during playback, assuming negligible recording distortion and perfect vertical angle matching.

% Second Harmonic Tracing Dist. $= \frac{2\pi f v r}{u^2} \times 50\%$

% 2nd Harmonic Due To Vert. Mis-match

$(u = .133 \times \text{Dia.} \times \text{r.p.m.})$ % 2nd Harm. $= \frac{v}{u} \times \tan\angle\varnothing \times 100\%$

Where:
f = frequency
v = velocity
r = tip radius
u = linear speed

Fig. 4a Formulas used to generate the curves shown in Figure 4.

handling machinery! We have made tape deck distortion measurements with several types of distortion meters ranging from inexpensive kit form products offered by Heath and Eico, to the automatic null Hewlett Packard equipment and have not experienced any problems unless the deck under test had some mechanical deficiency.

Looking at the test tape situation as a whole, since excellent frequency response test tapes like the MRL 21 series already exist and low distortion high level tapes are a reality, there is no reason why truly complete tape deck performance tests can not be done in the field. thus assuring the broadcaster that his tape playback quality is commensurate with the fidelity capability of the rest of the broadcast chain. A good, comprehensive test procedure for FM broadcast would consist of running a reproducer alignment tape through each tape deck to adjust the equalization for the flattest response, then run a high level low distortion test tape, including a 400 or 1000 Hz tone at 10 dB above reference level, as well as the 50 to 7500 Hz at 0 dB series. This procedure would show up any response, distortion or headroom problems in the tape equipment and yet still represents a very small investment of engineering time and money.

Now, How About A Distortion Test Record?

Our expert opinion for the test record project was Dan Gravereaux, of C.B.S. Labs, Recording Research Division. Dan is a top authority in the field of disk recording and playback and has had his work published nationally.

Like many other technical situations, there are two sides to the record distortion story; the distortion recorded onto the record during the manufacturing processes and the playback distortion, which depends upon many factors. While modern mastering techniques can produce a test record with a very small amount of recorded distortion through the use of motional feedback techniques, it is difficult to retrieve the same degree of perfection during playback. So, our investigation was aimed at finding out what type of test record would be best suited to AM and FM broadcast testing and what kind of results engineers in the field could expect to get with the kind of playback equipment currently in use. Assuming that tone arm tracking error has been kept to a minimum, high frequency tracking, or tracing error, is one of the prime playback distortion problems. Although the waveform on the record can be cut with as little as about ¼ percent distortion, it is cut with a chisel shaped cutting stylus which results in harmonic generation when we attempt to trace the waveform with a spherically shaped playback stylus. The larger the stylus radius, the more distorted the output waveform will be.

Unfortunately, the requirements for good low frequency tracking and good high frequency tracing are contradictory. To maintain good contact with the groove walls while tracking low frequency components, the stylus should be relatively large, but to trace the intricate treble modulation, the stylus should be as small as possible. The most common method of dealing with the problem is the elliptically shaped stylus. The dual radius tip does a good job of maintaining groove wall contact while tracing the higher frequencies with improved accuracy, because the smaller radius can better follow the path cut by the chisel point. Most of the distortion is second harmonic and can be calculated quite easily.

Figure 4a is the formula for estimating the second harmonic distortion. As you can see, the distortion is proportional to the frequency, the velocity and the minimum stylus radius. It is also inversely proportional to the square of the linear speed. From this relationship we may deduce that the best conditions for low tracing error distortion would be minimum velocity, minimum stylus radius and maximum linear speed. Since our test record is supposed to be a high level distortion testing device, the velocity must be the same as normal program material would produce, so, we are limited in this area. The stylus radius is a function of what the broadcaster has in his phono pickup at the station, usually a 0.7 mil. spherical in older equipment, or one of a variety of elliptical combinations in the high performance phono systems.

The linear speed is proportional to the disk r.p.m. and the circumference, therefore, the highest linear speed for a $33\frac{1}{3}$ r.p.m. record would exist at the outer band.

To get some idea of what the tracing distortion limitations are, we calculated the second harmonic content for various conditions of equalization for 0.7 mil. and 0.2 mil. stylii. The 0.2 mil. radius could be the smaller radus of an elliptical, so, these curves apply to the high performance systems, while the 0.7 mil. curves show the limitations of the common spherical. We assumed that the distortion test series would be cut at the outside of the disk and used $10\frac{1}{4}$" diameter to calculate the linear speed.

Using a reference velocity of 5 cm/sec., we first plotted the distortion for a constant velocity. Next we applied the increase in velocity resulting from the 75 usec. standard recording equalization used on the high end. This is not the distortion that would appear at the output of the phone pre-amp, however, since it does not take the

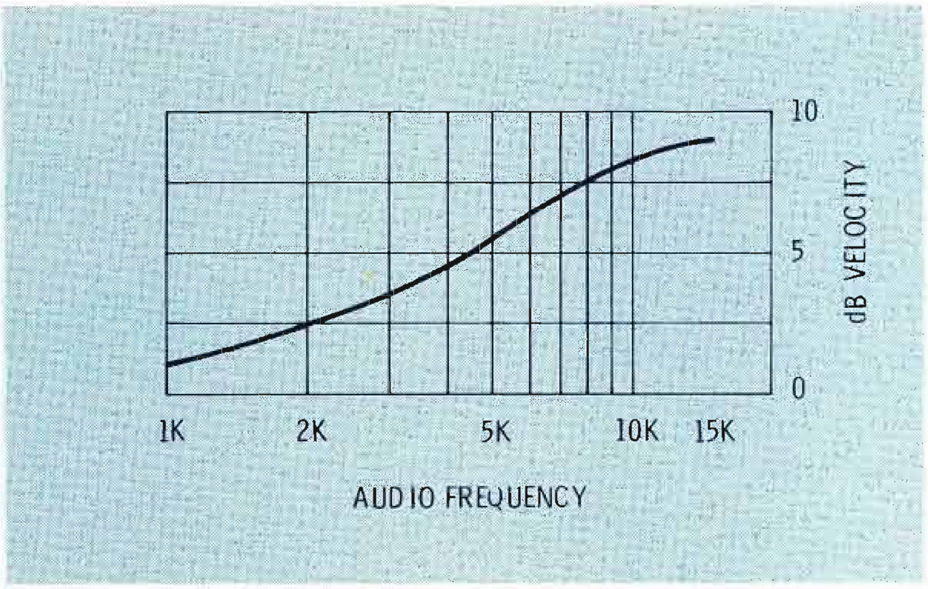


Fig. 5 A recording equalization curve is a composite of the standard 75 usec curve and an inverted 25 usec curve. This type of record equalization would result in a high level test record that would simulate the levels normally distributed across the band after the standard equalization is applied.

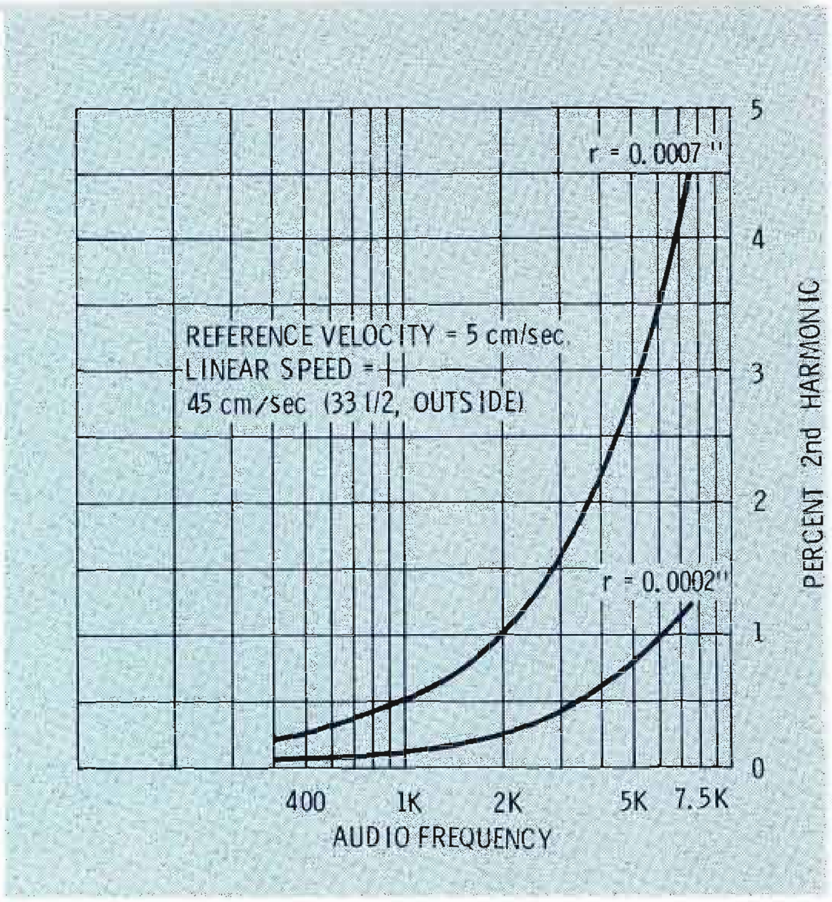


Fig. 6 Calculated values of second harmonic distortion due to tracing error that could be expected if the recording characteristics shown in Figure 5 are employed.

high frequency roll-off at the playback end of the system into account. Since the second harmonic of any of the higher frequencies would be attenuated more than the fundamental, a significant reduction of second harmonic content results.

The next curve shows the resultant second harmonic level for the closed loop; 75 usec. record equalization and complementary 75 usec. reproducing equalization, which is the standard high frequency characteristic of the RIAA or N.A.B. standards.

The last curve is a plot of the distortion for a constant velocity record characteristic when played back with normal equalization. This would result in an overall frequency response that rolls off on the high end with a 75 usec. characteristic. This has interesting implications for the FM broadcaster, because the phono output would be complementary to the transmitter's 75 usec. pre-emphasis. The break points of the curves are not exactly the same, but it is close enough that the error is negligible. If a test disk was cut with normal equalization on the low end and flat at the high end, the phono preamp roll-off would cancel the transmitter pre-emphasis resulting in constant modulation vs. frequency when the broadcast chain is flat.

Although this kind of test would provide a very convenient method of checking overall FM frequency response, it would not provide a very good distortion check for the phono system because the average spectral distribution of energy in modern program material contains more treble energy than the unequalized recording would provide for a distortion test. On the other hand, program material does not normally contain treble energy at full level, at least not for a sustained time period. Most recent studies show the average spectral distribution to fit very well into a 25 usec. characteristic. This is one of the reasons that Dolby B for FM broadcast converts the 75 usec. curve to 25 usec.

We conclude, therefore, that the optimum recording equalization for a distortion test record would be the standard 75 usec. minus 25 usec. to simulate the average spectral content of program material. This type of test would provide a good check of the reproducing system's ability to do its job with respect to distortion performance.

Figure 5 illustrates the composite +75, -25 usec. equalization curve that could be used. Figure 6 shows the second harmonic distortion due to tracing error that can be expected for 0.2 and 0.7 mil. stylii. A peak capability test as is already contained in the C.B.S. BTR150 test record would be a worthwhile addition to the distortion test series. This test provides a series of tone bursts at 10 dB above the reference level, excellent for assuring adequate "headroom."

It is important to bear in mind that the tracing distortion is not the only source of distortion. An error in the phono pickup vertical tracking angle can also result in the generation of considerable second harmonic distortion. A 5 degree error will cause about 1 percent but if the angle is within 2 degrees, less that ½ percent can be expected. Fortunately though, distortions do not usually add, so, the actual performance is really amazingly good if the phono reproducing system is in good shape. We would hope that any station holding an

FCC license would maintain a reproducing system capable of meeting the distortion and response standards for type of service licensed.

