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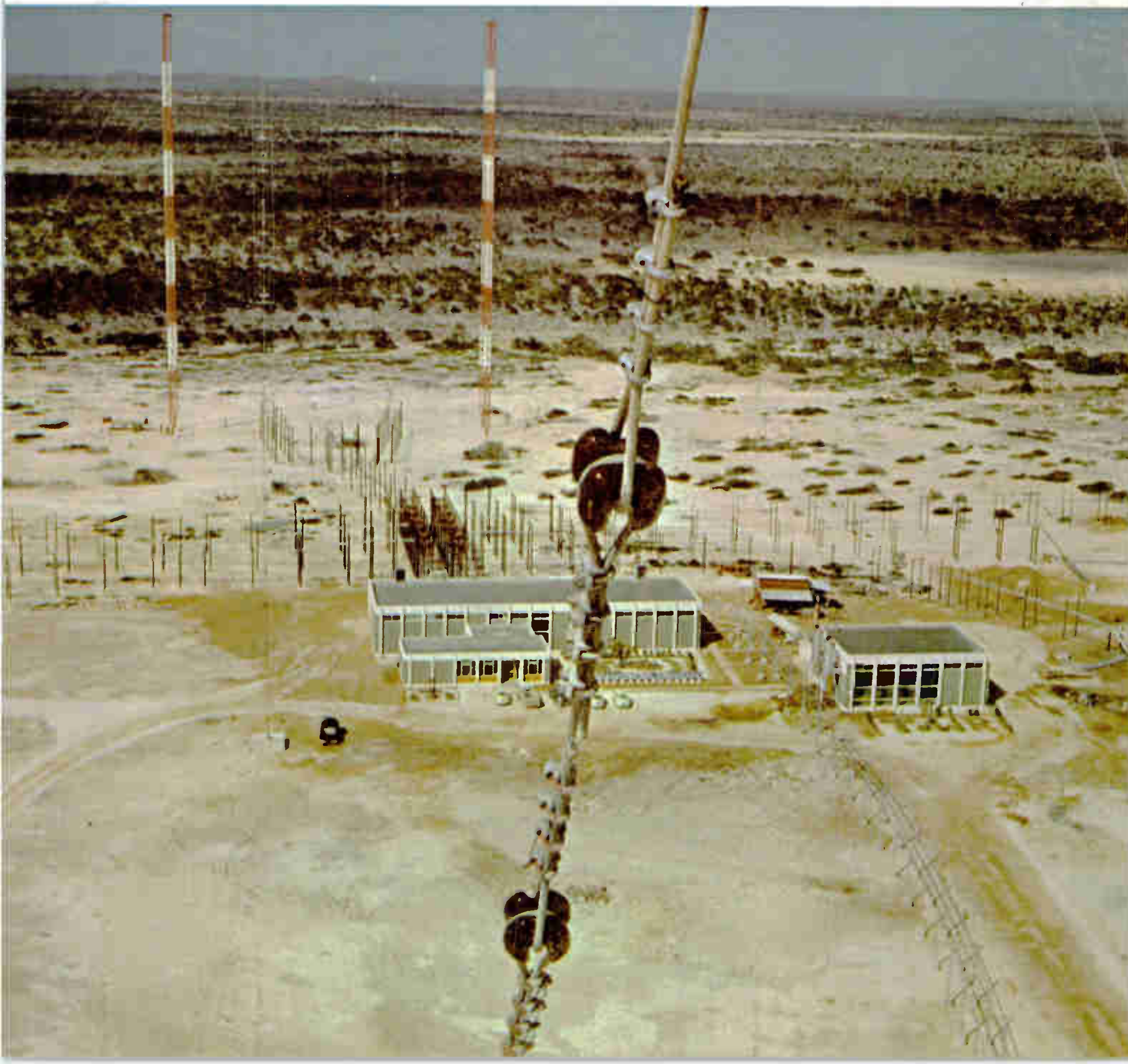
Broadcast Engineering

the technical journal of the broadcast-communications industry



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the technical journal of the broadcast-communications industry

Broadcast Engineering

Volume 10, No. 7 July, 1968

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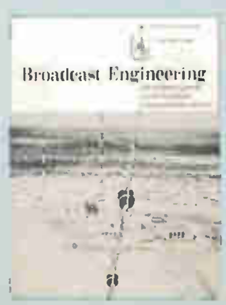
Departments

Shown on the cover is part of the transmitting complex of Transworld Radio on Bonaire Island in the Netherlands Antilles. Behind the transmitter building are the antenna switching matrix and a high-frequency curtain antenna. The view is from the tower of the 500-kw medium-wave station. (Photo courtesy of Continental Electronics Manufacturing Co.)



NEWS OF THE INDUSTRY

INTERNATIONAL

Wins Contract For Kuwait Earth Station

Nippon Electric Co., Ltd. (NEC) has been awarded a contract by the **Ministry of Post, Telegraph and Telephone** (P.T.T.), Kuwait, for a complete earth station for satellite communications in Kuwait. The Kuwait Government has been working on this project as part of a telecommunication expansion project for international telecommunications via Intelsat III, scheduled to be launched above the Indian Ocean this summer.

The contract calls for NEC to provide such items as antenna, transmitter-receiver, multiplex equipment, and power-supply equipment. NEC also will install the equipment and construct the station building.

Appointed Western-Hemisphere Distributor

Visual Electronics Corp. has been appointed exclusive distributor for data information communication devices manufactured by the **DASA Corp.** The new distributorship agreement, which covers sales of DASA products in the U. S., Canada, South America, Hawaii, the Caribbean, and those countries of Central America which do not already have existing distributor arrangements, has been initated by Visual's $750,000 order for DASA products.

NATIONAL

Factory Expanded

International Video Corp. has tripled its manufacturing space with the addition of an 18,000-square-foot facility in Sunnyvale, Calif. The leased facility will house assembly operations for the company's color television cameras and video tape recorders. It is twice as large as the company's present manufacturing space in Mountain View, which will be retained.

Georgia ETV Station Dedicated

The tenth Georgia Network station has been dedicated at Cochran. Assigned the call letters **WDCO-TV**, the newest station in the state network was named in honor of a former State School Superintendent, Dr. M. D. Collins. From its transmitter located outside of Macon, the channel-15 station broadcasts to 26 central Georgia counties as a service of the **Georgia Department of Education.**

Broadcast Systems Department Formed

RCA broadcast-equipment engineering, product-management, and sales activities have been grouped in a new Broadcast Systems Department of the Commercial Electronic Systems Division. The new organization will function under a three-executive team headed by Andrew F. Inglis, a division vice-president, who has been responsible for engineering and product management activities for the past two years. Mr. Inglis' associates are Edwin C. Tracy, division vice-president, broadcast sales, and Andrew L. Hammerschmidt, division vice-president, broadcast engineering and product management. Mr. Hammerschmidt, who has been manager, electronic recording products and scientific instruments, was promoted to division vice-president coincident with his new responsibilities. Mr. Tracy has headed broadcast equipment sales since 1950 and was named a division vice-president four years ago.

Group Reorganizes, Changes Name

A sales-force reorganization and new division name have been announced for the **Telex-Magnecord-Viking** group. Rather than having the sales department structured by the Telex, Magnecord, and Viking brand names, the department has been reorganized by markets.

National Sales Managers will be James R. Dow, Educational Products; Paul R. Bunker, Broadcasting and Industrial Products; Russ Molloy, Consumer Products; Sidney T. Kitrell, Aircraft Products. Gordon Thorburn, who headed up Viking tape recorder sales, has been named manager marketing administration, a new post with overall responsibilities for order-processing procedures, service, parts, and technical correspondence. Marketing and sales of Telex hearing aids are not affected by these changes and will be continued under the direction of Brian Hammond.

The Minneapolis-based group has assumed the new name **Telex Communications Division.** The Division operates manufacturing plants in Blue Earth, Glencoe, and Savage, Minnesota, with divisional management, sales, and engineering offices in Minneapolis. The Telex corporate headquarters is in Tulsa.

Division Formed to Market Electronic Measuring Apparatus

A new interdivisional group has been formed by **Philips Electronic Instruments** to distribute a line of Norelco electronic measuring and test apparatus in the United States. The new group—Norelco Electronic Measuring Apparatus (EMA)—is the first of a series of independent product groups which will be set up by Philips.

The EMA instruments include oscilloscopes, multimeters, pulse generators, transistor-curve tracers, low-frequency measuring systems, and instrumentation magnetic tape recorders. It is planned that the products of the new EMA group will be distributed exclusively through electronic manufacturers' representative organizations, and sold with a one-year warranty. Field service centers for EMA are now being established. By mid-1968 at least eight such centers are planned for key cities throughout the country. Field service centers already have been set up in Mount Vernon, N.Y., on the premises of the parent company's home office, in Philadelphia, and in Silver Spring, Md.

Microwave Contract Awarded

Receipt of a $200,000 contract from **New York Penn Microwave, Inc.,** for a microwave radio system to be utilized in transmitting television programs to central and western Pennsylvania, has been announced by **Lenkurt Electric Co., Inc.,** a subsidiary of **General Telephone & Electronics Corp.** Installation of the system is to begin in July and be completed by fall. The new network will interconnect with an existing microwave system which transmits TV programming from Sams Point, N. Y. to a site near State College, Pa.

Completion of the system will enable New York Penn Microwave to transmit TV programs from three New York City independent stations (channels 5, 9, and 11) to CATV subscribers in a number of cities, including DuBois, Ridgway, Emporium, Clearfield, Philipsburg, and State College, all in Pennsylvania.

The system, to be engineered, furnished, and installed by Lenkurt, will

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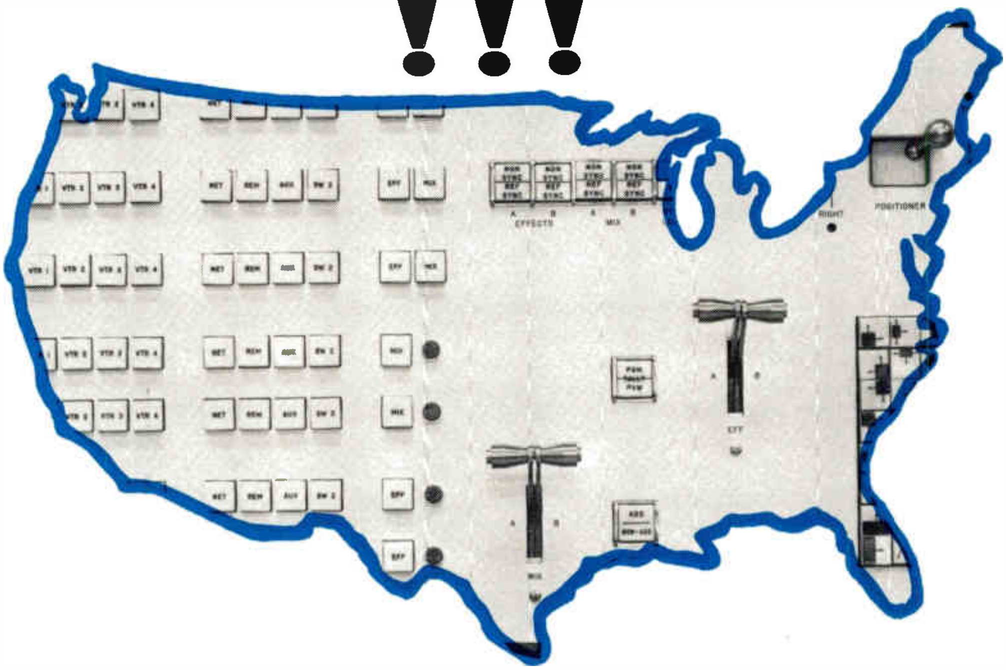

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cover 150 path miles and interconnect New York Penn's off-the-air TV pickup station at Ellenville, N.Y. to the existing microwave system at Corning, N.Y. The microwave network will utilize four repeaters on the main route and seven spur paths.

Expansion Program Continued

Rohn Manufacturing Co. is adding 38,000 square feet of space to its office and production facilities. Offices will occupy 12,000 square feet of the new construction, and the remaining 26,000 square feet will be utilized for factory expansion.

An area of approximately 22,000 square feet of manufacturing and warehousing space was completed in the spring of 1967.

Division Reorganized

The audio/video communications division of **Ampex Corp.** has been divided into three separate divisions under Thomas E. Davis, Ampex group vice-president. The new divisions are the video products division, the professional audio products division, and the special products division.

Lawrence Weiland, former video marketing manager of the audio/video communications division, has been appointed general manager of the video products division. Mr. Weiland joined Ampex in 1960 as manager of video engineering. The video products division manufactures video tape recorders, cameras, and accessories for use in broadcasting, location and mobile recording, and closed-circuit television applications.

General manager of the professional audio products division is A. A. Sroka, former video national sales manager of the audio/video communications division. Mr. Sroka joined Ampex in 1956 as a district sales manager in Los Angeles. The professional audio products division manufactures recorders ranging from studio models for master recording and radio-station use to portable models for field applications.

Jerome J. Dover, previously manager of the audio/video communications division's special products department, has been named general manager of the special products division. Mr. Dover joined Ampex in 1958 as southwest district manager of the instrumentation division. The special products division designs and installs complete recording and communications systems for a wide range of markets.

The new divisions have headquarters in Redwood City, California, with manufacturing facilities in Redwood City and in Colorado Springs, Colo.

ORGANIZATIONS

NAB

The Secondary Market Television Committee of the NAB has asked the Association to petition the Federal Communications Commission to extend the Commission's cable television (CATV) rules to all TV markets, regardless of size. The Committee also went on record against a proposed FCC rule that would prohibit the future ownership of more than one broadcast facility in a single market.

Later, the NAB asked the Commission to extend its deadlines for comments and replies to the proposed single-market ownership rule. In the filing, Douglas A. Anello, NAB general counsel, said the proposal is of "such profound significance to the broadcast industry that it requires an extensive analysis of market conditions in many communities." Therefore, he said, NAB requested an extension from June 26 to September 16 for written comments, and from September 16 to September 30 for reply comments.

The NAB has commissioned Glen O. Robinson, associate professor of law at the University of Minnesota, to study governmental organization and procedures for allocating and regulating the use of broadcast frequencies. NAB said Professor Robinson's independent study should enable the Association to contribute more meaningfully to this subject, which also is under review by President Johnson's Task Force on Communication Policy.

Professor Robinson's study will include a review of the background of governmental efforts to administer the frequency spectrum and will analyze the role of the legislative and executive branches. Professor Robinson is author of "The FCC and the First Amendment: Observations on 40 Years of Radio and Television Regulation," an analysis in depth of the applicability of the constitutional guarantee of free speech to FCC broadcast regulatory policies and procedures.

Earlier, NAB had contracted with Herman W. Land Associates Inc., of New York City, to conduct an intensive short-term research project designed to assist President Johnson's Task Force on Communications Policy in its study of the present and future domestic communications system. In commenting on the contract, NAB President Vincent T. Wasilewski urged all NAB member stations and networks to respond promptly to the Land firm's requests for information. The NAB president also said that some suggestions have been made to change broadcasting from a free on-the-air service to a wired system. He said the "implications of such suggestions make it imperative that NAB develop information as to the plusses and minuses of present broadcasting which now provides free TV service to 200,000,000 Americans." The report was to be made to the Task Force by June 30.

Addressing a recent luncheon meeting of the Mississippi Broadcasters Association, John M. Couric, NAB vice-president for public relations, said broadcasters' responsibility to the public is well known and called for more responsibility by the public toward broadcasting. He said the public's responsibility "is as deep as the responsibility of the citizen to his country, to his constitutional form of government, and to the freedoms which made this government possible and keep it viable." Mr. Couric said broadcasters should not forget that "our rights are not just our rights but the people's rights as well."

The NAB executive said one reason broadcasting comes under such heavy fire "is that we are the biggest and best . . . and exist in the public eye." However, he noted that nothing could be more fatal to broadcasters than for the public to lose interest. "But this does not require us to accept passively the slings and arrows of unfortunate outrage," he said. "Rather, it is time for us to start hurling some of them back." "Even if broadcasters wanted," he said, "others would not let us forget our responsibilities. Let us make sure that others, in turn, never forget their responsibilities to us."

NAEB

"Educational Broadcasting and the Fifth Freedom" has been selected as the theme for the 44th annual convention of the National Association of Educational Broadcasters scheduled to be held November 19-22 at the Sheraton Park Hotel, Washington, D.C. The "Fifth Freedom" was defined by President Johnson in his Education Message to the Ninetieth Congress as freedom from ignorance.

NAEB has announced that exhibit space for the convention, approximately fifty percent greater than the space used at the NAEB Denver convention last year, is virtually sold out. At the Denver meeting, which drew more than 3500 educational broadcasters and representatives from allied fields, 165 booths were sold to 66 exhibitors.

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National Academy of Engineering

The National Academy of Engineering has announced the formation of a Committee on Telecommunications to conduct a study of developments in communications technology through 1980. The 15-member committee is chaired by William L. Everitt, Dean of the College of Engineering of the University of Illinois, at Urbana.

The committee will advise both the President's Task Force on Communications Policy, created in August 1967 to review the nation's domestic and international policies in communications, and the Department of Housing and Urban Development, which is funding the study in connection with its long-range program of research toward the improvement of urban life.

The committee will first analyze data collected by the Task Force on current and anticipated developments in telecommunications technology to determine the extent to which such information provides a basis for policy judgments. It will then prepare descriptions of developments in telecommunications technology that are considered reasonably likely to be available by 1980, in order to provide policy makers with a framework of technological options.

The committee will examine long-distance transmission modes such as satellites, cables, and guided laser beams. It also will consider the problem of distribution of radio, television, telephone, and data signals within cities and the types of terminal equipment that may be available for business and personal use, such as receivers, video-phones, and data input consoles.

NCTA

The Engineering Subcommittee of the National Cable Television Association has approved the second draft of a Proposed Standard on Graphic Symbols for the cable television industry. The proposed standard will become effective after the subcommittee has reviewed and acted on any comments from associate members of NCTA.

SMPTE

The 103rd Conference of the SMPTE closed May 10 after drawing a record attendance at the Century Plaza Hotel, Los Angeles. More than 3000 engineers, scientists, and management personnel in the fields of motion pictures and television attended the technical sessions and viewed the exhibits. More than 100 scientific papers on new TV and motion-picture developments were presented, and equipment was displayed in 85 booths.

An audience of 700 attended the Conference Get-Together Luncheon on Monday, May 6, to hear Academy President Gregory Peck address the members. More than 800 attended the SMPTE banquet on Wednesday evening, May 8. These attendance figures also set new records.

Texas CATV Association

Local origination, new sales techniques, and the training of CATV technicians highlighted the program of the 8th Annual Convention of the Texas CATV Association. More than 250 CATV system owners and operators from Texas and surrounding states attended the three-day meeting at Dallas.

The need for formal training of CATV technicians was covered in two sessions. The first dealt with the feasibility of setting up a CATV technicians' 12-week course, much like the courses successfully used to train other electronic technicians. The other session was devoted to a review of

● *Please turn to page 52.*

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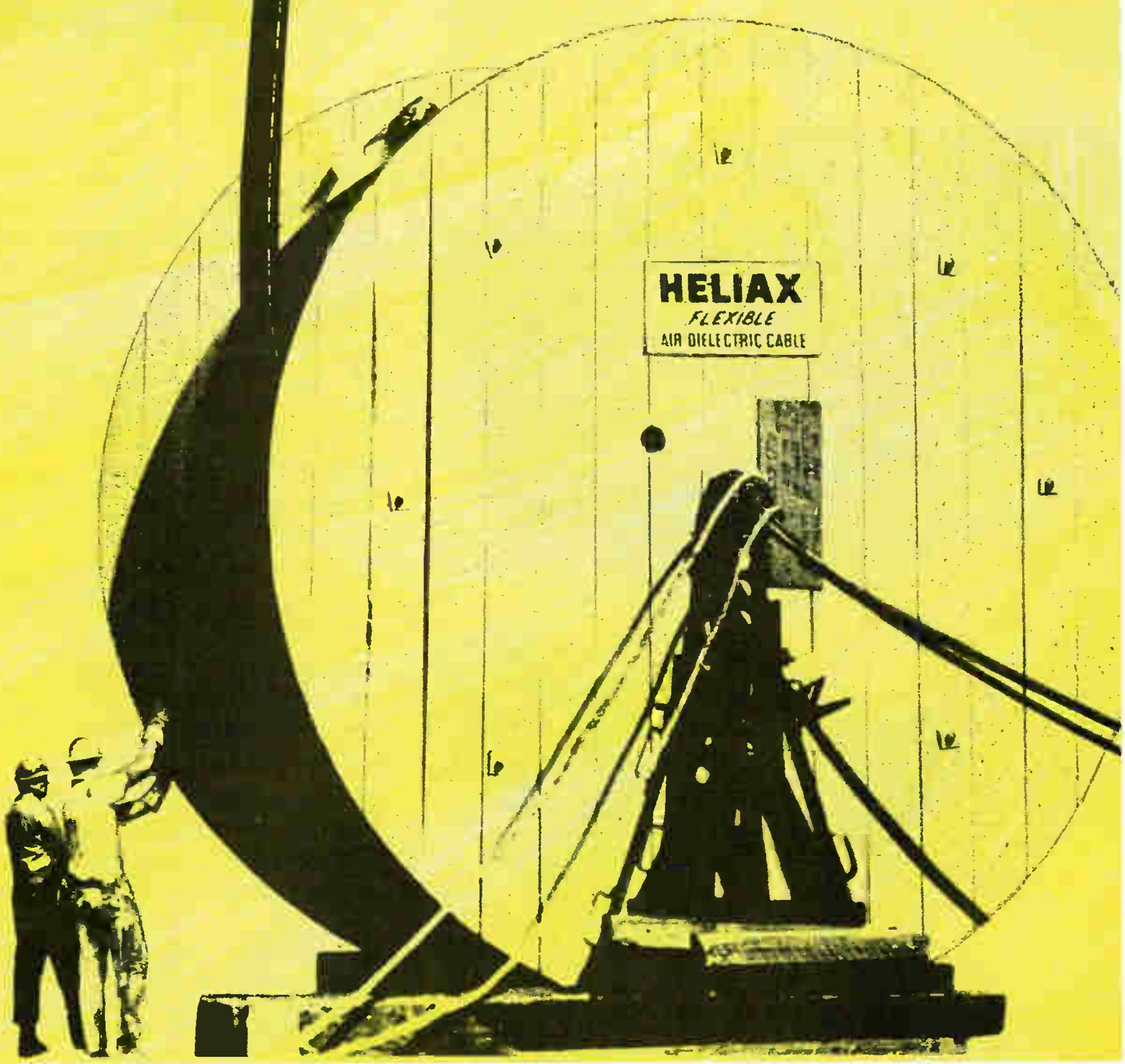


Circle Item 8 on Tech Data Card

July 1968

Late Bulletin from Washington

by Howard T. Head

Emergency Broadcast System Rules Revised

The Commission has adopted revised Emergency Broadcast System (EBS) Rules simplifying the emergency operating procedures of AM, FM, and television broadcast stations. The new Rules also provide for the use of the Emergency Broadcast System facilities and procedures in crises short of war or a national emergency. Under the new procedures, the emergency facilities may be used on a state or local basis.

The newly adopted rules spell out emergency situations in which EBS facilities and procedures may be employed. These include, among other things, tornados, civil disorders, industrial explosions, and widespread power failures. The use of unrestricted rebroadcast privileges, as well as the EBS attention signal, is also permitted. Complete details of the new procedures are spelled out at length in revised Section 73.971 of the Commission's Rules. (Incidentally, all broadcast stations are required to have up-to-date copies of Part 73 of the Rules on hand.)

The Office of Civil Defense (OCD) is studying a proposal involving a radically new approach to the nationwide dissemination of disaster information. Under this proposal, nine specially constructed, high-power, low-frequency transmitters, controlled from one of three specially hardened sites, would be permitted to seize control of specified broadcasting stations. The new report to the OCD has not yet been evaluated, but the practical disadvantages include the reliance on low-frequency signals around 200 kHz, since virtually no receivers in the hands of the public can tune the low-frequency band.

SHF CATV Relays to be Tested in Regular Operation

The Commission has issued a special developmental authorization to a New York CATV firm and a California equipment supplier for the field testing under actual operating conditions of an 18-GHz link for the relaying of CATV signals. Earlier tests (see October 1966 Bulletin) had indicated this mode of operation to be technically feasible, although reports of the initial tests were extremely limited.

The technique involves amplitude-modulating the 18-GHz carrier with the entire TV and FM broadcast bands (together with other services) in the frequency range from 54-216 MHz. The 18-GHz carrier is then fully suppressed, together with one of the two sidebands.

The proposal is visualized as being of particular value in New York City, where the difficulty and expense of laying CATV cables is quite substantial. The TV and FM signals would be picked up off the air at a central distribution location, from which the 18-GHz transmission could be made over short paths of only a very few miles. Each city block, and in many instances each building, would have its own 18-GHz receiver and converter, with distribution within the block or building being accomplished by means of conventional cable.

The proponents of the system suggest the use of the technique to provide CATV distribution for remote and rural areas. Whether this can be done at reasonable expense remains to be seen, and the Commission's authorization for the further New York City test requires that the system also be demonstrated in two rural areas having different characteristics. An important problem in rural distribution over any distance, as well as within the city, is the fact that 18-GHz signals are very substantially attenuated by even moderate rainfall.

