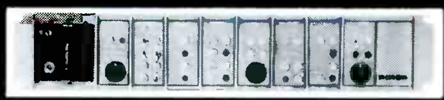
A HOWARD W. SAMS PUBLICATION

APRIL 1968/75 cents

®Broadcast Engineering

the technical journal of the broadcast-communications industry

how to simplify continuous quality control of television signals



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Circle Item 1 on Tech Data Card

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the technical journal of the broadcast-communications industry

Broadcast Engineering

Volume 10, No. 4 April, 1968

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Features

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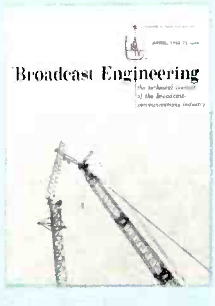
Construction is one phase of station activity that many operators don't have an opportunity to see. Our cover scene shows a tower being erected for an ITFS system in Broward County, Florida. Additional construction scenes are included in the picture story about WTRE, Greensburg, Indiana, which starts on page 38.



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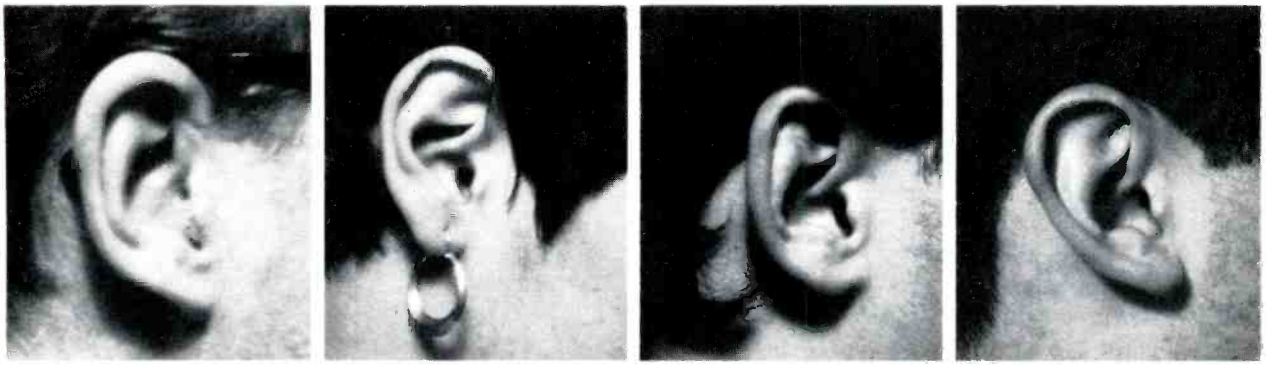

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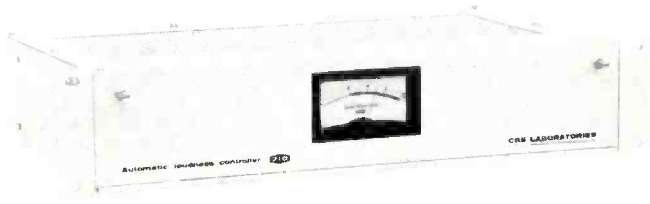


Circle Item 3 on Tech Data Card

NEWS OF THE INDUSTRY

INTERNATIONAL

Thailand's First Color TV

Color cameras and other television equipment were flown to Bangkok by the **Marconi Co.** in a crash program to put Thailand on the air with live color programs by the end of November. Marconi engineers completely equipped a two-camera outside broadcast unit for the **Bangkok Broadcasting and Television Corp.** The first assignment for the unit was the Thailand Beauty Contest, the nation's first scheduled live color transmission.

NATIONAL

Plant to be Expanded

Ampex Corp. has made plans to more than double its manufacturing facilities in Colorado Springs. Site-preparation work has begun for new construction that will add 116,000 square feet of plant space to the 100,000 square feet now occupied by Ampex. Estimated completion date is January or February, 1969.

The additional plant space will be an extension of the present building, permitting a fully integrated operation. A manufacturing facility of the Ampex audio/video communications division, the Colorado Springs plant presently manufactures professional magnetic audio recording equipment for broadcasting, master recording, industry, and education; scientific magnetic recorders for industrial and medical instrumentation; and video tape recorders and components for closed-circuit television and professional broadcasting.

Companies Merge

Preformed Line Products Co., Cleveland, has announced the acquisition of the **Smith Co.,** Canoga Park, California, through an agreement to purchase all of the outstanding stock of **Smith-Schreyer & Assoc., Inc.** The Smith Co. manufactures a line of accessories for all-buried-construction in the telephone and CATV industries.

In making the announcement, Jon R. Ruhlman, PLP president, said the acquisition will enable Preformed to enter a new area of business, that of developing, manufacturing, and supplying products for underground construction. He said the new company will also broaden Preformed's scope of operations to include products other than those made of preformed helical wire.

State University of New York Awards Contract

Visual Electronics Corp. has been awarded a $159,000 contract to supply and install complete studio equipment for the Learning Resources Center at the SUNY Brockport campus.

For Brockport, long a pioneer in the uses of instructional television, the Learning Resources Center's facility will be the third developed by Visual. Within the last two years, Visual has designed and installed closed-circuit television systems for the Science Building complex and for the Demonstration School. The new studios at the Learning Resources Center will include three image-orthicon television cameras; Visual's LS-8 switching system (built entirely to customer specifications); all associated video and audio equipment; and film, intercom, lighting, and test equipment.

Merger Announced

Sparta Electronic Corp. has merged with **Computer Equipment Corp.** through an exchange of stock. Sparta becomes a wholly owned subsidiary of C.E.C. No personnel or operational changes at Sparta are planned.

C.E.C. has six other divisions, including Jampro Antenna Co., Vega Electronics Corp., and the recently acquired Bendix Marine Div.

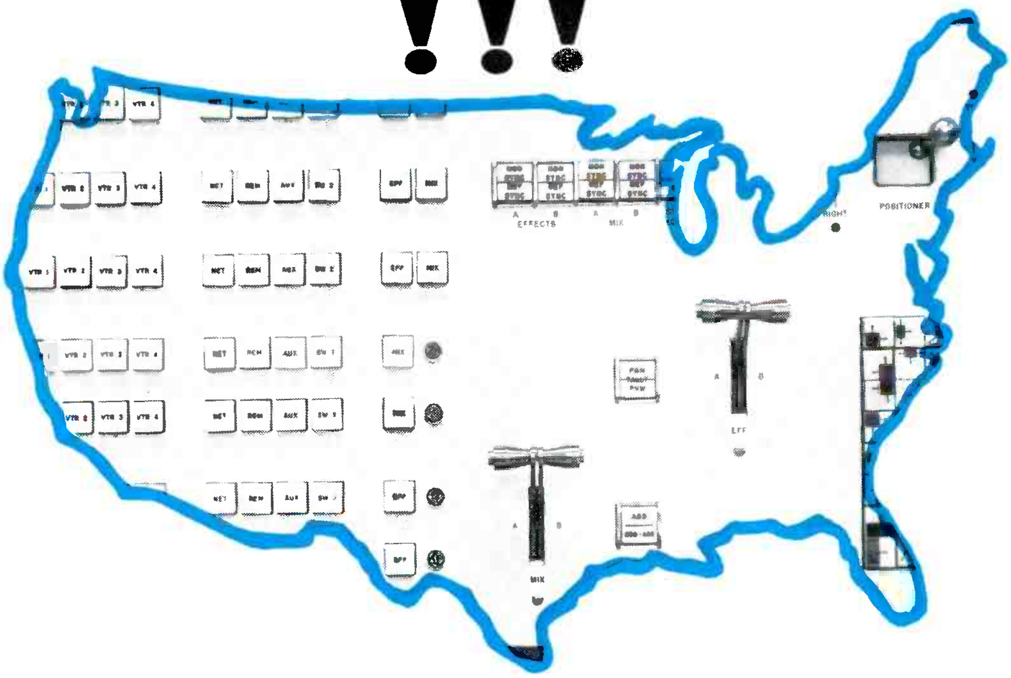
New Hollywood Facility

Magnasync/Moviola Corp. has opened a new sales, service, and rental facility in Hollywood, California, it has been announced by L. S. Wayman, vice-president and general manager. Address of the new service office is: 1429 Ivar Avenue, Hollywood, 90028. The phone number is: 466-5322.

Hand-Held Wireless TV Camera

A hand-held wireless television camera weighing less than 20 pounds

coast-to-coast* the switch is toWARD switchers !!!



. . . the choice of the skeptics, whose proof is performance!

Ward Electronic's all solid-state vertical interval switchers are years ahead. Hard to believe? Once you've checked the features and compared the performance of our switchers, you'll understand why so many major TV stations are switching to, and with Ward.

Here are only a few of the many features you will find of special interest in our Studio, Master Control and Routing Switchers.

- Automatic Composite / Non Composite Input Handling Capability
- Sync sensing, automatic sync adding and clamping on each input
- Spare 75 ohm clamped output from each input
- Two Independently Equalized Outputs per buss
- Additive / Non Additive solid state mixing amplifier
- Automatic Direct take when attempting to mix non synchronous sources
- Each buss self-contained with individual power supply, trigger pulse generator, latch and tally circuits
- Transient-less vertical interval switching
- Low Impedance, transmission line type input buss

* Write for a list of the TV stations that have switched to Ward, . . . and complete switcher specifications.

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142 CENTRAL AVE., CLARK, NEW JERSEY 07066 • (201) 382-3700

Circle Item 5 on Tech Data Card

was shown at the 1968 Brooklyn Museum Annual Design Show. The portable camera was developed by **CBS Laboratories** to transmit black-and-white television pictures from remote locations. It is designed to operate under varying weather conditions and to transmit high-quality pictures at light levels as low as five footcandles.

In operation, the system transmits video and sound signals to a remote control station from distances up to one mile. The control station, located in a television truck or van, relays pictures and sound to associated electronic equipment for retransmission.

New Facilities On West Coast

A specially designed VTR manufacturing facility for the **Visual Electronics** line of high-band color video-tape recorders has been established at Sunnyvale, Calif. The 21,600-sq ft plant incorporates two previously separate operations formerly located in Palo Alto.

The Division's technical staff has been increased, and a Video-Tape Recorder Training School for customers has been established. Classes will be held to train engineers in the operation and maintenance of the video recording units.

Million Dollar-Plus Buy

Trans-Tel Corp., permittee of WXTV, Channel 14, New York-Paterson, has contracted for a major purchase of transmitter and studio equipment from the **General Electric Co.**, and color video tape recorders from the **Ampex Corp.** In addition, the studio will incorporate a fully automated switching system.

WXTV is scheduled to go on the air July 1, 1968. It will be programmed entirely in Spanish.

Filmways Acquires Broadcast Electronics, Inc.

Filmways, Inc., has reported it has entered into an agreement to acquire **Broadcast Electronics, Inc.**, Silver Spring, Md., producer of magnetic tape-recording systems and other equipment for the broadcast industry.

Martin Ransohoff, president and chief executive officer of Filmways, said the agreement calls for an exchange of Filmways convertible preferred stock for Broadcast Electronics common stock, with the transaction totaling about $1,750,000.

ORGANIZATIONS

NAB

The NAB Engineering Advisory Committee has recommended that an Advanced Engineering Management Development Seminar be held next year for graduates of NAB-sponsored courses during the past three years. The special Seminar, to be held at Purdue University, Lafayette, Ind., would offer in-depth or post-graduate studies on one or more of the many subjects dealing with efficient engineering management covered at the earlier seminars.

Under the committee proposal, regular courses would be resumed the following year to provide three annual seminars on broad subjects of engineering management followed by an advanced, or specialized, course every fourth year.

STATION ACTIVITY

New Station Building

The new home of **WLCY** Radio and Television in St. Petersburg, Fla. is designed specifically to house AM, FM, and color television facilities under one roof. The building will encompass 33,000 square feet of working space. Over 125 employees will be involved in the overall TV-radio operation.

The technical area will consist of three basic parts: Telecine, for the operation of color film and slide projectors; Master Control, for day-to-day operation; and the Technical Operations Center, housing video-tape machines and camera control units.

A news-central type of facility will combine both television and radio news departments, with a single room handling all press-wire services as well as provisions for monitoring police, fire, and other emergency communications networks. A 16-mm color-film processor will be provided for television news.

The building, to be constructed of concrete blocks with bar joists, was designed to allow for future expansion. The only windows in the entire structure are those on each stairwell and in the entrance lobby; they will contain a special solar bronze glass.

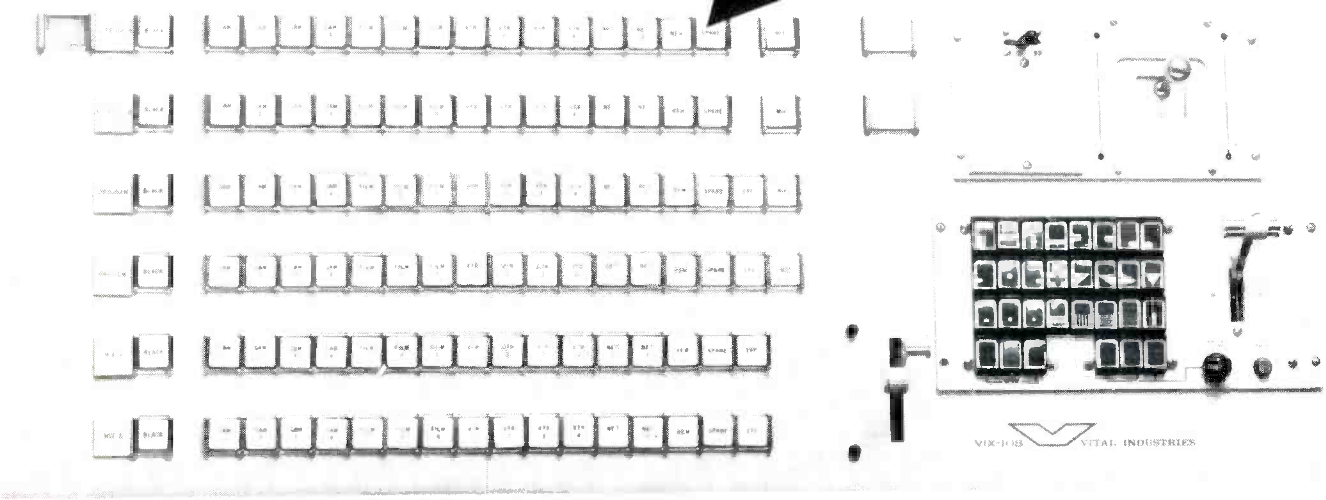
WTOA Power Increase

WTOA, Trenton, has been granted a construction permit by the Federal Communications Commission to increase its power to 100,000 watts (50,-

Vital News in Switching!