Although the rules do not specifically regulate the program sources, few engineers would approve of 7½ percent AM distortion or 3½ percent FM distortion before the program even reaches the control console! Most broadcast phono preamps have very low distortion levels, some less than 0.1 percent, so it is the mechanical aspects of the disk reproducing system that are likely to present the greatest challenge. The N.A.B. rumble spec is -35 dB referenced to 1.4 cm/sec. at 100 Hz. This may seem like a rather loose specification, but bear in mind that this frequency falls on the low frequency boost part of the reproduce equalization curve, so, if the turntable has rumble components around 50 Hz, they will be boosted about 5dB more than the 100 Hz reference level.

The N.A.B. rumble testing procedure specifies a measurement bandpass of 10 to 250 Hz, ± 1 dB, with 6 dB/octave roll-off below 10 Hz and 12 dB per octave above 500 Hz with 500 Hz 3 dB point. If the primary rumble frequency is kept below 10 Hz, the preamp response roll-off will usually exceed the N.A.B. numbers, so, the turntable and preamp system may add less rumble noise to the distortion measurements than the rumble spec suggests.

On the other hand, a system with a lot of 50 Hz rumble will be a tough cookie to crack if the turntable rumble spec does not exceed the N.A.B. spec by much. The test procedure specifies that standard reproduce equalization should precede the metering system, which means that the very low frequencies will get a lot of boosting. At any rate, if the rumble exceeds the playback distortion, the quality of reproduction being passed on to the listener is impaired and the engineer should know about it. Not many broadcast stations have rumble meters, but most have distortion meters or have a way of obtaining one for proof measurements. So, if some mechanical problem interferes with the phono distortion tests, the alarm flag will be raised, even if the actual measurement cannot be related to the N.A.B. spec.

Tone arm tracking error will also affect the distortion measurements as will the quality of the pickup itself. All of these factors combine to make phono distortion measurements look rather unimpressive. For this reason, not too many people brag about their phono system distortion specs: most engineers would rather talk about the preamp and its less than 0.1 percent spec. However, judicious selection of components, comprehensive testing and careful maintenance can produce startling improvements in audio quality. It is often amazing to find that records which appeared to have been distorted recordings, can be cleanly reproduced after improvements are made to the phono reproducing system. We must begin to go beyond the routine response tests and learn to accept the less than spectacular test results as reality and not shy away from distortion testing because we can't make a less than 1 percent across the board.

To see just what kind of performance an average system could actually produce, we ran some tests using high level recorded tones; the 1000 Hz "0" level tones on the C.B.S. BTR150 and STR100 test records. The tests were performed with two different pickups installed in the tone arm, one with a 0.3 x 0.7 mil. stylus and the other with a 0.4 x 0.7 mil. stylus, both by different manufacturers. A popular broadcast type turntable with a 12" arm adjusted for optimum tracking was used for the test platform. The turntable rumble measured -40 dB which would allow for a test resolution of 1 percent distortion using a null type distortion meter. The test bands near the outside of the disk were reproduced with 2 to 3 percent distortion while the same level tones near the inside showed 4 to 5 percent. The results for both phono pickups were about the same. Preamp distortion at the same frequency was below 0.1 percent.

These figures represent **stereo** playback specs which involve both lateral and vertical modulation and are therefore the result of tracing errors in both directions at once.

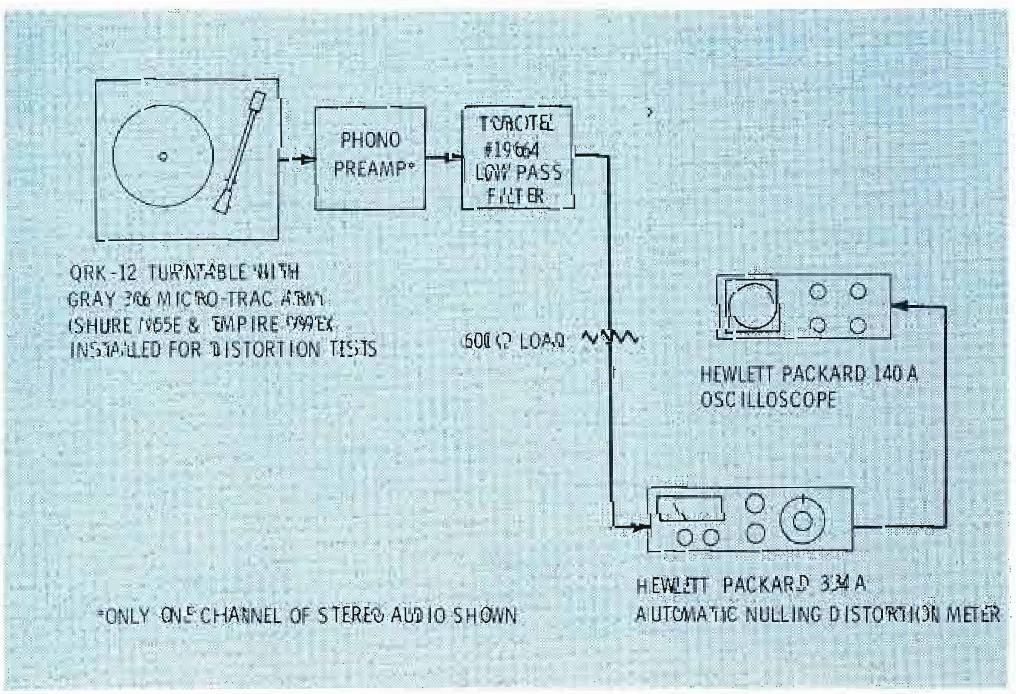


Fig. 7 Test equipment and connections for disk distortion tests. Using this setup, the distortion of the reprcducing system can be tested and corrections made to minimize tracking and tracing error.

This is one of the reasons that our measured results show more distortion than the calculations for simple lateral tracing distortion would indicate.

As a matter of fact, the distortion under the same test conditions, except for lateral modulation only, was about 1.5 percent. In all cases, standard RIAA reproduce equalization was employed. Generally, the greatest playback non-linearities are due to tracking and tracing errors, so, we reoriented the phono pickup in its mounting and measured the distortion after each modification. The vertical angle was varied by shimming the front of the pickup and then the rear and the angle of the pickup with respect to the tone head center line. The end result was that we were able to reduce the stereo distortion to about 1.5 percent at the outside of the disk and to about 3.2 percent at the inner bands.

Obviously, careful use of a test record and a little time can result in more audible performance improvement than just about any other engineering endeavor around the broadcast station. **You cannot expect to always obtain a two to one improvement in reproducing distortion, particularly if you get about 1.0 percent right off the bat, but the opportunity for increasing performance to some degree is always there just waiting for someone with a test record and distortion meter to come along and tweek it out.**

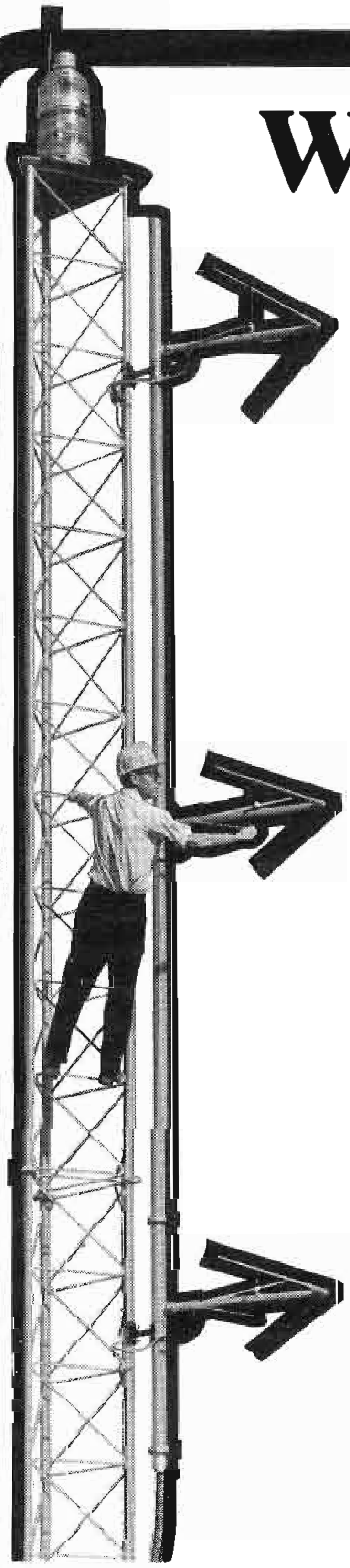
Figure 7 shows the test setup that we used, for those who wish to duplicate the tests. The turntable and phono pickups used for the tests are relatively inexpensive units and represent equipment that is likely to be in use at broadcast stations.

The 15 kHz toroid filter is not really required if distortion tests with a 1 kHz fundamental only are performed, since no significant components above 15 kHz are likely to be encountered. Be sure to check the preamp distortion and S/N ratio before starting the disk tests. The noise should be measured with the pickup installed so that any induced hum can be caught and corrected. Make sure that the frequency response is flat before attempting the distortion checks and don't be afraid to load the pickup with other than 47K if that's what it takes to flatten out a resonant peak.

Summing Up

In summary, tape and record transducer testing is still one of the sadly neglected corners of our business. Although we hope to see high level test records and tapes produced in the near future, no manufacturer can be expected to produce something that few people will buy. Familiarity breeds interest and interest breeds experimentation and toward these ends we submit this account of our exploration of the electro-mechanical conversion with the hope of sparking increased testing in the field. If you have any questions or comments, feel free to drop us a line.

We wish to thank Jay McKnight of Magnetic Reference Laboratory and Dan Gravereaux of C.B.S. Recording Research Division for their generous gifts of time and knowledge.



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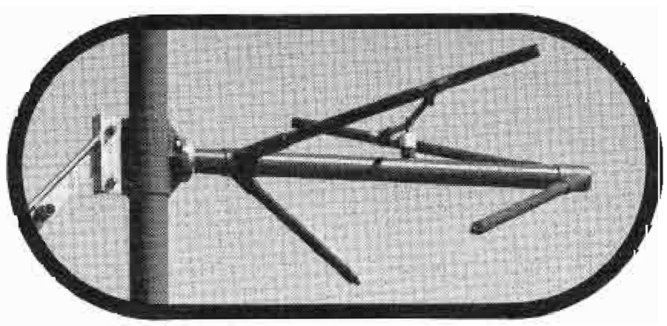

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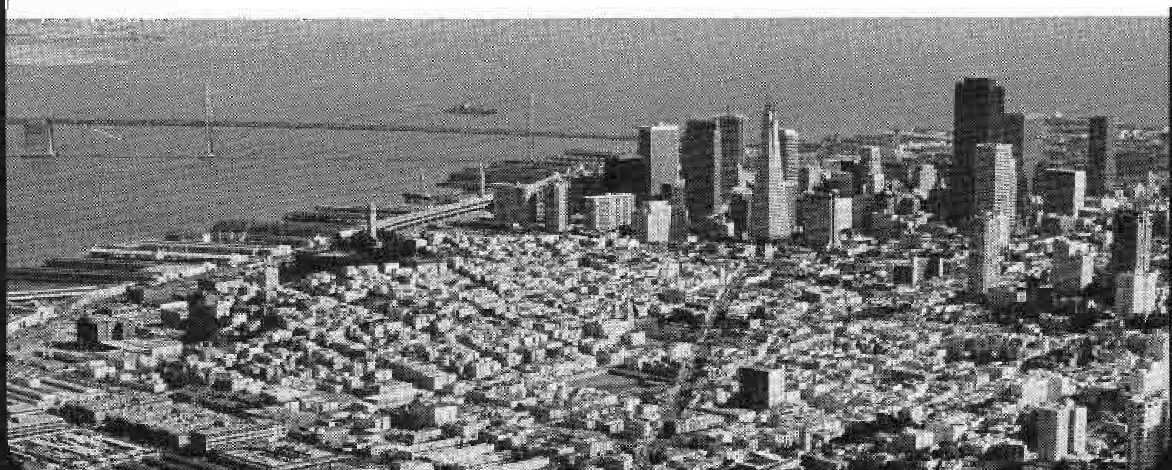