Little Progress in Mexican Treaty

Progress continues to be slow in working out the details of a new standard broadcast treaty with Mexico (see March 1968 Bulletin). Complete agreement is yet to be reached with respect to several details, although FCC Chairman Hyde made a personal trip to Mexico City to discuss the new treaty with the Mexican telecommunications officials.

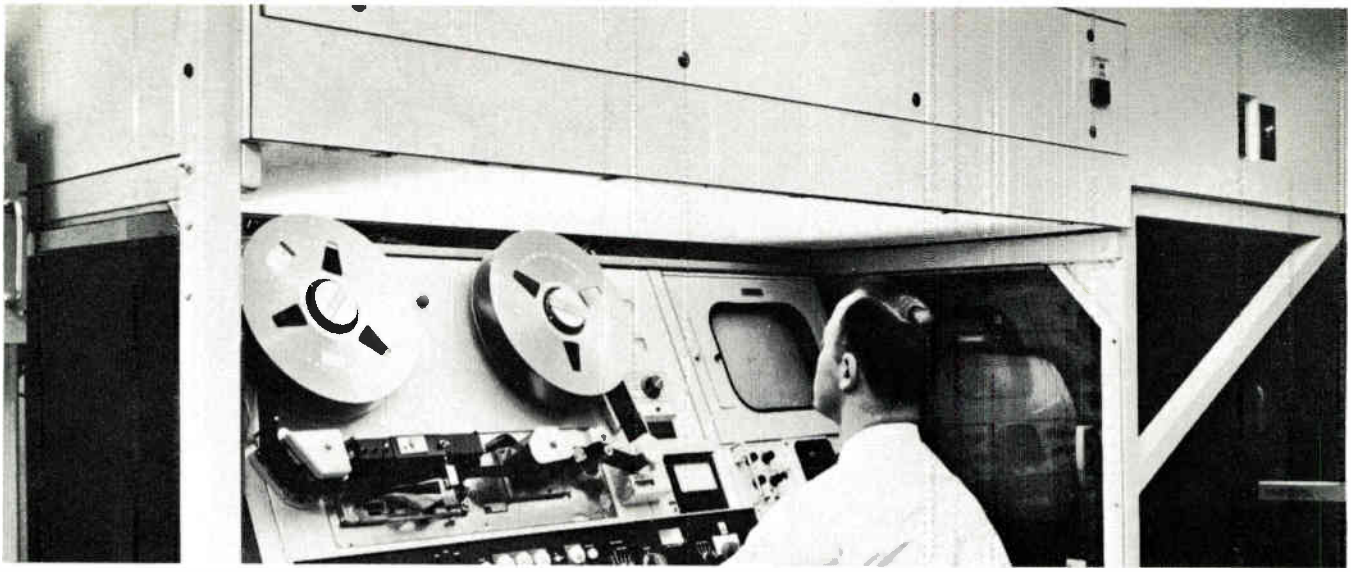
At stake in the new treaty are such matters as the use of the clear channels, presunrise operation by daytime-only stations on the Mexican clear channels and all channels near the Mexican border, and power increases to 1 kw both day and night for Class IV local-channel stations near the Mexican border.

The earlier treaty, which now has expired, has had its provisions extended by a special protocol until December 31, 1968.

Short Circuits

FCC Commissioner Bartley has proposed that the FCC be abolished. . .The Commission has given eight idle UHF television permittees thirty days to show why their permits should not be cancelled. . .The Court of Appeals has upheld the Commission's adoption of the presunrise rules for AM stations. . . Agreement with Canada is reported near with respect to commencing presunrise AM operation at 6:00 a.m. local time rather than 6:00 a.m. standard time (see April 1968 Bulletin). . .The Commission continues to authorize occasional short spacings between FM transmitters to permit the use of specific transmitter sites -- but not yet to squeeze in new FM stations. . .The Commission has accepted a supplementary Grade B coverage showing in a CATV case in Kansas directly at odds with the Menominee, Michigan decision reported in the June Bulletin. . .The Commission is considering establishing the equivalent of a "radio quiet zone" in Colorado; an existing "radio quiet zone" in Virginia and West Virginia blacks out most FM and television reception in an area of almost 14,000 square miles.

Howard T. Head. . .in Washington



TESTING OF VIDEO TAPE

by *Keith Y. Reynolds**

A summary of the tape tests which the user can perform.

A question that has been raised at practically every video-tape facility is whether or not to test newly purchased video tapes. If the answer is in the affirmative, the next question is either how do you test, or for what do you test.

Before any of these questions can be answered, it is necessary to determine what qualities make a video tape acceptable for a typical video-taping session. Naturally, some sessions demand a flawless length of tape, while others can get by with a few defects. Video-tape manufacturers strive to make a quality product and insist that quality-control standards are met, but as is the case with any manufacturing process, some production runs are better than others.

By now, most video-tape users have had enough experience with this medium to agree that a video tape must have several good characteristics to make it acceptable for their applications. They will probably agree that a good video tape must have:

1. Minimum dropouts
2. High signal-to-noise ratio
3. No noticeable video scratches
4. Long tape life
5. Low abrasion
6. Audio- and control-track stability
7. Reel-to-reel consistency.

Which priorities the tape user puts on his list of desirable parameters will depend on the application. As an example, a tape duplicator may be concerned primarily with video scratches, a recording studio may desire a tape with the highest signal-to-noise ratio, and a small TV station without a dropout compensator will place the highest priority on dropout count.

Regardless of whether you are planning to test and measure for one or all of these parameters, it is necessary to set some minimum standards at the test facility.

Ideal Testing Conditions

Although it may not be possible for everyone to test tape under ideal conditions, the tester should realize that allowance will have to be made in the final results for the fact that ideal conditions cannot be met. Following is a partial list of ideal tape-testing conditions.

Ultraclean Room

The room in which the tape testing is to be done should be as clean as possible. The walls and ceiling should be hard and cleanly painted. Lighting fixtures should be recessed into the ceiling to eliminate the possibility of dust and dirt falling on the tape or the equipment. Precautions should be taken so that ventilators do not stir up dust and debris near the tesing area. The floor (if it is not carpeted) should be mopped frequently with a sponge mop. A string mop should never be used, since it produces its own debris. If the floor is carpeted, it should be vacuumed frequently. Electrostatically filtered air should be provided to the room.

An excellent way to provide for an ultraclean working environment without having to adhere completely to the previously mentioned conditions is to use a vertical-laminar-flow ventilating system. This system usually consists of a special blower and filter-hood system which

*This article has been adapted with permission from the Memorex Corp. publication *Testing Methods for Broadcast Video Tape*, by Keith Y. Reynolds, Video Applications Engineer at Memorex.

provides a vertical, laminar flow of clean air that washes away dust particles and contaminants to less than 100 0.3-micron particles per cubic foot. The use of such a system over the test area will virtually remove any significant contamination that could affect the test results.

Temperature and Humidity Control

Many of the parameters to be tested will vary with temperature and humidity. Whether you do your testing in a clean room or use a vertical-laminar-flow system, it is still necessary to provide for temperature and humidity control. Keep the temperature at 70°, ±5°, with a relative humidity of 50%, ±5%.

Clean Equipment

The equipment used for the tests should be cleaned thoroughly prior to each test. Since dust and dirt may damage video tape permanently, it is absolutely necessary that the equipment be kept extremely clean. Otherwise, any tape tests may become completely invalid.

Tape Conditioning

The tape to be tested should be conditioned to the environment of the testing area by storing the tape at least 4 to 8 hours near the testing equipment. If the tape is in a sealed bag, the seal should be broken so that the tape can adjust to the environment.

Tip Engagement

Many of the parameters to be measured will change with the video-head-tip engagement that is used. Therefore, it is necessary to maintain a constant tip engagement for all tests. Most video-tape manufacturers have chosen an arbitrary 2-mil tip engagement for testing tape. One reason 2 mils was chosen is that a new head usually has approximately 3 mils of tip material, and a head ready for refurbishing has approximately 1 mil of tip material left. Since the average is 2 mils, this arbitrary tip engagement was chosen for testing tape. (Some argue that because an average tip wears faster between 3 mils and 2 mils than it does between 2 mils and 1 mil, a figure slightly less than 2 mils should be used.) Be this as it may, in order to get consistent results, the tester should decide on a standard tip engagement for tape testing and always use this tip engagement when making tests. One method for doing this is as follows.

1. Measure the four tips on the video head with a tip-measuring gauge.
2. Average the four readings.
3. Set up the video recorder for proper quadrature and vacuum-guide alignment with a standard SMPTE alignment tape.
4. Adjust the vacuum guide (in or out) for the difference between the tip engagement chosen for the tests and the average tip protrusion.

As an example:

Tip engagement used for testing	2.0 mils
Average of 4 tips	2.8 mils
Adjust the vacuum guide *out*	0.8 mil
or	
Tip engagement used for testing	2.0 mils
Average of 4 tips	1.6 mils
Adjust the vacuum guide *in*	0.4 mil

Testing Procedures

The problem of testing for any or all of the parameters is complicated by the sophistication of modern video-tape recording equipment.

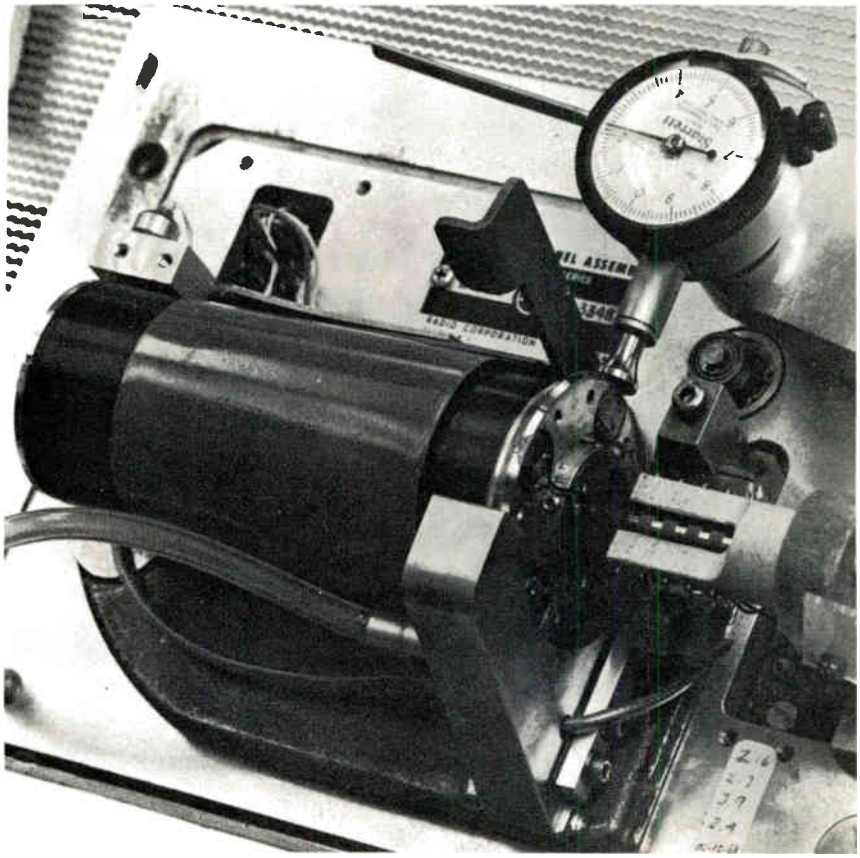
Do you record in high-band or low-band, black-and-white, or color? The answer you give will determine the method of testing because video tape reacts differently with different recording techniques.

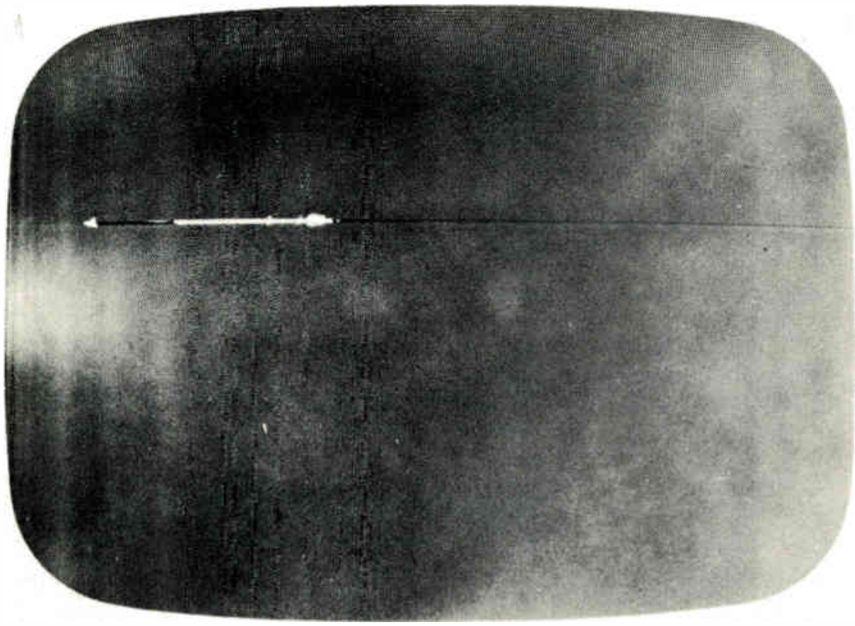
Let us take the important parameters one at a time and review some of the methods used to test them.

Dropout Testing

Dropouts may be caused by microscopic irregularities in the magnetic coating of the video tape. These may be the result of deficiencies in the coating process or they may be caused by debris or contaminants that adhere to the magnetic coating after the coating process. Regardless of the cause, the irregularity may lift the tape from the video head, causing a partial loss of signal.

Before listing some of the methods that are used for testing video tapes for dropouts, we should remember that in most cases the video-tape reproduction will be seen by nontechnical viewers, and the





distraction factor will depend on:

1. The amount of interest in the program material
2. The repetition rate of the dropouts
3. The dropout duration.

Thus, if the viewer is extremely interested in the program content, a few dropouts seldom will be noticed. Similarly, even if the program content is not too interesting and the dropouts occur at a regular interval of, say 5 per minute, there may be very little distraction to the viewer. However, if the dropout count is 5 per minute during the first three minutes and then 20 per minute during the 4th minute, the viewer may become distracted.

Also, if a large number of dropouts occur in a short interval (a "burst" of dropouts), the viewer may become distracted.

A very popular method of testing for video-tape dropouts is to record a video signal on the tape and observe the dropouts on a television monitor. The recorded signal for this test may be one of any number of test signals available at the facility, or an actual video program may be used. Test signals should be chosen with care to assure that they will be representative of the type of signal which will be used. Thus, if the tape is to be used for high-band color programming, the testing should be done in the high-band color mode with a color signal.

The advantage of testing tape in this manner is that the only equipment needed to test the tape is already available in the video-tape facility.

The disadvantage of testing tape in this manner is that the video-tape operator is the only person who can evaluate the tape, and he may be too critical (or not critical enough). The tape under test may meet the manufacturer's specification easily, but because of the subjective method of evaluation, the operator may feel that the tape does not meet the specification. This method of testing also can be expensive and time consuming, because it requires the undivided attention of the video-tape operator who evaluates the tape.

An alternate testing method involves the use of an electronic dropout-detection device. There are many ways of detecting dropouts electronically, and equipment to do this is available from several manufacturers. The results are basically the same. A dropout of a known duration and amplitude (often selectable) causes a pen recorder to record the event on a paper strip chart. The result is a graphic display which will tell at a glance the condition of the tape under test. A digital counter also can be used to total the number of dropouts electronically.

If the dropouts are to be measured with an electronic dropout-detection device, it is wise to define a dropout first. The subject itself is extremely controversial, and many hours have been spent in standards-committee meetings trying to reach an acceptable definition. However, before any value can be derived from electronically measuring dropouts, some definition must be established. One popular definition is the following:

"A video-tape dropout is the loss of RF signal caused by a momentary loss in contact between the head and the magnetic coating on the tape, and is of a random rather than a repetitive nature. For practical purposes, a dropout count should be made based on defects causing a 12-dB or greater reduction in unlimited playback RF for a duration of 10 microseconds or longer. The standard condition for measurement should be as follows:

1. A tip engagement of 2 mils during record and playback
2. A recorded frequency of 5 MHz for low band and 7.9 MHz for high band
3. The machine must be operated at an effective head-to-tape speed of 1560 inches per second, and with a head which produces a 10-mil-wide track."

Although this definition may be too strict to correlate with dropouts seen on a standard monochrome television monitor, it is a step toward standardization and will agree with the major video-tape manufacturers' tape-testing techniques.

Signal-to-Noise Ratio

It is desirable in any recording medium that the system have a good signal-to-noise ratio. In the case of a video-tape recorder, poor signal-to-noise ratio will produce a noisy picture. One working in the film industry would refer to this noisy picture as "grainy."

Should you test for noise? This is a question only you can answer. If the video-tape playback looks as sharp and clean on your television monitors as the incoming signal does, and if you do not plan to make multiple-generation tape copies or transfers to film, you may not need to be concerned particularly with the signal-to-noise ratio of the video tape you are using. However, there are some applications in which it is desirable to know the relative signal-to-noise rankings of the video tapes to be used.

There are several methods that can be used to measure the signal-to-noise ratio of video tape. Some methods may be better than others. Regardless of the method used, a video-tape recorder must be used in the tests, and there may be several factors than can change the absolute signal-to-noise figure. Some of these factors are:

1. Video-head-tip projection
2. Video-head-tip engagement
3. Record current
4. Playback equalization
5. Deviation standards.

Therefore, it may not be possible to obtain repeatable, quantitative results on a day-to-day basis.

Since the machine variables play such an important role in establishing signal-to-noise ratio, a good plan is to "rank" tapes. To establish a basis for comparison, at least three tapes should be chosen. One should be a tape considered to have the best possible signal-to-noise ratio. One should represent an average tape. And, one should be at the bottom of the acceptable scale.

Short sections of these tapes should be spliced together and kept for a reference. Whenever subsequent signal-to-noise-ratio measurements are undertaken, a new recording should be made on these reference tapes, and the resultant signal-to-noise ratio should be used to grade other tapes being measured. (Care must be taken to set the playback equalization properly when making these tests.)

Example 1
Date: October 5
Reference tape 1 . . . . 45 dB
Reference tape 2 . . . . 43 dB
Reference tape 3 . . . . 41 dB

All tapes that measure between 41 and 45 dB or better on October 5 are acceptable.

Example 2
Date: December 12
Reference tape 1 . . . . 49 dB
Reference tape 2 . . . . 46 dB
Reference tape 3 . . . . 45 dB

All tapes that measure between 45 and 49 dB or better on December 12 are acceptable.

The easiest way to "measure" the signal-to-noise ratio of a video tape is simply to observe the tape reproduction on a television monitor. An advantage of this measurement method is that it is a relatively simple test and no special equipment is needed other than the video-recording system itself. A disadvantage is that it is difficult to make a critical comparison between tapes since the eye cannot see small differences in tape noise.

Another way to measure tape noise is to record a gray-level video signal on the tape and then evaluate the peak-to-peak noise on an oscilloscope while replaying the tape. This method has practically the same advantage as the first method and is slightly more accurate. However, the results still depend largely on the observer's ability to see the differences in noise levels, and the results still may not be too accurate.

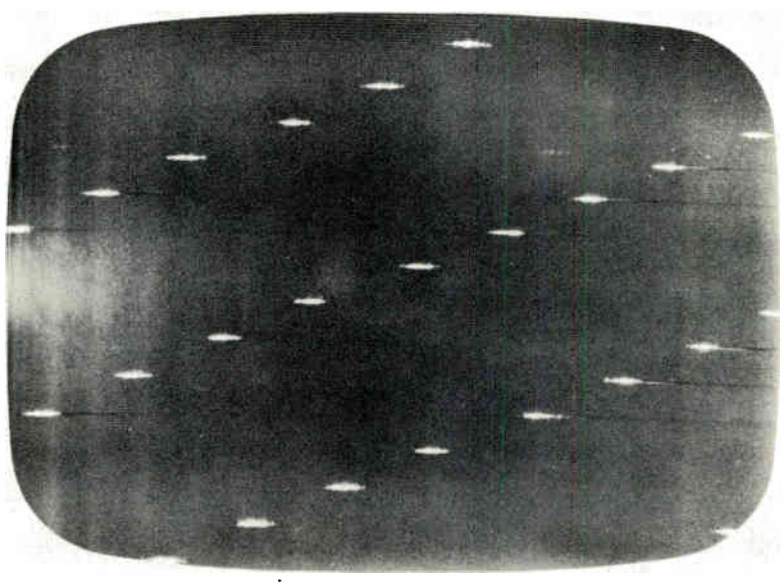
A more objective method would be to attach a voltmeter to the composite-video output and read the noise value directly on the meter. However, this will not work because the sync pulse is the highest source of energy in the composite-video signal.

To compensate for the sync-pulse problem, another method can be used to measure the signal-to-noise ratio of video tapes. Bypass the video-recorder modulator and record unmodulated RF on the tape. (The RF signal should be within the normal deviation range of the demodulator.) Play back the signal in the normal way. A continuous noise signal will be obtained, and the noise level can be measured directly on a voltmeter. This method is more objective and precise than the subjective methods, but it still has some limitations. It is not possible to compensate for changes in the frequency response (due to the tape characteristics) of different video tapes, since the video recorder is not used in its normal operating mode. Thus the video tape having the best frequency response will appear noisiest, all other factors being equal.

Still another method is used by most of the European television stations, and it is rapidly becoming popular in the United States. It involves the utilization of a normal video-tape recorder in its usual mode of operation and a means for removing the synchronization pulses from the video signal. Thus, the noise superimposed on the *active portion* of the video signal can be amplified and measured on a voltmeter. A weighting network usually is used to take into account the noise-frequency spectrum difference. The advantage of this measuring technique is that more consistent results are obtained. Since the video recorder is used in its normal mode of operation, compensation can be made for tip engagement, playback equalization, record current, etc.

Video Stratches

Video-tape scratches show up on the television monitor as a repetitive stair-step pattern. This tape defect is usually a longitudinal, physical scratch on the video-tape oxide surface. A scratch can occur during the manufacturing process or during normal use on a video recorder.



Any sharp object on the tape guides or heads can scratch the tape. This sharp object can be dirt, oxide debris, or a permanent burr.

An exception to this is the "false scratch." A false scratch looks like a regular scratch on the television monitor, but a physical examination reveals no scratch in the oxide. The false scratch is usually caused by a piece of magnetized oxide adhering to a tape guide. As the tape rubs on this oxide particle, a portion of the video signal is erased. This problem also can be caused by defective or improperly refurbished audio-head stacks. After correction of the problem, the scratch will disappear from subsequent recordings.

A simple method for detecting video scratches is to observe the tape replay on a television monitor. This can be done using either program video or one of the test signals available in a television facility. Again, since this is a subjective testing technique, care should be taken to assure that the recorded signal will simulate normal operating conditions.

As an example, recording just sync (no setup) will reveal video scratches very readily. However, for all practical purposes, this test is much too severe. Even if it is anticipated that the video will "go to black" occasionally, the black level has some setup, and the viewer will see black only a small percentage of the time. If gray level is to be used for visual scratch detection, the level of gray should be approximate 30% video.

The visual method for detecting video scratches is the most popular method in use today, but it has the same disadvantages as any of the subjective methods described previously. The intensity (and therefore the amount of distraction) of the video scratch is extremely dependent on the video-tape recording system. Tip engagement, record current, demodulator characteristics, frequency response of the television monitor, etc., all play an important part. Therefore, an objectionable scratch seen during the playback from one video recorder may be barely perceptible during playback from another.

Electronic video-scratch detection is possible, but it must be realized that, electronically, a video scratch is very complicated. Although a scratch may cause an RF reduction of only about 6 dB or so (well within the demodulator-limiter capability), this tape defect may become objectionable because of the abrupt nature of the scratch. RF modulation and the fact that the scratch produces a repetitive pattern make it more visible.

Some argue that electronic scratch detection should occur after demodulation, while others say that it can be accomplished best with the RF signal. Most video-tape manufacturers and some tape users have their own proprietary methods for measuring video-tape scratches.

Tape-Life Tests

If for no other reason than to insure that they are getting their money's worth, most video-tape users are interested in long tape life. However, long tape life is directly dependent on how much care the user gives the tape. If regular video-recorder maintenance is scheduled and performed, if cleanliness is rigidly enforced, if temperature and humidity are controlled, and if tape handling is kept to a minimum, longer tape life can be realized.

When one or more of the following conditions become evident, the useful life of a video tape is ended:

1. Dropouts become intolerable.
2. Video scratches become intolerable.
3. The tape causes head clogging.

Testing for long tape life can be done in various ways. Many video-tape facilities keep a tape-usage log with each tape and log each time the tape is used. In addition, comments by the tape operator help make it possible to predict the end of useful tape life before a catastrophic failure is experienced on the air. If the log is kept accurately, this is an excellent way to determine how many passes a given video tape can be used in a given facility.

This logging system also can be applied to tapes that are bicycled. ("Bicycling" is a term used to describe a system wherein a video-tape program or commercial is shipped to one or more video-tape facilities which, in turn, ship it to other users or return it to the sender after use.) However, since the original sender loses control of the video tape (he does not know how many times the users preview the tape, if the video recorders are properly maintained, etc.), he may not get an accurate accounting of the amount of tape usage or the conditions under which the tape was used.

Most video-tape manufacturers and some tape users measure tape life by means of a shuttle test. The shuttle test consists of automatically shuttling a short section of tape on a standard video-tape recorder. Each playback pass is logged, and the end of useful tape life occurs when the breakdown of the tape binder causes a reduction in RF level (head clogging), or when the dropouts become intolerable. This test can be duplicated in a video-tape user's facility by use of an automatic electronic editor.