VIX-108

First new concept in Switching in a decade is here



Vital Industries, Inc. has taken the custom cost and complications out of custom switching. A unique combination of mechanical and electrical packaging has yielded exceptionally high performance and specifications in the VIX-108 vertical interval switching system.

FEATURES:

- All solid state with integrated circuits including crosspoints and control circuits.
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SPECIFICATIONS for one typical 18 in 6 out system:

- Exceptional isolation between crosspoints . . . 65 DB down at 4 Mhz.
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- K factor less than 1%.

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Circle Item 7 on Tech Data Card

000 horizontal, 50,000 vertical), it has been announced by Herbert W. Hobler, President of the **Nassau Broadcasting Co.,** owners of the station.

The power increase, expected to be effective in the spring, will provide a coverage area with an estimated population in excess of 15,000,000 people. The station has been operating with 28,500 watts (14,500 horizontal and 14,000 vertical).

WBLG-TV On Air June 2

The third commercial television station in Lexington, Ky. is under construction, and an air date of June 2, 1968, has been scheduled, it has been announced by Roy B. White, Jr., President of **WBLG-TV, Inc.**

A new building of 9,200 square feet for offices, studios, and transmitter was started early in December and is to be completed by May 17.

New Call Sign

KMTW-TV, the Kaiser station serving the Los Angeles area, has a new name, KBSC-TV. The new call sign serves two purposes: "SC" identifies with Southern California, and "KB" is the group identification for **Kaiser Broadcasting.**

Station Transfer

Subject to approval of the FCC, **Career Academy, Inc.,** an International Educational school with its home base in Milwaukee, has purchased the assets of Radio Station **WTOS** of Wauwatosa, Wisconsin, a Milwaukee suburb. The seller is **Broadcasting, Inc.,** Robert H. Perthal, president.

CATV

Technical Training Program

Fifty operators, engineers, and technicians of community antenna television systems from 14 states and two Canadian provinces recently completed a week-long technical training institute conducted by the CATV Systems Division of **Jerrold Electronics Corp.**

The institute was held in Philadelphia at Jerrold's headquarters and was the first in this year's series of the company's educational program for training personnel in the techniques needed to operate and maintain CATV systems. Jerrold has conducted such programs for more than ten years.

The company plans eight more such institutes in Philadelphia this year. It also will offer 18 three-day regional seminars on CATV throughout the United States and Canada in 1968. Thus, training will be given to more than 1300 CATV personnel this year. ▲

April 1968

Late Bulletin from Washington

by Howard T. Head

Extension of Presunrise AM Operation Proposed

The Commission has invited comments on two proposals which would permit earlier sign-on times for both daytime-only and fulltime AM stations operating under the terms of a Presunrise Service Authority (PSA). Under the present Rules, operation under a PSA may not commence prior to 6:00 a.m. local standard time. In addition, Class II stations located west of the dominant stations on the clear channels may not operate prior to sunrise at the Class I station.

Following successful informal discussions with the Canadian authorities (see March 1968 Bulletin), the Commission has proposed to permit PSA operation beginning at 6:00 a.m. local time rather than local standard time. This would permit presunrise sign-on at 6:00 a.m. Daylight Saving Time in the 48 states which now observe uniform Daylight Saving Time. In addition, for Class II stations located west of the dominant station on a U.S. Class I-A clear channel, the Commission is proposing to permit presunrise operation to begin at the time of sunrise at the dominant station, without regard to the 6:00 a.m. restriction. In this latter case, only U.S. stations are involved, and agreement with Canada is not required.

Supreme Court CATV Rulings Expected Shortly

The U.S. Supreme Court has heard arguments on two CATV cases. In a case involving systems in San Diego, California, the Court of Appeals had held that the FCC had no jurisdiction over CATV systems generally (see July 1967 Bulletin). Although the case as presented to the Supreme Court was to some extent limited in scope, the opinion of the high court may well settle the question of Commission jurisdiction over CATV systems.

The second case involves the liability of a CATV system for the carriage of copyrighted program material (see July 1966 Bulletin). In this case, the Court of Appeals had held that CATV systems were fully liable for payment for all copyrighted material.

The Supreme Court is expected to hand down decisions in both cases before its summer recess.

Commission Acts on CATV Microwave Assignments

In two related actions, the Commission has established a new frequency band for CATV common-carrier microwave service, and it has proposed new microwave frequency assignments for links between CATV studios and head-ends and for CATV remote-pickup use.

In the common-carrier action, the Commission has adopted an order requiring all future common-carrier microwave service for CATV systems to be provided only in the 10.7-11.7 GHz band. Existing CATV common-carrier operations in the 3.7-4.2 GHz and 5.925-6.425 GHz bands may continue until February 1, 1971.

The proposed link and remote-pickup facilities would be permitted in the 12.7-12.95 GHz band already used for CAR service. The proposal notes that the Commission has "already found that the public interest is served by encouraging CATV systems to act as additional outlets for community expression."

The Commission order was far from unanimous -- the seven Commissioners had five separate opinions, some concurring in and some dissenting from the action.

Broadcasters Authorized to Rebroadcast Standard Time Signals

The Naval Observatory and the National Bureau of Standards have authorized broadcast stations to rebroadcast their standard time signals without the necessity of obtaining any further permission from the Commission. A number of conditions are attached to the permission, the principal ones being that the time signals must be obtained by direct radio reception from the originating station, they must not be associated with any sort of commercial continuity, and credit must be given to the Naval Observatory or the National Bureau of Standards as the source of the time signal.

Detailed instructions concerning the conditions attached to the use of these time signals may be obtained from the Commission; ask for Commission Notice 68-207.

Short Circuits

The deadline for FM SCA monitors has been extended to January 1, 1969. . . Low-power "translators" in the ITFS band have been authorized in New York City. . .The Commission has proposed that power-output meters of television transmitters be calibrated at 80%, 100%, and 110% of full power. . .Low-power broadcast auxiliary operation in the 942-952 MHz band has been authorized (see November 1967 Bulletin). . .The Commission has endorsed pending legislation which would bring manufacturers of devices capable of producing RFI under direct Commission jurisdiction -- presently only equipment users are covered by the Communications Act.

Howard T. Head. . .in Washington

NEW AMPEREX ELECTRO-OPTICAL PLANT, SLATERSVILLE, RHODE ISLAND

The Amperex Plumbicon camera tube is broadcasting's most accepted pickup device for live colorcasts. In fact, by year-end, 80% of all live color broadcasts will originate with Plumbicon-equipped color cameras.

To meet the ever-increasing demand for this device, a new manufacturing facility has been built and is in production in Rhode Island.

This new Amperex facility is more than just the world's most modern electro-optical production plant. Here, some of the world's most advanced research and development is conducted on TV pickup devices, image intensifiers and other light sensitive components. As the Plumbicon camera tube is the measure of our past success, so it is also the direction of our future.

If you would like to know more about our new electro-optical facility or about the products produced here, write to: Product Manager, Electro-Optical Devices Division, Amperex Electronic Corporation, Slatersville, R.I. 02876.

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TOMORROW'S THINKING IN TODAY'S PRODUCTS

Circle Item 11 on Tech Data Card

Care and Handling of Magnetic Tape

by Charles H. Dodson*—

Don't overlook the care of this basic element of tape-recording systems.

Possibly the most overlooked aspect of the broadcast engineer's daily routine concerns the magnetic tape which he uses to record program material and play back prerecorded programs. While he is constantly concerned with the maintenance and operation of broadcast hardware, little serious thought is given to the proper care and handling of the magnetic tape that plays such a vital role in today's broadcasting. Proper care is essential to the long life and continued high quality of the tape, and is an important preventive step toward assuring maximum performance from the recorders. Good tape-care habits should be applied to both video tape and audio tape.

Magnetic tape ranges in width from 0.15 inch to 2 inches, with a tolerance of less than .004 inch. Other widths are available for special applications. The total thickness ranges from less than 0.0005 inch to more than 0.0019 inch, the length from 150 feet to 7200 feet.

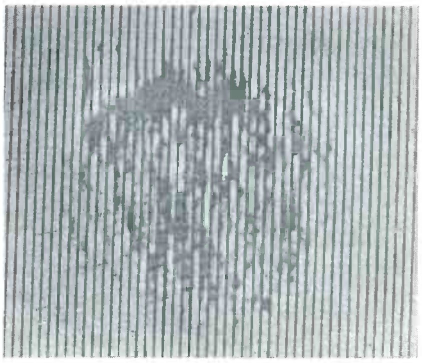
Magnetic tape consists of three principal elements—base material, binder, and oxide. The base material provides a means to hold the iron oxide and move it past the heads of the recorder in a controlled manner. It must magnetically insulate one layer of oxide coating from the next to prevent print-through. It must have enough strength to maintain resilience and be pliable enough to provide tape-to-head contact.

Polyester and acetate are the most common base materials. Generally, polyester has the best characteristics for most video, and many audio, applications. It has strength, long life, and relative stability in varying conditions and environments. Acetate, frequently used in less demanding audio applications, does not possess the stability and durability required for broadcast-quality recording. However, acetate is less expensive, and it does not stretch as much as polyester.

The binder joins the oxide to the base material. It must provide even dispersion of the oxide particles and confine them within a thin layer. It also must provide an efficient adhesion of the oxide coating to the backing material and an effective cohesion of the magnetic particles to each other.

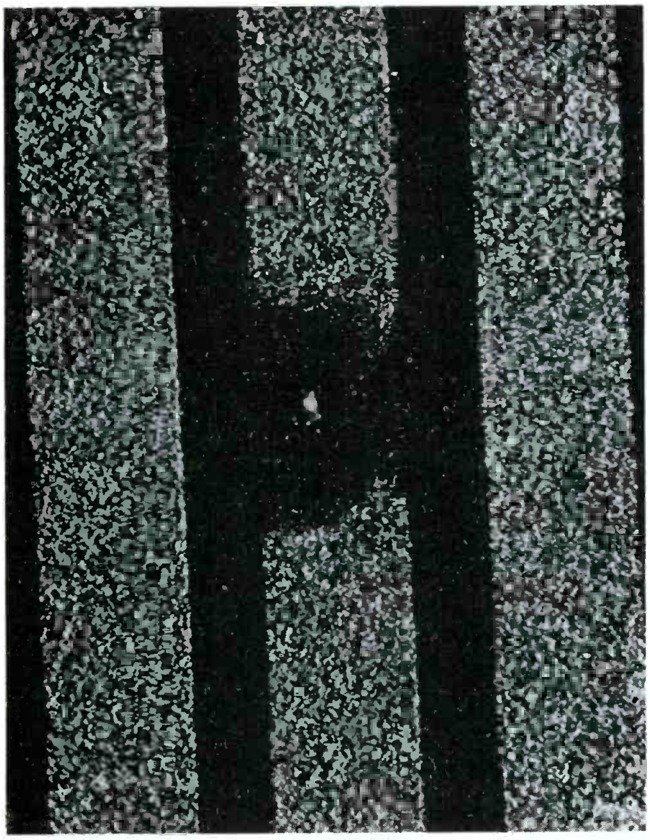
The oxide particle is the heart of any magnetic tape. In virtually all precision tapes, the oxide used is gamma ferric oxide in a cigar-shaped particle approximately 0.1 micron (about 0.000004 inch) thick and 0.7 micron long. These particles are suspended in the binder in much the same manner as almonds are held in a chocolate bar.

An example of how not to store magnetic tape. Stacking reels on top of others can bend the flanges and may damage the tape edges. Always store magnetic tape in boxes set on edge.

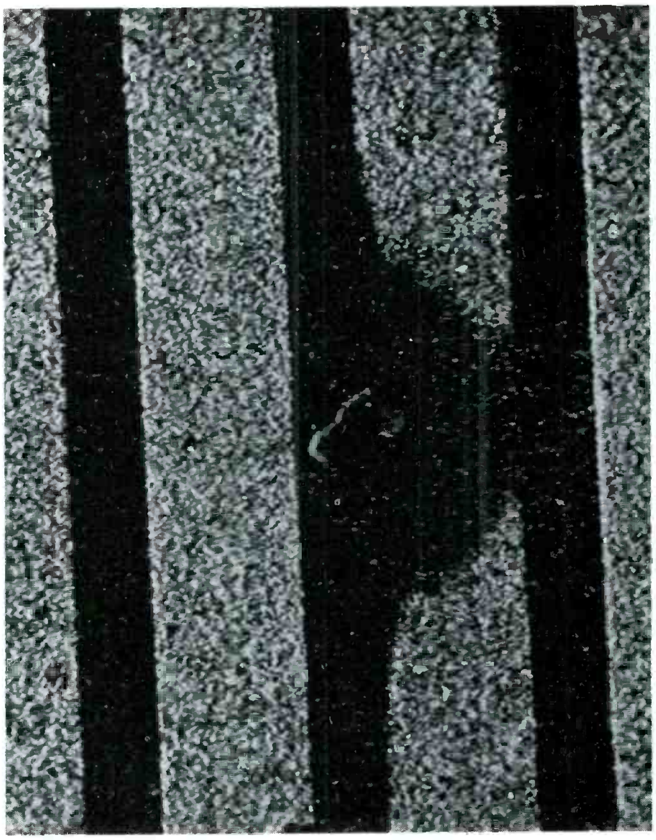


A fingerprint has caused the dropout burst on this section of video tape.