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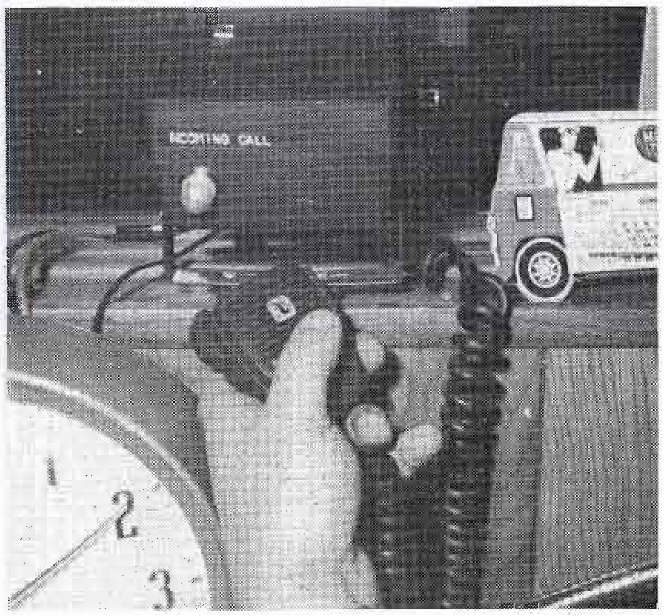
Avoid confusion with STATUS LIGHTS

By Pat Finnegan



Status lights can help you avoid confusion, and they can be extremely functional in the program format. Here you see a status light that indicates incoming calls from mobile units, even though the speaker may be muted. The light is operated by a carrier operated relay in the base receiver.

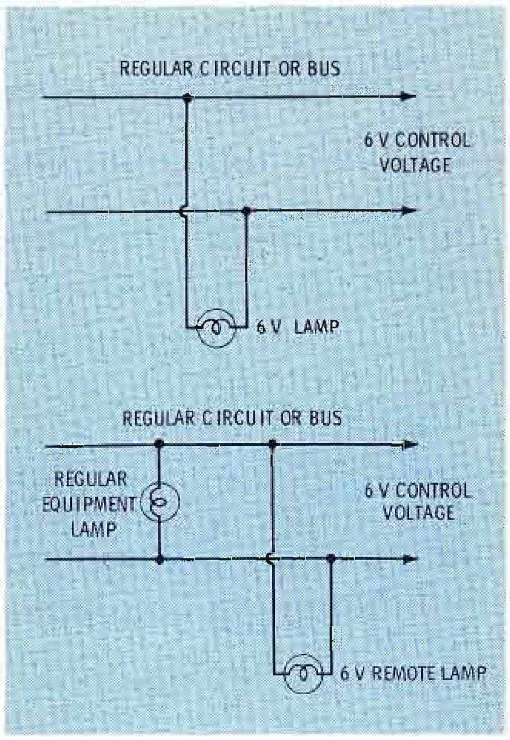


Fig. 1 These are the most common methods of adding a status light to a circuit. Care should be taken, however, to avoid changing the electronic characteristics of the circuit.

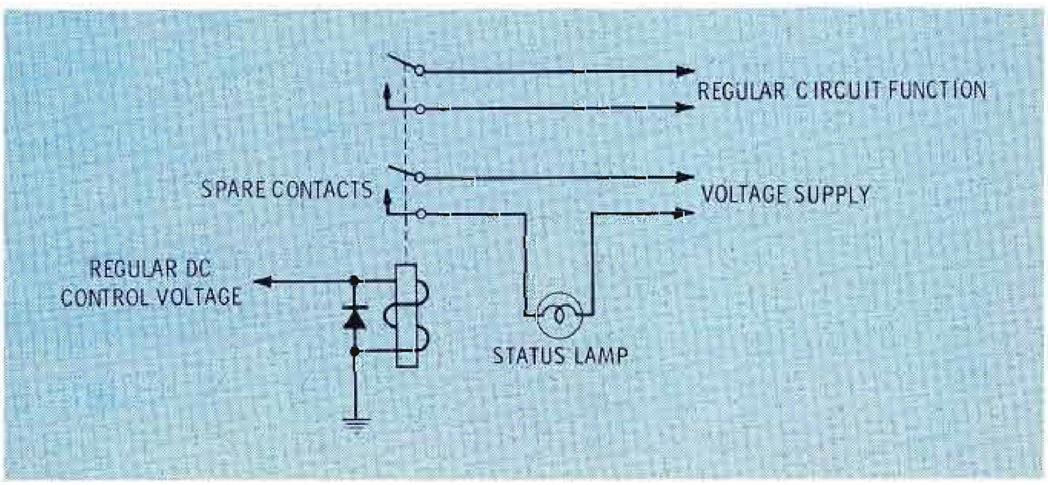


Fig. 2 Here is a simple example of how to use a relay or switch to show a condition. In this way, the status indicator is isolated from the circuit.

During multiple switching operations and at other times when special events take place, a few simple status lights wired to strategic points in the system can make the operator's life easier. At the same time, they may help avoid switching errors caused by operator confusion or forgetfulness.

Elaborate status monitoring arrays found in complex switching or automation systems are not needed in average station operations. But a few simple lights can alert the operator that certain events are happening, about to happen or should happen. Such lights can be easily added to any system.

General Methods

While there are a number of ways to operate status lights, most applications will fall within a few basic categories.

Connecting a lamp across a circuit or bus is the simplest and most common method. The lamp will draw its power from the circuit itself. If there is already a lamp in the circuit and a remote lamp is desired, the remote lamp is connected in parallel with the original one.

The use of spare contacts on a relay or switch that will operate during the times desired is the next most common method. The relay or switch has other primary duties, and the lamp switching is only a seconday function. The lamp may draw power from the relay or from an external power supply.

In circuits where IC's and transistors are directly involved, either transistors/relay combinations or relays only are used to switch the lamps. In many cases, a transistor will act directly as the switch for the lamp, the transistor driven by

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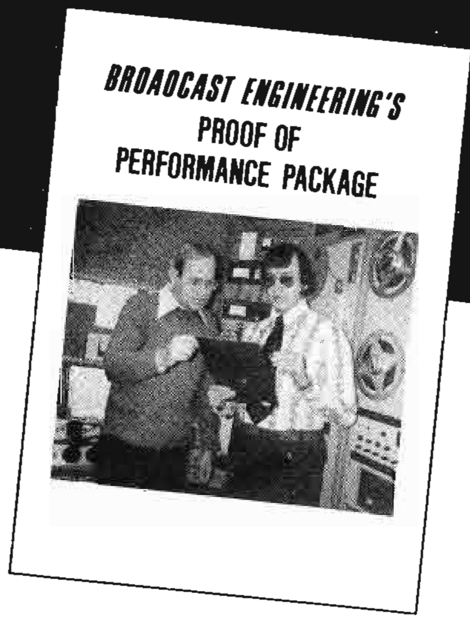

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low lever DC signals or logic signals.

A status light may be used in a double duty mode, that is, the lamp indicates two separate functions when they occur. By wiring a resistor in series with the lamp, during turn on by the first function, it will glow at less than full brilliance. A set of contacts from a different circuit function, when operated, will short out the resistor, causing the lamp to glow at full brilliance, indicating the second function is taking place.

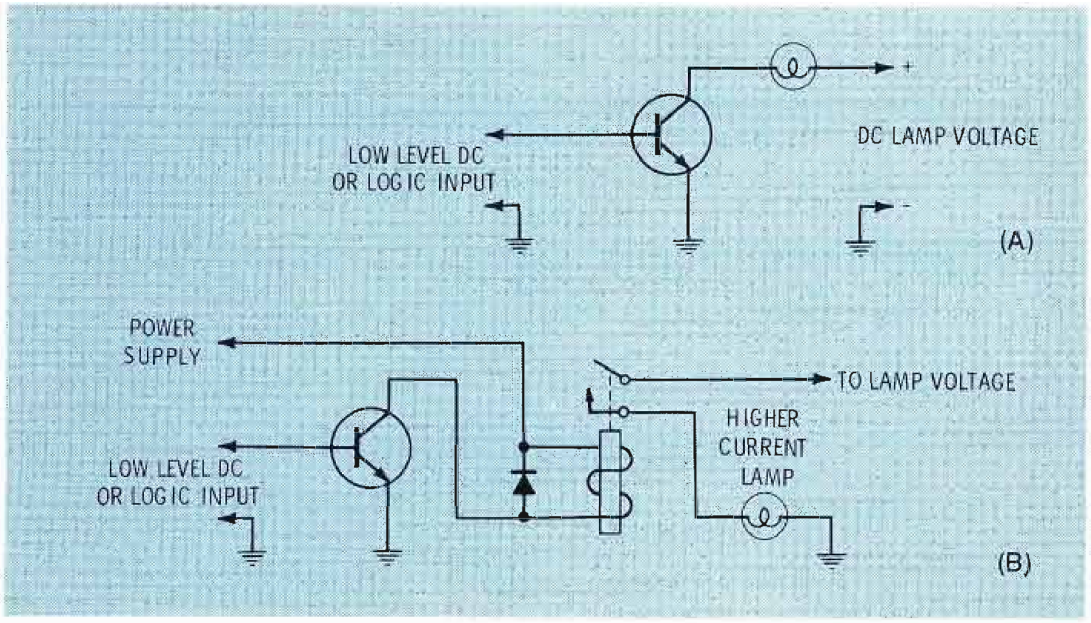


Fig. 3 Here are two ways to use a transistor as an interface. In (A), directly as a switch. In (B) it is used to operate a relay when the lamp requires more current than a transistor can carry.

Design Your Own

Although complicated circuitry is not necessary to operate status lights, a few basic principles should be given consideration in your design.

A lamp added at any point in an operating system should have no adverse effect upon that system. If the lamp obtains its power from the system internal power supply, care must be exercised that the additional current drawn by the lamp or lamps do not overload the power supply or damage components in its feeder system. Although many incandescent lamps are physically small, they still draw appreciable current.

Management highlights

Pat has shown how a lot of confusion can be avoided by using status lights to indicate conditions that operators should be aware of. In some cases, you can see that status lights can improve the program format by making the operator(s) more efficient.

The danger, of course, is that you can go overboard with status lights to the point that they actually add confusion. First, think about your operation and where irritating operating problems occur. You'll probably find a circuit here that will eliminate that problem. As long as you stick to solving problems, you'll improve your operation.

When many lamps are being added to an operating system, a special power supply should be built that will supply power only to the lamps and associated relays. This power should be isolated from internal power supplies by the use of "dry contacts" on relays or switches.