Some video-tape users conduct a similar life test by performing a loop test. The tape under test is spliced in a loop and run until the tape deteriorates. Metallic splicing tape can be used to trigger a counter for determining the number of passes. Although it would be expected that useful tape life might be less with spliced tápe stock, the proponents of this method usually edit tape by the splicing method and feel that this test is representative of their average studio condition.

Although the shuttle test and the loop test can provide a fair representation of tape durability, the logging method can give a more accurate method for determining actual tape life in a given facility.

Abrasion Testing

Any time two surfaces rub together, the surfaces must wear; thus, the heads in a video-tape machine experience wear. The amount of head wear is influenced by:

1. Temperature and humidity.
2. Cleanliness of the area
3. Amount of tip engagement
4. The video tape being used
5. Amount of vacuum in the vacuum guide
6. Transport adjustments
7. Whether the recorder is used for recording or playback

8. Whether or not spliced tape stock is used
9. Operating techniques.

Because of the great number of variables, it may not be possible for each video-tape user to experience the same head wear.

The video-tape stock does play a part in head wear, and many users may want to measure the abrasiveness of their video tape. This can be done in several ways.

One method for measuring abrasion is to measure the amount of tip material on the video heads at regular intervals, using a tip-measuring gauge. This should be done by one person to minimize the reading errors. Each time a reading is taken, the accumulated head hours should be logged. In this way an average head-wear per hour can be calculated. For example:

Hours	Average Projection of 4 Tips	Incremental Wear Rate
0	2.90 mils	
25	2.82 mils	3.2 microinches/hour
50	2.75 mils	2.8 microinches/hour
75	2.64 mils	4.4 microinches/hour
100	2.55 mils	3.6 microinches/hour
Average tip wear		3.5 microinches/hour

Although this is probably the most accurate method available for measuring head-tip wear, gross errors can be encountered. Care must be taken when making the measurements so that the tip temperature is approximately the same each time. If the tips are measured first thing in the morning before the head is used that day, the head should be allowed to cool after use before measuring the tips again. Parallax errors must be avoided when reading the meter scale. Because of an accumulation of inaccuracies, it may appear that the tips have more material on them than they had at the time of a previous reading. For these reasons, plus the fact that no two video heads wear exactly the same amount under the same conditions, several sets of measurements on several sets of video heads must be made before the head-wear data can be meaningful.

Of course, a simple way to accumulate head-wear data is to keep a running-time log for each head. In this way, it can be determined how many hours a given head lasted before it was necessary to retire it. Heads which are retired for reasons other than worn tips should be logged separately in order to have meaningful data.

There are several other methods for measuring the abrasive quality of video tape, but laboratory equipment is necessary for these measurements. Also, the results may not correlate with the data accumulated under normal tape-use conditions.

Audio Stability

When video tape is manufactured, wide sheets of polyester are coated with magnetic oxide. Sometime after the coating process, these wide, coated sheets must be slit to the proper width with very close tolerances. The audio track on a quadruplex video tape is very close to the edge, and there are several factors that can cause audio trouble. Edge damage to the tape is a major source of trouble, and it can occur on the video-tape transport, or while the tape is being shipped or stored. Therefore, good tape care and handling procedures are very imporant.

Another cause of audio instability is a worn audio head. Because of the tendency for video tape to cup (this cupping phenomenon is aggravated by the vacuum guide), it is possible to wear the audio head faster than the rest of the material in the audio-head stack. Therefore, it is possible, in the case of a severely worn audio head, to have a negative tip projection. Under these conditions, audio instability can cause a serious problem.

The easiest and fastest way to test for audio instability is to record a steady audio tone on the video tape and then play it back. If the audio output signal is not steady, the variation in level can be seen on a VU meter. If the audio level varies rapidly (a flutter-like instability), the variation can be heard on a monitor speaker. The audio output, after demodulation, can be fed to a chart recorder if a permanent record is desired.

Most video-tape manufacturers state that the audio output will vary no more than 1 dB throughout the length of the tape roll. If it is found that performance is below the manufacturer's specifications, it is wise to take the tape to another machine, make a new recording, and check it again to insure that a worn audio head is not the cause of the instability.

Reel-to-Reel Consistency

A video-tape manufacturing plant is similar to a bakery. The product is manufactured in batches. Naturally, great care is taken so that each batch is similar to the others, and in many cases, the video-tape user does not have to concern himself with reel-to-reel consistency. However, if editing or dubbing which involves more than one reel of tape is to be done, it is important that the tapes have similar characteristics. Some of the parameters to be considered are:

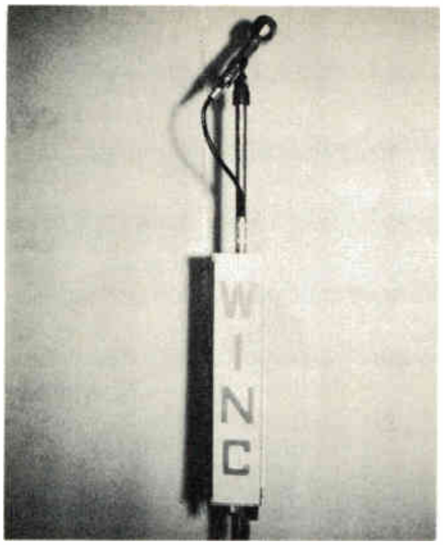
1. Signal-to-noise ratio
2. RF level
3. Audio level
4. Chroma level.

Reels of tape manufactured from the same batch should have very similar characteristics, but tapes from different batches may vary slightly. If tapes are to be tested for reel-to-reel consistency, it usually is adequate to spot-test the reels, since the four characteristics usually do not change to any significant degree within the length of a tape. Thus, a quick check with an oscilloscope or a VU meter usually will be sufficient to determine interspliceabilty.

It should be realized that it probably will be impossible to match exactly all of these parameters if tapes from different manufacturers are compared. Intersplicing tapes from different manufacturers, or tapes from the same manufacturer but having different product types, usually is impractical.

Conclusion

It would not be possible to describe all of the various methods that can be used to measure the important parameters of video tape. Also, it should be realized that a measurement technique which works well at one video-tape facility may be impractical at another. However, several methods have been described briefly so that it may be easier for you to answer the question, "What tests should we be making, and how can we best make them?" ▲



A Microphone-Mounted Remote Amplifier

by *Philip Whitney**

Construction details are given for a compact, low-cost, solid-state unit.

At present, several companies are manufacturing inexpensive transistor amplifier assemblies, and many of these units are adaptable for broadcast use. One such transistor amplifier was converted by WINC into a remote amplifier compact enough to mount directly on a microphone stand.

This particular unit was built around the Amperex PCA-4-9 prefabricated amplifier. Basically, this unit is a complimentary-symmetry amplifier in which iron components have been eliminated. The circuit is rated at 1-watt output. Before modification, the input impedance was in the order of 25,000 ohms, and the output impedance was 8 ohms to match a speaker directly. In the modified version (Fig. 1), we added an 8-to-500 ohm transformer. The amplifier specifications state that input sensitivity for 1-watt output is in the order of .035 volt. In the broadcast use described, we run the output considerably below its maximum capability and therefore obtain a good distortion figure with a good noise figure.

A few notes about the circuit may be of interest. For stability and improved frequency response, capacitors C3 and C4 provide feedback paths. The two isolation resistors (R1 and R3) in the input circuit of the amplifier serve to prevent loading of the generating device and to prevent frequency distortion caused by loading the transistor input circuit. (Without R3, there would be a tendency at low volume-control settings to bypass the base to ground through input capacitor C1.) Because the circuit feeds a low-impedance load, it is necessary to use a fairly large coupling capacitor (320 mfd, C5) to pass the bass notes.

The frequency response and distortion figure for the finished unit are shown in Table 1. The performance has been found to be quite satisfactory for sports broadcasts, church remotes, and the odd remote-pickup jobs every station has. The noise figure is better than that of the average telephone line, down 50 dB from a 3-volt output into 500 ohms.

The amplifier can be used with either high- or low-impedance microphones. In most applications at WINC, a high-impedance microphone has been used, since the microphone line is very short and the need for an input transformer, always a source of hum pickup in remote amplifiers, has been avoided. The approach of making the amplifier into a microphone-stand nameplate also offers another advantage: There is practically no setup for a remote. The announcer merely connects the telephone line to the output binding posts and plugs the power cord into an AC outlet. (The amplifier case could just as easily contain batteries instead of an AC power supply.) Because of the low current drain and long transistor life, the microphone-stand amplifier may be set up in a church, plugged in, and left running continuously. In this way, the embarrassment of

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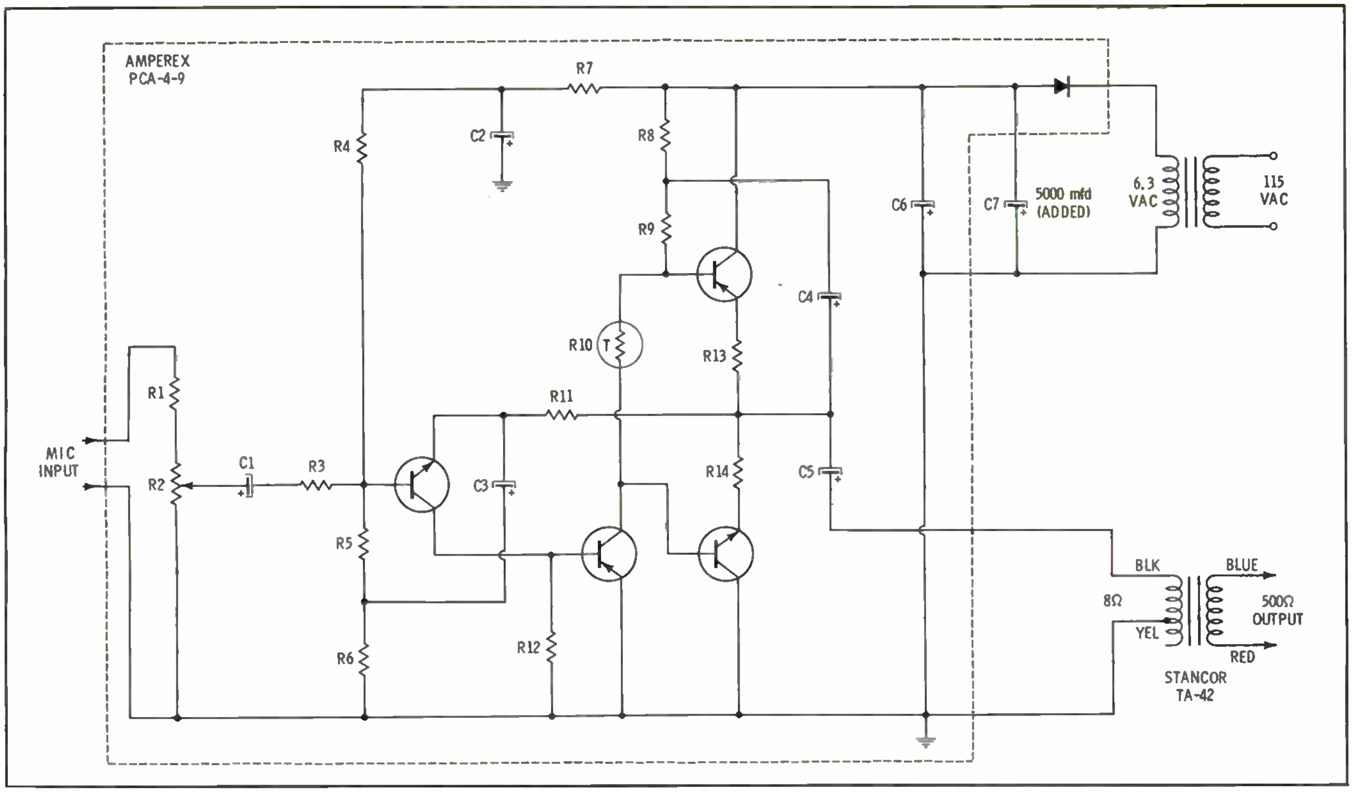


Fig. 1. The solid-state "call-letter-sign" amplifier is based on a commercially available unit, with modifications indicated.

someone's forgetting to plug it in on Sunday is avoided.

Construction is very simple. A 1-ampere filament transformer is mounted in one end of a Bud CU-3014A 2¼" × 2½" × 12" *Minibox*. In the other end of the box, the amplifier assembly is mounted, with its volume-control shaft used as the mounting lug. The knurled volume-control shaft was hack-sawed off so that only a slot remained for external gain adjustment. This arrangement prevents accidental misadjustment of the gain.

The amplifier contains its own diode rectifier and filter system, but the hum figure was greatly reduced by the addition of a 5000-mfd filter capacitor across the 1600-mfd unit (C6) already in the assembly. A Stancor TA-42 output transformer was mounted on the amplifier heat sink. (A substitute could be a Triad TY-45X). This transformer matches the 8-ohm amplifier output to a 500-ohm line. Binding posts mounted in the bottom end of the case are attached to the 500-ohm winding of the transformer. The power cord is brought out through a rubber grommet in the bottom of the case. The input connector is installed at the top of the box.

The original unit is fastened to a microphone stand with three snap fasteners of the type used to mount electrolytic capacitors, but any other means of attachment could be used.

A sign painter put the station call letters on the top of the box so that when the unit is clamped to a microphone stand, it appears to be a call-letter sign. The short line from the microphone to the amplifier does not exceed two feet in length.

All parts, purchased from a mail-order electronics house, cost less than $22. ▲

Table 1. Amplifier Performance

Frequency Response

Freq Hz	Output dB*
50	−4.0
100	−0.5
250	0
1000	0
5000	−0.5
7000	−1.0
10,000	−1.5

Distortion

With 3 volts output at 1000 Hz: 1.4%

*Reference, 8 volts output at 1000 Hz.

Feeding Signals Into a PA System

Here's an idea for the station manager to use the next time he addresses the local service club. Most hotels or meeting rooms have a rostrum with a single microphone which picks up the speaker's voice when he addresses assemblies. When we at WINC give a talk to a local group, we like to enhance it with taped actualities, themes, or sound effects. Getting into the sound system, which is often at a great distance from the rostrum, can be a problem. We decided that the best way to get our tapes into the system was through the microphone, but not by audio pickup. We hang a telephone pick-up coil over the microphone in the area of the matching transformer, then plug the coil into the output jack of the tape recorder. The sound goes through beautifully by induction. The station engineering staff may even wish to wind a coil to fit tightly a particular type of microphone. It's easy, and we have found that it works like a charm!

—*Philip Whitney*

BROADCASTING SPACE FILMS

by Tom Levy*—

Unusual frame rates pose a problem in reproducing space-flight films on television.

Some of the most expensive, dramatic — and difficult to acquire — motion-picture film has been shot by America's astronauts during their Extra Vehicular Activities (EVA). Network feed for this film is handled on a pool basis from KPRC-TV, Houston. Three space films, from GT-4, 10, and 12, have been transmitted, and Apollo film is to be handled in the same way when the first flight is made.

Viewers, especially those with color receivers, thrilled as they watched the late Col. Edward H. White "walk in space." But behind the scenes, KPRC-TV engineers were having problems. They had spent two hours dismantling one of their film chains to use a borrowed 16-mm motion-picture projector in place of their own equipment. When they previewed the 90 feet of "cleared" film, it looked like an old silent film.

The problem was that the film was exposed and printed at six frames per second. To project at this speed, the station borrowed a rheostat-controlled projector from NASA. However, as it turned out, the rheostat provided approximately eight to ten frames per second. Since time was short, the only immediately available solution was to use an insulated screwdriver to put a load on the projector motor. The film-room supervisor literally wrapped himself around the machine to help hold it in place, and watching the monitor, adjusted the pressure of the screwdriver to keep the film running smoothly. Obviously, some more professional method for handling the film had to be found.

By the time the next film was available, a representative at one of the major networks had passed along information on a multispeed 16-mm television projector, equipped to operate without flicker at 1, 2, 3, 5, 6, 12, or 24 frames per second. A TV shutter and synchronizing circuit permit operation as a television projector at all the frame rates.

One of these units was rented for showing space film, but it was still necessary to spend hours moving equipment to get the special unit into place in the film chain. While space film was being shown, the station was crippled with only one color chain left for commercial work.

*Eastman Kodak Co.

After the use of the projector proved successful, the networks sharing pool film decided to purchase one for permanent storage at KPRC-TV. It was used for GT-12 film (the last two-man flight) and is scheduled for use throughout Apollo.

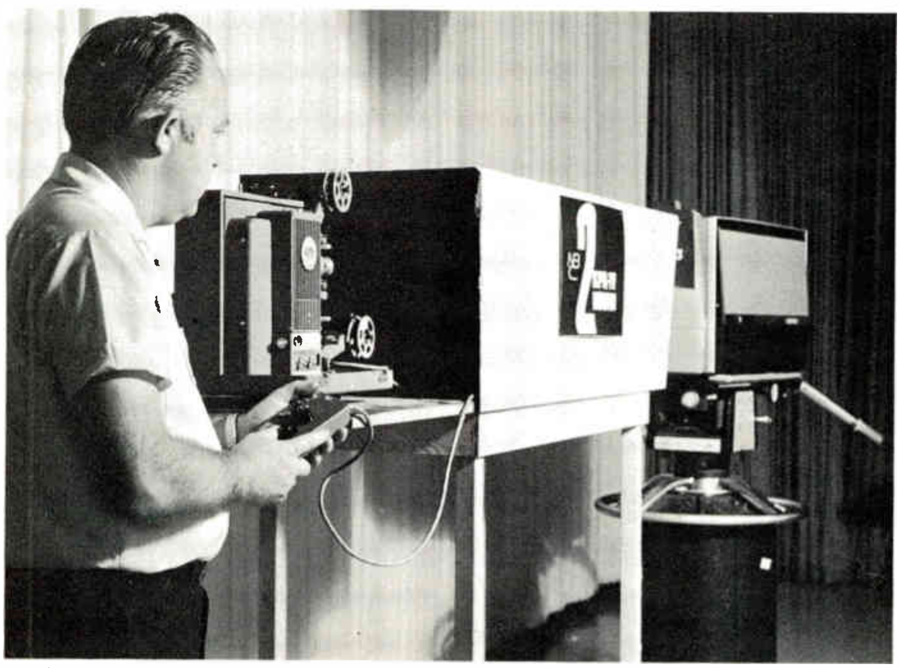
To use the new projector effectively, and at the same time leave the station film chains free for regular programming, engineers wanted (1) a low-cost device to combine with the projector, (2) something easily moved and stored, and (3) a device that would provide quality transmission. After some experimentation, the best approach seemed to be using a shadow box. This was possible because NASA uses double-sprocket film. To keep the image from being reversed, the film is "flopped" on the projector. The shadow box cost between \$10 and \$15—a small investment compared to moving the film-chain equipment for each feed.

The KPRC-TV shadow box is 50" x 18" x 15" and has both ends open, one for projection and the other for a color television camera. A piece of back-projection screen is framed inside. Station engineers decided this material was best after experimenting with materials from tissue paper to ground glass. Glass was discarded because of the danger of breakage, which would be catastrophic if it happened just before air time.

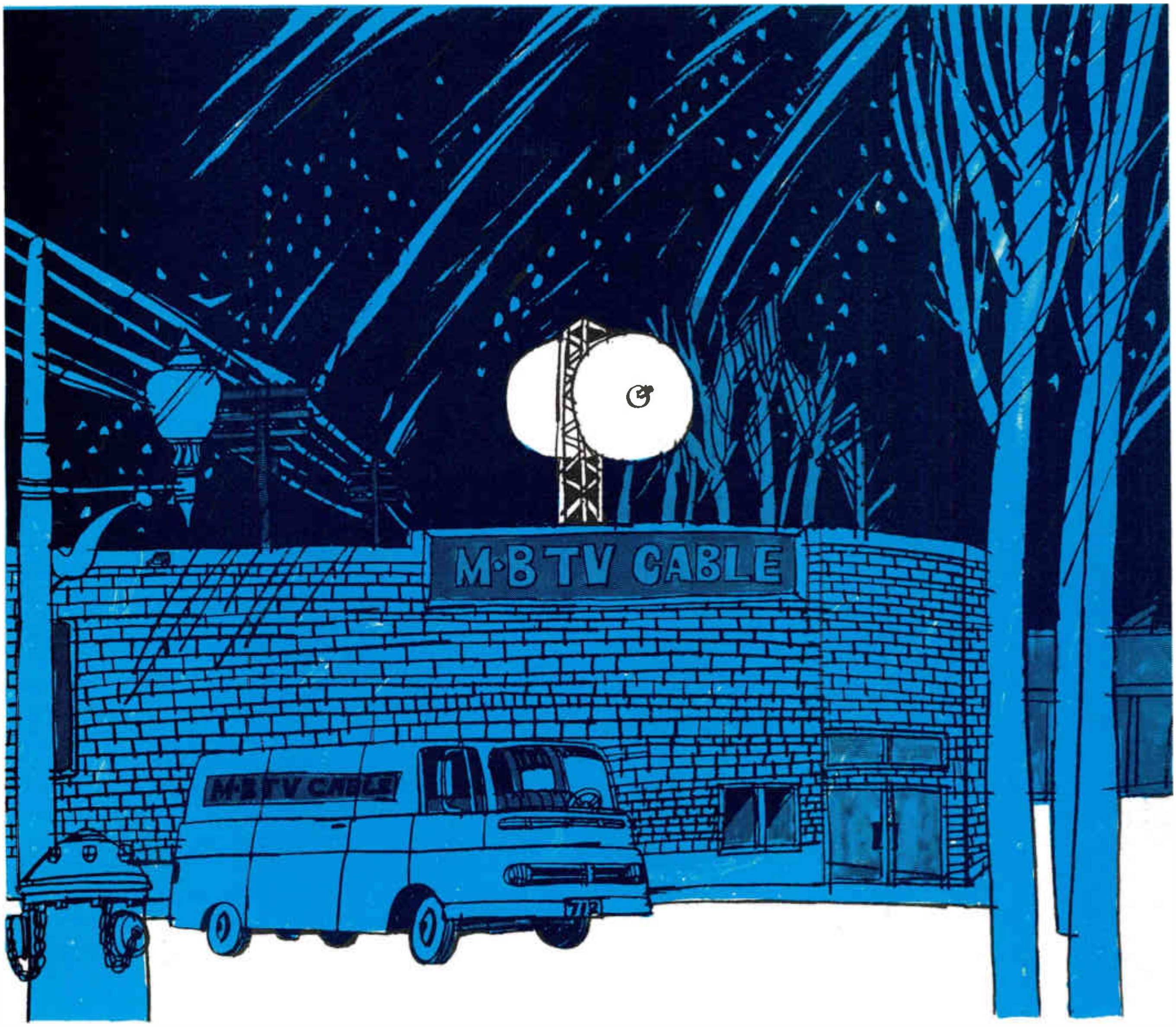
With the special projector and shadow box, KPRC-TV can be ready to feed color film in less than 10 minutes from the time the station is notified that film is available. The shadow box can be set up in any corner of a studio, a color camera focused on the internal screen, and the analyzer projector positioned at the other end.

On-the-air experience has suggested a few modifications to make the transmission better. One change is to place the projector on a separate table to eliminate the possibility for vibration. Originally, a shelf attached to the shadow box was used. For more light, and crisper reproduction, the 750-watt projector lamp will be replaced with a 1000-watt lamp.

Actual handling of space film is controlled by NASA. The agency notifies KPRC-TV that the film is ready and will be delivered—usually by helicopter—and at a certain time. The networks then agree on the earliest time they can accept the feed, and whether it will be programmed live or taped for future use. As a matter of practice, a NASA representative has stayed at the station until all transmission is complete. This representative then returns the film to NASA's Houston headquarters. ▲



Left to right are the special projector, shadow box, and studio color camera.



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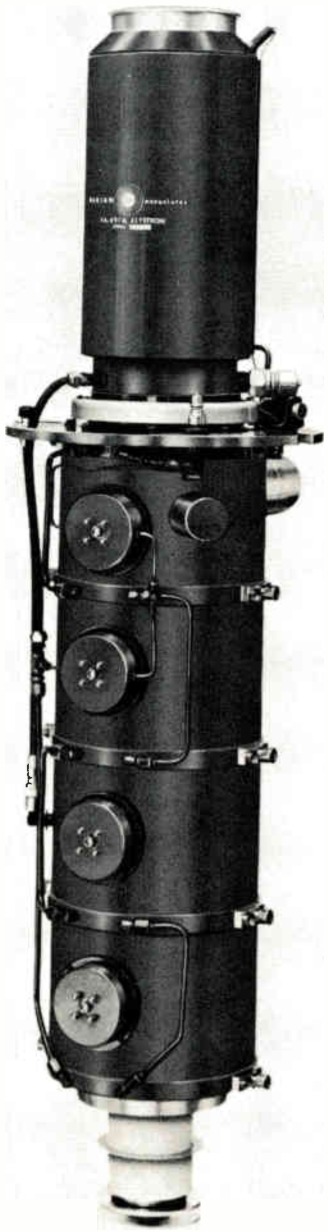
Introduction to

*by Rudy Schubert**



The fundamental problem encountered in amplifying signals in the microwave region with tubes of conventional design is twofold. One problem area lies in the inability to construct resonant circuits using lumped constants that will exhibit the classic characteristics of inductance and capacity. Thus a coil of wire appears, in fact, as a capacitor when the shunting effect of the capacitive reactance between adjacent turns of the conductor causes the current to become capacitive at frequencies above self-resonance. Similarly, the foil and leads of a capacitor may exhibit a greater inductive reactance than capacitive reactance at high frequencies.