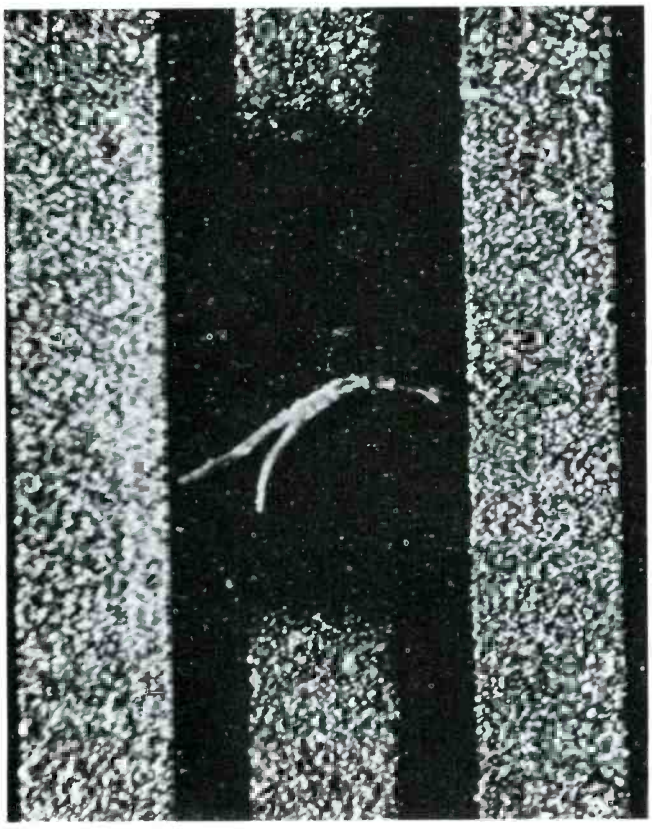
*Video and Audio Product Manager, Magnetic Tape Division, Ampex Corp.



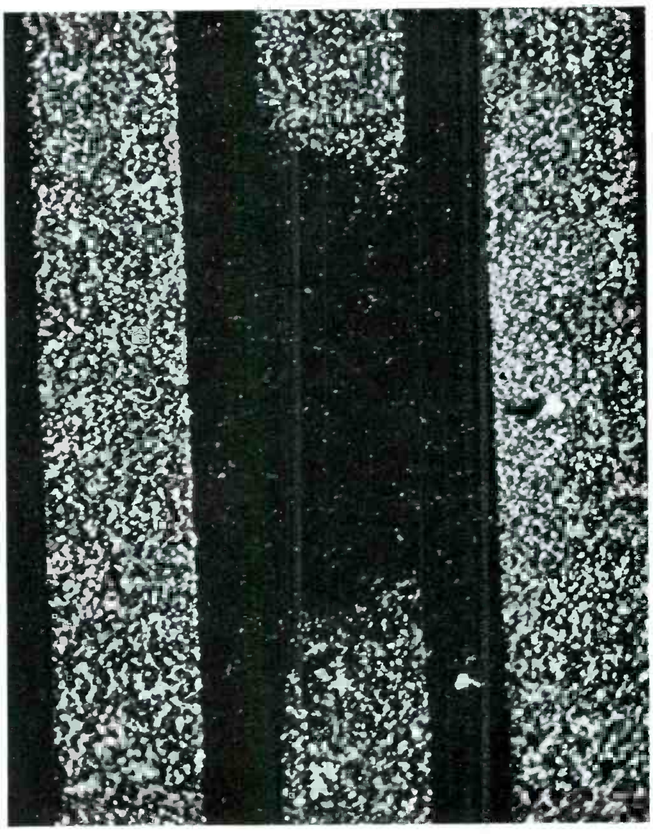
A typical nodule (a small mass of mineral substance) has caused the dropout seen on this section of magnetic tape.



Redeposited oxide caused this dropout. Frequent cleaning of the tape recorder reduces the number of these defects.



Some foreign particle, possibly a human hair, landed on this section of magnetic tape and caused this dropout.



The object which caused this loss of signal is no longer present; the damage is known as a temporary dropout.

Video Tape

In video-tape recording, the frequency range required for good recording is from a few hundred Hertz to over 10 MHz. To record such a range of frequencies, a high head-to-tape speed is necessary. Normally this is made possible by placing video heads in a drum and rotating the drum at high speed. The combination of tape movement and head rotation results in a writing speed (relative tape-to-head speed) in the range of 1000 inches per second or greater. The heads mounted on the rotary drum protrude approximately 3 to 4 mils. As the drum rotates, each head digs into the tape about 2 mils in order to maintain intimate tape-to-head contact. As the high-speed head digs into the tape, it places extreme stress on it. In addition to the stress resulting from this penetration, tremendous point-contact temperatures are generated at the heads. Heat is one of the worst enemies of tape and shortens its life.

In video recording, the heads sweep across the tape at such a high rate of speed that if the tape is lifted from the head by a surface defect, there is a relatively long period of time before the head and tape come together again. To record one complete frame, or picture, requires a ½″ x 2″ segment of tape. Many tape surface defects, such as scratches, are longitudinal in nature, and they will appear as standing patterns on the monitor, affecting numerous scanning lines. Foreign particles, however, may affect only a portion of one line. The duration of the dropout may be as short as 5 microseconds. Some new video tapes require burnishing or "running in"—running the tape through the machine two or three times to minimize the effect of surface imperfections.

Since broadcast video tape is two inches wide, it appears more rugged than narrower tapes. As a result, many operators tend to abuse it. Nevertheless, video tape is susceptible to physical damage, and it should be protected. Guiding is most critical, and edge damage to any degree, however slight, will affect the recording performance. Damage to the edge is apt to cause variations in the output levels of the audio and control tracks. The tape itself should be handled as little as possible, except at its beginning and end, and should not touch any surface that might contaminate it. The operating area should be as dust-free as possible to minimize head wear and temporary dropouts. Transports should be cleaned thoroughly on a regular basis, and an active, effective cleaning program should be maintained in the tape library as well as in the recording studio.

Audio Tape

Because audio recording requires much less information to be recorded and, consequently, a narrower bandpass, and since the playback requirements are generally not as critical, audio-tape specifications are not as demanding as those for video tape. However, for maximum tape life and performance, audio tape should be handled as though it were precision tape. It should be stored in a cool, dry place, and the recorder should be kept clean at all times.

General Handling and Storage

When tape is exposed to excessive fluctuations of temperature and humidity, the base material expands or contracts, setting up tremendous internal stresses in the tape pack. This stress can induce distortion beyond the elastic limits of the base material, which, in turn, renders the tape useless for its intended purpose.

Tapes normally do not wear out. They usually are retired from service because of damage caused by improper handling and storage. Although it is impractical, if all tapes could be stored in a controlled environment, theoretically they could last indefinitely. In the absence of a perfect environment, tape is best stored in an area that is kept within "people conditions": 70° F and 50% relative humidity.

Because of the magnetic properties of tape, a storage area away from any stray magnetic fields should be chosen. A steady DC field, a permanent magnet, or a concentrated AC field should be avoided when choosing a storage area. Tape should not be located immediately adjacent to such strong magnetic sources as transformers or power supplies.

The most familiar but least appreciated component of audio and video tape is the reel. Everyone takes the reel for granted and fails to realize the significant contribution a properly designed reel makes to proper system performance. Reels for audio and video tape are designed specially for their particular applications. Good handling practice dictates that reels of tape should always be handled by the hub and never by the flanges. Handling by the flanges could squeeze them into the tape pack and cause edge damage.

When audio or video recorders are threaded, care should be taken that the tape is placed carefully around the recording heads. Enough slack should be given so that there is no unnecessary pull or stretching of the tape as it is threaded. The tape should remain completely threaded while on the machine and should be rewound to one reel or the other before it is removed.

Of great importance to tape life is the operating condition of the recorder itself. All areas that come in contact with the magnetic tape should be kept clean and free of any foreign material. The recording heads should be checked and cleaned periodically, and they should be replaced at the end of their recommended life. Trying to get a few extra hours out of the recording heads may necessitate the purchase of several new reels of tape.

When magnetic tape is shipped by the manufacturer, it is placed in a container designed to minimize temperature changes and keep out dust and humidity. Usually this shipping case makes the best and safest container for storing the tape. Tape should be in one of two places — either on the transport, ready to work, or stored in the original shipping container. It should never be lying unprotected on a table or shelf.

Although proper care and handling ,takes a little more time and effort, it pays off with extended tape life and top-quality recording. ▲

Color-Signal Timing and Phasing

*by Roy K. Brandt**

Timing and phasing of color signals become important considerations when a television station has more than one color source.

In the past, the matter of signal timing was often overlooked, and until a station could boast of more than one color source, phasing was of no concern. Sophisticated switching systems and effects equipment in use today require timed and phased input signals. Servo instability in modern video tape recorders and color break-up of taped video are often indications of poorly timed and phased input signals.

Signal timing has to do with three reference points: leading edge of sync, leading edge of blanking, and beginning of burst (50% level). In Fig. 1A, two noncomposite signals, A and B, are considered. If the leading edges of blanking are coincident, the signals are said to be timed—in other words, they occur at the same time. If the signals are composite (Fig. 1B), the leading edges of sync are made to coincide.

Signal phasing refers to the instantaneous phase of the back-porch color burst. If the burst signals are in phase (Fig. 2), the signals are said to be phased. A phase error may be expressed as a timing error of small magnitude according to the following equation:

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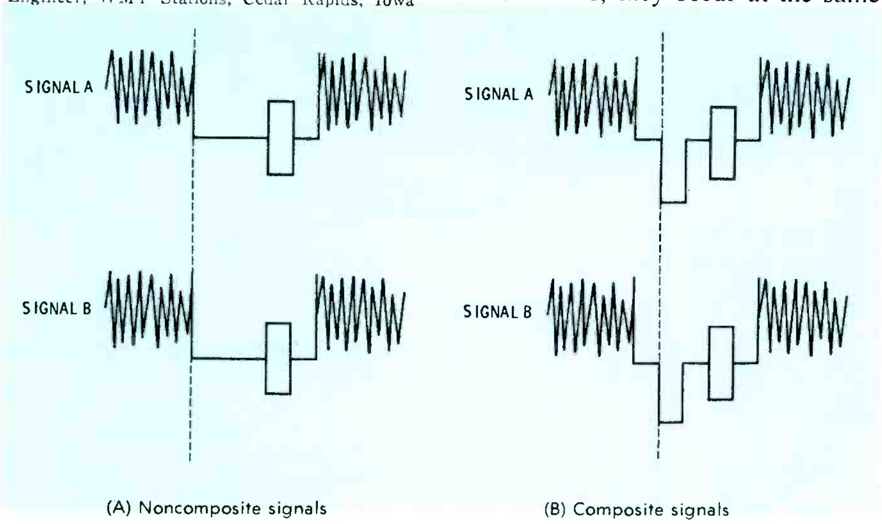

(A) Noncomposite signals (B) Composite signals

Fig. 1. The meaning of timing of video signals is illustrated by waveforms.

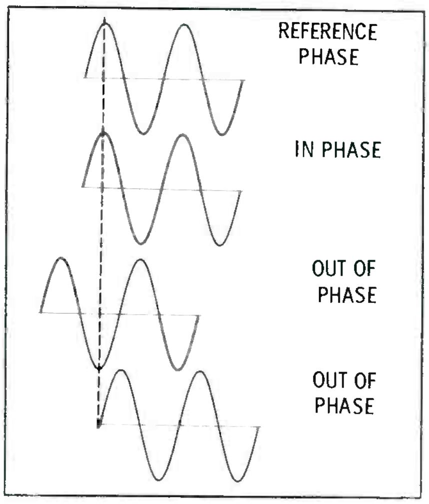

Fig. 2. In-phase, out-of-phase signals.

$$t = \frac{\theta \times 10^3}{360 \times 3.58}$$

where,

t is timing error in nsec, and

θ is the phase error.

Thus, 45° of phase error in the burst signal is the equivalent of a timing error of 35 nsec.

A practical method for checking timing and phasing is shown in Fig. 3. Here, a simple 2-input switcher feeds a scope and vectorscope. The scope is triggered externally by a reference sync pulse, and the vectorscope is referenced to an external subcarrier. If the input is switched from one camera to the other, the timing error will be seen as horizontal movement of pulses on the scope screen. The signal that moves farther to the right is used as the reference, and the other signal is delayed to occur at the same point. Only two inputs are shown, but the principle applies to any number of synchronous inputs. A phasing error from one input to another will be seen as a change in the direction of the vector on the vectorscope and is measured in degrees. Some phasing methods will be discussed later.

Fig. 4 shows how it is possible for two signals to be mistimed although they are apparently in phase at the vectorscope. Here, signal A leads B by 0.28 μsec—the duration of one cycle of 3.58-MHz burst. Switching between the inputs will show a 0.28-μsec horizontal shift on the scope, but the vectorscope will show the signals to be in phase. For this reason, the signals should always be timed before attempting to phase them.

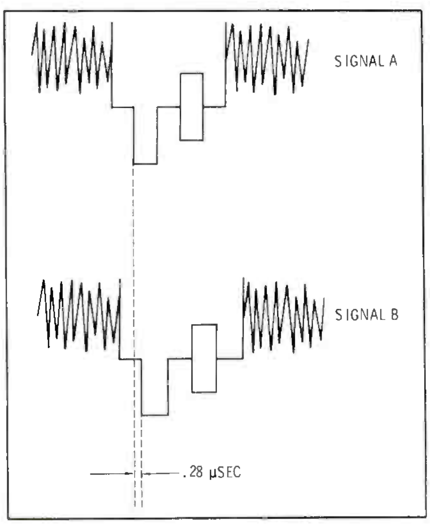

Fig. 4. Untimed bursts appear in phase.