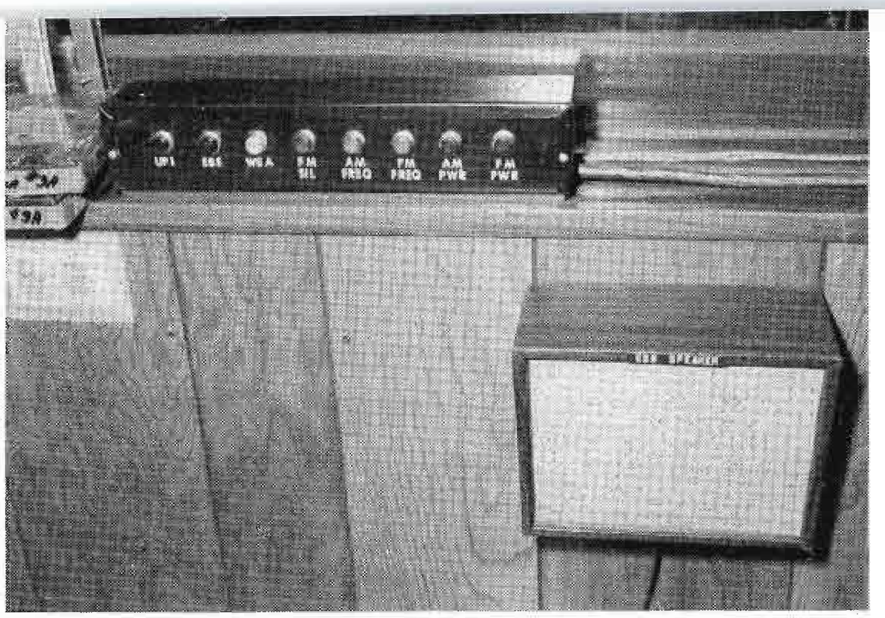
Strong RF fields can induce currents in long remote cable leads and allow interference to enter the equipment in this manner. When strong fields are present, shielded cable should be used for the lamp runs.

Techniques

How a lamp will be operated when applied to a circuit will often be dictated by the circuit itself. But when there is a choice of methods, here are a few of the many techniques possible.

The **switched ground** technique has developed with solid state equipment and can be used to switch a lamp also, especially from a remote location. There is nothing complicated about it, the ground return side of the circuit is switched rather than the voltage side. This method has the advantage of reducing transients into the equipment, since static or similar transients are usually positive going voltage. Also, should the cable become shorted, the only adverse effect will be a continuously burning lamp rather than a blown fuse in the power supply. However, if the lamp is at a remote location from the power supply, then it makes no difference which way the switch is done since the high side of power must be routed to the lamp anyway.

A transistor as a switch or an interface is another technique, especially useful when working directly with IC's or transistors. An IC normally cannot carry the current draw of a relay or of a lamp. As an interface or a switch, the transistor can be turned on by low level DC signals from the IC's or logic signals. If the lamp level of current is a high value, the transistor can turn on a relay which will handle the higher current through its contacts. When selecting a transistor for this application, the relay coil or lamp



This status indicator panel used at WLBC shows which alarm has gone off.

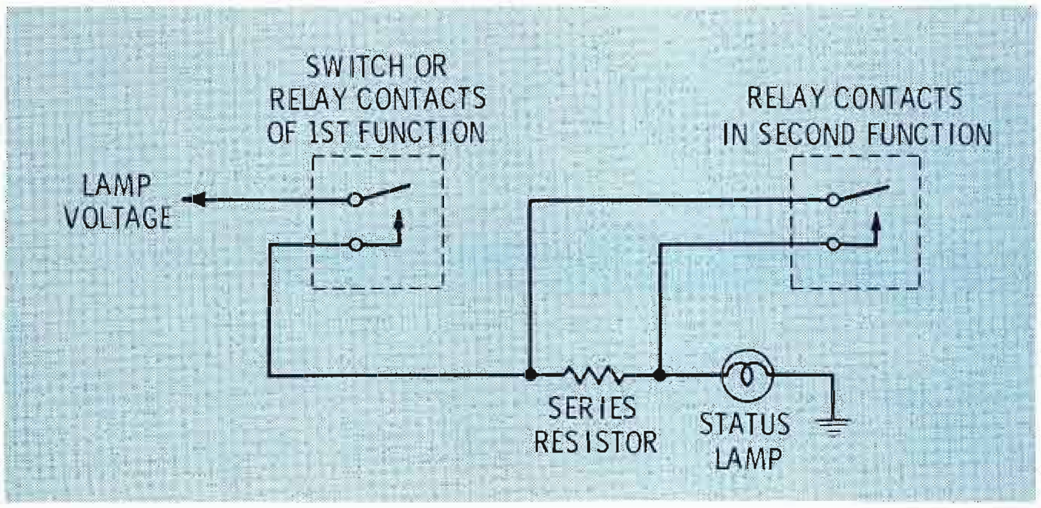


Fig. 4 Here's how you can make the lamp provide a second indication while the first function is still in operation. You'll note that shorting the resistor will make the lamp glow brighter.

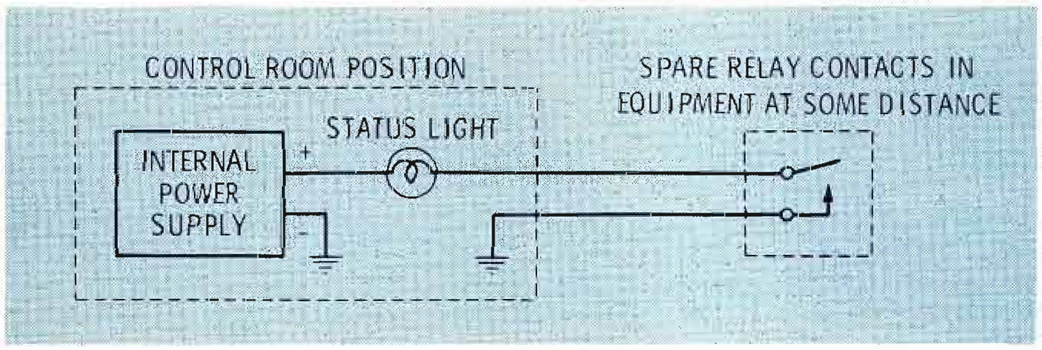


Fig. 5 This is an example of the switched ground technique.

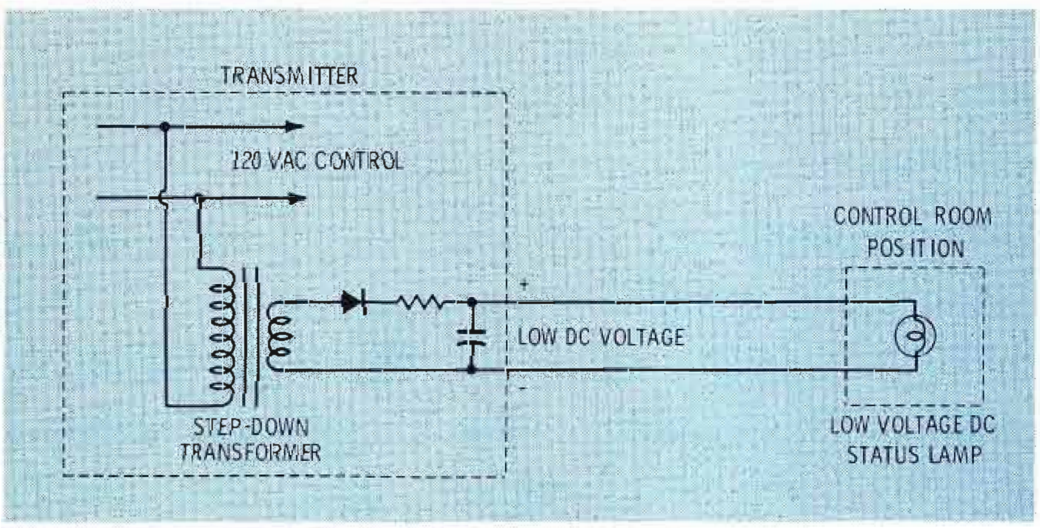


Fig. 6 When a 120 VAC circuit must be monitored at a distance, use a step-down transformer and a rectifier to send low voltage DC to the lamp.

current will flow through the transistor, so the one selected should have adequate power rating.

Other applications require a very large and bright light as can be supplied by 120 VAC. If this light circuit is to monitor one that is solid state, it is important that the 120 VAC be isolated from the low level solid state circuits. Even the field around the AC circuit can be damaging to sensitive solid state elements. The best device in this application would be the solid state relay. Isolation is provided by the photo-optics in the relay, and the relay can be turned on by logic levels from the solid state equipment.

If the circuits that are to be monitored are only 120 VAC or higher, such as found in a transmitter, it is not desirable to route this high AC voltage out through low voltage switching or monitoring circuits. A step-down voltage transformer will provide the safest method. The transformer is located at the higher voltage location and a further refinement can be obtained by rectifying the low level AC voltage into a DC voltage for routing to the remote point.

Maintenance

Whether the status lights are those in a large system, individual lights on separate equipment items, or lights the station has added to a system, most can be afflicted with common problems.

Troubleshooting failures in lamp circuits, particularly a multi-light system, can prove difficult if the only information provided is that of a hazy memory. When designing and installing status lights, even if only a single lamp added to a piece of equipment, make some clear drawings that can be read at some later date when trouble develops. On a single lamp to a piece of equipment, the information can be drawn in on the regular schematic.

One major fault that can afflict any light system is the application of over-voltage to the lamps, resulting in very short lamp life. Many power supplies, (both commercial and home-brew) that provide power only for lamps, are unregulated. Design often concerns itself mostly with providing an adequate current capacity for the expected number of lamps in use. But seldom are all the lamps turned on at the same time, and at other times there may be none turned on. At such times, the output voltage of the transformer or rectifier can rise to almost the peak value of the AC voltage. As lamps are turned on, the load will pull down that voltage depending upon the load at the time. For example, a 24 Volt DC supply with only one or two lamps drawing current can be supplying over 30 Volts to those lamps. The lamps will glow very brightly, but they will also have a very short life!

The real solution to overvoltage is regulation of the power supply if possible. This can be done with zener diodes, or if the transformer can handle it, add a bleeder resistor across the supply to draw an amount of current that will hold the voltage within limits. But you must remember the full load situation when all the lamps are on. The transformer can become overloaded, or the voltage will be so low that the lamps are very dim.

Transistors can be the victim of lamp over-voltages. When higher than rated voltage is applied to the lamp, it will draw more than normal current. If this current is passing through a transistor used as a switch, the transistor can fail when it is used as a switch. It a situation where the lamp and transistor are designed only for an intermittent duty cycle, something else may fail causing the equipment to stay on continuously. The equipment in turn will cause the lamp to remain on. Current flowing through the transistor in this continuous duty manner will cause it to overheat and probably fail.

As mentioned earlier, an overbright lamp is a sure sign of an over-voltage situation, and this can be used as a clue in troubleshooting. If the overbright lamp is operated from the regulated power supply of the equipment itself, something has caused it to lose regulation and its output voltage is now higher than normal. But this voltage is not only fed to the lamp, it is supplying the other solid state circuitry also. The high voltage will damage many of the transistors and IC's unless it is corrected quickly. Thus a bright light in this situation can be a clue to an alert operator to check the power supply and correct the situation before further damage occurs.

A large automation system will have many lights. These are not merely "dress lights" but serve a useful function. When lamps burn out, it is important that they be replaced as soon as possible. It can be very confusing to have more than one machine operating at once and not knowing which one is on the air and which one is cueing up. Such a system, however, can have a number of different voltage lamps in use. So it is important to use the correct one for replacement. Many of the miniature lamps look the same physically, but the type number on them will tell you which to use. A 28 Volt lamp, for example, plugged into a 6 Volt socket will barely light if at all, while a 6 Volt lamp plugged into a 28 Volt socket will burn out immediately.

Longer lamp life can be obtained in many cases by the use of over rated lamps. That is, use a 28 Volt lamp in a 24 Volt socket, etc. Of course, the lamp will be dimmer, but if the situation can tolerate a dimmer light the life will increase remarkedly.