Closely allied with the design problems which crop up in attempts to utilize lumped-constant devices are the difficulties encountered in attaching these devices to the vacuum tube. As the inductance and shunt capacity of the connecting leads become significant fractions of the total circuit values, the upper frequency limit is attained.

These problems have been solved—to a degree—by ingenious methods of distributing the constants throughout the dimensions of the leads. These endeavors have led to the design of tuned lines, open and coaxial, and finally to the evolution of the tuned cavity. However, this progress was limited in scope, due to the limitations of conventional vacuum tubes.

The second facet of the fundamental problem has its basis in the deficiencies inherent in a conventional tube when it must operate in the microwave region. These deficiencies also may be divided into two general areas. From the brief discussion of the problems encountered in external circuitry, the first of these inadequacies of the tube may be inferred: Connection of the external circuit to the tube structure becomes impossible at the higher frequencies. This will become more readily apparent as the second limitation of the conventional tube is explored.

Transit time, as applied to vacuum tubes, is the time required for an electron to pass from the cathode to the anode. At frequencies below a few megahertz, the effects of transit time are of purely academic interest; however, when transit time, particularly the transit time

*Applications Engineer, Varian Associates

KLYSTRONS

Part 1 of 2 parts.

The evolution of this high-frequency tube and the fundamentals of its operation are discussed in this installment.

from cathode to grid, becomes significant with respect to the period of one cycle of the signal involved, amplification becomes difficult. (It is not our intent to treat at length the effects of transit time, but only to point out their existence. From an empirical point of view, the effect of transit time is to reduce the input impedance of the grid circuit.)

By careful design of the tube to be used at high frequencies and by the use of properly constructed external circuitry, useful amplifiers operating up to perhaps 4.5 gHz are possible. The tubes used in these applications are known generally as lighthouse or planar-grid tubes. Fig. 1 is a drawing of the 2C40 lighthouse tube which is typical of the class. Transit time is minimized by extremely close spacing of the elements; the cathode-to-grid space is in the order of 0.1 mm, and the grid-plate spacing is about 0.3 mm. Obviously, the power-handling capabilities of this design are seriously limited; less than 1 watt at 2% efficiency at 3 gHz is typical.

A device capable of amplifying signals in the microwave region must meet the criteria to be inferred from the foregoing. It must be of a configuration adaptable to distributed-constant circuitry, it must not be affected to any great degree by transit time, it must be of sufficient size to dissipate substantial amounts of heat, and it must be rugged enough to withstand high voltages and large conduction currents.

A. Arsenjewa-Heil and O. Heil (Germany) announced, in 1935, new principles of operation for a high-frequency oscillator tube. Announcement of the discovery of similar principles for oscillators and amplifiers by R. H. and S. F. Varian of Stanford University, California, followed in 1939. In the same year, W. C. Hahn and G. F. Metcalf of Schenectady, New York made a similar announcement. The name "klystron," from the Greek "klyzo" (waves breaking on a beach), was coined at Stanford University.

Fundamentals of Operation

The klystron stands as a radical departure from the lighthouse tube, which was a logical extension of low-frequency techniques to the requirements of microwave. Instead of furthering the attempt to minimize transit-time effects in a region of the tube where electron velocities are low, control of the electron beam in the klystron occurs after the electron beam has attained a relatively high velocity. Thus, the amount of time spent by an electron in the input gap (corresponding to the region of a conventional tube bounded by the cathode and control grid) is diminished by several magnitudes. Fig. 2 is a schematic drawing of a two-cavity klystron amplifier, perhaps the best design of the tube from the standpoint of explanation.

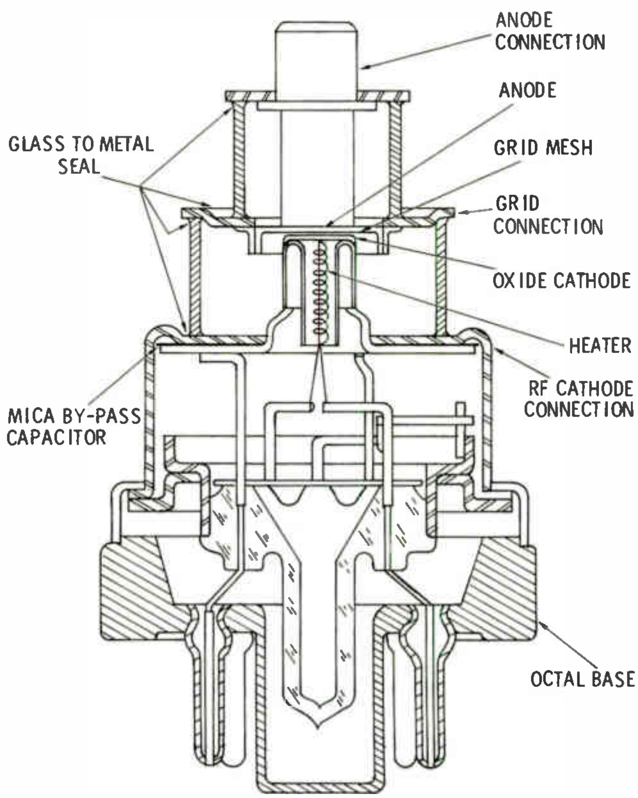


Fig. 1. The lighthouse tube minimizes transit-time effects by extremely close spacing of cathode, grid, and anode.

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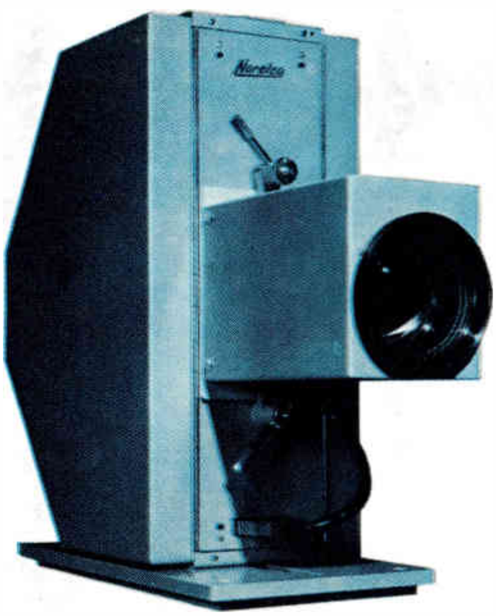

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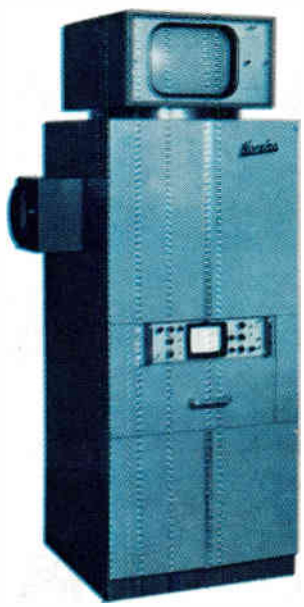

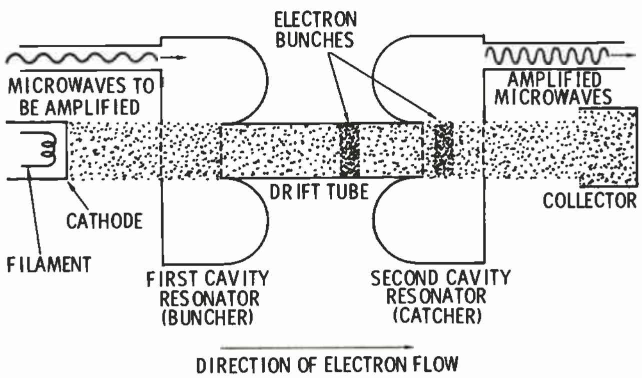

Fig. 2. Basic elements of a two-cavity klystron amplifier.

This drawing is not representative of any specific klystron, and several liberties have been taken in the illustration. The tuned circuits across the input and output gaps are, in practice, tuned cavities which surround the cylindrical drift tube. Klystron amplifiers having 3, 4, or 5 cavities are in use today. Beam-focusing devices have been deleted for the sake of simplicity.

The length of the tube, its diameter, and the operating potentials vary so widely that no typical values can be assigned. Lengths vary from inches to several feet, and beam voltages vary from a few hundred volts at a few milliamperes to pulsed values as high as 280 kv at 320 amps. Power outputs vary from milliwatts to 1 megawatt in CW klystrons, and models available for pulsed applications have ratings as high as 30 Mw pulse power. High-power-klystron pulse amplifiers have duty cycles from .005 to as high as 0.1.

Without excitation, a relatively uniform electron flow exists from cathode to anode of the tube shown in Fig. 2. However, when an RF signal is injected into the input cavity, electrons are either accelerated or decelerated, depending on the instantaneous voltage across the cavity ends. If, for example, the RF voltage across the gap is positive, electrons crossing it are accelerated and tend to overtake previously emitted electrons. Conversely, electrons entering the gap when it is negative are decelerated and tend to be overtaken by electrons which are emitted subsequently. Thus, electrons which had approximately equal initial velocities assume new speeds which are either greater or lesser, depending on the time of entry of the specific electron into the gap. Notice that although the velocities of the individual electrons has been modified, the average velocity of the electron beam is unaffected by the injection circuit. Accordingly, very little energy is expended in the circuit.

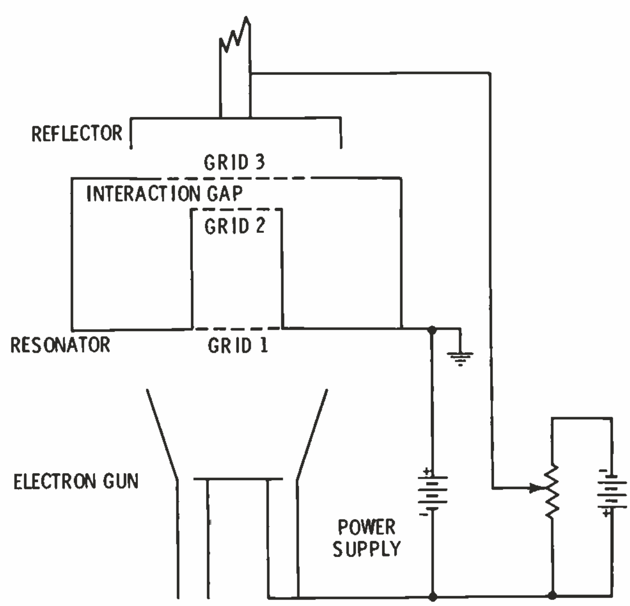

Fig. 3. Simplified diagram of a reflex-klystron oscillator.

As the electron beam drifts towards the anode, the electrons of various velocities tend to form discrete bunches; that is, the beam is "density modulated." The average velocity of the beam is adjusted so that the bunches attain their maximum density at the second gap (catcher). Here, the passage of the density-modulated beam excites the resonant cavity into oscillation. This cavity acts as a transformer to match the impedance of the attached load to the impedance which appears across the gap. Coupling from the cavity may be by means of a loop, probe, or window.

The effect of a load on the catcher cavity is analogous to the load across the output terminals of any transformer; i.e., the input impedance is lowered and energy is withdrawn from the source. In the klystron, loading results in deceleration of the electron beam and extraction of energy from it.

A cursory examination of the process of density modulation implies that a very slight bunching voltage will produce a high level of modulation if the drift tube is sufficiently long. However, the mutual repulsion of the electrons in the bunch precludes this, and relatively short drift lengths attended by increased drive are necessary. Nevertheless, power gains as great as 50 dB are practical for 4- or 5-cavity klystrons.

Historically, the need for a low-power oscillator predated the requirement for a high-power transmitting klystron. (The magnetron showed greater promise for this latter application in the late '30s.) The two-cavity klystron oscillator, made by adding a feedback loop to the two-cavity amplifier, was an early adaptation of this new tube, but the difficulties encountered in electronically and mechanically tuning the two-cavity oscillator led to the development of the single-cavity reflex klystron.

Fig. 3 illustrates the basic structure of the reflex klystron. Again, all non-essentials have been deleted. In the configuration shown, the cavity is operated at DC ground potential, which allows the microwave-output circuit also to be at ground potential. The reflector, or repeller plate, is negative with respect to the cathode, and no current flows in the repeller circuit. Fig. 4 is a cutaway drawing of the type 6BM6, an external-cavity klystron which operates in the range from .55 to 3.8 gHz.

Referring again to Fig. 3, cathode current flows because of the accelerating field which exists between cathode and cavity, and this stream excites the cavity as it passes the gap. The oscillating voltage of the cavity velocity modulates subsequent electrons passing

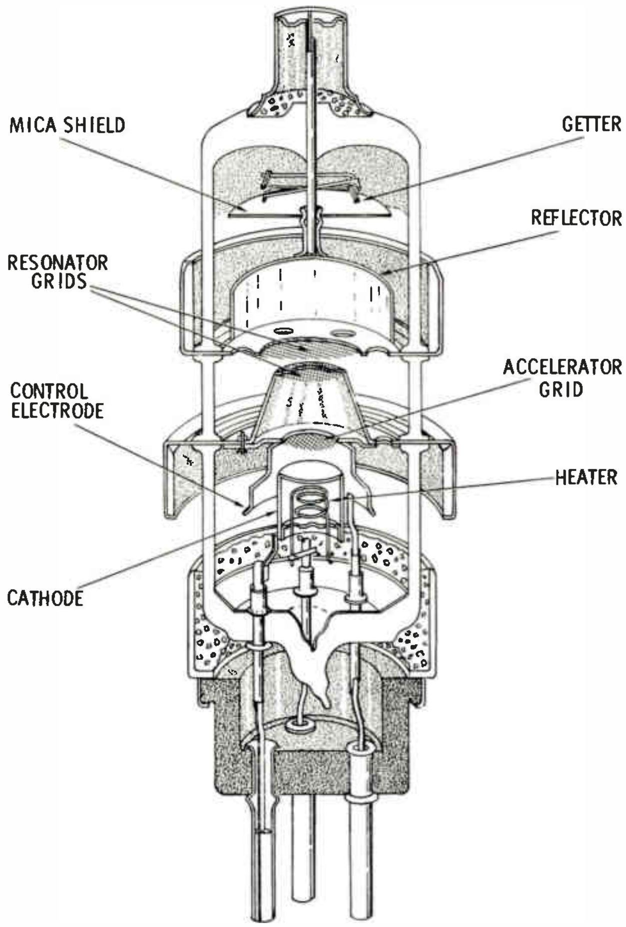

Fig. 4. A cutaway of an external-cavity reflex klystron.

through the gap, and the characteristic bunching phenomenon occurs in the region between the cavity and the repeller.

As the electrons pass beyond the interaction gap, they encounter the negative reflector potential. Eventually, this brings them to rest and then turns them around. Now they pass through the interaction gap a second time. If the operating parameters (repeller voltage, drift space, and cavity resonance) are correctly chosen, density modulation of the beam will have reached its maximum at the time when the beam is traversing the gap in the direction from repeller to cathode. Passage of the density-modulated beam through the cavity gap transfers energy from the beam to the cavity, and this energy may be extracted from the cavity by any of the usual means. The power output of reflex klystrons (usually less than 1 watt) is usually extracted from the cavity by an iris coupling to a waveguide or a coupling loop to a coaxial line.

Modes of Oscillation

Up to this point, it has been assumed that the distance the electron beam travels from gap to turnaround point and back to the gap is just sufficient to allow the maximum translation from velocity modulation to density modulation. The time required for this to happen may be calculated with reasonable accuracy by considering an electron which was passing through the gap towards the repeller at a time when the RF voltage across the gap was zero and about to become polarized to decelerate the beam. Electrons transiting the gap prior to the electron of our example were accelerated and penetrated the region of the repeller to a greater depth, thus requiring more time to return to the gap. Electrons passing the gap at a later time than the reference electron are decelerated, penetrate the region of the repeller less deeply, and return to the gap in less time. Thus, those electrons which were accelerated and those which were decelerated arrive at the gap at about the same time and form a bunch around the reference electron.

For this bunch of electrons to deliver maximum energy to the cavity, its passage through the gap must occur at the time when maximum retardation will occur. Since the field at the gap at the time of the first transit of the reference electron was passing from accelerating to decelerating, the period of ¾ cycle of the microwave signal must elapse before the second transit for maximum energy transfer to occur.

Maximum retardation also will occur at 1¾, 2¾ . . . cycles after the initial transit from cathode towards repeller. Hence, the phase angle between bunched current and gap field which permits maximum energy transfer to the cavity is $\theta = 2\pi\ (N + ¾)$ where $N = 0, 1, 2, 3. \dots$ The limit of N is determined by the available length of the drift tube and also by the tendency of the beam to debunch (to be discussed later). It usually does not exceed, perhaps 12. These frequencies at which oscillation is possible are termed modes, and these modes are identified by the value of N in the equation above, or by the parenthetical quantity of the equation; e.g., ¾ mode, 1¾ mode, etc. Fig. 5 illustrates the relationship of modes, frequency, reflector voltage, and output power.

The mode of operation may be selected by changing either the physical or electrical length of the drift space. If the distance from gap to repeller is decreased, or if the repeller is made more negative, a lower mode of operation at the same frequency is made possible. As a corollary, if a higher-frequency cavity is connected across the gap, the same mode of operation is possible at a higher frequency. This allows a wide range of frequencies to be generated by a single tube. For

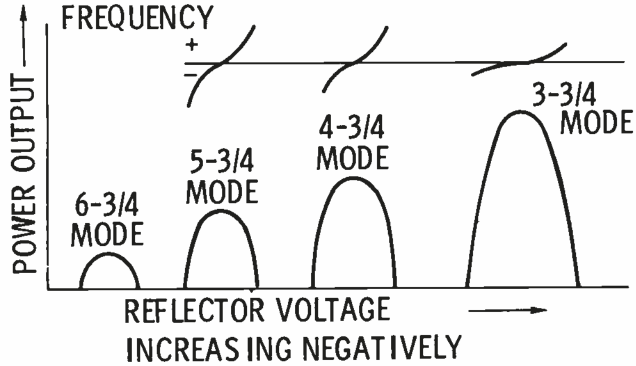

Fig. 5. Reflector-mode graph showing power vs reflector voltage and frequency vs reflector voltage for each mode.

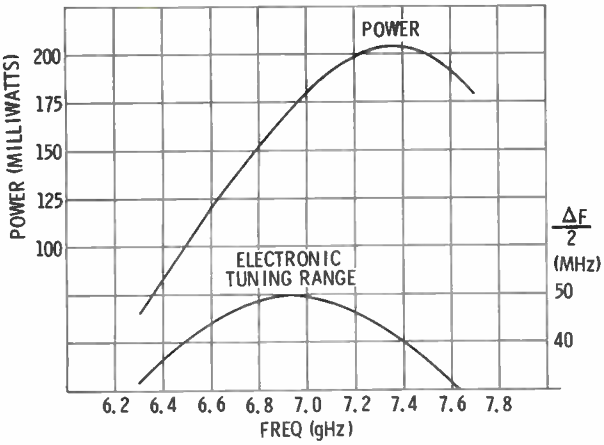

Fig. 6. These curves show the power output as a function of mechanical tuning and the electronic-tuning range of a typical reflex klystron which operates in the lower X band.

example, two types, the 6BM6 and 6BL6, having identical dimensions except for gap length, may be used to cover the ranges from .55 to 3.8 and 1.6 to 6.5 gHz, respectively, if the proper cavities are selected.

Tuning

In considering modes of operation, it was assumed that the arrival time of the reflected bunch coincided with a maximum retarding field across the gap. Variations of this phase relationship from optimum results in a reduction of energy transfer to the cavity and a corresponding reduction in the available output power, and also in a change of frequency. Slightly out-of-phase bunched current appears as either a leading or lagging current, insofar as the circulating current of the cavity is concerned, and has an effect somewhat analogous to the reactive current supplied to a conventional oscillator by a reactance-tube modulator or AFC.

There are three common methods of tuning a klystron oscillator, one of which is electronic while the other two are mechanical or electromechanical. The electronic-tuning method may be inferred from the preceding paragraphs; i.e., the repeller voltage is determined manually, by the output voltage of some type of AFC circuit, or by the amplitude of some intelligence signal such as voice, music, etc. Incidentally, since the repeller-plate draws no current, frequency modulation with no expenditure of power is possible.

From a purely theoretical point of view, oscillation is possible so long as the phase angle of the bunched current is favorable for energy transfer to the cavity. Thus, the permissible phase angle is $\theta = 2\pi(N + k)$, where the limits of k are ½ and 1. Of course, the power available from the oscillator will decrease as the phase angle departs from optimum. In practice, the limits of electronic tuning are much reduced. The top curve in Fig. 6 shows the output power at various frequencies as a function of mechanical tuning, and the lower curve shows the electronic tuning range at various frequencies. The electronic tuning range is defined as the frequency range between half-power points, the change being caused by varying the repeller voltage.

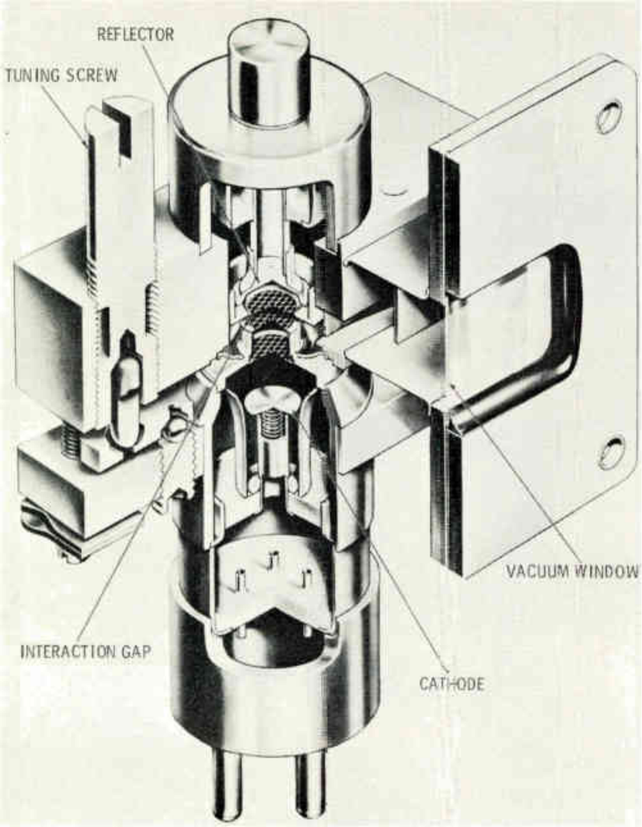

Fig. 7. Cutaway illustration of a reflex klystron. Tuning is accomplished by varying the width of the interaction gap.

There are three common methods of mechanical tuning. Gap tuning is a method whereby gap width is changed by adjusting the tuning screw. (See Fig. 7.) The change in gap dimensions causes a change in capacitance which, in turn, changes the cavity frequency. A different method is used to tune the thermally tuned klystron. This method has been used in the 24 gHz region and employs a technique whereby the repeller is physically attached to the specially constructed plate of a triode. AFC error voltage is used to control the triode conduction; this conduction causes the plate to warp and position the repeller.

In the case of reflex klystrons using an external cavity, mechanical tuning is accomplished by variable slugs (often a screw) or vanes inserted in the cavity, or by a combination of the two. In applications where the klystron oscillator is required automatically to tune across a spectrum greater than its electronic tuning range, one cavity slug may be tuned by a two-phase motor connected to an amplified output from a conventional discriminator-type AFC loop. A second output from the same discriminator is used for control of the repeller potential to decrease the delay in response inherent in a mechanical system.

Because of their increased ruggedness, ease of mounting, small physical size, etc., integral-cavity reflex klystrons are commonly used at frequencies above about 5 gHz. Fig. 8 is a cutaway drawing of the configuration used in many applications in the C band (3.9 to 6.2 gHz). Mechanical tuning is accomplished by adjusting the tuning screw of the tuning cavity to vary its resonant frequency. AFC or frequency-modulating voltage is applied to the repeller plate after the center frequency has been selected by positioning the tuning screw.

Debunching Effects

In the foregoing discussion, factors which adversely affect the translation from velocity modulation of the electron stream to density modulation (bunching) were intentionally ignored. Actually, there are several phenomena which tend to diminish the overall efficiency of the electron stream in transferring energy to the cavity. The most easily visualized of these is transverse debunching; that is, the tendency of the electron beam to fan out from its axis. This is caused by the mutual repulsion of the electrons in the stream and by the effects of induced currents if the walls of the drift tube are metallic. The net result of this transverse debunching is to decrease the number of electrons which travel from the signal injection gap to the load-cavity gap (in the case of a reflex klystron, back to the gap). In low-power klystrons, beam density is relatively low, thereby diminishing the amount of transverse debunching, making the effects negligible. In high-power tubes, which have much longer beams than reflex klystrons, rather elaborate focusing devices (electrostatic or electromagnetic) are used to maintain a tight beam along the axis of the tube.