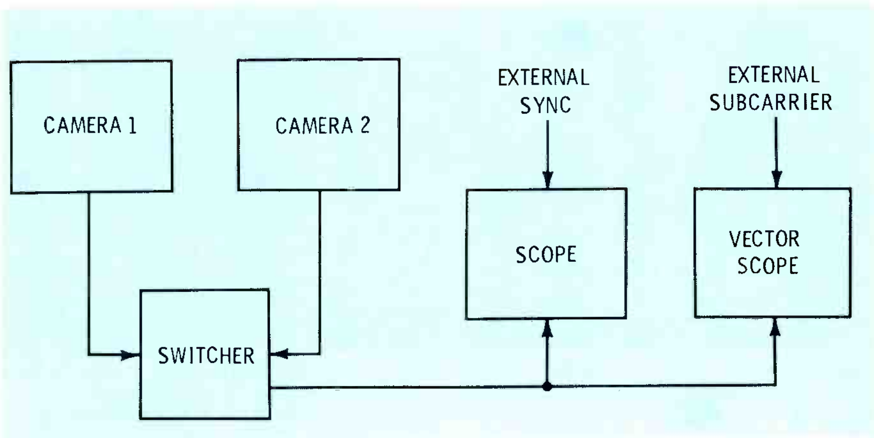

Fig. 3. Equipment setup for determining if video inputs are timed and phased.

Delay Lines

The video cables from the cameras to the switcher should not vary in length more than 50 feet, due to response variations caused by different lengths of unequalized cable. Timing errors not exceeding 0.08 μsec may be corrected in the video cable (Fig. 5). This allows a maximum variation in cable length of about 50 feet. (As a close approximation, 1000 feet of 75-ohm coax represents a delay of 1.5 μsec.) It is good practice to correct larger timing errors in the pulse lines. Lumped delays available for this use usually consist of tapped sections which may be strapped for equivalent delays of 50, 100, 150 feet, etc. As an example, assume that a delay of 1 μsec is needed. This is considered a fairly large timing error, but it could be encountered when mating equipment made by different manufacturers, or of different vintages. Instead of inserting 666 feet of cable in the line, it is standard practice to use a delay line in conjunction with a short length of cable, as shown in Fig. 6. The delay line is strapped for 650 feet, and the remaining 16 feet is made up of coax.

In the foregoing example, the signal source requires three input pulses—sync, blanking, and burst flag. Therefore, three delays are needed. If several large delays are encountered, it may be desirable to use noncomposite video inputs to the switcher so that only the individual blanking and burst-flag pulses need to be timed. This arrangement is shown in Fig. 7. Use of noncomposite input signals requires that the single delay inserted in the sync line to the sync adder be cut for proper front-porch width at the switcher output. Do not adjust the sync generator for front-porch width at the switcher output. Follow the manufacturer's instructions to adjust for proper front porch at the generator, and then vary the sync-cable delay for proper front-porch width at the switcher output. The same holds true for breezeway width. Always adjust the generator for proper breezeway at the generator, then time the burst-flag cable to each signal source for proper breezeway at the switcher output.

Sometimes, different amounts of delay are required in the blanking, sync, and burst-flag cables. Remem-

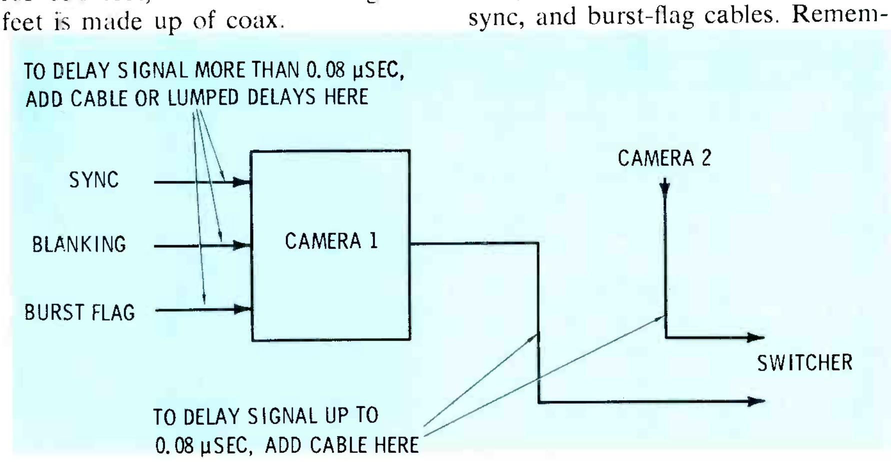

Fig. 5. Compensation for small delay differences can be obtained with cables.

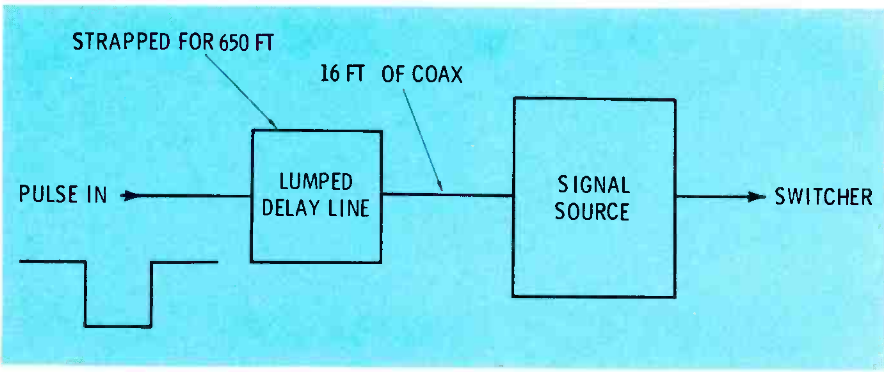

Fig. 6. Longer delays require lumped delay lines trimmed with cable lengths.

ber that the desired result is to be able to switch between signal inputs with the setup shown in Fig. 3, with no horizontal shift at three points on the scope trace—leading edge of blanking, leading edge of sync, and beginning of burst.

Delays are not required in the subcarrier cables if the individual color sources are equipped with 360° phasing controls. With the setup in Fig. 3, switch up either camera and adjust the vectorscope to some reference point. Then switch up the other camera and adjust its 360° phasing control until the vector returns to the reference point. If one color source does not have a phasing control, it is used as the reference and the other sources are adjusted to match it. If two or more sources are without phasing controls, one must be selected as the reference, and the subcarrier cables to the others must be cut to length until the phase of all nonadjustable color sources is the same. The phase delay of 75-ohm coax is approximately 2° per foot at 3.58 MHz.

Color Tape Recording

If full automatic operation of color tape recorders is used, the setup in Fig. 3 also may be used for adjusting the sync-timing and color-phasing controls on the tape machine. While switching between the color source selected as the reference and the tape recorder, adjust the recorder timing and phasing controls for no horizontal shift of the leading edge of sync and for no displacement of the vector on the vectorscope.

A few words about processor setup in tape machines are appropriate at this point: Pulse widths should be standard for all broadcast signals, whether they are live or taped. All too often, sync generators are carefully set up, and then the tape processors are adjusted to clean up the off-tape signal, with the result that the taped signal no longer conforms to the original standards. This is not to imply that the tape-machine instruction books should not be followed. Just don't get carried away when it comes to cleaning up the off-tape signal in the processor. Breezeway width is critical when making tape dubs, but this, too, is sometimes altered in the processor. Measure the pulse durations of your off-tape signals. They might not be what you think they are.

To adjust the sync generator for remote signal or genlock operation from a remote or network signal, switch the generator to remote operation, and, using the setup in Fig. 3, switch between the reference-signal source and the remote signal. The generator timing control is adjusted for no scope shift on the leading edge of sync. The generator phasing control is adjusted for no vector rotation as seen on the vectorscope.

Black-Signal Timing

For many of us, the technical description of a black signal has been "sync only". All switchers should have provision to "go to black," and the easy way to provide for this has been simply to feed sync to one of the switcher inputs and call it "black." This practice will no longer work. The black signal must also have fixed setup and color burst for proper operation of effects equipment and the making of color tapes —and this black signal must be timed and phased the same as any other synchronous color source. Your switcher may have a color black-signal source incorporated in its design. If not, consideration should be given to the purchase of one. The required inputs are sync, blanking, burst flag, and 3.58-MHz subcarrier. It is standard practice to record a color-bar signal on the leader of color tapes, and good practice dictates that this signal, too, should be timed and phased.

Summary

Remember—a signal must be timed before it can be phased.

Small timing errors of the order of 0.08 μsec may be corrected in the video cables. Larger errors should be corrected in the pulse cables. Lumped delays may be used for pulses, but not for video.

All synchronous signals to the switcher, including black, must be timed and phased if the switcher has fading or effects provisions, or if the switcher is used for making color tapes.

The result of a carefully timed and phased switching system is a composite video signal at the switcher output that does not shift in timing or phase when switching operations are performed. ▲

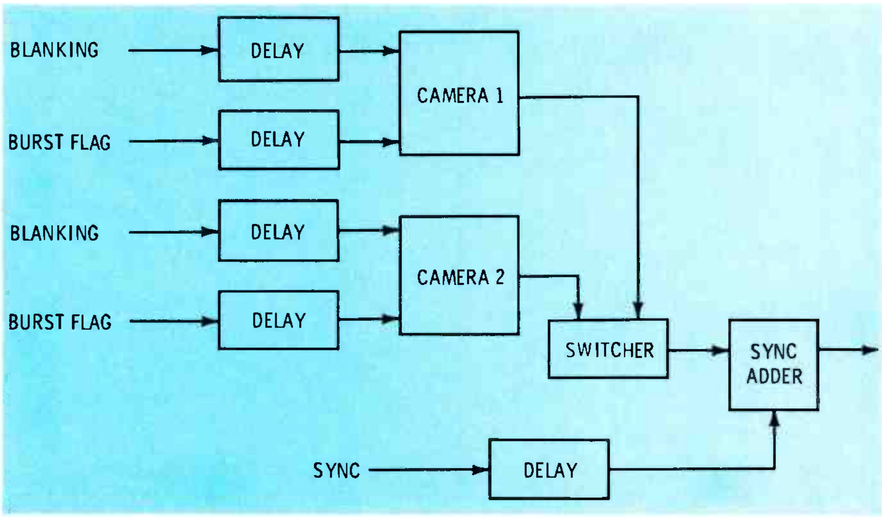

Fig. 7. Using noncomposite signals makes only two delays per source necessary.

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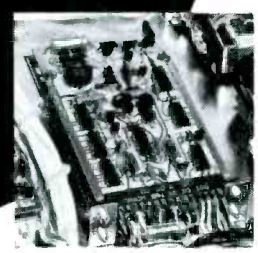

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DIGITAL CIRCUITS FOR BROADCASTERS

By J. L. Smith*

Bistable circuits and circuit combinations used in digital applications are examined.

Part 3 of four parts.

Digital circuits and logic techniques are being used more and more frequently in broadcast equipment. The reliability and increased capability of these circuits are filling a need for the more sophisticated requirements of modern broadcast stations. This is the third in a series of articles presented to introduce the broadcast engineer to the techniques used and to provide an understanding of the basics involved.

Part 1 covered binary numbers, fundamental binary arithmetic, and the concept of digital data. Part 2 discussed the basic logic functions of AND, OR, and NOT. Combination of the basic logic functions in simple applications was shown, and the rudiments of elementary Boolean algebra were touched briefly. In this third part of the series, the various forms of the bistable circuit will be presented, and bistable circuit combinations to form registers, counters, storage, etc., will be explained.

Bistable Circuit

The AND, OR, and NOT circuits function without "memory." For example, in the case of the AND circuit, a logic 1 output is obtained only as long as *all* the inputs are at logic 1 simultaneously. If each input becomes logic 1 sequentially and not simultaneously, the output remains at logic 0.

There is a need for a circuit which can be placed in one of two stable states and will remain in that state until it is intentionally placed in the opposite state. Such a circuit is known as a bistable. The output of a bistable is a voltage which is near zero in one state (logic 0) and at a nonzero voltage in the opposite state (logic 1). The bistable, in effect, provides a "memory." That is, the circuit will "remember" the last state in which it has been placed.

One method of implementing the bistable is shown in Fig. 1. Assume that the state of the bistable is such that Q2 is not conducting. The collector of Q2 will be near the supply potential because little current flows through R4. Transistor Q1 is conducting heavily because its base is biased by the potential applied through the R5-R6 divider from the collector of Q2. The collector of Q1 is near zero volts because Q1 is conducting heavily. This results in a low potential at the base of Q2, and Q2 is thereby held in the nonconducting state. Thus the bistable remains in this state with output Q at logic 1.

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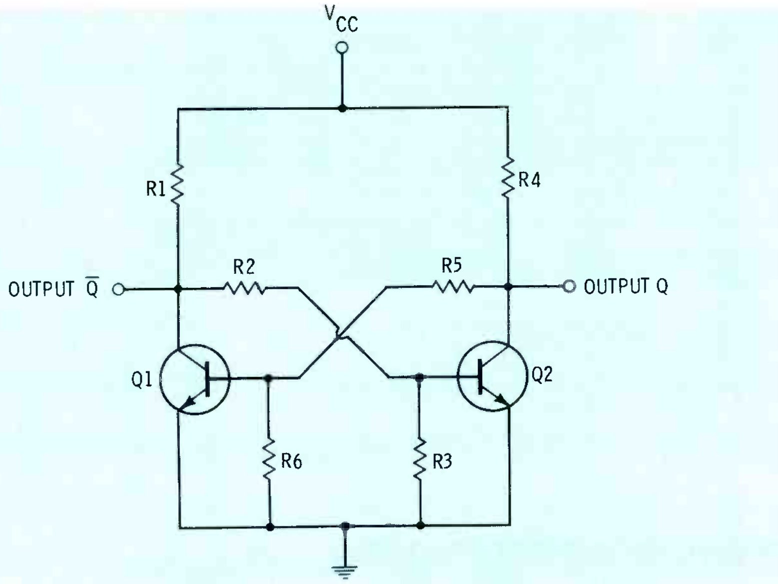


Fig. 1. The bistable circuit has two stable states; outputs are complements.

The bistable will change states if the collector of Q2 is temporarily shorted so that the collector voltage falls to zero. The bias is thus removed from Q1, that transistor goes out of conduction, and its collector voltage rises. Transistor Q2 then is biased to the conducting state by voltage divider R2-R3. The collector of Q2 remains at low potential even after the short is removed, because the bias holds it in the conducting state.