Summary

A few status lights can prove very helpful in the average station operational system. But overdoing the job and adding lights for the sake of lights, will only make the situation confusing and negate the purpose of adding them in the first place. □

Workshop in digital math

Part 5 of a series/By Harold Ennes

These practice problems will enable you to double-check how well you have absorbed previous material. The Part number of the text to be reviewed is indicated after each exercise number. Solve each exercise on your own, (with the help of a suitable review if necessary), before checking the solution.

1. (Part I). Convert the following binary numbers to their decimal (base 10) equivalents:
   (a) 101001.01
   (b) 1011.1111
   (c) 11101010.101
   (d) 0001.0001

2. (Part I). Find the binary sum and give decimal equivalent of:
   (a) 1000 + 1001
   (b) 1101.1 + 1000.101
   (c) 0000.1110 + 0001.1110
   (d) 0000.11111 + 0011.111

3. (Part I and Part IV). Find the difference of the following by two methods; straight arithmetical as in Part I, and by using complements as in Part IV.
   (a) 1110-0110
   (b) 101001 - 001010

4. (Part II). Find the products by over-and-over addition:
   (a) 1011 X 1110
   (b) 1011 X 11010

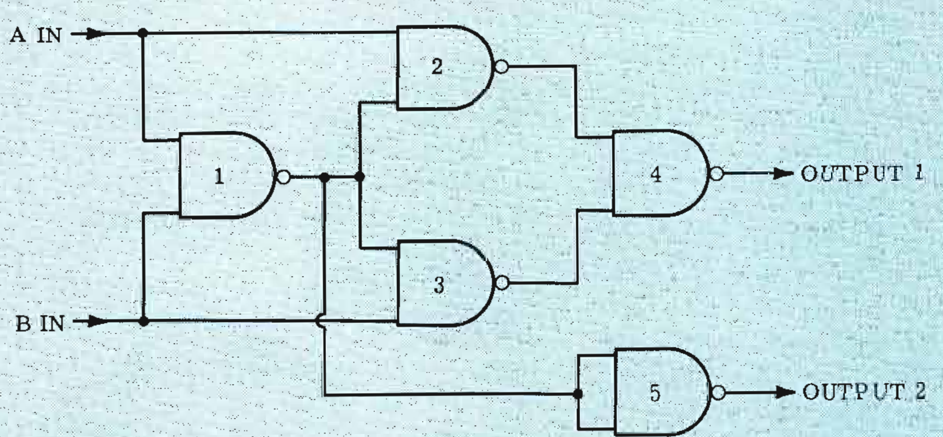
5. (Part II). Find the following quotients. Remember that a quotient, in math, is the result of division; the number of times one quantity is contained in another. Therefore, solve by two different methods: straight arithmetical division, and by over-and-over subtraction.
   (a) 100100/1100
   (b) 1000/0010

6. (Part III). Convert following decimal numbers to binary notation:
   (a) 124.875
   (b) 250
   (c) 0.53125
   (d) 187.625

7. (Part III). Write the following decimal numbers in BCD:
   (a) 864.2
   (b) 1,087
   (c) 25.8
   (d) 265

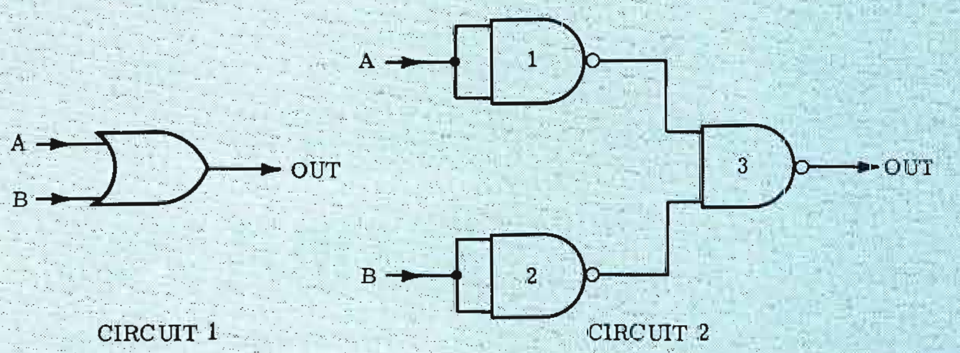
8. (Part III). Convert the following binary numbers to octal:
   (a) 1000110100
   (b) 111100100.01

9. (Part III). Convert following octal values to decimal using binary as intermediary:
   (a) 744.2
   (b) 1064
   (c) 272.5
   (d) 31.7



TRUTH TABLE			
INPUTS		OUTPUTS	
A	B	1	2
0	0		
0	1		
1	0		
1	1		

Fig. 17 Logic diagram and truth table (to be completed) for exercise 13.



TRUTH TABLE			
INPUTS		OUTPUTS	
A	B	CIRCUIT 1	CIRCUIT 2
0	0		
0	1		
1	0		
1	1		

Fig. 18 Logic diagrams and truth table (to be completed) for exercise 14.

10. (Part III). Convert following octal numbers to decimal using straight octal conversion (no intermediary):
   (a) 31.1
   (b) 1064

11. (Part III). Read aloud the Boolean expressions:
   (a) AB
   (b) A+B
   (c) $\overline{AB}$
   (d) $\overline{A+B}$

12. (Part IV). Solve by additive method:
   (a) 110101 - 001011
   (b) 1111 - 11010
   (c) 1110101 - 1111010
   (d) (1001 0100) - (0001 0010) This is BCD.
   (e) (0001 0010) - (1001 0100) This is BCD.

13. (Part III). Complete the truth table for logic diagram in Figure 17.

14. (Part III). Complete the truth table for the logic diagrams of Figure 18.

Solutions To Exercises

1. (a) 32+8+1+0.25 = 41.25
   (b) 8+2+1+0.5+0.25+0.125+0.0625 = 11.9375
   (c) 128+64+32+8+2+0.5+0.125 = 234.625
   (d) 1+0.625 = 1.0625

2. (Review Table 3 and examples, Part I).

(a)
```
  1000   (8)
 +1001   (9)
 10001   (17
```

(b)
```
  1101.100   (13.5)
 +1000.101   ( 8.625)
 10110.001   (22.125)
```

(c)
```
  0000.1110   (0.875)
 +0001.1110   (1.875)
  0010.1100   (2.75)
```

(d) Note: $2^{-5} = 0.03125$
```
  0000.11111   (0.96875)
 +0011.11100   (3.875)
  0100.11011   (4.84375)
```

3. (a)
```
arithmetical:  1110
              - 0110
                1000

complement:    1001   (inverted 0110)
             +    1
               1010   (complement of 0110)
        add    1110
              11000   (answer) = +8
```

(b)
```
arithmetical:  101001
              -001010
               011111   (ans)
```

ANSWERS TO EXERCISE 6

	256	128	64	32	16	8	4	2	1	.	0.5	0.25	0.125	0.0625	0.03125
(A)			1	1	1	1	1	0	0	.	1	1	1		
(B)	1	0	0	0	0	0	1	1	0	.					
(C)									0	.	1	0	0	0	1
(D)		1	0	1	1	1	0	1	1	.	1	0	1		

Fig. 19 Solution to exercise 6.

Procedure for above (review Table 6 and examples of Part I) is as follows, starting with LSD as 1st digit:
1st digit: 1-0 = 0.

1st digit: 1-0 = 0.
2nd digit: 0-1 = difference of 1 and borrow 1.
3rd digit: no 1 exists to borrow yet, so 0 in top row becomes 1 and 1-0 = 1 with borrow 1 carried over.
4th digit: now a 1 exists to borrow, so 1 in top row becomes 0 and 0-1 = difference of 1 and borrow 1.
5th digit: no 1 to borrow, so 0 top row becomes 1 and 1-0 = 1 with borrow 1 carry over.
6th digit: now a 1 exists to borrow, so 1 in top row becomes 0 and 0-0 = 0. Prove answer by noting that decimal equivalent is 41-10 = 31. Note that this procedure is cumbersome relative to the following **complementary** operation:

(b) complement: 110101 (inverted 001010)
+ 1
110110 (complement of 001010)
add 101001
1011111 = +011111 = 31

4. (a) 1011 X 1110

Accumulator	Multiplier	Operation
00000000 10110	1110	Move multiplicand 1 space left - add
10110 1011 - -	1100	Move multiplicand 2 spaces left - add
1000010 1011 - - -	1000	Move multiplicand 3 spaces left - add
10011010	0000	Answer = 154 (11 X 14 = 154)

(b) 1011 X 11010

Accumulator	Multiplier	Operation
000000000 1011 -	11010	Move multiplicand 1 space left - add
10110 1011 - - -	11000	Move multiplicand 3 spaces left - add
1101110 1011 - - - -	10000	Move multiplicand 4 spaces left - add
100011110	00000	Answer = 286 (11 X 26 = 286)

5. (a) straight arithmetical division

```
        0011.0  (answer)
 1100 ) 100100
        1100
        ------
          1100
          1100
          ----
          0000
```

over-and-over subtraction

```
   100100
 -   1100
   ------
    11000   First subtraction
 -   1100
    -----
     1100   Second subtraction
 -   1100
     ----
     0000   Third subtraction
```

Answer is decimal 3 = binary 0011

(b) straight arithmetical division

```
        0100  (ans)
 0010   1000
        10
        ----
        0000
```

Over-and-over subtraction:

```
  1000
 -0010
  ----
  0110  (First subtraction)
 -0010
  ----
  0100  (Second subtraction)
 -0010
  ----
  0010  (Third subtraction)
 -0010
  ----
  0000  (Fourth subtraction)
```

Answer is decimal 4 = binary 0100

6. See Figure 19 for answers. If necessary, review operations given in Figure 8 (Part III).

7. (a) 1000 0110 0100.0010
(b) 0001 0000 1000 0111
(c) 0010 0101. 1000
(d) 0010 0110 0101

8. (a) 001 000 110 100 binary 1000110100
1 0 6 4 = octal 1064

(b) 111 100 100 . 010 binary 111100100.01

7 4 4 . 2 = octal 744.2

9. octal : 7 4 4 . 2
4-2-1 binary : 111 100 100 . 010
=pure binary: 111100100.010
= 256+128+64+32+4+0.25 = 484.25 decimal

(b) octal : 1 0 6 4
4-2-1 binary: 001 000 110 100
=pure binary: 001000110100
= 512+32+16+4 = 564 decimal

(c) octal : 2 7 2 . 5
4-2-1 binary: 010 111 010 . 101
=pure binary: 010111010.101
= 128+32+16+8+2+0.5+0.125 = 186.625 decimal

(d) octal: 3 1 . 7
4-2-1 binary: 011 001 . 111
=pure binary: 011001.111
= 16+8+1+0.5+0.25+0.125 = 25.875 decimal

10. Refer to Table 7, Part III.
(a) octal 31.1 = $(3 \times 8^1) + (1 \times 8^0) + (1 \times 8^{-1})$
= (3 X 8) + (1 X 1) + (1 X 0.125)
= 24 + 1 + 0.125 = 25.125 decimal
(b) octal 1064 = 512 + 48 + 4 = 564 decimal

11. (a) AB reads "A and B"
(b) A+B reads "A or B"
(c) $\overline{AB}$ reads "Not A and B", "inverted A and B"
(d) $\overline{A+B}$ reads "Not A or B", "inverted A or B"

12. (a) 110100 (inverted 001011)
+ 1
110101 (complement of 001011)
add 110101
1101010 = +42

(b) 00101 (inverted 11010)
+ 1
00110 (complement of 11010)
add 1111
00101 = -0101

recomplement: 1010
+ 1
1011 = -1011 = -11

(c) 0000101 (inverted 1111010)
+ 1
0000110 (complement of 1111010)
add 1110101
01111011 = -1111011

recomplement: 0000100 (inverted)
+ 1
0101 = -0101 = -5 decimal

```
(d) 1110   1101   (inverted subtrahend)
  +    1      1
    1111   1110   (complement of subtrahend)
add 1001   0100
   11000  10010 = BCD 1000 0010 = 82 decimal
```

Note that the complementary method of computation is the same for BCD as for pure binary. Just remember to add 1 to **each** group of 4-bits.

```
(e) 0110   1011   (inverted subtrahend)
  +    1      1
    0111   1100   (complement of subtrahend)
add 0001   0010
   01000  01110 = -(1000  1110)

recomplement:  0111   0001   (inverted)
             +    1      1
               1000   0010

recomplemented = -(1000 0010) = -82 decimal
```

13. The symbols of Figure 17 indicate all NAND gates. The small circle on the output indicates the output is 0 **only** when simultaneous 1's occur at the input. The output is a "1" at all other times.