Longitudinal debunching is caused by a number of factors, one of which is the mutual repulsion of the electrons in the bunch. By increasing the drive in a

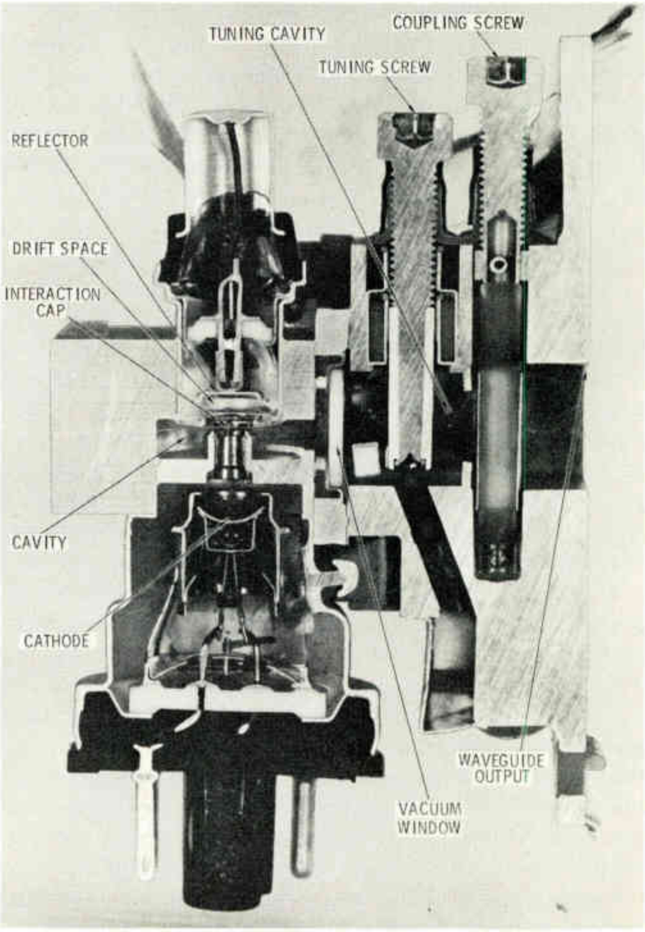

Fig. 8. A reflex klystron tuned by a cavity tuner. Most of the modern external-cavity klystrons are of this type.

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multiple-cavity klystron, higher degrees of bunch density are obtained, counteracting this type of debunching. This, of course, reduces the overall power gain of the klystron.

Another cause of longitudial debunching is the effect on electron velocity of the changing field across the gaps during the transit time of an electron. Throughout this discussion, the buncher and catcher gaps have been considered as point sources of fields for the sake of simplicity. Actually, the gap transit time is finite and significant since the instantaneous gap field changes during the time that an electron is passing through it. In general, the net effect is similar to the debunching process mentioned above.

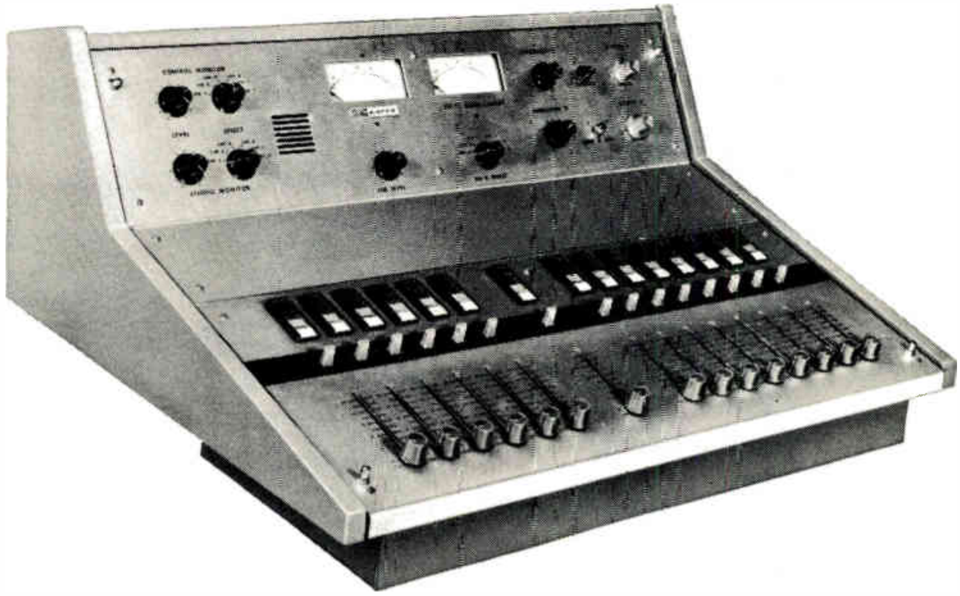
While effects of longitudinal debunching are, perhaps, of greater interest in high-power applications, a second manifestation of the effect is important in low-power, frequency-multiplying configurations. This effect might best be explained by a rigorous analysis of bunching and debunching, but some insight into the problem may be had by a simplified analogy. Consider the beam at the load gap, or catcher, as if it were one which varies in density at a sinusoidal rate. That is, the beam density varies sinusoidally from a minimum (antibunch) to a maximum (bunch). A similar current flowing in a transformer primary would induce a sinusoidial voltage having no harmonic content into the secondary. Similarly, a current having sharp transitions from minimum to maximum induces a secondary voltage which contains more or less harmonic content, depending on the rapidity of the transition. By applying this well-known principle to the electron beam in the klystron, it may be inferred that poorly defined bunches and antibunches have relatively less harmonic content, limiting the amount of harmonic output obtainable from a single klystron.

Noise

Due to statistical fluctuations in electron velocities in the gap and the drift space of a reflex klystron, both the frequency and the output power are modulated. Called noise modulation, either the AM or FM component may be of concern, depending on application. In a microwave link, the FM component results in a random modulation of the transmitter and local oscillator which is termed frequency noise and expressed as the root of the mean-square fluctuation of frequency. This characteristic may be measured with a sensitive receiver and discriminator and is normally plotted as a function of repeller voltage. It is noteworthy that minimum noise is often produced at the repeller voltage which causes maximum power to be developed by the klystron.

Amplitude-modulation noise is of relatively less importance insofar as FM transmitters and receivers are concerned. When a klystron is used as the local oscillator for an AM receiver (principally radar), the use of a balanced mixer satisfactorily alleviates the difficulty. The inherent noise of the klystron has made it impractical as a low-level RF amplifier, but as an oscillator or a high-power amplifier, the klystron has the lowest noise level available from microwave sources. ▲

New Gates TV Audio Console



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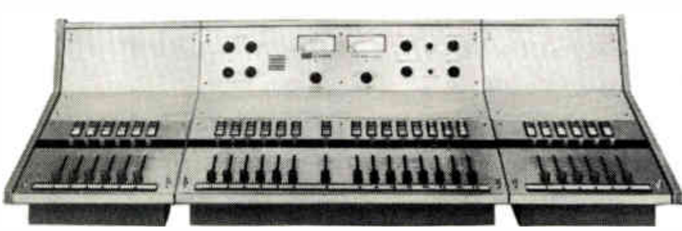

Gates TV-15 with two TVS-6's added for a total of 27 mixing channels and 108 inputs.

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Circle Item 15 on Tech Data Card

July, 1968

the decoder unit (connected to PL 12) to be grounded, completing the coil circuit for relay K11. Capacitor C3 across the coil of K11 causes this relay to hold closed for about 1 second. Closure of a pair of K11 contacts causes relay K13 to operate, and a circuit is completed through SO9 and SO10 to cause an auxiliary tone to be put on the cartridge. Relay K11 also causes relays K16, K17, and K19 to operate.

Relay K16 holds itself through a normally closed time-delay relay (TD1), which opens in 10 seconds and de-energizes K16. While K16 is closed, it mutes the audio to the input of the recorder thru SO11 and SO12.

Relay K17 is held on through normally closed contacts on relay K18. While K17 is operating, it supplies voltage to time-delay relay TD2, which operates in 3 seconds and completes a circuit to relay K18, which then operates and de-energizes K17. Relay K18 also opens a pair of contacts between SO13 and SO14; these contacts are in series with the Remote Stop on the cartridge machine. The cartridge machine stops; it remains in the record mode, however, since relay K7 is still energized.

Relay K19 holds itself through normally closed contacts on relay K20. Voltage is supplied by K19 to time-delay relay TD3, which closes its contacts at the end of 30 seconds. This closure completes the circuit to K20, which operates and opens the holding contact for relay K19. Relay K20 also closes a pair of contacts between SO7 and SO8, which are connected to the Remote Start of the cartridge machine. The cartridge machine starts recording again.

At approximately 20 minutes after the hour, the ABC Program Off tone is received (letter code A). This tone causes terminal 3 of the decoder unit (connected to PL13) to be grounded. This completes the ground circuit for relay K12 and causes it to operate. Capacitor C4 across the coil of K12 causes this relay to remain closed for about 1 second. Relay K12 operates relay K14, which holds itself through normally closed contacts on relay K15. Through K14, voltage is supplied to time-delay relay TD4, which operates in 8 seconds. When TD4 closes, it completes a circuit to relay K15, which operates and opens the holding contacts for K14. Relay K15 also operates relay K13, which puts an auxiliary trip tone on the cartridge. In addition, K15 operates relay K16, which mutes the audio to the record amplifier for 10 seconds. The time-delay operation of this circuit is necessary since the ABC program-off tone comes before the tag line "A service of ABC News . . . " If it were not necessary to pick up the tag line after the tone, relay K12 could operate relays K13 and K16 directly, thus eliminating TD4, K14, and K15.

At 20:00 minutes by the digital clock, relay K6 operates and remains closed until 30:00 minutes by the digital clock. This relay prepares a circuit for relay K5.

At 21:00 minutes by the digital clock, relay K5 operates and, through the circuit prepared by K6, supplies voltage to relay K9. In turn, K9 opens the holding contacts for relay K7; the latter relay is released after capacitor C1 discharges (in about 5 seconds). Operation of relay K9 also opens the Record Set contacts between SO3 and SO4; these contacts are routed through the normally open contacts on K7 and then through the normally open contacts on K9. Relay K9 also opens the normally closed contacts between SO5 and SO6, which are in series with the holding contacts on the Record Relay in the record amplifier. The record amplifier is then restored to the playback mode. The cartridge machine is still running, but is now in the playback mode. The cartridge runs back to the beginning and is cued for playback when called for by the automation programmer.

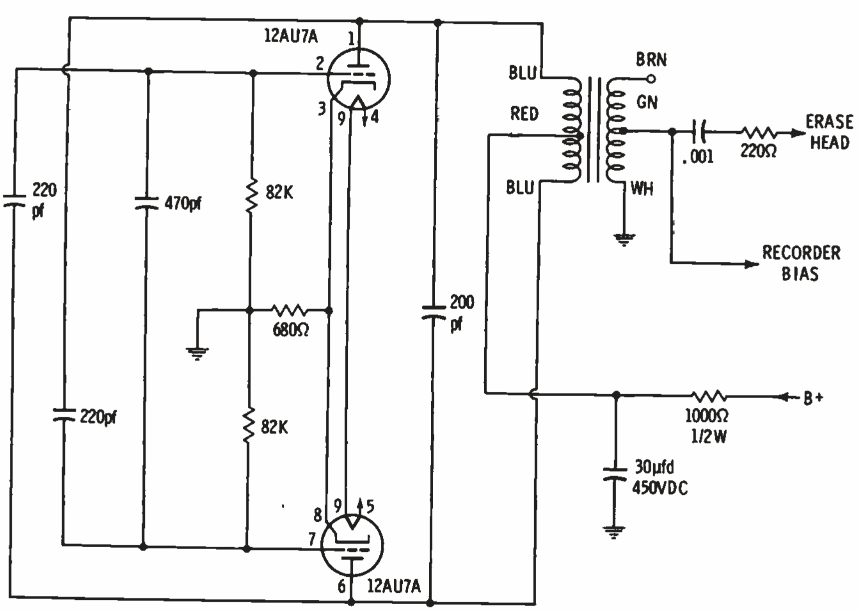

Fig. 2. This push-pull, 70-kHz bias/erase oscillator replaces the original.

Cartridge-Machine Modification

A Nortronics No. 4401 full-track erase head was mounted using a Nortronics Model QK-115 "Quick Mount" ahead of the existing record and playback heads on the ATC cartridge machine. An NAB "B" size cartridge is used, since it has three openings for heads. Also with this arrangement, it is impossible to erase a standard cartridge because the erase head is outside the cartridge.

The original bias oscillator was removed and rebuilt using a Nortronics Model T-60-F bias transformer in the 12AU7A push-pull circuit which is shown in Fig. 2. Record-head bias was tapped off using variable capacitors which are adjusted for proper head bias. A 0.001-mfd ceramic capacitor and a 220-ohm resistor were connected in series with the lead to the erase head from the output of the bias-oscillator transformer. The value of this capacitor may be adjusted for proper bias. The ground on pin 11 of the jack on the back of the cartridge deck was moved to a separate ground. A wire was added from the junction of R228 and R229 at capacitor C217B through the normally open part of K201 (Run Relay) section A to pin 11. This feeds B+ voltage from the cartridge deck to the record amplifier to power the bias oscillator. The jumper cable between the cartridge deck and the record amplifier was modified by moving from pin 11 to pin 3 the wire grounding the shield of the coaxial cable on pin 7.

Record-Amplifier Modification

In the record amplifier, the ground on terminal 11 of the jack was removed, and a wire was routed from this terminal to the normally open contact on section A of relay K102. The ground on the center of section A, K102, was removed. The wire on the normally closed section of K102 was used to feed B+ voltage to the rebuilt bias oscillator.

When the cartridge deck and record amplifier were remounted in the rack, a jumper was run between terminal 1 of the terminal strip on the back of the record amplifier and terminal 1 of the terminal strip on the back of the cartridge deck.

Conclusion

Since this system has been installed, no problems have been found with the operation of the unit. However, it should be noted that any time the cartridge used for recording is stopped and removed from the machine before it cues itself, the cartridge should be bulk erased before it is used again. Also, it is good practice to bulk erase the cartridge each day before it is used.

When the power to the network-recorder control is turned off, the cartridge machine and record amplifier function as before and are used for normal programming as needed.

The unit described here was built for use with a particular automation system. However, it is hoped that this description will inspire some ideas for readers who would like to make a similar modification to their systems, even if the equipment is of different manufacture. ▲

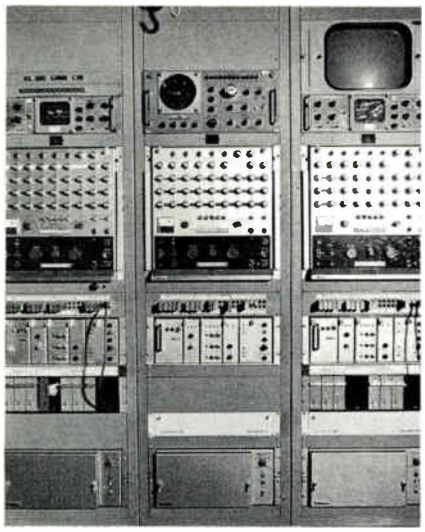

Fig. 4. Vertical aperture equalizers, in the right racks, are on order for all.

There are many ways of laying out camera-control equipment in the racks. First, of course, is the space consideration. We also wanted a layout which would give the least operational and maintenance problems. We hoped to have an arrangement which would permit operation with the video operator in the control-rack area, rather than in the studio, should we so desire.

It was decided to install each camera control in a separate rack, seven racks in a row, with two regular monitoring stations. These monitoring stations, with monochrome and color monitors, are mounted in racks that are winged off each end of the camera-control racks at a 90° angle (Figs. 3 and 5). This arrangement allows the monochrome registration monitor to be at eye level with zero-angle viewing from several camera controls, and it allows space for waveform

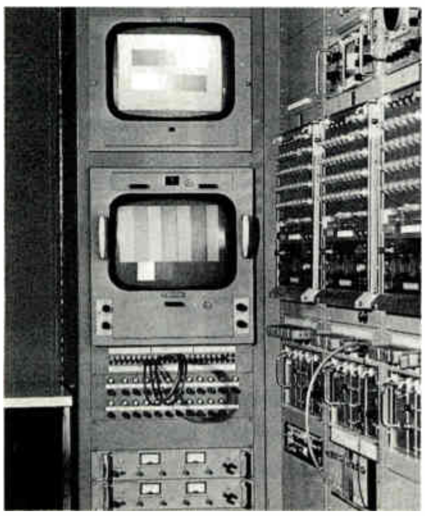

Fig. 5. Close-up of one of two monitoring positions at ends of rack bay.

and vectorscope monitoring at eye level in the camera-control racks. A third, patchable, monitoring position is provided in the center rack for emergency use. The camera control, which requires the most adjustment, was located at a convenient operating height. The power supplies were placed at a very low position. Each camera-control rack has a video jackfield, mostly associated with the corresponding camera, an encoder, a picture enhancer, and a power supply. Monitoring video amplifiers are grouped in trays located in every other rack. In order to avoid adjusting or interrupting a camera that is in use, a readout located in each rack indicates the camera is (1) not in use, (2) patched to a studio, (3) positioned in the studio, (4) control taken, or (5) on the air.

Interphone is provided at each monitoring station on a selector which enables an operator to talk directly to the cameraman or the studio conference bus.

Video monitoring is also on a selector, and the YGRB waveform can be monitored sequentially, supered, encoded, or on a line-select basis. The color-match monitor selectors cover all cameras, and since all circuits are timed, it is quite simple to adjust burst phase to match color-bar phase, and therefore studio burst phase. Pulses are fed to the cameras separately so that sync locking of any one or group of cameras can be accomplished easily. Sync-locked reference signals also are provided for ease of operation.

Studio Remote Camera Control

All of the control rooms use the same general arrangement (Fig. 6). There has been a deliberate effort to locate the same equipment and controls in the same relative positions. The jackfields and labels are all as similar as can be practical. We have no problem with an operator's becoming confused and professing unfamiliarity with a particular control room.

When the control rooms were originally laid out, we made a model and tried it with different-sized operating personnel, directors, and technicians to make sure that sizes and locations would satisfy all operating problems. On the upper level at the far left in a glass enclosed booth is the announcer. Next to him is the audio operator, then the switcher, director, and producer. Naturally, it is desirable to have everybody as close as possible to the director, but it was felt that the produced (or AD) and the switcher needed this proximity more than the audio operator. So that the audio man can maintain the maximum contact, an amplifier and speaker, located near him, were bridged off the director's microphone.

On the same level with the studio and 3 feet below the operating level is the camera-control operator; in front of him at a distance of 7 feet are the preview and operating monitors. The arrangement is such that the operating personnel on the upper level look over the CC operator and his console directly at their monitors. Without even raising their heads, only glancing slightly upward, they can look over the monitor bank, through the control-room window, and into the studio.

On the top level of the monitoring bank, reading from left to right in Fig. 6, are:

PRE 4	**Monochrome (Patch)**
AIR MON	**Color**
PRE 1	**Color (Switchable)**
PRE 2	**Mono (Switchable)**
PRE 3	**Mono (Semi-switchable)**
MATCH MON	**Color (Switchable)**

The match monitor was deliberately placed as far as possible out of the director's line of vision so that the switching of it during a rehearsal or broadcast will not distract him unduly. Three color monitors in each control room have proved adequate and necessary.

The monochrome monitors in the lower row are bridged across each live camera position.

For the monochrome installation, individual camera-control units were located in each control room. After we had reached a decision concerning a common location of color-camera controls, there still remained a decision with respect to controlling a camera for a particular studio. After much soul-searching and comparison of the ways of other stations, it seemed that our best approach would be to provide a remote of the most important controls into the associated control room. There was some argument that the operation could be done just as well from the central camera

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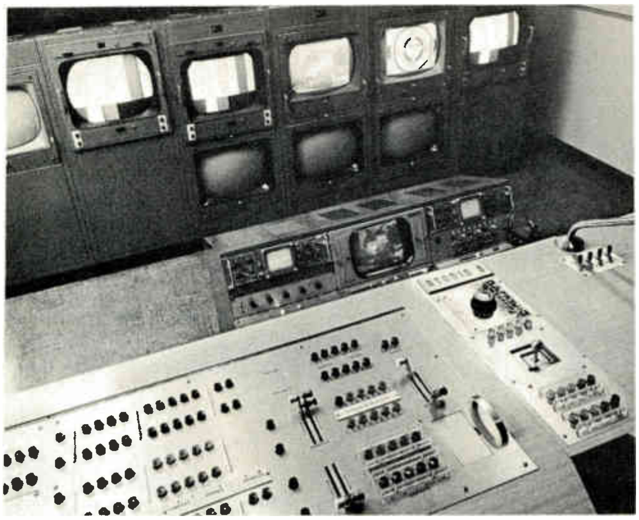


Fig. 6. View of studio control room from the upper level.

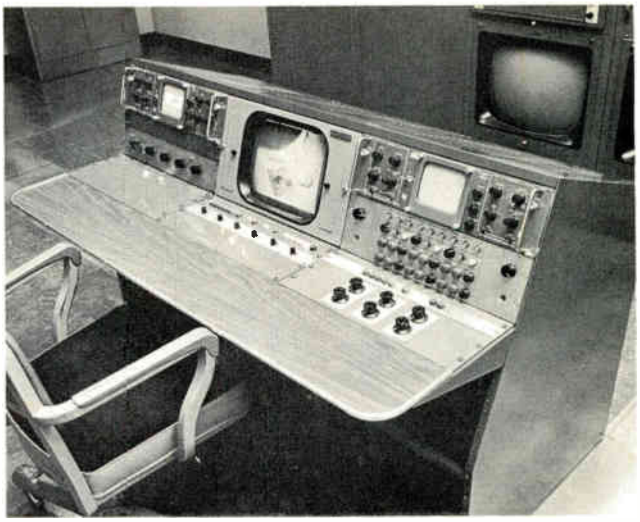


Fig. 7. View of remote camera-control operating position.

location, and in some cases, perhaps even more economically. It seemed unlikely, however, that one operator could successfully work with more than one studio even if he were located in the central control area. If we should be limited to a CC operator for each operating studio, there were some obvious advantages to having him in the control room: (1) He could look conveniently out the control-room window and discover for himself what his picture should look like if there were any doubt in his mind. (2) There would be more interest in the show and its outcome as a result of the operator's being more directly involved with it, *i.e.*, in the control room and aware of the desires of the director. (3) The operator could assist the TD with errands, suggestions, and relief, particularly during rehearsals. (4) He would be observing the same monitors as the directors and the TD, thus limiting the possibility of disagreement over picture quality.

After we decided that the CC operator should operate in each control room, there still remained the determination of how much he should control and what he should monitor. We designed a small limited-function console (Fig. 7) which has proved quite adequate. It is low enough that the operator can look over it conveniently at preview, air, and match monitors. It is high enough to accommodate his knees without cramping, and it contains all of the controls that we have found necessary to date. The vertical control panel accommodates the controls less frequently used, and a horizontal control panel has the more frequently used ones.

On the vertical panel are controls for these functions: camera off/on, beams off/on with indicator lights, monochrome/color, encoder bridging, tally/call, coarse iris, GRB gain, and GRB black level.

On the horizontal panel are fine iris and luminance black-level controls. These controls are mounted on a hinge-type assembly such that when the knob is depressed slightly, a miniature switch is operated to connect the waveform and color-match monitors to the particular camera. This was a feature of our own design which has been very popular with operating personnel. The normal weight of the operator's hand on either the iris control or the set-up control effects the monitor switch that he desires. The normal position of the match and waveform monitors is on a preselected prime or reference camera. Only when the operator touches a control to make an adjustment is the switch made to the camera involved.

The camera-beams off/on switch also operates tally relays which switch from "available" to "taken" on the console as well as at the main camera control. The encoder bridging switch serves to bridge all encoder inputs across each other for precise balance adjustments. The tally/call is a combination of air tally and call signal which flashes the cameraman's air tally.

The cameraman can call the video operator with a tone signal. The same tone generator operates automatically as a warning if a camera control is turned on without a camera attached. The CC operator can switch his interphone to any one of his cameras or to the conference bus. Should the interphone at the camera-control rack be left on, it can be released from the studio control position.

To the operator's left are a 14-inch monochrome monitor, a waveform monitor, and three video selectors. He also has a color insert keyer. He can switch from regular switcher output iso to emergency output iso, which completes the switcher's dual circuit for fail-proof operation. The operator can switch both waveform and picture monitor to reference signal, video switcher Preview 2, special effects, color insert keyer, or regular or emergency line iso output. For the picture monitor only, provision is made so that it can be switched to the color-match monitor circuit for close-range observation of any camera signal, or left on the above selector for setting up a key. Two studios also have chroma key in this console. The video switcher can switch this auxiliary waveform monitor to his Preview 1 switcher for level checking.

Painting Panel

The painting panel may be seen in Fig. 8. From the beginning there has been some question as to the real necessity of painting controls in the control room. They are not used frequently, and under normal conditions, if the set is properly lighted, they very seldom are touched. They are a convenience in time of trouble, however. A camera can be compensated for inadequate

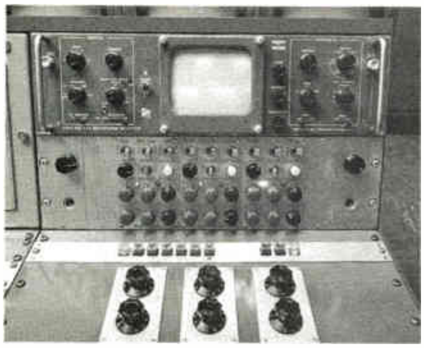


Fig. 8. The main operating controls on the remote camera-control console.

lighting on a particular scene, for drift, and in some cases, for minor camera trouble. The zero point is at 12 o'clock, and any control can be returned quickly to its normal setting.

Camera Termination in Studio

For the monochrome installation, we found it convenient to have camera-cable outlets on three sides of the small studio and on all four sides for Studio 1. Needless to say, we have reduced this to only one side for color cable. We located terminals for color in the same box which had been used for monochrome. We obtained an angled front plate which permits the cable to slant slightly downward to the floor (Fig. 9).