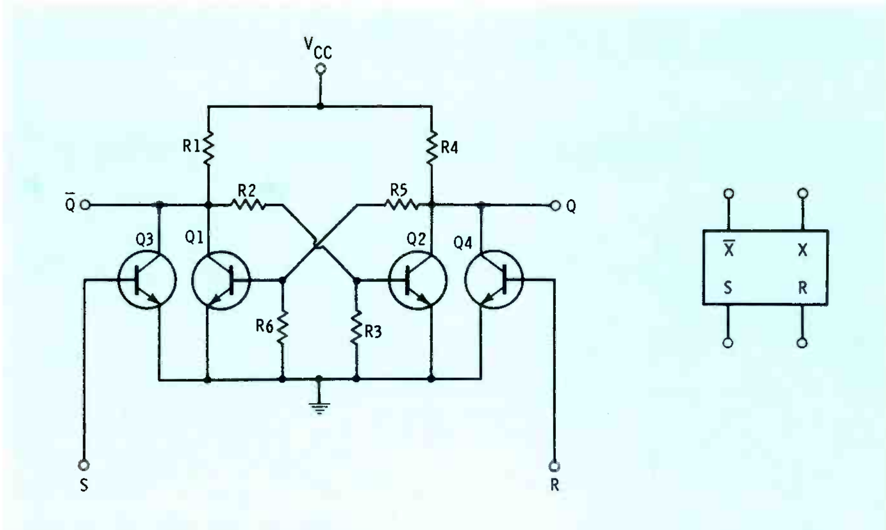
If it is desired to reverse the state of the bistable again, the collector of Q1 is shorted temporarily, and the Q1 collector voltage remains low even after the short is removed. The collector of Q1 goes to logic 0. Notice that the two outputs are complements of each other: when one is logic 1, the other is logic 0. The output of the bistable is Q and $\overline{Q}$.

RS Flip-Flop

An RS flip-flop, sometimes called a set-reset flip-flop, is a circuit with two inputs and two outputs. The outputs are complements of each other. The name of the circuit is derived from the fact that the bistable circuit can be set by applying a positive pulse to the S input; this action causes output Q to be logic 1. The circuit will remain in this state until it is reset by applying a pulse to the R input; output Q then becomes logic 0. Output $\overline{Q}$ is the complement of Q and is always in the state opposite that of Q.

The electrical operation of the cicuit is shown by Fig. 2A. It may be noticed that the basic bistable circuit has been supplemented by adding Q3 and Q4. If a positive pulse is applied to the S input, Q3 shorts the collector of Q1, causing output Q to go to logic 1. A positive pulse at the R input causes Q4 to short the collector of Q2, and output Q goes to logic 0. Meanwhile, $\overline{Q}$ is always the complement of Q.

The RS flip-flop is used in registers and memory circuits when it is desired to retain a record of a binary bit. Fig. 2B shows the schematic representation of the RS flip-flop.



(A) Circuit (B) Symbol

Fig. 2. State of RS flip-flop may be reversed by pulses applied to inputs.

JK Flip-Flop

A JK flip-flop (sometimes called a toggle) is another version of the flip-flop and is a circuit with a single input and two outputs. As in the RS flip-flop, the outputs are complements of each other. Each time the circuit receives an input pulse, it reverses its state; that is, if the output is logic 1, it will go to logic 0, and vice versa. The circuit remains in one state until another pulse is received.

Fig. 3 shows both the general schematic representation and an elementary circuit of the JK flip-flop. Fig. 3A shows that the JK is made up of the basic bistable circuit to which have been added diodes D1 and D2 to provide the input point, T. Assume the bistable is in the state in which Q2 is conducting (logic 0). A positive pulse at input T causes a current through diode D1 and turns on Q1. This action reverses the state of the bistable, and Q2 is caused to go out of conduction. If a second pulse is applied to input T, diode D2 then passes the current to the base of Q2, and the bistable reverses its state again when Q2 goes into conduction.

The JK flip-flop is used in counting and divider circuits because it provides one complete output pulse for each two input pulses.

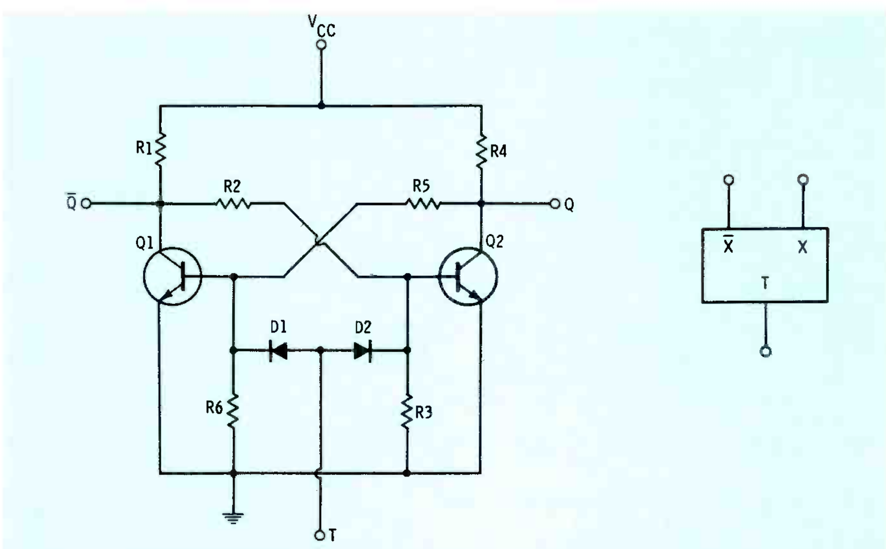
Resettable JK Flip-Flop

There are often requirements for JK-type flip-flops which can be set and reset to known states before they are used for a particular purpose. These flip-flops are known as resettable JK flip-flops and consist of the basic bistable circuit, plus those additions made for the RS circuits, plus those additions made for the JK circuit. In commercial production, most flip-flops are of the resettable JK type.

One-Shot

The one-shot is a circuit with a single input and two outputs which are complements. An input pulse causes the circuit to reverse its state, remain in the reversed state for a given period of time, then automatically return to its original state. The one-shot is not a bistable device, but instead is a monostable circuit; that is, it has only one state to which it will always return.

Fig. 4A shows that the basic bistable circuit has been modified by using AC coupling between the collector of Q2 and the base of Q1. Transistor Q1 normally is biased on by current through R6; Q2 is then normally off. When an input pulse is applied to T, Q3 shorts the collector of Q2, and the collector side of C1 goes to near ground potential. The current through R6 which normally biases Q1 is now diverted to charge C1, and as a result Q1 goes to the nonconducting state. Transistor Q2 goes to the conducting state because of the bias furnished from the collector of Q1. This condition (with Q1 in the nonconduction state) continues until C1 charges sufficiently through R6 to allow enough current to be available to the base of Q1 for it



(A) Circuit (B) Symbol

Fig. 3. JK flip-flop reverses state each time pulse is applied to input T.

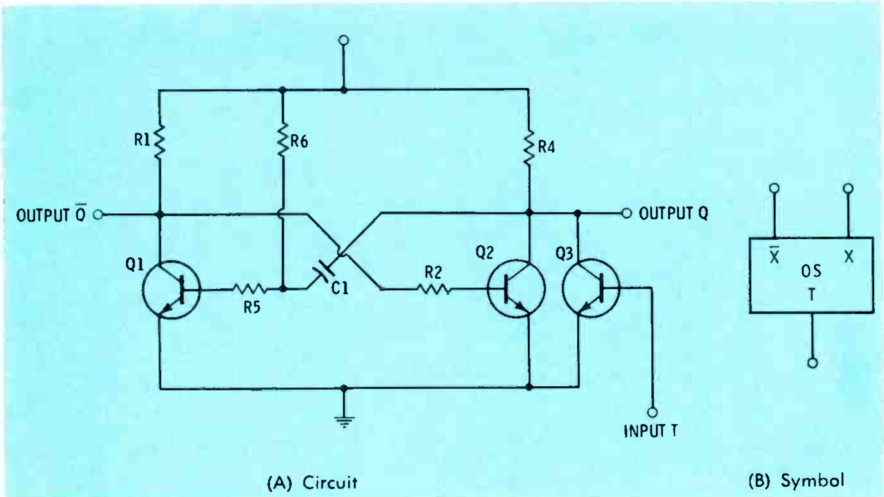


Fig. 4. One-shot results when AC coupling is added to one side of bistable.

to start conducting again. When this happens, Q2 goes out of conduction, and the circuit is in its normal state.

The duration of the output pulse of the one-shot is determined by the time constant of R6 and C1. The output pulse will always have the same width even though the input triggering pulses vary in width. The one-shot is used to "stretch" pulses, to provide a means of obtaining a delayed pulse, to make constant-area pulses, etc.

Multivibrator

The multivibrator is a form of oscillator circuit. It takes no input signal but does have a pair of complementary outputs which are continuously reversing at a rate determined by the circuit components.

Fig. 5 demonstrates that the multivibrator is simply a self-triggered one-shot which is formed by AC-coupling both bases of a bistable circuit. The operation of the circuit is the same as the operation of the one-shot except that the time constant is now effective in both states. If the time constant of R5 and C2 is made equal to that of R6 and C1, the output at Q will be a nearly symmetrical square wave whose period is determined by this common time constant. If, however, the time constants are made unequal, then the output at Q will be a series of pulses whose repetition rate is governed by the sum of the time constants, and whose pulse width is determined by the R5-C2 time constant. The output at $\overline{Q}$ will always be the complement of Q: If Q is a square wave, $\overline{Q}$ will be a square wave 180° out of phase with Q; if the output at Q is a series of narrow positive pulses, the output at $\overline{Q}$ will be a series of wide positive pulses which occur during the off time of Q.

The multivibrator is used wherever it is desired to have a string of pulses or square waves. The output repetition rate of the circuit may be synchronized to an external source if desired.

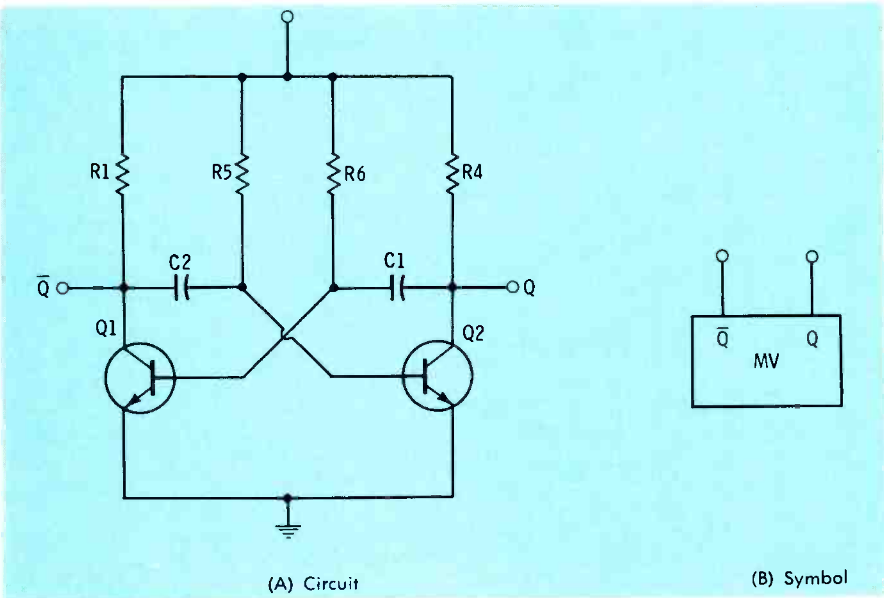


Fig. 5. The multivibrator is formed when the bistable circuit is AC coupled.

Schmitt Trigger

The Schmitt trigger is a circuit with one input and one output; the output level changes sharply when the input level exceeds a preset value.

Fig. 6 shows that the Schmitt trigger consists basically of a two-stage direct-coupled amplifier with a common emitter resistor. With no input, Q1 is cut off and Q2 is conducting. The current through Q2 and R3 develops a positive voltage across R3; this voltage holds Q1 in the nonconducting state. If, however, the base voltage of Q1 is made to exceed the emitter voltage, a regenerative action occurs to cause Q1 to go into full conduction and Q2 to go out of conduction. This action occurs as follows: The voltage across R3 sets the threshold point at which Q1 conducts. This voltage is caused by current through Q2. When the input threshold at Q1 is barely exceeded, the collector voltage of Q1 starts to drop, and as a result Q2 draws less current. When Q2 draws less current, the voltage across R3 decreases, which causes a larger base-to-emitter potential difference for Q1. Thus, once the threshold is exceeded the circuit changes state very quickly. When the input voltage is lowered, the circuit returns to the original state; however, the threshold for this reversal is not exactly the same voltage that caused the original level change-over. The circuit is said to have "hysteresis," in that once the circuit changes state, the input must be lowered below the change-over level to cause the circuit to revert to its original state.

The Schmitt trigger is used to detect levels, *i.e.* to determine when a voltage exceeds a predetermined value. Also, the circuit may be used to restore pulses which have been deteriorated by transmission, etc.

Timing Diagram

The timing diagram for a logic circuit is usually just as helpful as the schematic. The timing diagram is a pictorial display of how logic levels vary as a function of time. It is helpful in obtaining an overall view of the proper operation of a circuit and is very useful in trouble-shooting digital circuits. Fig. 7 shows the timing diagram for several functions of the logic variables A and B. The variables are shown in the top two rows of the diagram. Variable A is represented as a stream of serial data composed of alternate 1's and 0's. Variable B is also a string of serial data, but it is composed of alternate groups of two 1's and two 0's.

If A and B are combined in an AND gate, whose output may be called C, the results are found on the third row. Output C is logic 1 when A *and* B are logic 1. The result then is a repetition of data composed of one 1 and three 0's. The complement of C is shown in the fourth row; notice that C is logic 0 when C is logic 1, and vice versa.

If A and B are combined in an OR gate, the result shown on the fifth row as D=A+B is obtained; its complement is shown in the sixth row.

As an example of the use of the timing diagram, assume that it is desired to determine if the AND gate of C=AB is working properly. An oscilloscope will indicate the correct presence of A and also the presence of B. The technician must know, however, what to expect at C. The results viewed at C on the oscilloscope may be compared with the timing diagram for correctness.