See Figure 20 for the completed Truth Table. Reason as:

TRUTH TABLE				
CONDITION	INPUTS		OUTPUTS	
	A	B	1	2
1	0	0	0	0
2	0	1	1	0
3	1	0	1	0
4	1	1	0	1

Fig. 20 Completed truth table for Figure 17.

Condition 1. Since A and B are both 0, gate 1 output is high. (1). Gates 2 and 3 receive this 1 at one input, but a 0 from A and B inputs. So gates 2 and 3 outputs are both 1's, thus gate 4 will have simultaneous 1's at the input, resulting in low (0) at Output #1. Gate 1 feeds paralleled inputs (both inputs tied together) of gate 5. Since gate 1 output is high, gate 5 will be low (0) at Output #2.

Condition 2. B input now a 1 while A input is a 0. So gate 1 output is still a 1, and you know immediately that Output #2 is still a 0. The 1 from input B and the 1 output of gate 1 makes gate 3 a 0 output. Gate 2 has inputs of 1 and 0, so its output is a 1. Therefore gate 4, having a 0 and a 1 input, goes high (1) for Output #1.

Condition 3. A now a 1, with B a O. Note that the overall result is the same as for condition 2.

Condition 4. A and B both 1, making gate 1 a 0 output. Thus gate 5 goes to a 1 at output #2. The 0 out at gate 1 feeds one of the inputs of gates 2 and 3, while 1's are injected at the opposite inputs from A and B. So gates 2 and 3 will both a high (1) output, giving gate 4 simultaneous 1's at its inputs. Therefore gate 4 produces a 0 for Output #1.

If you now study your completed Truth Table, you will see that Output #1 could be called the **sum,** and Output #2 the **carry.** The overall circuit satisfies the following addition table:

```
A + B = Sum   Carry
0 + 0 =  0      0
0 + 1 =  1      0
1 + 0 =  1      0
1 + 1 =  0      1
```

14. Circuit 1 should be recognized as an OR gate. The symbol and Truth Table was given by Figure 12, Part III.

Circuit 2 indicates 3 NAND gates. Gates 1 and 2 have inputs tied together. Following the reasoning of the solution to exercise 13, you should be able to complete the Truth Table as shown by Figure 21. Note

TRUTH TABLE			
INPUTS		OUTPUTS	
A	B	CIRCUIT 1	CIRCUIT 2
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	1

Fig. 21 Completed truth table for Figure 18.

that the hookup of these NAND gates forms an OR gate, and could be replaced by the symbol of circuit 1.

Don't Stop Here

This entire series has hopefully enabled those of you needing help to overcome your initial "mental block" to digital math. But it admittedly serves only as the "kindergarten" grade in your complete training. There are many more "codes" than those covered in this study. There are many different procedures, many more challanges, many more opportunities.

If you have applied yourself to the contents of previous text, and have really "digested" the operations outlined, you will have little difficulty in mastering more advanced studies. You will have constructed a solid foundation upon which to build your future growth.

Author's Note

Re/Digital Math, Part 3 in the November issue, page 59, middle column, lines 13-14-15-16 from the top should read:

```
Octal    2     6  .  1
         ↓     ↓     ↓
Binary  010   110 . 001 =
```

Pure binary 10110.001 (This was shown as 101110.001)

PEOPLE IN THE NEWS

Dennis G. Christensen has been appointed Vice President, Marketing, at Television Research International, Mountain View, Calif. He was previously national sales manager for IVC and Datatron. Also at TRI, **Gary H. Beeson**, formerly regional distributor sales manager at IVC, has been appointed Manager, Marketing, and will be responsible for the company's new helical VTR editing system.

Peter Waldeck has been appointed Vice President as well as a member of the Board of Directors of CPD International, Inc., the newly formed export marketing subsidiary of Cinema Products Corp., Los Angeles....The Lynch Communication Systems Inc. announced the appointment of **Victor Mayer** as Manager, Systems Assembly...**Brian C. Mitchell** has been appointed field service engineer of Conrac video products....Javelin Electronics, Division of Apollo Lasers, Inc., has announced the promotion of **Donald T. Heckel** to Vice President of Marketing....The International Division of Communications Technology Corporation, Los Angeles, has announced the appointment of **James C. Hawley** as Manager for Latin America.

Lykes Electronics Corporation, Tampa, Florida, announced the appointment of **James Starks** as General Manager of the Systems Division, and **Carlo McDaniel** as the new Chief Engineer.

CATV

Carl De Simone has been named outside sales representative in Anixter-Pruzan's Southwest district. De Simone will call on CATV, power utility and telephone accounts in Southern California from the company's district office and warehouse facility in Santa Ana....**Larry G. Morris** has been named director of corporate planning for General Cable Corporation. He replaces **William N. Nuckols**, who has been elected vice president of the corporation and general manager of the Special Products Group.... **Carlos Katz** has been named chief research engineer at General Cable's Power and Control Cable Research Center.

Radio/TV

Harold L. Kassens, Assistant Chief of the Commission's Broadcast Bureau, has announced his retirement. Kassens expects to continue his broadcast activity in the Washington, D.C. area as a consulting engineer....**James R. Hobson** special assistant to Chairman **Richard E. Wiley**, has been appointed Chief, Renewal Branch, of the Broadcast Bureau. He replaces **Richard J. Shiben**, recently named Chief of the Renewal and Transfer Division....**James J. Brown**, senior supervisory attorney of the License Renewal Branch, has been appointed assistant chief of the Broadcast Bureau's Renewal and Transfer Division.

NEW PRODUCTS

TBC Systems

Television Microtime, Inc., has announced two new TBC systems, the Series 610 and Series 640.

The new Series 610 is an advanced analog TBC and replaces the separate stand alone units that preceded it. The Series 640 is Microtime's entry into the standalone digital TBC field.

Both of the new systems include a host of features such as built-in sync generators, full proc amps and direct/heterodyne processing. In addition, both the Series 610 and 640 will accept RS-170 or RS-330 composite sync and may be interfaced to H lock, V lock (capstan servo'd) or no lock VTR's.

Because of this breakthrough, Microtime is offering to retrofit its present customers' TBC's to assure them of obtaining full benefit from the advanced design of the newer Microtime systems.

For More Details Circle (68) on Reply Card

Wideband Delay Lines

Walther M. A. Andersen has introduced the Model BID-600 wideband IF delay line available, off the shelf, in binary increments up to a maximum of 8.0 usec and with 250 nsec the least significant bit. Other delay values may be furnished to meet individual requirements.

A low loss wide bandwidth device, the BID-600 is designed specifically to simplify system delay trimming. The line may also be used in other applications requiring distortion-free signal delay at IF.

The Model BID-600 offers center frequency of 60 MHz and 3 dB bandwidth of 30 MHz. Amplitude ripple, across the bandwidth, is ±0.2 dB maximum. Maximum attenuation is 20 dB. Both input and output VSWR is 1.4:1. Third-Time spurious is -35 dB maximum while other spurious is -45 dB maximum. Delay tolerance, singly, is ±0.005 usec and in matched sets, ±0.001 usec.

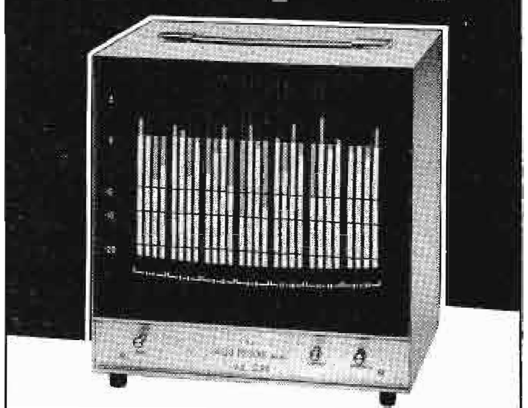
For More Details Circle (69) on Reply Card

Modular Storage System For Carts

Simpac International, Newport Beach California, has recently introduced its modular storage system for broadcast cartridges. The modules are like building blocks, interlocking in all directions; top, bottom, sides, and back. Several configurations can be made; such as carousels, or "A" frames. With this capability, carts can be stored in wasted space.

Features of the system include: space saving - you can store 10 carts in an area 5 inches by 10 inches. These modules in most cases, will store carts in 25-50% less space than anything on the market. The parts are light weight and rugged and due to the precision molding, carts suffer no damage as a result of being dropped into slots of existing racks.

For More Details Circle (36) on Reply Card



NEW PRODUCTS

(Continued)

Modules sell for about half the cost of other racks.

For More Details Circle (70) on Reply Card

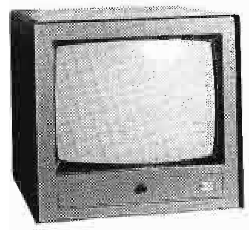
Automatic Movie Programmer

Dynasciences Video Products, Blue Bell, PA. has announced the introduction of the MCM-90, Automatic Movie Programmer.

This new addition to the Dynasciences line is a low cost, automatic sequential switcher intended for use with video cassettes for automatic programming of movies and other multi-reel events. The MCM-90 can be used with an external timer to provide programming at scheduled times during the day.

The MCM-90 will be available in two versions: The MCM-90S for use with Sony machines and the MCM-90J for use with JVC cassettes.

For More Details Circle (71) on Reply Card



Tall Structure Beacons

Flash Technology Corporation is introducing its ElectroFlash™ System for radio and TV towers. The FAA approved system utilizes sharp lower cutoff of the optical beam to reduce downward radiation.

Internal louvers are included to provide ground shadowing, if needed. The system also includes two-wire control and monitoring, failure alarm contacts, two beacons driven from one power converter, and extended effective flash duration at night.

For More Details Circle (72) on Reply Card

Electronic Synchronizer

A new electronic synchronizer developed by **Automated Processes, Inc.**, 80 Marcus Drive, Melville, N.Y. 11746, is described by the company as "the lowest-priced and smallest professional-quality synchronizer on the market today". Called the Minimag®, it measures only 19" wide x 1¾" high x 12" deep, and sells for under $2,000.

The Minimag provides all essential functions required for the synchronization of mag tapes. It will interlock any two tape machines, video, multichannel, sprocketed or unsprocketed audio, and two or more Minimags can be used to synchronize additional tape machines.

Typical applications for Minimag include: connecting two 16-track audio tape recorders (ATR) to make them function as a single 30-track machine; providing variable or fixed delay effects; keeping an ATR in perfect sync with a VTR for audio "sweetening"; synchronizing for TV and FM stereo simulcasts; recording remote overdub tracks, etc.

The Minimag synchronizer is supplied as a complete unit, with built-in code generator. It has a capture range of ±50 seconds and will maintain sync, or variable offset for any length of time regardless of tape stretch or shrinkage. If tapes are within 50 seconds of sync, it will adjust motor control voltage automatically until they are in perfect sync, with or without offset.