Conclusion

The proof of a satisfactory installation largely hinges upon a determination of how much you would change if you had to do it over again. This one was made under the same pressures that most stations have encountered in their color installations—shortage of equipment, lack of time to plan carefully, and the overriding need to put the system into operation yesterday.

In spite of this situation, there is no major aspect of the installation that we would change. There are times when we find seven cameras only barely sufficient to service four studios. We do service them, however, and we would find it difficult to justify another camera. We put the first cameras of a particular model into operation in the U. S. There are some penalties attached to being first with new equipment. There has been much maintenance, and many modifications have been made, but the end result has been very rewarding.

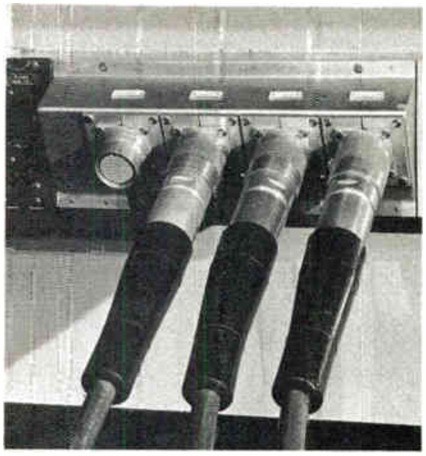


Fig. 9. Camera cable is terminated in studio terminal box with angled front.

The authors wish to thank Mr. Robert McCormick, formerly of CBS Engineering & Development, now with Central Dynamics, Ltd., and Mr. Ray Schneider, Associate Director of Systems Service Engineering & Development for their kind assistance throughout this project. ▲

Turntable Power Switch Also Controls Audio

by Richard Smart & Gene Hostetter

Switch and relay control adds convenience to turntable starts.

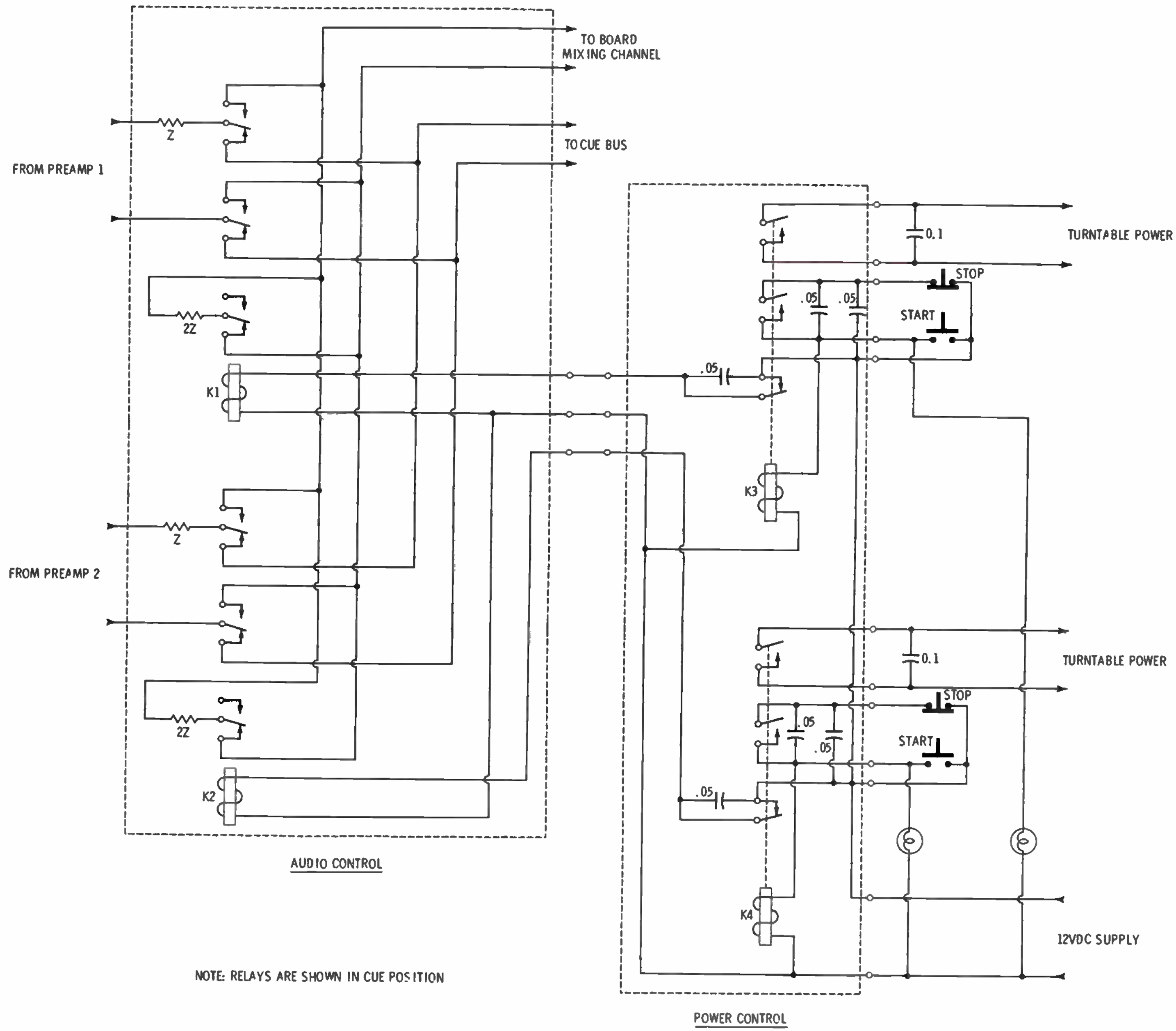
Record cueing and airing at music-format stations can be facilitated by combining the turntable power switch with an audio switch. The idea certainly is not new, but it is well worth considering at any station where the board operators spend a large part of their time cueing records. Such a system, when used with fast-starting turntables, results in a "tighter" on-air sound and a noticeable reduction in the number and severity of operator mistakes when starting records. Such a system was installed at KOL.

In practice, the operator normally cues a record by rotating it under the needle on a turntable which has its motor power off and its preamp output connected to the cue bus instead of an input channel on the board. When it is desired to air that record, the "On" button is pressed, activating relays which start the turntable motor and, at the same time, disconnect the preamp output from the cue bus and connect it instead to the appropriate board input channel. The operators then can set the turntable channel pots and leave them, making only slight corrections from time to time for varying levels from the records.

At the conclusion of a record, pushing the "Off" button reverses the process. The turntable motor is turned off, and the preamp output is disconnected from the board input channel and switched again to the cue bus, ready for the next record to be cued.

Yet another advantage may be gained from such an arrangement: the multiple use of board turntable channels. At KOL, four turntables are used. Although the board has ten mixing channels, it was deemed undesirable to tie up four of these channels just for the turntables. The

Fig. 1 Schematic at right shows two turntables feeding one input. →


TO BOARD
MIXING CHANNEL
TO CUE BUS
FROM PREAMP 1
Z
2Z
K1
FROM PREAMP 2
Z
2Z
K2
AUDIO CONTROL
NOTE: RELAYS ARE SHOWN IN CUE POSITION
TURNTABLE POWER
0.1
STOP
START
.05
.05
.05
K3
TURNTABLE POWER
0.1
STOP
START
.05
.05
.05
K4
12VDC SUPPLY
POWER CONTROL

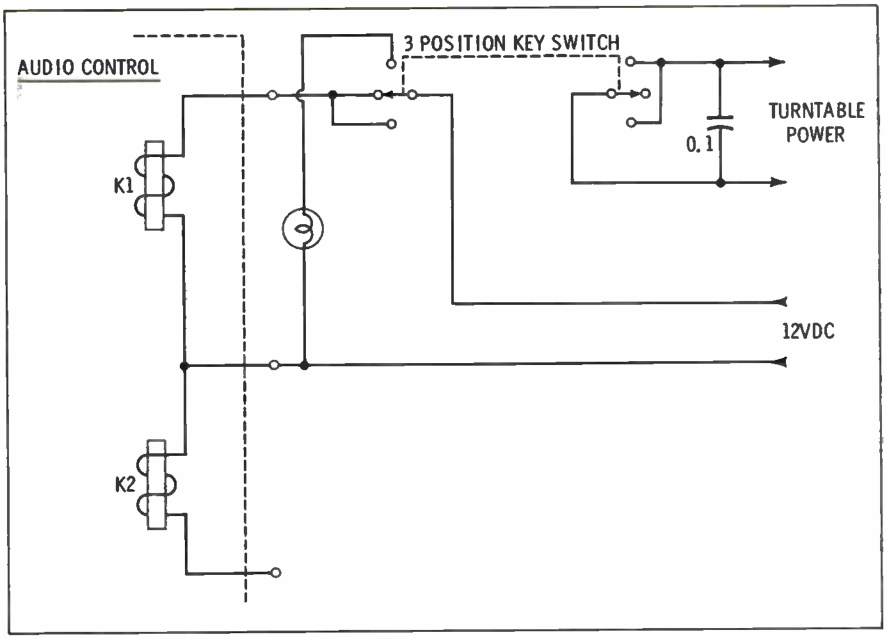


Fig. 2. Alternate arrangement uses key switches to control power and audio.

solution was to gang two turntables on each of two pots. The two left turntables are switched into one pot; the two right turntables are connected to the other. When, once in a while, it is desirable to cross-fade records, the play order is simply alternated between the left- and right-side turntables.

To retain the ability to play records through the cue speaker, the original motor switches on the turntable bases were not removed. These only turn on the motors; they do not switch the audio from the cue bus to the mixing channel. An alternate arrangement would be to use a three-position key switch for each of the turntable start controls. In the center position, the motor power is off and the preamp is connected to the cue bus. In the up position, the preamp is switched to the board. In the down position of the switch, the preamp is left connected to cue, and power is supplied to the turntable motor.

Fig. 1 shows a typical two-turntable switching circuit which feeds two turntables into a single board channel. A number of precautions have been taken to avoid noise and switching pops. First, separate relays have been used for motor-power switching and for audio switching. All power-carrying relay contacts have been capacitor bypassed. It was found to be unnecessary to load the board input when a turntable is not connected to it, although such loading was included as good engineering design. Turntable preamps generally have plenty of gain to make up for the loss of the pads used. Resistor values for the input-channel pads are shown in terms of Z, the board input impedance. The cueing positions are bridged to the cue bus to avoid loading it and to provide some isolation from the cue amplifier in the event of a preamp failure.

Fig. 2 shows a key-switch start arrangement rather than the push buttons described above. The key switches take the place of one of the two relays used for each turntable in the above system and provide a single control to allow playing records on the cue speaker as well as cueing and airing them. (Only the switch for one turntable is shown in this simplified diagram.)

One other feature has been incorporated into the design: a failsafe which operates in the event of loss of the DC supply voltage. The audio relays are normally on when the turntable preamps are connected to the cue bus. If the DC supply fails, the preamps connect to the board, where the turntables may be mixed in the usual fashion; the power switches on the turntable bases control motor power. In the alternate design of Fig. 2, if relay power fails, the motors may be started by pulling the key switch to the down position.

In the system as installed at KOL, the four sets of turntable start and stop switches are in the right-center part of a brushed aluminum control panel (shown mounted below the console in Fig. 3.) The four motor power relays are mounted on one side of the console desk, and the four audio relays are mounted on the other side. DC power is supplied from a rack-mounted master supply which also is used for other switching functions.

In more than three years of use of the turntable switcher, both management and operators have been pleased with its operation and the few seconds per record, day in and day out, that it saves in record-cueing time. It is well worth the small cost and construction time. ▲

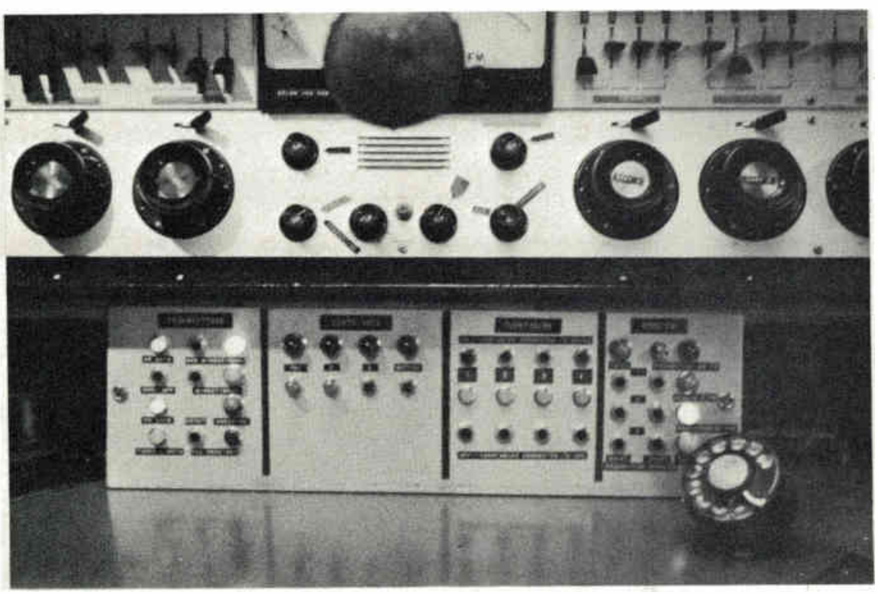


Fig. 3. Right-center panel below console has controls for four turntables.

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Circle Item 19 on Tech Data Card

News

(Continued from page 10)

correspondence courses now available to train new CATV technicians as well as advanced courses for now-qualified technicians.

In addition, Association members attended local-origination program sessions, a sales seminar, a discussion on the individual's responsibility in political affairs, and demonstrations of CATV products and equipment.

CATV

Chosen to Build System

Ameco, Inc. has been selected by **Reeves Broadcasting Corp.** to design and build a complete 20-channel cable TV system in Huntsville, Alabama. Ameco reports that in the contract it has agreed to meet some of the most exacting specifications yet seen in the CATV industry, and that it will use new techniques developed especially for the Huntsville system.

CATV Holdings Expanded

General Instrument Corp. has announced a major expansion of its CATV holdings through the acquisition of systems and franchises to serve a total potential of 95,000 homes in 21 communities in Texas, New York, Virginia, and Kentucky.

The newly acquired Texas complex comprises three CATV systems which will serve 14 communities stretching from Mission to Raymondville, including Brownsville, in the Rio Grande Valley. The company recently received approval from the Federal Communications Commission for a microwave path from San Antonio to the Rio Grande Valley. The three systems are expected to be in operation by October.

The three upstate New York systems will serve the cities of Cortland, Penn-Yan, and Wellsville, with an extension planned from Cortland to Homer, N.Y. The Cortland and Wellsville plants, already wired for operation, are being modernized and expanded by construction crews of the **Jerrold Corp.,** a General Instrument subsidiary. The Penn-Yan system was scheduled to be in full operation by mid-June.

Construction is under way on new systems to serve Petersburg, Va. and Middlesboro, Ky.

Early CATV Site

The site of one of the first CATV systems in the United States was formally dedicated recently at Astoria, Oregon. Also honored on the occasion was L. E. (Ed) Parsons, who, on Thanksgiving Day, 1948, first received the television signal being broadcast by KRSC-TV (now KING-TV), Seattle, some 125 miles away. Using a crude set of antennas mounted atop a downtown Astoria hotel, Parsons piped the signal by cable to his own apartment at the hotel and later to residences and commercial establishments in the city.

In a ceremony on Coxcomb Hill at the base of the "Astoria Column," a granite momument commemorating the event was unveiled. G. L. Davenport, Pacific Northwest Manager of **Cox Cablevision Corp.,** owner and operator of the Astoria cable system, introduced Frederick W. Ford, president of the National Cable Television Association (NCTA) and past member and chairman of the Federal Communications Commission (FCC). Also present at the dedication ceremonies were: Roy A. Duoos, acting mayor of Astoria; Marcus Bartlett, vice-president of Cox Broadcasting Corp., who presented the monument and marker to the City of Astoria; and Douglas C. Talbott, national general manager of Cox Cablevision Corp. ▲

Equalization of Magnetic Cartridges for Broadcasting

By Ronald J. Rockwell*

A method of cartridge-response measurement and equalizer design is described.

The factors involved in selecting new cartridges and equalizers, or adapting old circuitry to a new cartridge, become quite numerous and complex if the ultimate in performance is desired. Therefore, a rigorous method for designing the RIAA equalizer, calibrating the test record, and accurately determining the cartridge response was devised. The technique was developed for monophonic design; however it is also applicable to stereo. The equalizer which was designed incorporates compensation for cartridge inductance and resistance, and it provides an output that is flat, ±0.2 dB, from 20 to 20,000 Hz. The procedure for test-record calibration eliminates all nonconformity to the RIAA characteristic, including plastic-resonance effect.

Cartridge and Equalizer Requirements

Currently, there are many excellent cartridges available; however, only a few of these meet exacting broadcasting requirements. To be completely suitable for broadcasting purposes, a cartridge must operate properly through an equalizer loaded with 500 ohms, and it must conform closely to the following:

1. Frequency response:
   ± 2 dB, 20-20,000 Hz
2. Output:
   1 mv per cm/second, or higher
3. Cartridge resistance:
   600 ohms or less
4. Inductance:
   225 mh or less
5. Tracking force:
   Capable of operating at 5 grams
6. Lateral compliance:
   5 x 10^{-6} cm/dyne
7. Vertical compliance:
   5 x 10^{-6} cm/dyne
8. Shielding:
   Triple *Mumetal* or equivalent
9. Mounting centers:
   1/2″ spacing
10. Replaceable stylus:
    Highly desirable
11. Cueing:
    Capable of tracking with reverse record rotation
12. Mechanical design:
    Extremely rugged

If a stereo cartridge is to be used for mono reproduction, the parallel-connected coils must conform to items 1 through 4.

Some of the above specifications may seem out of line with those currently accepted as standard. In the light of present-day tracking forces of 1 gram or even less, item 5 seems high. Nevertheless, day-to-day operation with all varieties of records, involving nonstandard grooves, warped discs, etc., dictates a tracking force much higher than 1 gram in order to provide maximum tracking insurance.

Item 11 refers to the ability of a cartridge to track with record rotation reversed. Many cartridges with slanted stylus arms dig in and jump off the record during cueing.

Since the maximum input impedance of most broadcast preamplifiers is 500 to 600 ohms, and since the input impedance of the newest audio consoles also is a maximum of 500 to 600 ohms, it follows that the cartridge and its equalizer must be capable of proper operation at this impedance.

Many stations incorporate patching or other facilities to provide flexibility of microphone, turntable,

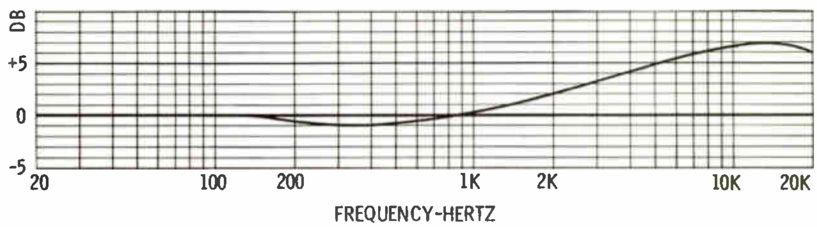


Fig. 1. Response curve of a commercially available, equalized preamplifier.

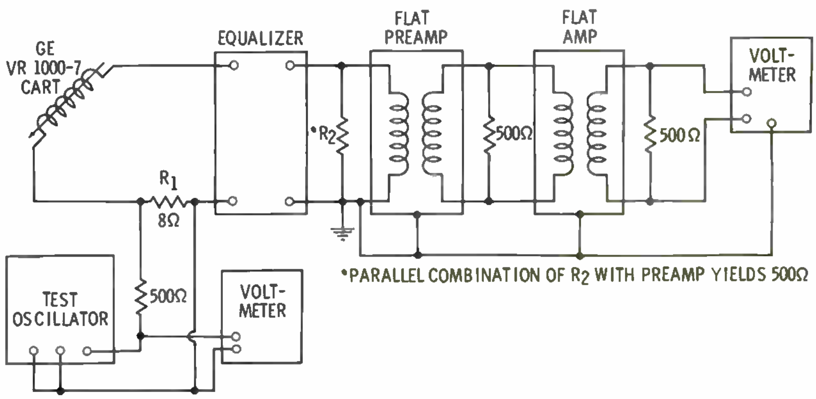


Fig. 2. Setup for measuring overall response of the equalizer and amplifier.

*Electronic Consultant, formerly Vice President and Engineering Director, AVCO Broadcasting—retired.

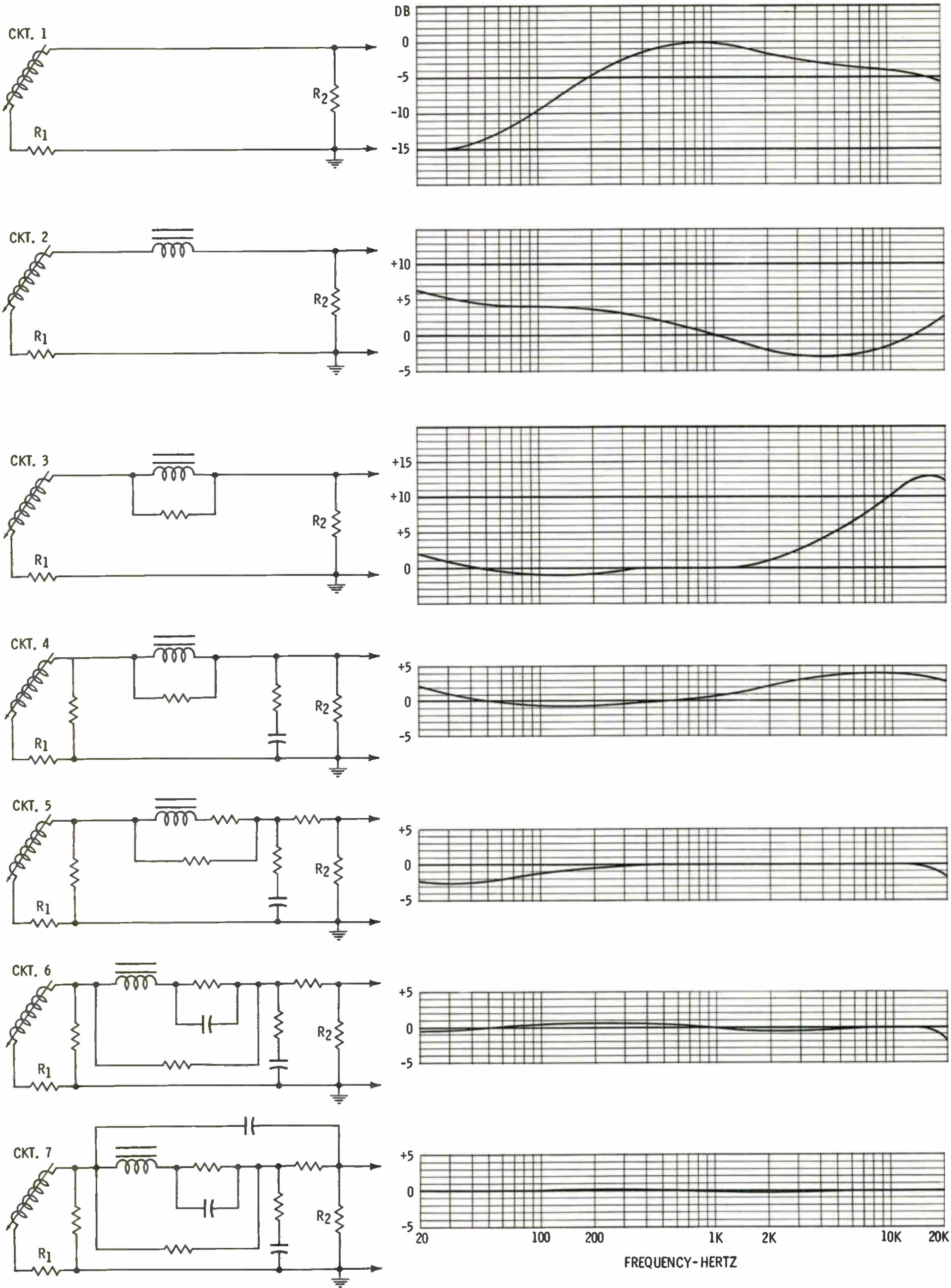


Fig. 3. Seven steps in the evolution of the equalizer. The curves show the output with a standard RIAA input.

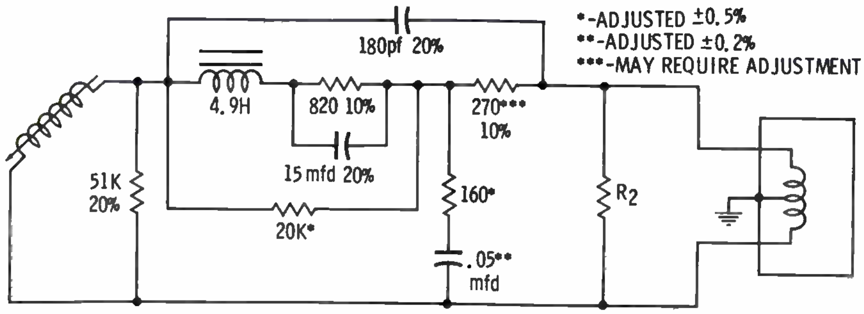


Fig. 4. The completed RIAA equalizer. Values and tolerances are correct for an 18-inch, low-capacity, shielded cable from the tone arm to the equalizer.

tape, and remote inputs into one or several preamplifiers. The equalizer, therefore, must be part of the cartridge circuit instead of being located in or after a preamplifier.