Digital Frequency Dividers

The JK flip-flop is a natural divide-by-two circuit because the JK changes state each time a pulse reaches its input; that is, the first pulse sets the JK at logic 1, and the second pulse resets it at logic 0. Thus, two input pulses are required to provide one output pulse. The variables A and B of Fig. 7 were chosen to illustrate this division. If A is considered to be the input to the JK, then B will be the output. Notice that there are only half as many pulses in B for a given time segment as there are in A. Consequently, the frequency of B is half that of A.

If two JK's are connected in cascade (*i.e.,* with the output of the first driving the input of the second), the result will be a divide-by-four circuit because the first JK will divide by two and the second JK will divide the result again by two. When JK flip-flops are connected in cascade, the result is a division of 2^n, where n is the number of cascaded stages. Thus three JK's in cascade divide by eight because $2^3=8$. See Fig. 8 for the timing diagram of such a divider.

It is quite straightforward to make dividers with divisors which

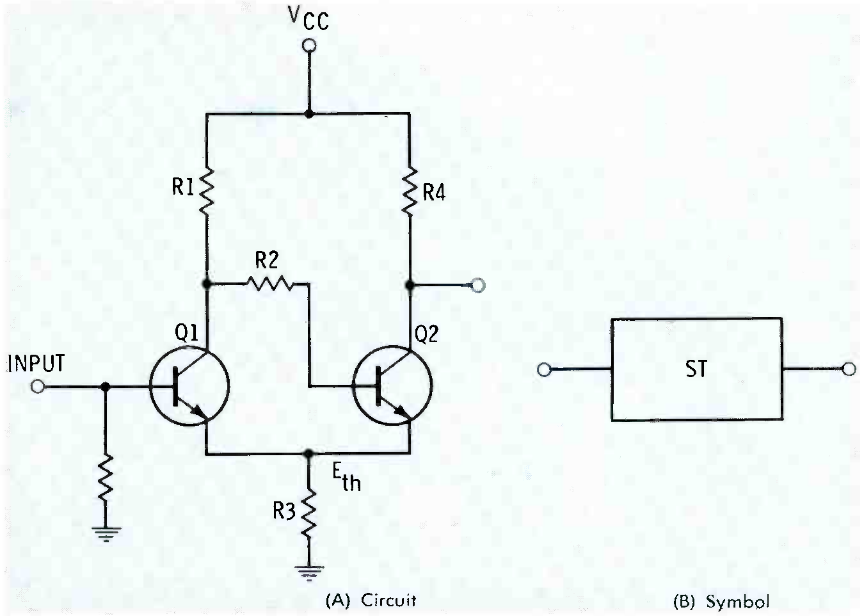


Fig. 6. Schmitt trigger; output changes sharply when input exceeds threshold.

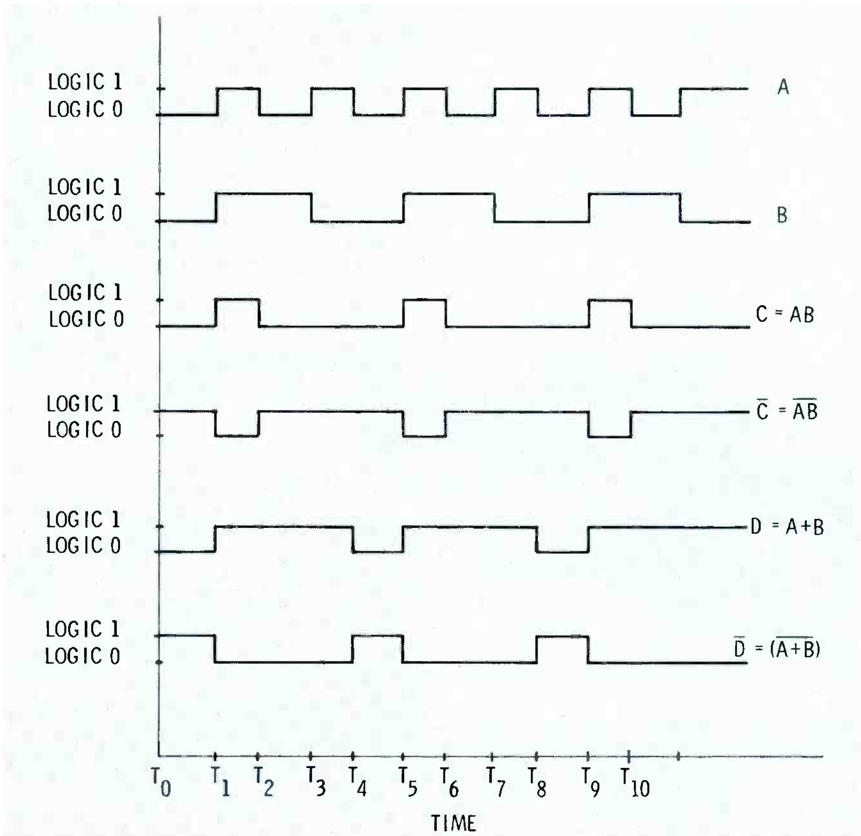
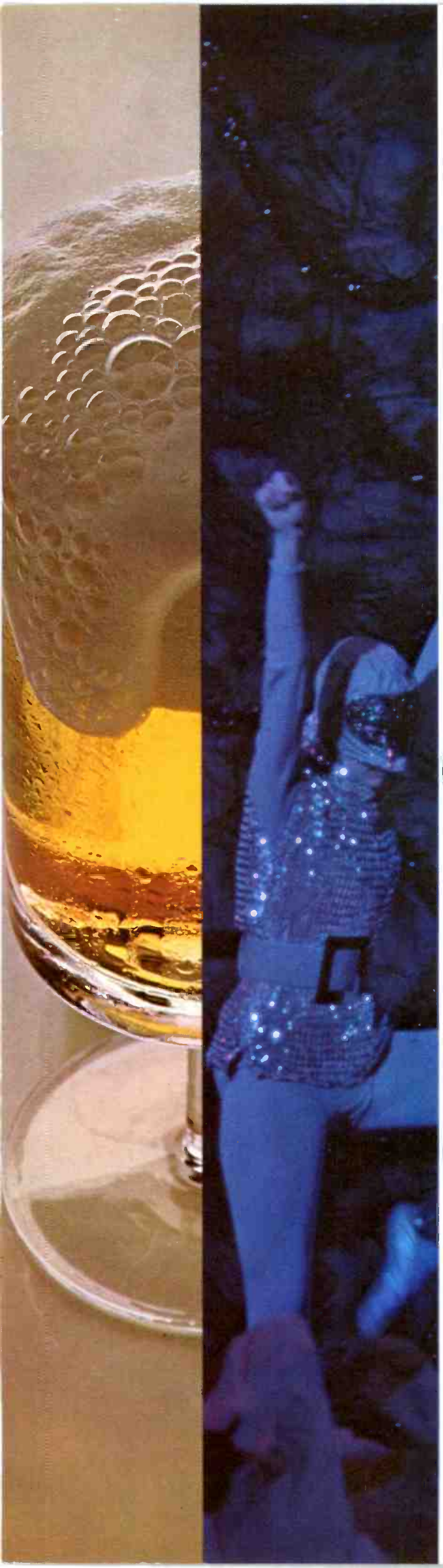


Fig. 7. Timing diagram shows relations of logic functions varying with time.



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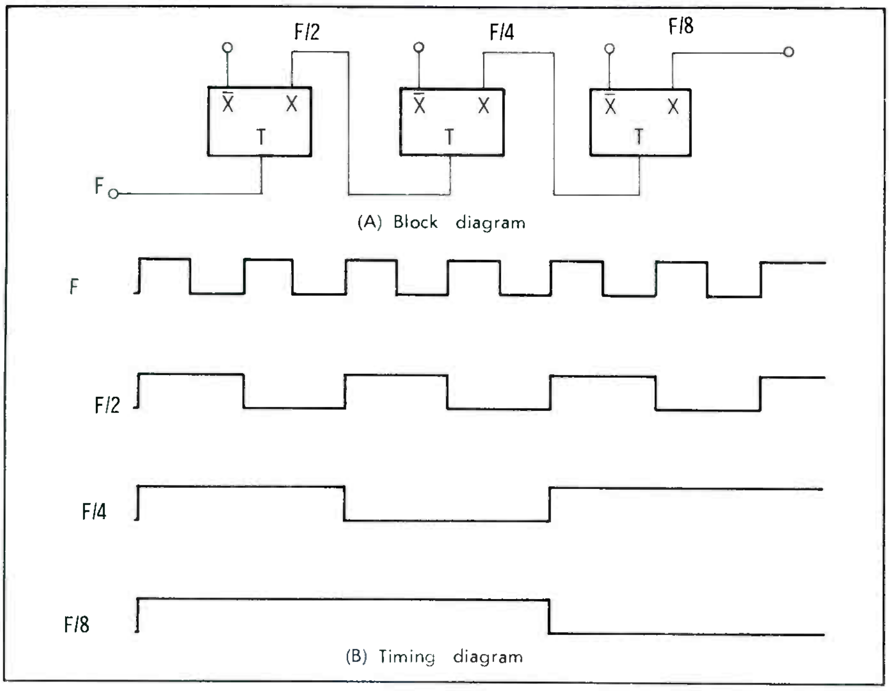


Fig. 8. Block diagram and timing diagram, divide-by-eight frequency divider.

are integral powers of 2. It is a little more complicated, however, if one desires to divide by ten, for example, because three JK's divide by 8 and four JK's divide by 16. It is necessary, then, to use four JK's and monitor the count accumulated. When the count reaches ten, it is necessary to provide an output pulse and reset all the JK's to start at zero again. This is done as shown by the logic diagram of Fig. 9.

A divide-by-ten circuit will, in effect, count from 0 through 9. The binary numbers are represented along with their decimal counterparts in Fig. 9A. (Notice that the action described by the table of Fig. 9A requires the circuit arrangement to be such that each stage changes state only when the preceding one changes from logic 1 to logic 0.) The letters A, B, C, and D refer to the JK's in Fig. 9B. (Note that the JK's are numbered from right to left so that their states, when tabulated, appear in the conventional order for binary numbers.) When all the JK's are in the logic-0 state, they hold the number zero. When A is logic 0, B is logic 1, C is logic 0, and D is logic 1, the flip-flops hold the number 5. The above reasoning can be extended to any number, 0 to 15.

To divide by 10, it is necessary to detect the number 9; for this number, A is logic 1, B is logic 0, C is logic 0, and D is logic 1. In other words, it is desired to obtain the Boolean expression

$$E = A\bar{B}\bar{C}D,$$

which reads "E is equal to A and not B and not C and D." The four-input AND gate is used to implement this function, as shown in the upper portion of Fig. 9B. Notice that the JK flip-flops provide directly the outputs for NOT B and NOT C. The $\bar{B}$ output is logic 1 when B is not logic 1.

Once the number 9 is detected, the AND-gate goes to logic 1. This logic 1 serves both as the output signal from the divide-by-10 and as a reset signal to set all the JK's back to logic 0 so that the count can begin again at zero and run through nine.

Notice that a one-shot is included between the output and the reset inputs to the flip-flops. The one-shot generates a fixed-length pulse so that the flip-flops are reset after the data pulse has fallen. This same principle of feedback is used to generate the output and reset circuitry of any other divisor as desired.

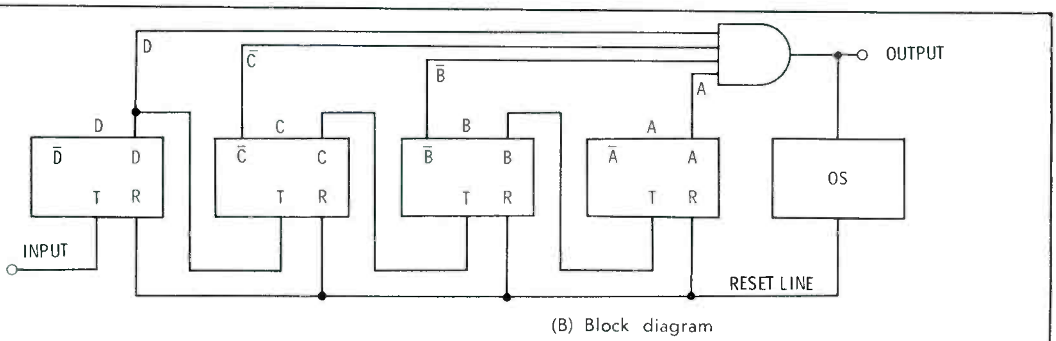
A unique feature of the digital frequency divider is that a frequency may be divided accurately, and no error will be incurred because the division has taken place. This is opposed to the method of obtaining a lower frequency be heterodyning, where the stability of the heterodyne oscillator directly affects the output frequency. For example, if it were desired to lower the frequency of a 100-MHz FM carrier signal so that it could be measured in the 1-MHz range, it is a simple matter to use two divide-by-10 circuits in cascade ($1/10 \times 1/10 = 1/100$), and it is not necessary to be concerned about the stability of a heterodyning oscillator.

Counters

A digital counter is constructed in much the same way as the frequency divider. In fact, the divide-by-10 circuit is indeed a counter, because it counts up to ten pulses and then gives an output and resets ready to repeat the procedure time and again. If a number of JK flip-

BINARY A B C D	DECIMAL
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9

(A) Binary-decimal equivalents



(B) Block diagram

Fig. 9. Circuit for dividing by 10 includes divide-by-two stages and logic for detecting binary equivalent of 9.

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flops are connected in cascade and started at binary zero, a burst of serial pulses at the input will leave the flip-flops in states such that they indicate in binary form the number of pulses impressed on the input. (Again note that each stage must change state only when the preceding one changes from logic 1 to logic 0.) This is a very useful means of determining frequency if the input to the counter is opened to an unknown frequency for a precisely controlled time. The positive half-cycles of the unknown frequency are counted, and the number of counts and the counting period thus establish the frequency.