For More Details Circle (73) on Reply Card

Tape Cart Machines

Broadcast Electronics, Inc. announces the introduction of the new Spotmaster® Series 2000 tape cartridge machines. These machines are of completely new design, and they

NEW PRODUCTS

(Continued)

represent a significant advancement in Spotmaster design.

The Series 2000 quality cartridge machines incorporate unique, new features which enhance operation. Simplicity of design permits these machines to be offered at new low prices without sacrificing the quality, performance and durability previously available only in more expensive units.

Series 2000 cartridge machines have low power consumption and run cool to protect tapes. Their noise figure exceeds 57dB, and start/stop times are the fastest in the industry—under 80 milli-seconds. Standard features include balanced transformer output, 1,000 Hz cue, 150 Hz cue and provision for remote control and telephone interface.

Separate front panel plug-in modules are used to implement record and audition functions. These add flexibility and permit instant field conversion of Series 2000 playback machines. Table top units accept A, B and C size cartridges, and the dual rack mount configuration accepts size A and B cartridges.

Broadcast Electronics is offering the new Series 2000 machines with an 18 month warranty.

For More Details Circle (74) on Reply Card

Splice Finder/Bulk Eraser

The Senstrol automatic splice finder and bulk eraser minimizes audio cartridge tape splice search time, saving AM and FM radio stations countless man-hours in cartridge handling. The **UMC** splice finder features a built-in bulk eraser to further simplify the processing of the thousands of A, B, and C sized cartridges required by most radio stations.

For More Details Circle (75) on Reply Card

Video Compressor

Consolidated Video Systems has introduced a video compressor as an option to its Model 600 digital video synchronizer.

The video compressor is designed to electronically reduce a video picture to one-fourth its original size both horizontally and vertically. Designated Model 600-2, the video compressor is believed to be the first commercially available device which compresses a video picture and meets broadcast standards. The effect of the television compression is similar to a half-size photo in optical terms. Once the signal is compressed, the operator has a choice of positioning the reduced picture in any of six locations on the CRT.

"The significance of this product to broadcasters is vast" says Daniel J. Yomine, CVS President. "Until the announcement of the video compressor, the only way to accomplish the same thing has been either to use film or a 'Rube Goldbert' method of shooting a TV monitor with a live camera. In television news, sports, and special events coverage there has always been a need for video compression. It is one more television production technique which was previously only practical through the use of film."

For More Details Circle (76) on Reply Card

Back-Pack Color TV Camera

A new back-pack color TV camera offering production quality performance was introduced by **CEI** of Mountain View, California.

Designated the CEI-290, the camera is ideal for mobile video taping and live TV broadcast production applications. The system includes four discrete units: (1) camera head with standard 10:1 Angenieux f2.8 lens; (2) back-pack electronics; (3) detachable view finder and Bell hip-pack mounting adapters; and (4) camera control unit with NTSC encoder and operating control panel. For greater economy and flexibility, the control unit is interchangeable with the CEI-280 broadcast studio camera.

The CEI-290 back-pack system weighs only 40 pounds. It will operate up to 600 feet from the control unit. The camera head can be operated up to 30 feet from the back-pack electronics unit. For studio use, it has a tripod mounting and quick-connect 7" view finder. The system is priced from $43,000 and includes the only 2-year warranty in the industry.

In addition to TV broadcast cameras, CEI offers a line of TV camera systems for medical and industrial applications. All CEI equipment is designed and manufactured in the U.S.A.

For More Details Circle (77) on Reply Card

Delay/Echo Unit

Revox is now offering a delay/echo unit that incorporates an endless loop cassette that can be used with any A77 recorder by removing the deck plate and reel turntables and attaching the cassette mounting plate. The changeover takes less than 10 minutes.

Applications include: automatic message repeating; continuous short-term program monitoring; time delay for tape echo or control of programmable machinery. For the last application, the variable speed control unit may be used to extend the range of available time delays.

For More Details Circle (78) on Reply Card

Video Delay Module

Andersen Laboratories, Inc., has developed a high-performance, compact 1H unity gain video delay module for applications in drop-out compensators, vertical aperture correctors, comb filters, and video disc systems.

The 1H Video Delay Module contains the drive and recovery circuitry necessary to pass base-band NTSC or PAL video with outstanding fidelity. The actual delay is achieved in an ultrasonic glass delay line at RF frequency.

NEW PRODUCTS

(Continued)

The unit is also available in ½ H configurations.

In quantities of 100, the module is offered at a unit price of less than $250. Delivery is 90 to 120 days ARO.

For More Details Circle (79) on Reply Card

MCR Microwave Repeater System

The MCR-11 from **Communications Carriers** is an all solid state RF heterodyne microwave repeater system for long haul transmission in the 10.7 GHz through 15 GHz frequency bands.

The MCR system offers several advantages over standard microwave equipment. It is self redundant or fail safe. (The system can tolerate component failures and still maintain service without switching to stand by equipment. Because of this feature, the MTBF of the MCR-11 is an order of magnitude greater than typical IF heterodyne equipment.) The repeater is nearly distortion free due to the near perfect transmission properties of RF amplifiers. The parts count is ⅓ that of an IF heterodyne system. Instantaneous RF bandwidths are available from 25 MHz up to 250 MHz; output power up to 1 Watt; noise figure 6 dB; frequency stability .001%; fade margins up to 50 dB; power consumption 70 Watts.

The MCR-11 will meet signal-to-system noise transmission standards consistent with 1 picowatt per mile. Both indoor and outdoor packaging is available. The MCR repeater system can be used for single and multiple TV signal transmission, 1800 voice circuit F.D.M. or 40 megabit quadrature phase PCM.

The MCR system has been in field trials for 1.5 years at the F.A.A. and is now F.C.C. type approved.

For More Details Circle (80) on Reply Card

Flutter Meter

An inexpensive audio flutter meter that complies with the IEEE and DIN recommended standards is now available from **3M Company's Mincom Division.**

Designed to sell for under $400, the Model 8160 is the third in the 3M Brand Industrial Instrumentation line of audio flutter meters.

For More Details Circle (81) on Reply Card

(Continued from page 16)

Lucas demonstrated applications of the Tektronix 1480 oscilloscope, the 7L13 Spectrum Analyzer, and the Tektronix color video monitor and color corser.

Chapter 26: Chicago, Ill.
Chairman: Brad Anderson
Chicago, Ill. 60680

New chapter officers elected at the November 19th meeting are: Chairman, Bob Churchill; Vice Chairman, Craig McCartney; Secretary-Treasurer, Jim Grinnell; Past President and Chairman of Convention Planning, Brad Anderson; Program Chairman, Ken Steininger.

The scheduled program was cancelled at the last minute, thus providing the opportunity to exchange information concerning the move of some of the stations to the Sears Tower and the circular polarizations tests being conducted by WLS-TV. Descriptions of the equipment being used by WLS-TV, WTTW-TV, WFYR-FM, WCLR-FM, WLAK-FM, and the problems they have encountered were presented by Larry Ocker, Pat Alvarez, Warren Schulz, and Jim Grinnell. A movie showed some of the construction in progress. Tours were provided through the transmitter

(Continued on page 57)

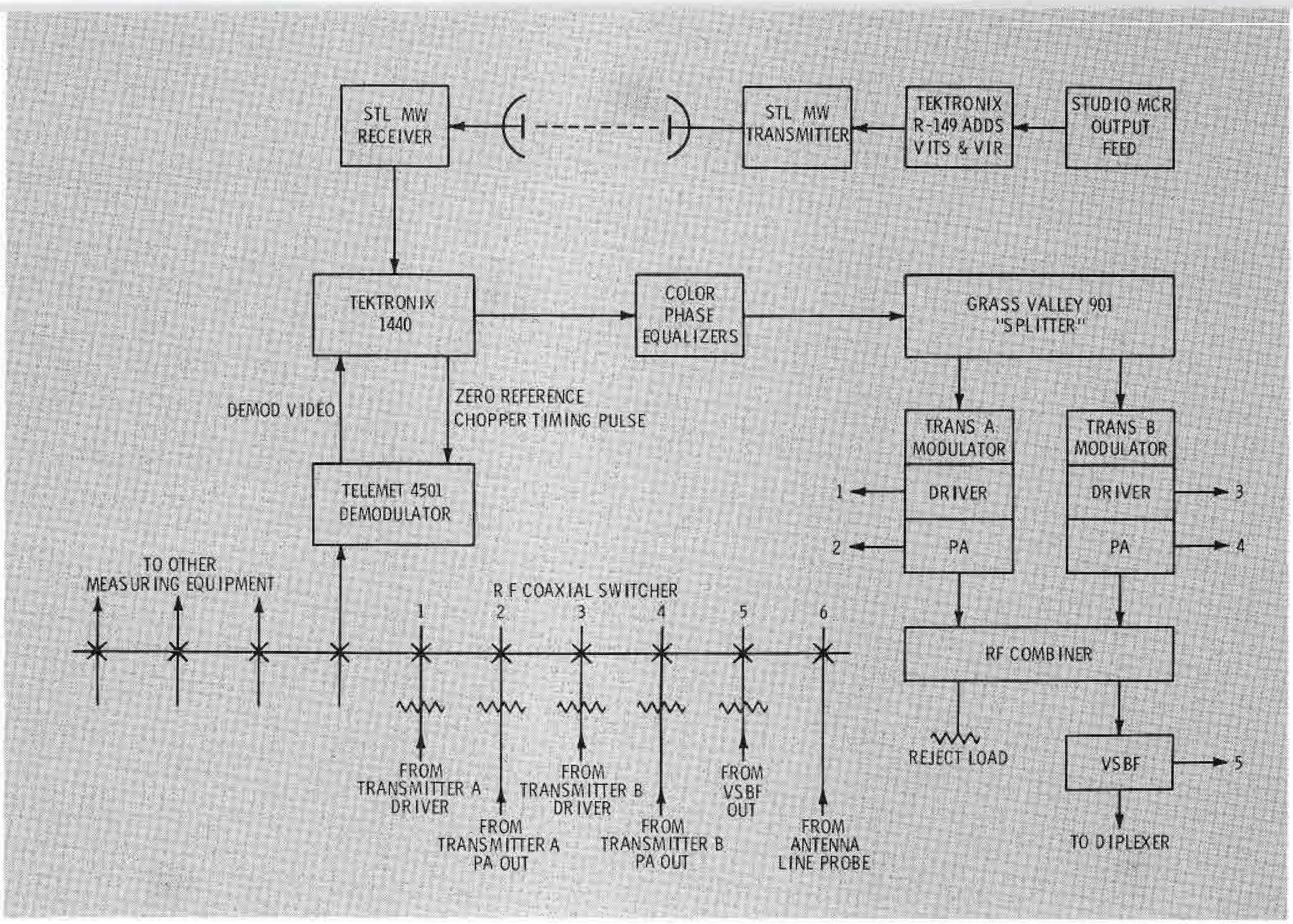


Fig. 3 The KATU system of RF feed points.

(Continued from page 24)

Band pass is probably the most important. As mentioned previously, the 1440 will "baby" soft tubes as discussed under its "tube checker" function.

Only one RF coax feed line from the directional coupler at the output of the Vestigial Sideband Filter is necessary to make the 1440 perform excellently. But is it a flat line? To make sure, you might feed it into your station sweeper, (ours is an RCA BW-5) and note your waveform, perhaps take a Polaroid photo of same. Then add a quarter wavelength line to the end of the feed line and sweep the system again. Now compare the two sweeps. If they are reasonably close in appearance, your line is probably flat.