Commercially available equalized preamplifiers can be inserted after the cartridge, but this adds unnecessary equipment whose performance may be less than optimum. Fig. 1 shows the calibration curve of a commercially available, equalized preamplifier. This curve speaks for itself. The deviation from flat response is the result of using a very simple and inexpensive circuit.

A 500-ohm equalizer is easily tolerated by a few standard cartridges rated at 47,000 ohms, provided items 3 and 4 are satisfied, but many of the best cartridges are intended to work into a high-impedance load; 47,000 ohms seems to be the prevailing value. If the cartridge resistance is in the order of 600 ohms, or less, a 500- to 600-ohm load will reduce the output to one-half the open circuit voltage. Usually, the input transformer of a preamplifier steps up the signal voltage by a factor of 10. At low frequencies, where the equalizer presents a minimum insertion loss, the signal at the input to the preamplifier itself therefore will be about 5 times greater if an input transformer is used than it would be if both the equalizer and transformer were omitted.

If the cartridge inductance is not materially above 225 mh, the 500- to 600-ohm load will not drop the high-frequency output quite as much as the RIAA playback characteristic requires. From this and the preceding considerations, it appears possible to design an equalizer to be inserted between the cartridge and the 500- to 600-ohm preamplifier.

Equalizer Design

Most of the better cartridges are now essentially free from mechanical resonance from 20 to 20,000 Hz. This makes it possible to insert an oscillator in series with the ground end of the cartridge and the equalizer feeding the preamp, as shown in Fig. 2. Then the equalizer components are adjusted until the inverse of the RIAA recording characteristic is obtained. When this result is accomplished, a good RIAA test record will produce a flat output. As a matter of fact, if the output of several cartridges is averaged, the deviation from flat output can be used to calibrate the test record.

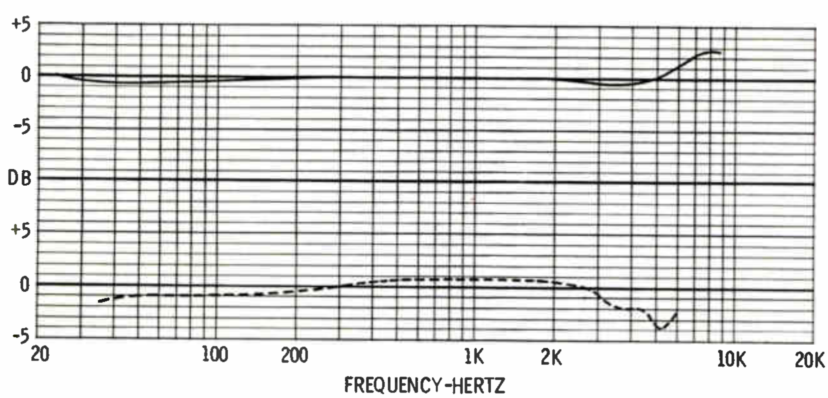


Fig. 5. Deviations from the RIAA recording curve of two "standard' records.

The most important component in the equalizer is the series reactor. Its inductance must be sufficient to drop the 1000-Hz output a few dB more than desired. A value of approximately 5.0 henrys is required. The winding consists of 1250 turns of No. 35 wire. The core is a 3/8-inch stack of EE 24-25 *Mumetal* laminations with one lamination on each side reversed to act as a keeper. The gap is approximately 1 to 5 mils, and the shield is made of two concentric *Mumetal* cans. The outer can is 1-1/2" long × 1-1/4" in diameter.

A resistor of approximately 20,000 ohms shunted across the reactor brings the 1000-Hz output back to the required level and starts to insert the mid-frequency step. A small capacitor, approximately 0.05 mfd, and a series resistance which are shunted across the load side of the equalizer reduce the high-frequency response. Following this step, certain trimming components are required, depending upon the flatness desired. Circuits 1 through 7 and the corresponding curves (Fig. 3) show the progression toward a flat response as the various components are added to the equalizer.

In order to obtain flat output from the preamplifier, it is desirable that its frequency characteristics as well as any non-linearity in the average cartridge of the type selected, be compensated in the equalizer that is to precede it. In the investigation and considerations involved here, it was found that the

Table 1. Output Required for Flat RIAA Compensation

Freq (Hz)	dB	Freq (Hz)	dB
20	+19.0	7,000	–10.8
30	+18.6	8,000	–12.0
50	+17.0	9,000	–13.1
70	+15.3	10,000	–14.0
100	+13.1	11,000	–15.0
200	+ 8.2	12,000	–15.9
300	+ 5.5	13.000	–16.7
400	+ 3.8	14,000	–17.5
700	+ 1.2	15,000	–18.2
1000	0	16,000	–18.8
2000	– 2.6	17.000	–19.3
3000	– 4.8	18.000	–19.8
4000	– 6.6	19.000	–20.3
5000	– 8.2	20.000	–20.8
6000	– 9.6		

Note: 8 kHz to 20 kHz progressively more negative, 0.1 dB at 8 kHz to 1.0 dB at 20 kHz, to compensate for change in stray capacitance when preamp input-transformer primary has center tap grounded.

Table 2. Test Record No. 1

Freq (Hz)	dB	Freq (Hz)	dB
15,000	−1.3	3000	−0.1
14.000	−1.0	2000	+0.1
13,000	−1.0	1000	0
12,000	−1.3	700	+0.3
11,000	−0.7	400	+0.5
10,000	−0.8	300	+0.4
9,000	−0.3	200	+0.6
8,000	−1.0	100	+0.5
7,000	−0.9	70	....
6,000	−0.6	50	+0.3
5,000	−0.6	30	+0.9
4,000	−0.2		

Note: 70 Hz not used, due to tone-arm resonance.

Table 3. Test Record No. 2

Freq (Hz)	dB	Freq (Hz)	dB
15,000	+0.4	3000	−0.2
14.000	+0.1	2000	0
13,000	+0.3	1000	0
12,000	+0.2	700	+0.3
11.000	−0.3	400	+0.4
10.000	−0.3	300	+0.3
9.000	−0.2	200	+0.4
8.000	−0.8	100	+0.2
7,000	−0.8	70	....
6,000	−0.4	50	+0.1
5,000	−0.6	30	+0.7
4,000	−0.2		

Note: 70 Hz not used, due to tone-arm resonance.

General Electric Type VR 1000-7 met the several specifications listed above. In particular, its frequency response was so nearly flat that only the cartridge inductance needed to be compensated in the equalizer design.

Fig. 4 represents the final design. Component values and tolerances are shown. If the inductance is adjusted to 5.0 henrys at 1000 Hz, trimming generally will involve only adjusting the 20,000-ohm shunt resistor to compensate for differences in inductance and Q, and a slight adjustment of the 270-ohm and 160-ohm resistors. The final circuit adjustment results in an equalizer which compensates for cartridge inductance and inverts the RIAA recording characteristic to an accuracy of ± 0.2 dB from 20 to 20,000 Hz. Table 1 shows the RIAA output data for a perfect equalizer. Since the oscillator has some inherent capacitance to ground, primarily back through the power line, the calibration must be performed with one side of the circuit grounded (see Fig. 2). Test-record corrections should also be obtained with one side grounded. After calibration, the circuit is changed to conventional configuration with the center tap of the input transformer grounded. Since this change results in a very small increase in level at 20 kHz, due to changes in stray capacitance, the RIAA tabulation has been modified slightly to compensate for the center-tap ground.

Record and Cartridge Response Curves

Fig. 5 shows response curves for two standard test records made by different companies. It will be noted that one record indicates a rise at the high-frequency end while the other shows a fall. Since the above-described method of equalizer design is quite rigorous, a tabulation of corrections was prepared for the best side of RCA Test Record No. 12-5-49-RL 992. These corrections were obtained by averaging four measurements of the standard cartridge and four similar cartridges and determining the calibration at each frequency. Table 2 lists the test-record corrections.

Table 3 contains the calibration data for a second RCA test record. It is included to show the deviation between two test records. Of particular interest is the fact that all test-record errors, including plastic resonance, are eliminated by this procedure.

The curves in Fig. 6 show the response of six General Electric Type VR-1000-7 cartridges selected at random and tested with the calibrated equalizer and corrected test record. There is good agreement among the various cartridges, and the average response is within ± 1.0 dB from 30 to 15,000 Hz when the equalizer is loaded with 500 ohms. (All the curves are flat and on the 0-dB line up to 2 kHz. To conserve space, only the region from 1 to 20 kHz is shown in Fig. 6.)

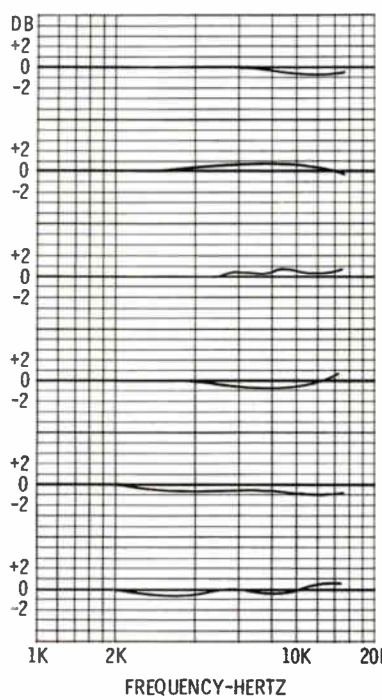


Fig. 6. Response curves of six VR 1000-7 cartridges selected at random.

Summary

If the ultimate in frequency response is the principal criterion in the selection of a cartridge and the design of the equalizer, a number of rather difficult problems must be solved. Not the least of these is finding a type of cartridge which is adaptable for use in a broadcasting studio. Although a great number of cartridges fulfill most of the requirements, several of these are eliminated by their inadequacies in the areas of ruggedness, operation with reversed record rotation, shielding, internal impedance, etc.

The design of the equalizer itself is an interesting, albeit straightforward, exercise. Final trimming is complicated by the need to develop measurement techniques of sufficient accuracy. The method used, injecting a signal in series with the cartridge, closely approximates actual operating conditions. The only deficiency in this method is the requirement that one side of the equalizer must be grounded. In actual operation, the equalizer input to the preamplifier is balanced, changing to some degree the stray capacitance of the system, and therefore, the high-frequency response.

The effects of changing from unbalanced to balanced operation are predictable and measureable, using a "standard" test record—if the record is calibrated beforehand. It was observed that anomalies in the output of the record were significant with respect to the effects of the stray capacitance cited above. Therefore, a method of calibrating the test record was developed. While the method of calibration was somewhat statistical in nature, judged in the light of the overall performance of the product, it is valid. ▲

PERSONALITIES in the Industry

Mr. Dressler

Robert Dressler has been made president and chief executive officer of **Riker Video Industries, Inc. Mario Alves,** executive vice-president, has been serving as president. Mr. Dressler was formerly director of advanced systems at Raytheon Co.

Mr. Wheatley

Robert Wheatley has been named operations manager for the CATV Construction Department of **Jerrold Electronics Corp.** In his newly created position, Mr. Wheatley will supervise the department's five project managers. The project managers serve as liaison between the department and its customers, with responsibility for all phases of Jerrold's CATV turnkey construction contracts.

Dr. Goldmark

Dr. Peter C. Goldmark has been named a recipient of the George Washington Award for contributions to scientific research and human knowledge. The award is given annually by the American Hungarian Studies Foundation. Dr. Goldmark, president of **CBS Labortories,** a division of **Columbia Broadcasting System, Inc.,** is responsible for the development 20 years ago of the long-playing record. Holder of more than 150 patents, he also is the inventor of the first color television system adopted for broadcasting in the United States. More recently, he spearheaded the development of Electronic Video Recording.

Richard H. Weingrad has been elected a vice-president of **American**

Electronic Laboratories, Inc. Mr. Weingrad joined AEL in 1967 as general manager of the company's manufacturing division; prior to joining AEL, he was vice-president, manufacturing, at Fischer and Porter Co.

Mr. Carver

Appointment of **Christopher S. Carver** to the newly established post of manager-business planning for the **General Electric Co.** Visual Communication Products Department has been announced. In his new position, Mr. Carver will be responsible for developing new business opportunities. His present primary responsibility is for marketing development of the new GE large-screen-display monochrome and color television systems introduced in April at the NAB annual convention.

Mr. Crawford

Robert L. Crawford has been named manager of the new **Belden Corp.** insulated copper wire and cable plant now under construction at Jena, La. Mr. Crawford, until now engineering manager for Belden's Richmond, Ind. plant, joined the firm in March, 1953, as a process engineer. Subsequent positions included those of development engineer, engineering group leader, chief manufacturing engineer, and assistant engineering manager.

James E. Remmer has been elected vice-president and general manager of the Westwood Division of **Houston Fearless Corp.** Previously, he was with Xerox Corp. in a number of executive assignments, most recently as zone manager for the western states, Hawaii, and the Far Pacific.

James H. Green, Jr. has been appointed a vice-president of **Continental Electronics,** a subsidiary of **LTV Electrosystems, Inc.** Mr. Green assumes duties as general manager of the Pickard and Burns Division of Continental Electronics. During 1967, Mr. Green was associate director of Telecommunications Management (Advanced Concepts and Technology), Executive Office of the President of the United States. He brings to Continental Electronics a background of 25 years of experience in the planning and construction of large communications systems throughout the world.

SALES APPOINTMENTS

Berkey-ColorTran

The appointment of **Marion M. Rimmer** as northwestern marketing manager of Berkey-ColorTran Inc. (a division of Berkey Photo Inc.) has been announced. Mr. Rimmer will service ColorTran dealers as well as motion-picture, television, and still-photographic installations in nine Northwestern states. He will headquarter at 3813 E. Laurel Lane, Phoenix, Arizona.

General Electric

Appointments of two new headquarters salesmen and one system salesman have been made at the General Electric Co. Visual Comunication Products Department.

Robert F. Henderson, previously a field service engineer for the GE Heavy Military Electronics Department, will coordinate sales and shipments of broadcast equipment to GE customers serviced from the Dallas, Atlanta, and Cleveland district offices.

Frederick A. Smith will use his experience as a studio engineer to design and develop working broadcast systems including custom-product studio equipment. He will serve all VCPD customers represented by the Company's field salesmen.

The new system salesman is **George I. Hardy,** formerly district engineer in Atlanta, Ga. His new duties will include arranging home-office and onsite customer demonstrations of General Electric color television cameras.

Gotham Audio Corp.

Eli Passin has been named as national sales manager of Gotham Audio Corp. Mr. Passin was formerly sales manager of the Professional Audio/Video Division of Harvey Radio Co., Inc.

International Electro Exchange

The appointment of **Thor Johnson** as vice-president, sales and marketing, for International Electro Exchange Corp. has been announced. Mr. Johnson joins the Minneapolis-based firm from Nortronics Co., Inc., where he most recently served as distributor sales manager.

Memorex

A number of sales engineers have been appointed by Memorex Corp.

James J. Ringwood, Jr. will be responsible for the sale of video and computer tape in New York City. Mr. Ringwood formerly was a sales engineer for Reeves Soundcraft in New York City.

Sanford Duncan will serve accounts from the district office in Boston. Prior to joining Memorex, Mr. Duncan was a sales representative with Burroughs Corp.

Frederick Koehler will be sales engineer in Westchester County, New York. Most recently, Mr. Koehler was an agency sales representative for American Airlines.

Robert Hazlett and **Robert Sidell** will cover portions of Texas, Oklahoma, and Louisiana and make their office in Dallas. Prior to joining Memorex, Mr. Hazlett was Production Manager for KTVT-TV Dallas-Ft. Worth; he will serve as a specialist in video tape. Mr. Sidell has been employed for the past four years by Consolidated Electrodynamics Corp., a Division of Bell and Howell, as a regional coordinator.

Bernard Reeder will serve accounts from a newly opened branch office in Albany, New York. Prior to joining Memorex, Mr. Reeder was employed for more than seven years as an account representative with the Todel Division of Burroughs Corp. The new Memorex district office is located at 680 Troy-Schenectady Road, West Latham, New York 12110.

Jack Baker will be responsible for the sale of instrumentation and video tape in Northern California. Prior to joining Memorex, Mr. Baker was regional coordinator for Consolidated Electrodynamics Corp., a Division of Bell and Howell.

Don Giauque will be responsible for the sale of all Memorex products in the states of Utah, Idaho, and Montana. Mr. Giauque has been employed for the past 6½ years as a sales representative for Moore Business Forms, Inc. The new Memorex district office is located at 543 East Fifth South, Salt Lake City.

Nortronics

Roger Czerniak has been promoted to dealer and distributor sales manager of the Nortronics Company, Inc. Mr. Czerniak has been assistant sales manager in the dealer and distributor division for the past two and one-half years. His new assignment will include the administration of replacement-head sales.

Packard Bell

Gregg T. Scott has been appointed sales administrator for Packard Bell closed-circuit television products. For the past three years, Mr. Scott has worked in the Packard Bell design engineering department. Previously he operated his own company selling, designing, and installing CCTV distribution systems. In his new post, he succeeds **Robert L. Weir,** recently named Southwestern regional marketing representative. Mr. Weir has been sales administrator of the department for the past 2-1/2 years; previously he was with Cohu Electronics.

Philips Broadcast Equipment Corp.

Rupert F. Goodspeed is the new general sales manager for Philips Broadcast Equipment Corp. Mr. Goodspeed came to Philips Broadcast early in 1967, assuming the duties of broadcast product manager. Before joining Philips, he was with Radio Corp. of America as Rocky Mountain regional sales and engineering representative.

Superior Continental

Jac N. Johnson, former assistant to the president of Inter-County Telephone and Telegraph Company, Ft. Myers, Florida, has been appointed general product manager for Superior Continental Corp. In his new position, Mr. Johnson will coordinate marketing and sales efforts of specific product managers and will work closely with the general sales manager in planning and supplementing marketing programs in support of sales.

John E. Chaney has been promoted to the position of supervisor in the customer service department, sales and service division, Superior Continental Corp. Mr. Chaney joined Superior Cable in February 1966 as a member of the inside sales department and later became a customer service representative. In his new position, Mr. Chaney will be responsible for coordinating customer service activities involved in sales and marketing of wire and cable products, outside plant equipment and accessories, and electronic communications systems equipment.

Visual

Visual Electronics Corp. has announced the appointment of **Sidney V. Stadig** to the new post of manager-headquarters sales. Most recently, Mr. Stadig was director of engineering for W. B. C. Productions, and prior to that he served in engineering management capacities for Group W Stations in Cleveland, Philadelphia, San Francisco, and Boston. ▲

For further information about any item, circle the associated number on the Tech Data Card.

ITFS Antennas

(60)

Alford Manufacturing Co. has introduced its Type 4760 ITFS Antennas for Instructional Television Fixed Service applications in the 2500-MHz range. Five standard models, as well as others for custom requirements, are rated for omnidirectional power gains ranging from 7 to 16 dB over an isotropic source. The 2 to 16 (depending on the antenna gain) vertically stacked slotted cylinders are enclosed in a radome that may be heated for de-icing purposes. The Type 4760 lightning rods, where required, may be either top or side mounted.

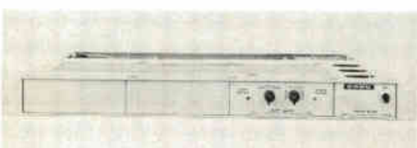
For those applications where a directional pattern is desirable, Alford offers a Type 4585.

Patch-Panel Systems

(61)

A major addition to **Trompeter Electronics'** line of miniature coaxial patch-panel systems is detailed in the company's latest catalog, which illustrates both Standard Miniature and the newly added Western Electric type patch panels, together with matching jacks, looping plugs and cords. Although all panels are of standard 19-inch width, both types permit high-density patching. Both are available in aluminum or insulated panel form, 1¾-inches or 3½-inches high, with 32, 64, or 96 jacks.

Trompeter's Standard Miniature panels are designed for data systems using coaxial cable up to 1/4" O.D. with Trompeter Type J8 jacks. The Western-Electric-type panels are designed for low-VSWR 75-ohm coaxial circuits used in microwave subcarrier telephone systems. Trompeter Type J12 jacks are used and are similar to W.E. 560A jacks used in the L4 carrier system.



Dot Bar Generator

(62)

Generation of test patterns for the checkout of television studio equipment is the function of the 2600 Series dot bar generator available from **Cohu Electronics, Inc.** Selected by a front-panel control, four basic test patterns are provided by the generator to measure scan nonlinearity of television camera chains in accordance with EIA RF-170, and for converging multigun CRT's as recommended by color-monitor and receiver manufacturers. Patterns include horizontal bars, vertical bars, grating or crosshatch, and dots. The width of the bars and the size of the dots is variable, as are the number and spacing of vertical bars and dots. An output-polarity switch controls the display of patterns as black lines or dots or as white lines or dots.

This dot bar generator is a plug-in solid-state circuit assembly designed to be inserted in a mounting frame. A single frame, which occupies 1-3/4 inches of vertical space in a standard 19-inch rack, has room for three plug-in modules and a power supply. Design of the generator incorporates FET's and IC circuitry for maximum reliability and minimum maintenance. The price (including frame) is $725.

New Modulator Line

(63)

A modulator with separate audio and video attenuation has been announced by **Packard Bell.** Two models —MPS-15 for channels 2-6 and MPS-16 for channels 7-13—allow variation of input level from zero to maximum. Cost of the MPS-15 is $150; of the MPS-16, $160.

Two RF carriers are produced which transmit picture and sound on the same standard TV channel to one or more receivers in a closed-circuit system. Operating on either color or monochrome signals, the crystal-controlled modulators are self-contained

Erratum

In the June 1968 issue, on page 42, the caption for Fig. 2 should read, "Three-stage microphone preamplifier has two outputs driven in parallel."

and transformer-operated. They need not be placed near the camera if some other location in the system is more desirable. More than one camera may be used and switched to the modulator as desired.

Available as accessories are 70-ohm attenuators of 3 dB, 6 dB, 10 dB, and 20 dB that balance standard TV receiver closed-circuit systems by reducing output as required.

Cable for 2 gHz
(64)

A low-VSWR coaxial cable to minimize antenna-feeder echo distortion in high-capacity 2-gHz microwave systems is offered by **Andrew Corp.** The low-VSWR *Heliax* air-dielectric cable is offered in ⅞-inch (Type 25817) and 1⅝-inch (Type 25816A) sizes. EIA flanged and tunable type N connectors are available to provide matched performance between antenna, cable, and operating equipment.

Electrical characteristics given for the ⅞-inch size include: maximum operating frequency, 5.2-gHz; average VSWR, 1.05 (1.7-2.3 gHz); attenuation, 1.9 dB per 100 feet at 2.1 gHz. For the 1⅝-inch size, specifications include: top frequency cutoff, 2.63 gHz; VSWR, 1.08 average; attenuation, 1.08 dB per 100 feet.

All shipments are tested and selected to insure compliance with system specifications.

Dynamic Microphones
(65)

A new "Starmaker" line of dynamic microphones for use in professional broadcast, recording, and stage performances has been unveiled by **RCA Electronic Components.**

The "Starmaker 96" microphone is for use on stage, for recording sessions, or in a variety of broadcast applications. This microphone features a 3-position bass roll-off switch to reduce rumble and unwanted background noise. A special 5-pin connector permits switching the output impedance from 200 ohms (–78 dBv level) to 15,000 ohms (–60 dBv level) by reversing the connector. The cardioid pick-up pattern reduces feedback and unwanted audience and offstage sounds.

The "Starmaker 96" is of die-cast metal construction with a black and chrome finish; it comes complete with wind-screen, slip-on swivel mount, and 20-foot shielded cable and is packed in an attache-type carrying case. This microphone weighs 16 ounces (less cable), is 9-3/4-inches long and slightly less than 1-1/2-inches in diameter. The optional user price is $50.

The"Starmaker 97" microphone is for stage use by individual performers, or by groups in which each individual has a separate mircophone. The frequency response, unidirectional pick-up pattern, and impedance-switching features are identical to those of the Starmaker 96. The "Starmaker 97" weighs slightly over 6 ounces (less cable), is 7½-inches long and almost 2-inches in diameter, and is provided with an on/off switch. It is of die-cast metal construction with a black and chrome finish, and comes complete with windscreen, slip-on fixed mount, and 20-foot shielded cable; it is packed in an attache-type carrying case. The optional user price of the "Starmaker 97" microphone is $40.

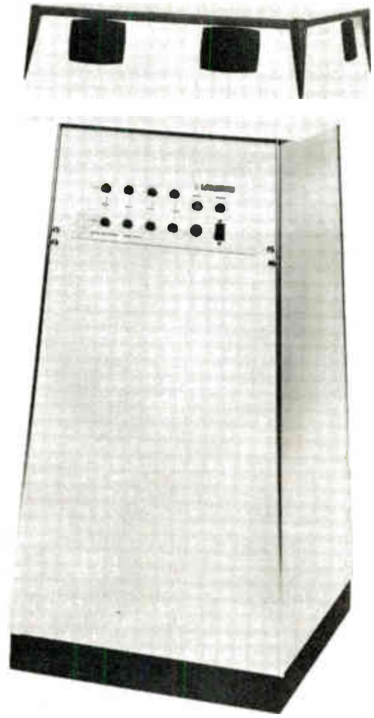
The "Starmaker 98" omnidirectional microphone is designed for on-stage, recording, and broadcast use where two or more individuals desire to use the same microphone. This microphone also features an on/off switch and changing of the output impedance by means of a special 5-pin connector.