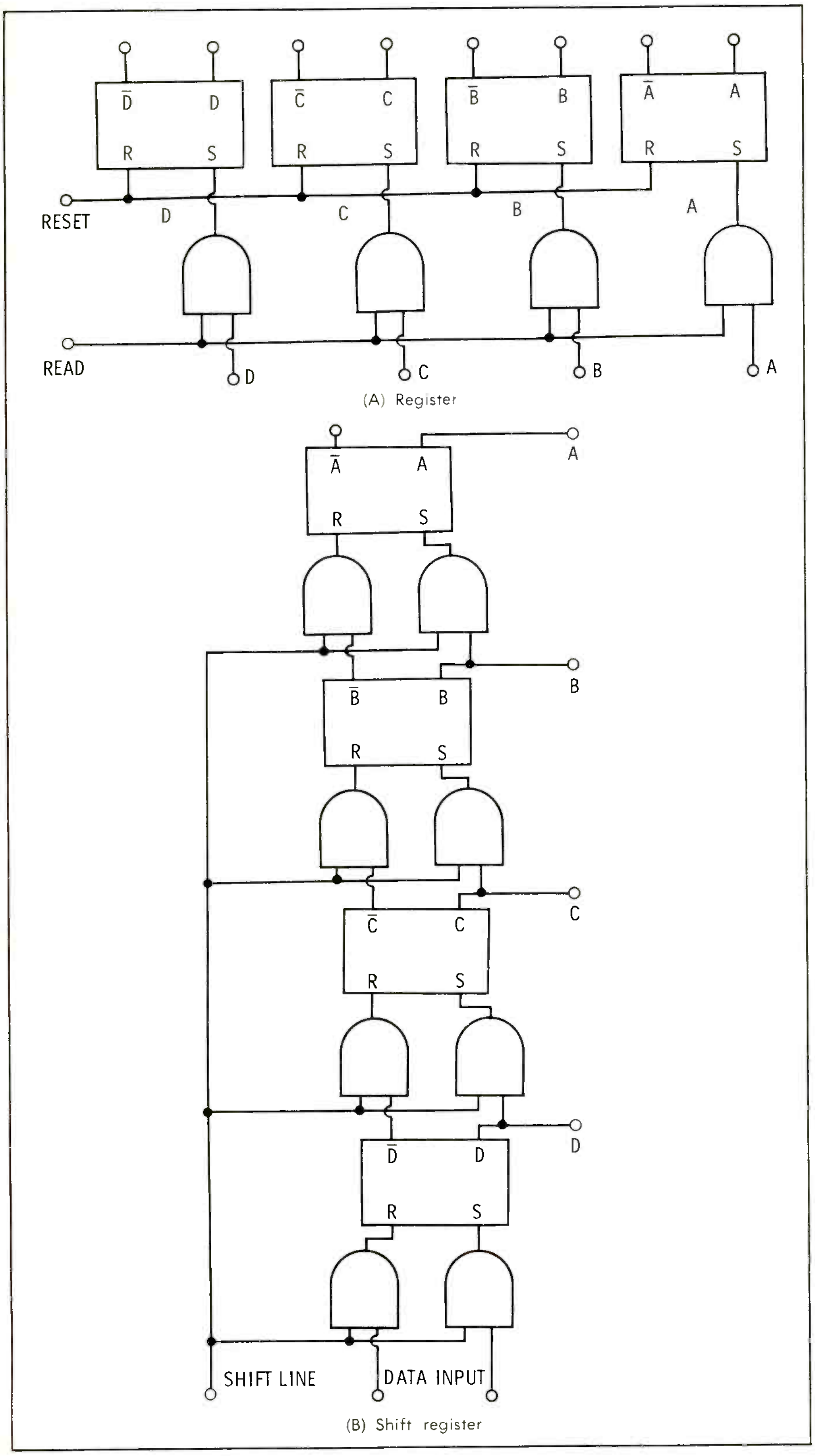


Fig. 10. Diagrams above show how flip-flops may be arranged to form registers.

If the complement side of the JK flip-flop is used to drive the next one, then the counter is known as a backward counter; that is, it starts at 1111 and counts down successively through 1110, 1101, 1100, etc. This type of counter is very useful when it is desired to determine the difference between an unknown frequency and an assigned frequency. The counter may be preloaded with the assigned frequency, and one count is subtracted for each cycle of the input frequency. The remainder, either positive or negative, left in the counter is the difference.

Registers

A register is a group of flip-flops arranged to store binary data. The register is sometimes called a buffer, particularly if the storage is for only a short time. Each of the flip-flops is set to either 1 or 0 depending on the data to be "registered."

Fig. 10A illustrates a method of loading the data into the register. The data appear on the input lines labeled A, B, C, and D, each of which is associated with one input of a two-input AND gate. These gates are called the read gates. All flip-flops are set to logic 0 by applying a pulse to the reset line.

When it is desired to load the data into the register, the read line is made logic 1, and the output of each read gate then will be logic 1 or 0 depending on the logic state existing at the other input to the gate. Thus the flip-flops are set to the logic-1 or logic-0 state, depending on the data to be registered. When the read line is returned to logic 0, the flip-flops hold their states even though inputs A, B, C, and D may change.

A special version of the register is the shift register, shown in Fig. 10B. The data are introduced to the register through the pair of AND gates at the bottom of the diagram. Each time the shift line is made logic 1, each RS flip-flop assumes the state of the flip-flop immediately below it. Assume all flip-flops are in the logic-0 state. Notice that two gates are employed between successive flip-flops so that the complement may be transferred if the information is logic 0. If logic

1 is presented to the input and the shift line is made logic 1, then RS flip-flop D will assume the logic-1 state. Outputs C, B, and A will not change because the preceding flip-flops were at logic 0. Let the input data return to logic 0 and the shift line again be made logic 1. This time flip-flop C changes to logic 1. Outputs B and A remain at logic 0, and D changes from logic 1 to logic 0. With the next shift pulse, flip-flop B will become logic 1 and all the others logic 0, etc. As successive shift pulses are applied, the single logic 1 originally applied to the input works its way along the register until it eventually works "out the other end." As a further example, using Fig. 10B, consider the case where four bits of serial data are to be registered. The data are presented serially at the register input, the shift line is made logic 1 four times (this is sometimes called "clocked four times"), and the data are stored in the shift register. The first bit is stored in flip-flop A and the last in flip-flop D.

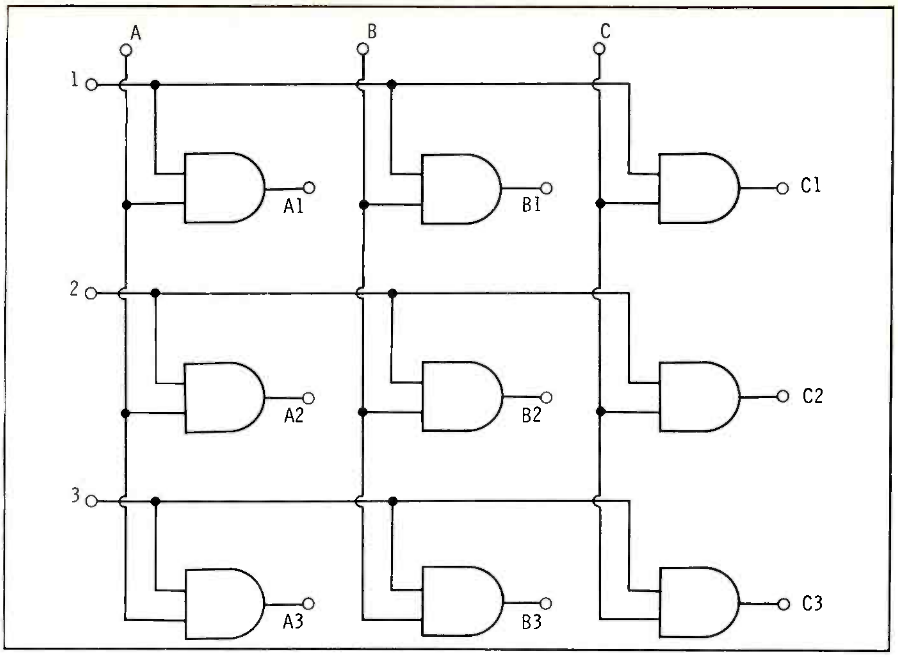


Fig. 11. Selector matrix has only one output for a given input combination.

Selector Matrix

A selector matrix provides a means of selecting a particular output from a choice of many. It can be understood best by referring to Fig. 11. A number of two-input AND gates are arranged in rows and columns. One input from each gate connects to an input line which runs vertically, and the other connects to an input line which runs horizontally. If one of the inputs which is designated by a letter is made logic 1 AND one of the inputs which is designated by a numeral also is made logic 1, then the output of one and only one of the AND gates will be logic 1. For example, if B is logic 1 and 2 is logic 1, the output of the gate labeled B2 will be logic 1, and none of the other outputs will be logic 1.

If the matrix of Fig. 11 represents a means of controlling program material from 9 sources, the desired source may be selected by placing logic 1 on one line designated by a letter and by placing logic 1 on another line designated by a numeral. The unique output which results may then be used as the controlling logic for a program source.

Comparators

A comparator is a device with multiple inputs and a single output. See Fig. 12. The inputs are in two groups—a reference group and an input group. An output is obtained only if the inputs are identical to the references.

The circuit is made up of a group of Exclusive OR gates followed by NOT's whose outputs combine in an AND gate. It will be recalled that the output of an Exclusive OR is logic 1 if its two inputs are different, and the output is logic 0 if the two inputs are the same. This is exactly opposite to what is needed for a comparator, so a NOT circuit is placed at the output of the Exclusive OR. The output of the NOT

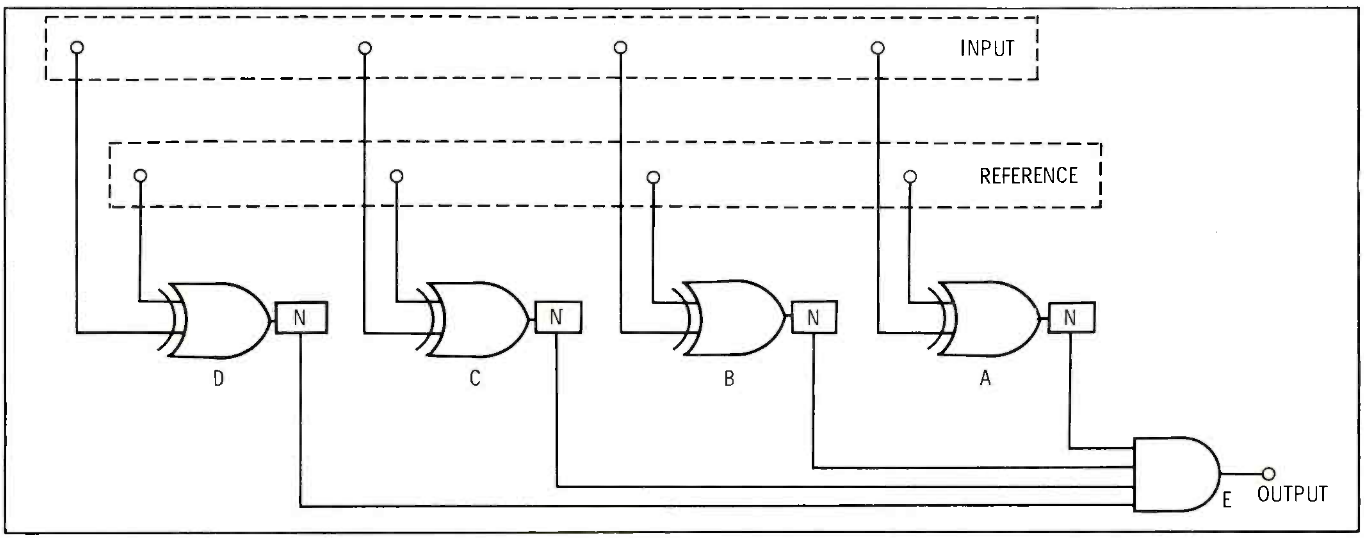


Fig. 12. A 4-bit comparator circuit; output is logic I only when data in input group match those in reference group.

is logic 1 when the inputs to the Exclusive OR are identical. The AND gate labeled E provides an output when *all* of its inputs are logic 1. If the data furnished to the comparator were changing with time, the occurrence of a certain combination of input data could be detected simply by placing these data on the reference inputs. Assume that it is desired to determine when the input data are 1001. The reference inputs to A and D would be made logic 1, and the reference inputs to gates B and C would be made logic 0. When the input data became this identical combination, all inputs to AND gate E would be logic 1, and its output would be logic 1.

In order to change the combination of comparison, it is only necessary to change the levels on the reference inputs to a new combination.

Serial/Parallel Converters

Sometimes it is necessary to convert parallel data to serial data, and vice versa. This process is accomplished easily by using a register to store the data, and then transferring the data out of the register in the desired manner.

Fig. 13 shows a means of converting parallel data to serial data. First of all, the RS flip-flops are all reset to logic 0 by applying a pulse to the reset line. The data are present simultaneously and continuously on all inputs (A, B, and C). When a pulse is presented on the load line, these data are transferred through the AND gates labeled LC, LB, and LA to set the corresponding flip-flops. If a particular input is logic 1, the flip-flop is set to logic 1. If the input is logic 0, the flip-flop remains in the 0 state, The data are now stored in the flip-flops and will remain until removed either by resetting or by "clocking-out."

"Clocking out" is the process of removing the data from storage in a serial fashion. A clock signal is a series of pulses that occur at the data rate. Each time a clock pulse occurs, the gates marked TC, $T\overline{C}$, TB, $T\overline{B}$, and 00 are enabled. If a logic 1 is present on the other input to one of these gates, its output will be logic 1 for the duration of the clock pulse. For example, if the loading of the data had left flip-flop A in the logic 1 state, then the first clock pulse would cause the output of gate 00 to be logic 1.

If the output of flip-flop B is connected to the set input of flip-flop A and the complement of B (B) is fed to the reset input of A, then each time a clock pulse is applied, the data contained in B will be transferred to A. The similar connection of C to B provides a data transfer from C to B with each clock pulse. The data can be visualized as being "pushed" out of storage from left to right with each clock pulse; thus the data appear at the output in serial form at a data rate determined by the clock rate.