Having made sure the sampling line from the directional coupler is flat, then the demodulator should be adjusted according to the manufacturer's instruction book so that it is neither under-driven nor over-driven by the sample. This problem was solved long before the advent of the 1440 when we purchased the Telemet 4501 Demodulator. The AGC on this device allows us to go to quarter power and less without disturbing the quality of the recovered RF signal from the demodulator. The Telemet 4501 performs very satisfactorily and a second one is used at the studio remote control operating console.

Whichever type of demodulator is employed, a simple field change is required to allow the 1440 to "time" the chopper pulse generated by the demodulator. In the case of the 4501, a BNC fitting and a small piece of coax was all that was required. The manufacturer of your demodulator will supply you with the needed information. More recent serial numbers of some demodulators, including Telemet, have the change built into them to accomodate the 1440.

We wish to thank those who have cooperated with time and information toward this article. Mr. William Vandermay, Chief Engineer of KATU has spurred us on with both encouragement and cooperation. Mr. C. J. Benninger, night Transmitter Maintenance Engineer, has patiently borne our plea for special tests and checkouts. Other members of our staff and community have shown lively interest in our efforts and our thanks goes to them for their cooperation and assistance in making this project possible.

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2. Harry Etkin, **Broadcast Engineering Magazine,** "Network VIR Signals Provide Critical Tests," January, 1971, BE.

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4. Tektronix Application Notes No. 8a.

(Continued from page 55)

rooms and through the Sears closed circuit studios. Larry Ocker, Chief Engineer of WTTW hosted the meeting which was also made possible by Bruce Wallace and the Sears A/V Department.

Chapter 28: Milwaukee, Wisc.
Chairman: Ed Wille
Milwaukee, Wisc.

Members and guests met on December 10th at the Oak Creek Power Plant to hear Armand Trinitapoli, Lynn Kaiser, and Larry Calvin, present the program "WATTS UP" which included a tour of the Oak Creek Power Plant of Wisconsin Electric. A number of members and guests met prior to the tour at Donny's for dinner.

Chapter 32: Southern Ariz.
Chairman: Hobart J. (Bart) Paine
Tucson, Ariz. 85717

The December Christmas party was reported in the preceding issue. The January meeting was scheduled to feature Richard N. Lawrence of Telemet for a program on the new 3706 Sideband Analyzer and related transmitter tests.

advertisers' index

Akai America 15
American Data Corporation 7
Ampro Corporation 31
Andrew Corporation 9
Anixter-Mark 39
Audio Designs 50

Belar Electronic Laboratory, Inc. 54
Bethany International 55
Broadcast Electronics 50, 52, 58
Broadcast Engineering's Proof of Performance Package 37

CBS Laboratories 45
Canon, U.S.A., Inc. 16
Capitol Magnetic Products 17
Cleveland Institute of Electronics 48
Communication Technology 8
Continental Electronics 57
Cooke Engineering 43

Datatron, Inc. 25
Dynair Electronics, Inc. .... Cover 2

Edutron, Inc. 60

Fidelipac 41

Grass Valley Group, Inc. 3

Ikegami Electronics Industries, Inc. of New York 47
International Tapetronics Corp. 53, 55

Jampro Antenna Co. 35
Jensen Tools and Alloys 58

Magnasync/Moviola Corp. 23
Minneapolis Magnetics, Inc. 39
Modtec Division-Broadcast Electronics 50

Nasco Television Systems CE-4

Nurad, Inc. 12

Opamp Labs, Inc. 58

Philadelphia Resins Corporation 57
Potomac Instruments, Inc. 51

Quick-Set, Inc. CE-2

RCA Global Communications 1
Radio Time Service 57
Ramko Research .... Cover 3
Recortec, Inc. 31
Revox Corporation 16
Russco Electronics 52

S C Electronics 49
Schafer Electronics 10
Shintron Cυmpany, Inc. 54
Shure Brothers, Inc. .... Cover 4
Sony Corporation 21
Sparta Electronic Corporation 5
Spotmaster 52, 58

Television Equipment Associates 38, 54
Texas Electronics, Inc. 55
Time & Frequency Technology 14
Tiner Commı'nications Service, Inc. 58
Tracor Industrial Instruments 38

Ultra Audio Products 50
United Systems Corporation, a subsidiary of Monsanto 34
United Recording Electronics, Inc. 29

Vamco Engineering 52
Varian-Eimac 13
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IMMEDIATE OPENING for studio maintenance technician, experienced with Quad VTR's, to work with color facility and FM radio station, First Class license required. Write, enclosing resume, to L. Alexander, Personnel Dept., San Diego Community College District, 3375 Camino Del Rio South, San Diego, CA, 92108. 2-75-1t

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PASS FCC first and second class exams with new 21 - lesson, 450-page course. Starts with basic electricity. Over 600 FCC-type, multiple-choice questions and sample exams incluided. No previous technical knowledge required. Commercial Radio Operator Theory Course, #15-01. Only $5.95. Ameco Publishing, 275G Hillside Ave., Williston Park, N.Y. 11596. 8-72-tf

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BROADCAST ENDORSEMENT and third phone preparation on cassettes. Illustration book includes current FCC-type exams. Radio License Preparation, 1060D Duncan, Manhattan Beach, Calif. 90266. 8-74-tf

FIRST PHONE in six to twelve weeks through tape recorded lessons at home plus one week personal instruction in Boston, Philadelphia, Detroit, Atlanta, Minneapolis, Seattle or Los Angeles. Our twentieth year teaching FCC license courses. Bob Johnson Radio License Preparation, 1060D Duncan, Manhattan Beach, Calif. 90266 Telephone 213-379-4461 2-75-tf

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MP-8E Mono $86 SP-8E Stereo $137

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Dual function and superb performance. Inputs for mic and line, ±0.5db response 10Hz-20KHz, 67db gain on mic channel(s) +26db gain on line inputs. Balanced inputs & outputs, +21dbm out max, 0.1% distortion. Internal power supply.

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DA-6/E	Table top. 1 in/6 out.	$131
DA-6R/E	Rack mount. 1 in/6 out.	$149
DA-6BR/E	Rack mount. 1 in/6 out. Individual level controls for each output.	$165
DA-6RS/E	Rack mount. 1 in/6 out stereo or 2 in/12 out mono.	$229
DA-16BR/E	Rack mount. 1 in/8 out stereo or 2 in/16 out mono. Individual output level controls, selectable metering & headphone monitoring.	$287
DA-2080/E	Rack mount main frame with protected power supply, metering & headphone monitor. Will accept up to 10 slide in modules. Each module has 2 inputs & 8 outputs. Individual output level controls & selectable meter switch. Up to 20 in/80 out.	
DA-2080/E	Main Frame	$150
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Performance specifications are; 0.3% or less distortion, 124dbm equivalent noise on low level channels, approximately 25w power consumption, —70db crosstalk, balanced bridging/matching inputs & response within ±2db 20Hz-20KHz. Series 35 audio controllers start at $1200.

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ACL-60B/E	(Blank tape loader)	$331
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SMA-50/E	Table top (mono)	$125
SMA-500/E	Rack mount (mono)	$142
SMA-1000/E	Rack mount (stereo-40w)	$196

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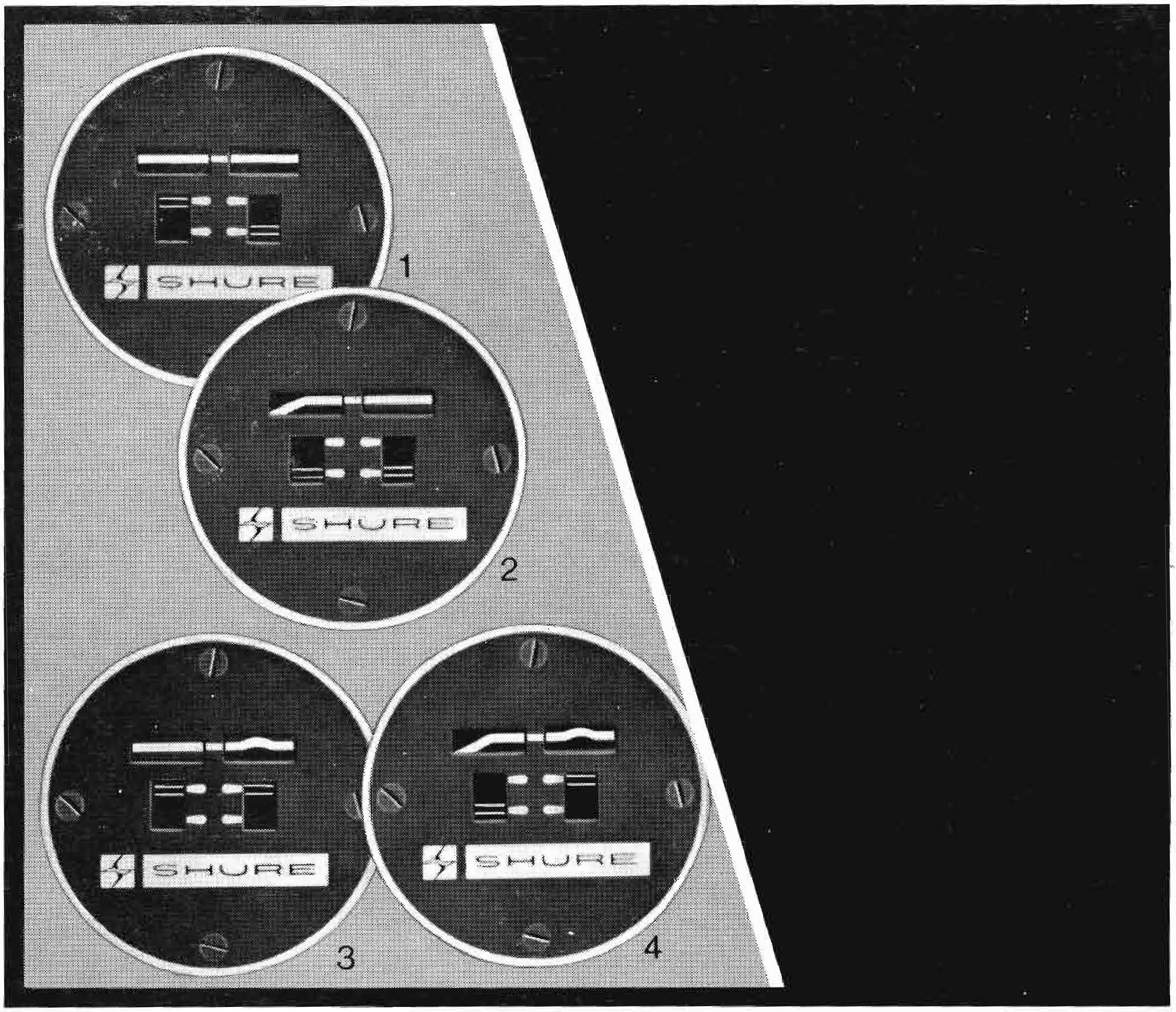

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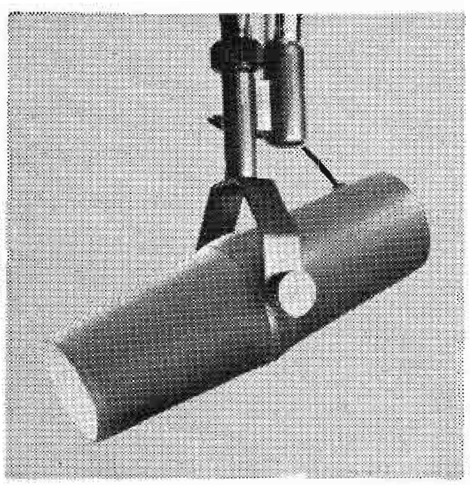

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