The Starmaker 98 is of die-cast metal construction with a black and chrome finish, and comes complete with wind-screen, slip-on fixed mount, 20-foot shielded cable, and an attache-type carrying case. This microphone weighs slightly over 6 ounces (less cable) and is almost 8-inches long and 2-inches in diameter. The optional user price of the "Starmaker 98" microphone is $40.

Optical Multiplexer

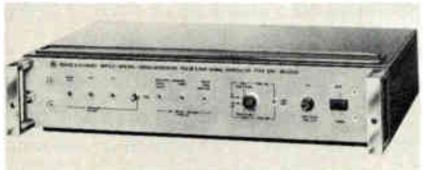
(66)

A new four-input, two-output optical multiplexer is available from **TeleMation, Inc.** Intended for broadcast use, the Model TMM-211 uses four movable mirrors to optically switch any of four film and/or slide projectors into either of two cameras. Each mirror is mounted on two ball-bearing pillow blocks to insure vertical and horizontal alignment. Each mirror is supported on one edge only.



When not in use, mirrors fold beneath the surface, in semaphore action, to retard dust accumulation. All surfaces are silicon-monoxide coated to permit repeated cleaning without damage to the mirrors. The optical assembly "floats" on a three-point mounting designed to prevent impairment of optical alignment from external stress. The mounting also provides a means of adjusting the optical plane.

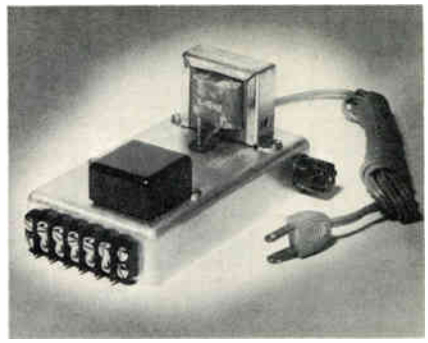
The beige and brown unit is 21 inches square and weighs 100 pounds. Overall height is about 51 inches.



New Pulse and Bar Generator
(67)

A new pulse and bar generator for use in monitoring and measuring TV video characteristics has been announced by **Rohde & Schwarz.** The Type SPIF sin^2 pulse and bar generator generates T, 2T, and 20T sin^2 pulses and reference bar signal with distortion rated at 0.25%. The instrument generates the 3.58-MHz color subcarrier from an internal oscillator and also provides auxiliary horizontal pulses. It can be operated from internal or external sync pulses.

Type SPIF is all solid-state. It is available for NTSC, PAL, and SECAM systems, and in a 19-inch rack version. Price is $1600.



Matching Preamplifier
(68)

The **Gray Research and Development Co. Division** has added the Model 602-I.M.P. impedance-matching preamplifier to its line of professional broadcast products. This preamplifier, with its self-contained 115-volt AC power supply, is designed to match the new high-impedance stereo cartridges to an existing console where a 602-C or similar passive equalizer is used at the front end of a disc input channel. It is intended to maintain the existing output levels and equalization curves while offering distortion of less than 0.5% with 20 mv input, and a noise figure of −70 dBm at the output. The price of the preamplifier is $59 75.

Portable Color Camera
(69)

The *Norelco* Model PCP-70 portable color television camera is identical in circuitry, pick-up tubes, color-separation prism, and electronics to the same manufacturer's Model PC-70. Also, the portable unit is fully compatible with the camera control unit of the PC-70.

All set-up and operating controls are located at the camera control unit, except lens functions such as zoom and focus. The PCP-70 "Little Shaver" camera can be operated up to 3000 feet from the CCU using standard single cable. A special light-weight cable can be used for runs up to 200

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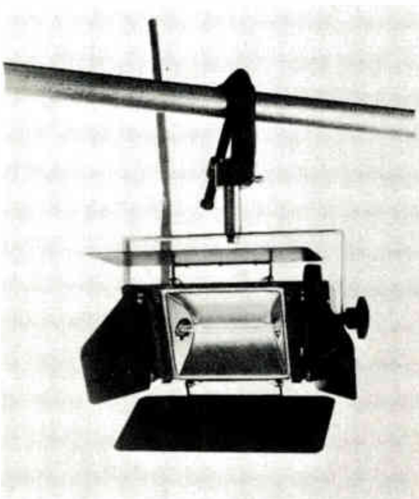
feet; this lightweight cable can be combined proportionally with TV-79.

The PCP-70 employs the new, extended red sensitivity *Plumbicon* tube. Separate mesh *Plumbicons* are employed in all three color channels.

A 6-to-1 Angenieux zoom lens is standard; it can be disconnected and replaced by a 10-to-1 studio lens. (In such case, a tripod or dolly is needed.)

The back-pack unit contains all the electronics to drive the camera head except the yokes and preamplifiers. Terminal boxes for the interphone system, headset outlet, and an audio cue signal outlet are mounted on the recessed bottom panel of the back pack. The back pack can be detached from the harness and located up to 30 feet from the cameraman.

The "Little Shaver" is marketed by **Philips Broadcast Equipment Corp.**



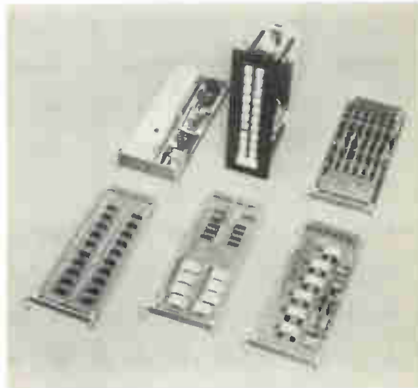
Quartz Lighting Units
(70)

Berkey-ColorTran, Inc., (A Division of **Berkey Photo, Inc.**) has announced the introduction of the ColorTran Mini-Lite "6" and "10," with integral 4-leaf barndoors incorporating a reflector design intended to give more than a 30% increase in light output. The units weigh less than 5 pounds and measure less than 3 inches deep.

The Mini-Lites operate directly from 120 or 230 volts, AC or DC. Utilizing a 650-watt 3200°K quartz lamp, the Mini-Lite "6" is designed to produce 97 footcandles at 10 feet with a smooth, broad light pattern. The Mini-Lite "10" is designed to produce 159 footcandles at 10 feet using a 1000-watt 3200°K quartz lamp. Tungsten-halogen quartz lamps are available in a number of color-temperature ratings.

Accessories include single and double scrims as well as a dichroic daylight conversion filter. A "snoot" for pinpoint lighting also is available for the Mini-Lite "6" only. The Mini-

Lites can be stand-mounted or fitted with a C-clamp for mounting on an overhead rail or pipe. Prices for the Mini-Lite "6" and "10" in motion-picture or TV models range from $38.95 to $53.00.

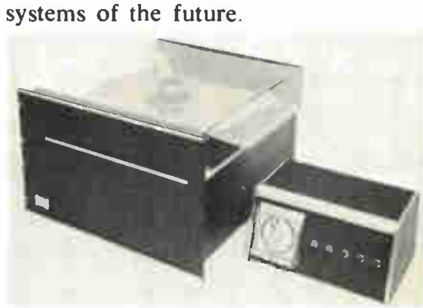


Video Distribution Switcher
(71)

A new video distribution switcher has been announced by the **General Electric Co.** Visual Communication Products Department. Featuring a solid-state building-block design, the Model TS-301-A switcher has the capability to handle from 10 studio inputs and 6 outputs to 100 inputs and 96 outputs. If needed, additional expansion can be provided with minor modifications to the system.

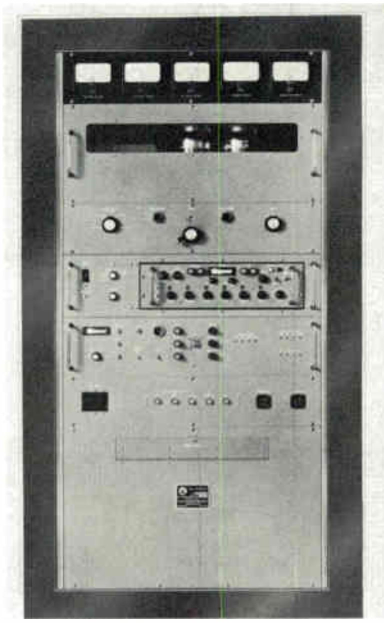
A computer-logic wiring concept has been used for the purpose of permitting a reduction in the number of wires and connections, and to allow easier installation and simplified maintenance. Solid-state design, including integrated circuits and printed wiring, is used to minimize the overall size of the system.

The new unit is designed to produce fast, transient-free switching; to offer improved isolation between inputs and outputs, better signal-to-noise-ratio, better overall frequency response, and lower differential phase and gain; and to be readily adaptable to automation systems of the future.



Weather-Analysis Television
(72)

A weather-display system available from **General Electrodynamics Corp.** is intended to aid the television-station meteorologist in preparing his weather report, and also to be used in the program to provide the audience with a graphic display of the progress of a storm. Using a radar input from an available facility, the system converts this input to a television format and automatically records one frame on a video disc. The video disc then goes to the next track position and awaits the recording of another frame after the expired preset time interval. During the day, a sequence of frames will have been recorded; these can be displayed in a manner similar to time-lapse photography. In a time interval of several seconds, the viewer can see a dynamic display of how a storm has developed during the course of several hours. A geographical overlay can be added electronically to give a location reference.



10-kw Transmitter
(73)

The Technical Materiel Corp. Model BCT-10KA transmitter is a high-power, air-cooled unit for operation in the 450-2000 kHz range. A synthesizer exciter is used, and operation is provided in CW, AM, AME, SSB, ISB, and FSK modes. The transmitter has a rating of 10,000 watts average carrier power.

Some specifications for this transmitter are: frequency stability, 1 part in 10^6 per day for ambient temperature change of 15°C within the range 0-50°C (1 part in 10^7 or 10^8, optional extra); spurious signals (120 Hz or more removed from carrier frequency), at least 50 dB below carrier output; harmonics, at least 50 dB below full carrier output; audio response, (AM) ±2 dB from 100 to 10,000 Hz, (SSB) ±1.5 dB from 350 to 3500 Hz (other SSB response characteristics as optional extras); audio input, 600-ohm balanced or unbalanced, −20 to +10 dBm (full RF output from −20 dBm); altitude, transmitter designed for full output at 10,000 feet. ▲

Engineers' TECH DATA

100. **ACME FILM & VIDEOTAPE LABORATORIES**—New 28-page film and video-tape processing catalog and price list is offered.
101. **ALTEC LANSING**—Brochure AL 1375 explains "Acousta Voicing" method of improving sound quality in recording and broadcasting studios.
102. **AMERICAN PAMCOR**—Complete line of thick-wall, heat-shrinkable, self-sealing tubing, boots, end caps, and aperture seals is described in Product Information Bulletin L 79.
103. **ANDREW CORP.**—ITFS antennas [2.5 to 2.7 gHz], in offset and omnidirectional patterns, are the subject of Technical Bulletin 182.
104. **ATLAS SOUND** — Form PP-1840 describes microphone stands, microphone booms, and studio accessories.
105. **BARKER & WILLIAMSON**—Specifications and descriptions of test equipment, coaxial switches, dummy loads, RF filters, and RF components are included in an 8-page catalog.
106. **BERKEY-COLORTRAN** — Product sheet describes LQTB-10 and -10/TV flood lights.
107. **CAPITAL RADIO ENGINEERING INSTITUTE**—An illustrated brochure for high-school graduates, "How to Prepare for Tomorrow's Jobs in Electronics," is offered.
108. **CCA**—Catalog sheet describes "Watchdog No. 1," automatic transmitter control and power switcher.
109. **CLEVELAND ELECTRONICS**—52-page catalog gives information on vidicon, **Plumbicon**, and image-orthicon deflection components.
110. **CLEVELAND INSTITUTE OF ELECTRONICS**—Pocket-size plastic "Electronics Data Guide" includes formulas and tables for frequency vs wavelength, dB, length of antennas, and color code.
111. **COHU**—2600 Series video multiplexer is subject of Data Sheet 6-497.
112. **COLLINS**—Literature describing printed-circuit toroids is available.
113. **COLORADO VIDEO**—Reprint from SMPTE Journal and a data sheet tell about the Model 302 video analyzer.
114. **CONCORD ELECTRONICS**—The VTR-700 remote-controlled VTR designed for continuous recording or playback is described in 4-page brochure.
115. **DELHI**—Twelve-page catalog concerns towers and masts for Citizens-band and similar applications.
116. **DELTA ELECTRONICS** — Specification sheets and applications bulletins give information about the RG-1 receiver/generator, OIB-1 operating impedance bridge, and CPB-1 and -1A common-point impedance bridges.
117. **DIAMOND POWER**—Specification sheets for 8 models of CCTV silicon-transistorized cameras, with and without viewfinders, and 3 models of video-tape recorders are offered.
118. **DRESSER**—A 6-page color brochure shows tower installations and manufacturing processes.
119. **DYNAIR**—Literature describes new Series 4000 solid-state TV demodulator for CATV applications.
120. **DYNASCIENCES**—Model 468 vertical-aperture equalizer is subject of specification sheet.
121. **FAIRCHILD**—Technical bulletin gives details for Model FICM integrated control module.
122. **FT. WORTH TOWER**—Literature dealing with towers, passive reflectors, and equipment buildings is offered.
123. **GATES**—A product information bulletin describes tape cartridges, storage units, and accessories.
124. **GAUSS ELECTROPHYSICS** — Series 1200 ultra-high-speed tape-duplication equipment and Model 1260 high-capacity endless-tape bin are subjects of a brochure and a specification sheet.
125. **JAMPRO**—Descriptions, patterns, specifications, and prices are included in an 8-page brochure on circularly polarized FM antennas.
126. **JENSEN TOOLS & ALLOYS**—More than 1700 items, tools, micro-tools, soldering equipment, lighting equipment, and optical equipment, are listed in Catalog 368.
127. **JOA**—Prices and data are given for new cartridges and cartridge-reconditioning service.
128. **KALART/VICTOR** — Victor Models STV-18 and STV-TB 16 mm projectors and Tele-Beam Model A912 large screen television projection system are covered in three brochures.
129. **KEMLITE LABORATORIES**—Electronic flashtubes for stroboscopes, photography, and lasers are subjects of data sheets.
130. **L-W PHOTO**—Athena Model 1900 and 1900-M 16-mm stop-action projectors for TV are described in a catalog sheet.

131. **MEMOREX**—Three brochures describe the 78V series of video tape, the 79 series of video tape, and a new case for video tape.

132. **MOLE-RICHARDSON**—Catalog K lists lighting, power-generating, and special-effects equipment; light booms; dollies; and technical books on lighting and photography.

133. **MOSELEY ASSOCIATES**—Detailed information about Model PCL-303/C solid-state composite-aural STL is available in Applications Notes 222X.

134. **PARABAM**—Technical Bulletins No. 465-22A, 1066-29, 566-24, and 566-25 describe digital clocks, digital calendars, digital-time programmer, and an elaspsed-time digital programmer, respectively.

135. **POTOMAC INSTRUMENTS**—Model AM-19 antenna monitor, for measuring phase angle and loop current in AM directional arrays, is the subject of a specification sheet.

136. **RICHMOND HILL**—33-page quick-reference catalog gives information on complete line of TV terminal equipment.

137. **RUSSCO ELECTRONICS**—Literature for preamplifiers and turntables is offered.

138. **SCALA** — Data sheet describes Model CL 1483, a precision antenna for UHF television.

139. **SCHAFER ELECTRONICS**—New 16-page color brochure describes broadcast-automation systems and taped-music library.

140. **SEALECTRO**—Catalog No. 3-68 describes miniature RF connectors for applications up to 18 gHz.

141. **SECO ELECTRONICS**—Operating manual for Model 240, SCR analyzer, is offered.

142. **SIMPSON**—A 28-page catalog, Bulletin No. 2079, gives complete details for more than 1400 sizes and types of panel meters; 16-page catalog, Bulletin No. 2078, describes test-equipment line.

143. **SONY**—Specification sheets and applications bulletin give information about the 2-inch PV series, 1-inch EV series, and ½-inch CV series of video-tape recorders; video tape; monitors; and cameras.

144. **SPARTA**—Quick Reference Product Guide covers complete range of audio consoles, tape-cartridge equipment, turntables, accessories, and cabinets.

145. **SPRAGUE**—64-page Short-Form Catalog CN-116M describes monolithic networks, compatible components, and transistors.

146. **SPECTRA SONICS**— Technical information, including AES Preprint No. 566, describes Model 101 audio amplifier used in professional recording consoles.

147. **SUPERSCOPE**—32-page catalog, "All the Best From Sony," features Sony/Superscope tape recorders, magnetic tape, microphones, and accessories. Additional catalog gives technical specifications of consumer and professional microphones.

148. **SURFACE CONDUCTION**—Specifications and prices for single-wire VHF, UHF, and SHF transmission lines are offered.

149. **SWITCHCRAFT**—Bulletin 174 describes a new multiple-station push-button switch.

150. **TECH LABS**—Two short-form catalogs list attenuators and stereo controls; a 24-page attenuator catalog also is offered.

151. **TELEMATION**—Data sheets for the following devices are offered: Model TMV-400 black-burst generator, Model TMV-650 video-control center, Model TMM-211 optical multiplexer, Model TMV-529 waveform sampler, Series TSG-1000 portable TV sync generators, and Series TSG-2000 TV sync generators.

152. **TELEMET**—Data sheets describe Model SS-140 video switcher and Model 4231-A1 processing amplifier.

153. **TELEVISION ZOOMAR**—TVP pneumatic pedestals; H.T.S. studio equipment; Mark II Colorgard meter, for production-line color-receiver balancing; and TV Colorgard meter, for balancing color TV monitors, are described in product-information sheets.

154. **TELEX**—Descriptions of Viking Studio 96 and Magnecord Models 1021 and 1022 tape-recording and reproducing equipment are given in literature.

155. **TELTRON**—Two 1-inch vidicons, a 4½-inch image orthicon, a 3-inch image orthicon, and the 3-inch **Fabicon** for low-light applications are described in technical literature.

156. **TEXWIPE**—Information and prices for tape-head cleaning kit and its individual components are offered.

157. **TRIPLETT**—New literature sheet tells about all-solid-state VOM, Model 601.

158. **TROMPETER**—Catalogs T-7 and M-4, listing coax, twinax, and triax products, for patching, switching, and matrixing, are offered.

159. **UNIMAX SWITCH**—Twelve-page catalog 50-1 lists LPB Series 9 illuminated push-button controls.

160. **VACO** — 28-page Catalog T-90 lists terminals, connectors, and installation tools.

161. **VITAL INDUSTRIES** — Model VIX-108, new integrated-circuit, vertical-internal switching system, and Model VI-1000 video processing amplifier are subjects of literature.

162. **VOLTRONICS**—Sixteen-page Catalog No. 766A covers the complete line of precision piston-type trimmer capacitors.

163. **WARD/DAVIS VIDEO ACADEMY**—Literature gives details about maintenance courses for video, video-tape, and CCTV equipment.

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Audio Equipment bought, sold, traded. Ampex, Fairchild, Crown, McIntosh, Viking F. T. C. Brewer Company, Town & Country Plaza, Pensacola, Florida. 3-64-tf

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CO-AXIAL CABLE Heliax, Styroflex, Spiroline, etc. Also rigid and RG types in stock. New material. Write for list. Sierra-Western Electric Co., Willow and 24th Streets, Oakland, Calif. Phone 415 832-3527. 5-66-tf

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Manual color film processor. Complete unit requires simple plumbing and electric plug-in, $3,000. George Wright, 1521 Falcon Dr., Odessa, Texas. 7-68-1t

Increasing power, must sell perfect Collins 830D-1A, 1000-watt FM transmitter with stereo generator and extras. Like new. Howard Dybedock, Chief Engineer, WJOL, Joliet, Illinois. 7-68-1t

Gates M3663 Audio Proof Package. New condition, with manuals. Includes B&W 210 Audio Oscillator, 410 Distortion Voltmeter, Gates M03625 Gain Set, M03626 Diode Rectifier. Best offer over $530. Lohr, 208 14th St., Pocomoke City, Maryland. 7-68-1t

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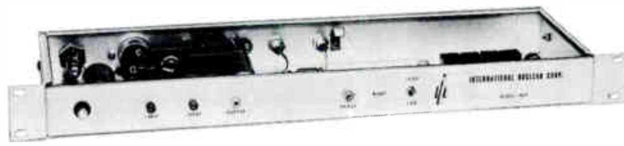

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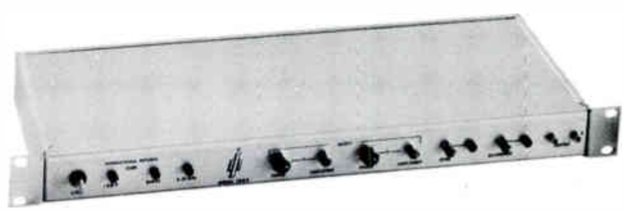

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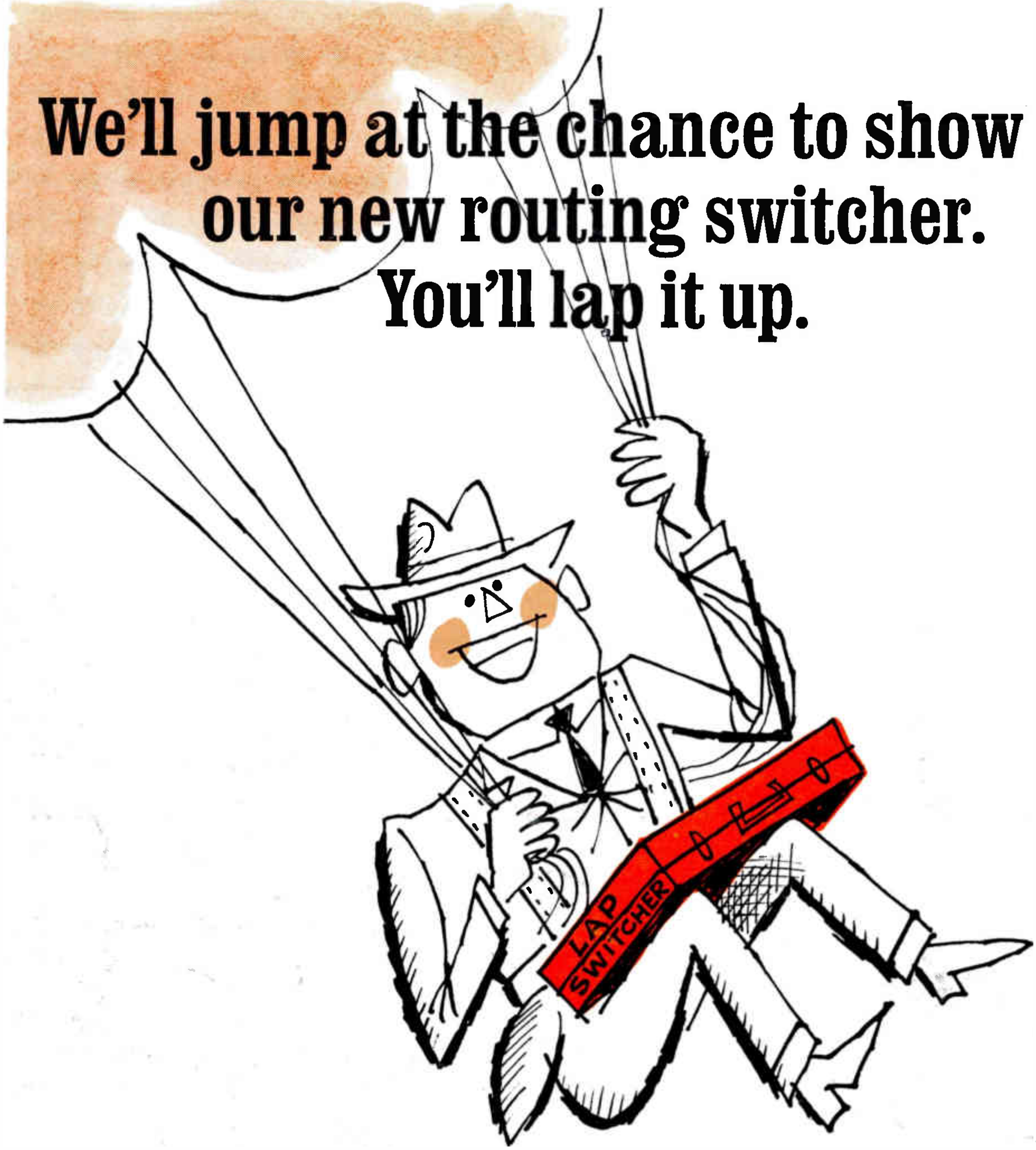
We'll jump at the chance to show you our new routing switcher. You'll lap it up.



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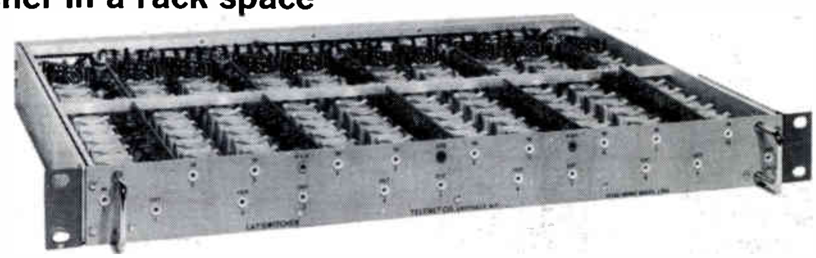

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