Consider the case in which the inputs represent the number 101. Inputs A and C are logic 1, and input B is logic 0. The reset pulse resets all flip-flops to logic 0, and the load pulse places flip-flops A and C at logic 1 while flip-flop B remains at logic 0. The first clock pulse causes the output line to be logic 1 for the duration of the pulse because flip-flop A was logic 1. Flip-flop A, however, becomes logic 0 because B was 0. Also, flip-flop B becomes logic 1 because C was logic 1. Lastly, flip-flop C becomes logic 0 because the clock pulse resets it through OR gate RC. The second clock pulse leaves the output at logic 0 for the duration of the pulse because flip-flop A was 0. Now, however, A assumes a 1 state from B, which assumes a 0 state from C. The third clock pulse

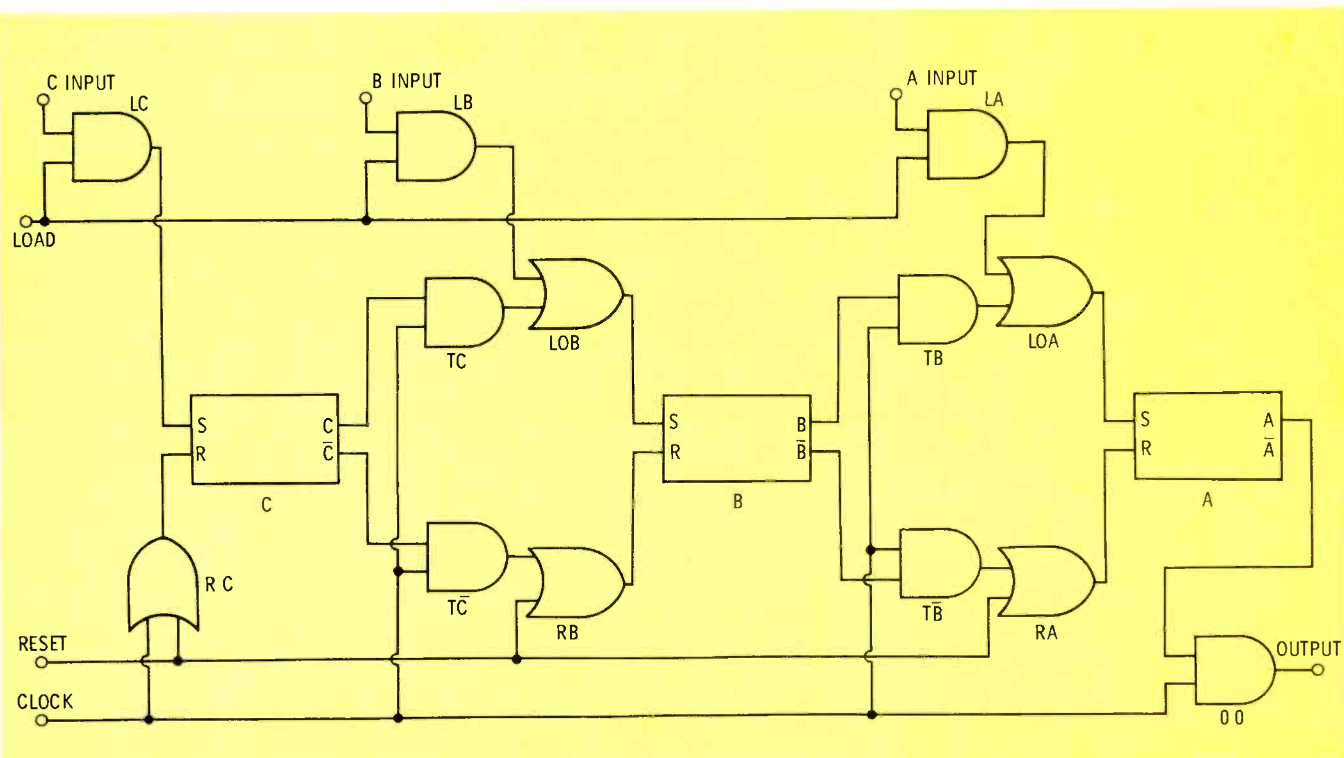


Fig. 13. RS flip-flops, AND gates, and OR gates may be connected as shown here to form a parallel-to-serial converter.

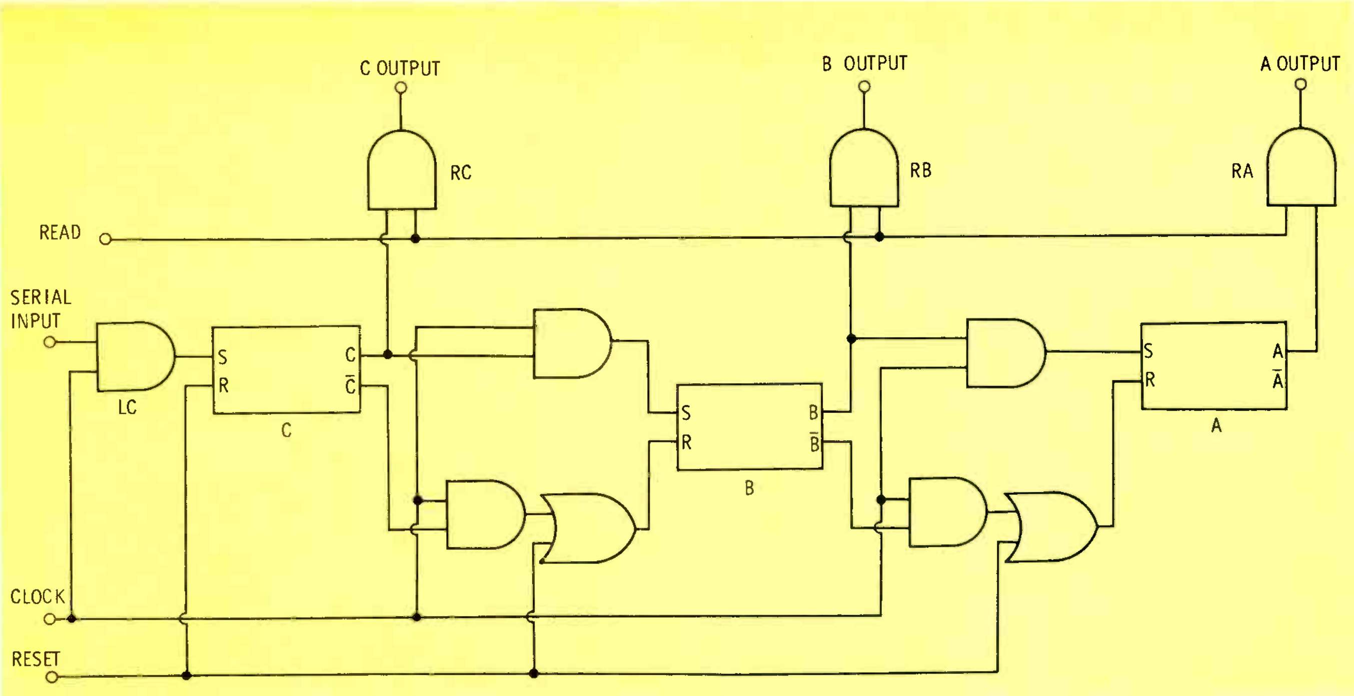


Fig. 14. In this arrangement, RS flip-flops, AND gates, and OR gates are used to form a serial-to-parallel converter.

causes the output to go to logic 1 for the duration of the pulse because A was at logic 1. Successive clock pulses will leave the output at logic 0 because all of the flip-flops are now at logic 0 and will remain so until set with new data.

Fig. 14 represents a method for converting serial data to parallel data. The principles are the same as for the previous converter, but the inverse function is performed. Data presented at the input shown on the left are synchronous with the clock; *i.e.*, the data are present during the same time interval as the clock pulse.

All flip-flops are reset to logic 0 by the reset line. The first data bit is transferred to flip-flop C through the AND gate labeled LC by the action of the first clock pulse. The second clock pulse transfers this data bit from flip-flop C to flip-flop B and brings the second data bit into C. The third clock pulse moves the data in B into A, moves that in C into B, and brings the third data bit into C. All flip-flops now have been loaded from serial data by "pushing the data into the storage from left to right." The output consists of the three lines at the top of the diagram labeled A, B, and C; at the appropriate time, a pulse is placed on the read line, which enables AND gates RA, RB, and RC and provides the data at the output simultaneously in parallel form.

Analog-to-Digital Converters

Many monitoring and control functions require that an analog voltage or current be converted to a digital form so that it can interface with other digital circuits. The process of making this conversion is rather involved, and in those cases where high accuracy is desired, it involves decoding and feedback circuits which are beyond the scope of this series. However, it is important for the reader to know of the existence of these converters and to understand the basic principle involved. For that reason, a simple shaft encoder will be described briefly, and some of the terminology will be presented.

The analog-to-digital converter is most often referred to as an "A-to-D" converter. It is sometimes called an encoder. The A-to-D converter divides the analog level into discrete units and then denotes how many of these units are present. The minimum value to which the analog level is divided is called the quantum level. It is not possible to have resolution to a value less than the quantum level.

Fig. 15 illustrates a method for digitizing a shaft position by making use of what is called an encoder wheel. The operation is understood easily if it can be imagined that three brushes make contact with the three concentric tracks on the wheel, and that the darkened areas are conductors at a logic-1 potential and the other areas are insulating material. The output of this encoder is a three-bit parallel data word. Since there are 2^3, or 8, possible states, then the quantum level for this device is 360°/8, or 45°.

It is possible to determine the shaft location only to within a 45° segment. The accuracy can be increased by adding bits through utilization of additional rings on the outer perimeter of the wheel. A little imagination shows that, as the wheel rotates in a counterclockwise direction, the output will change from its illustrated 000 progressively through 001, 010, 011, etc., through 111.

This example illustrates a fundamental of encoders: The analog

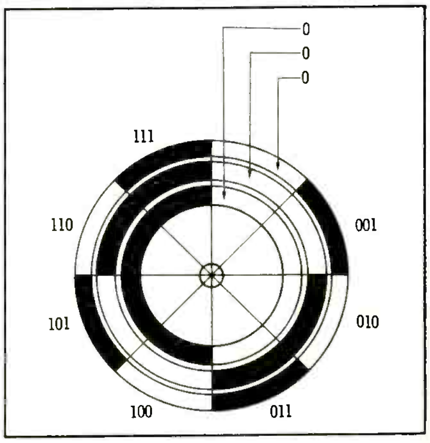


Fig. 15. Simplified diagram represents a shaft encoder with 45° resolution.

range is divided in half (notice the innermost ring), and it is determined in which half the analog lies. Once this is determined, it is further determined which half of the half contains the unknown, then which half of the quarter, etc.

Digital-to-Analog Converters

The digital-to-analog converter (called a D-to-A converter) performs the inverse function of the analog-to-digital converter. It is somewhat simpler than its counterpart, although its complexity is a function of the accuracy desired.

A simple D-to-A converter (also known as a decoder) is made up simply of summing resistors, as shown in Fig. 16. In this case, the logic-1 level is 12 volts, and logic 0 is 0 volts. It is noticed that if A is logic 1, there will be 1 ma of current through the 100-ohm summing resistor, and 0.1 volt will be developed at the output. If B is made logic 1, a current of 2 ma is established in the B branch, and an output of 0.2 volt results. If both A and B are logic 1, then approximately the sum of 2 + 1, or 3 ma, of current is established in the summing resistor, and a 0.3-volt output is developed. The accuracy of such a converter is determined by the ratio of resistor values.

This circuit will convert digital numbers 0 through 7 to analog decimal outputs in increments of 0.1 volt. Additional bits can be weighted similarly for greater coverage.

Next month, the concluding part of this series will deal with the systems aspects of digital circuits and with various types of logic. ▲

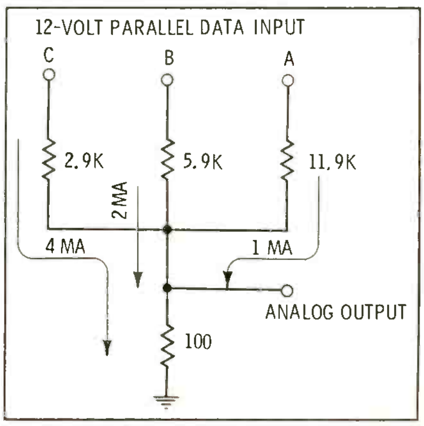
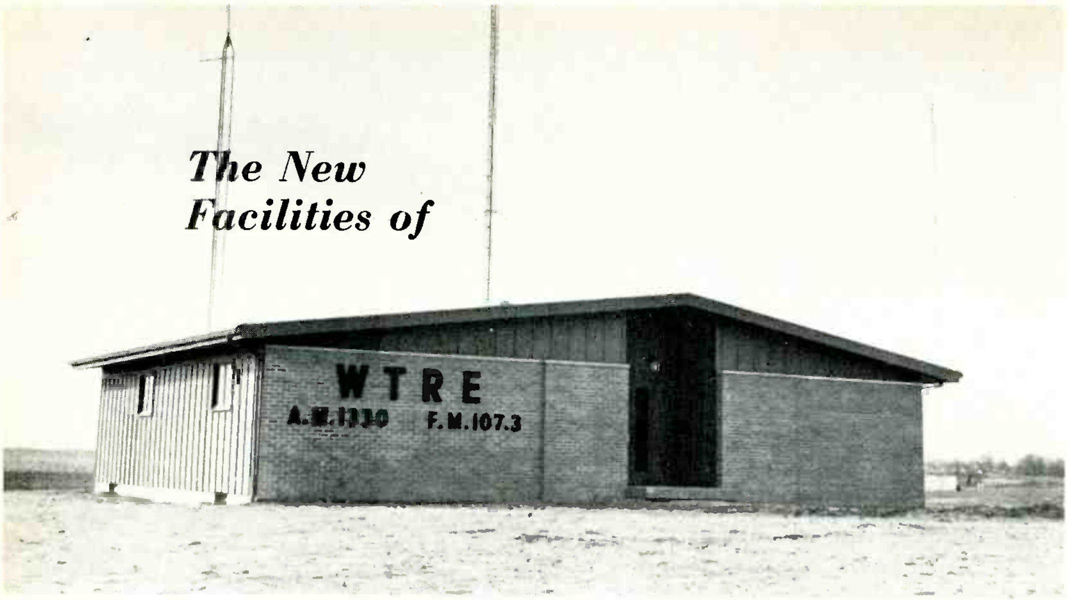


Fig. 16. Simple digital-to-analog converter consists of summing resistors.

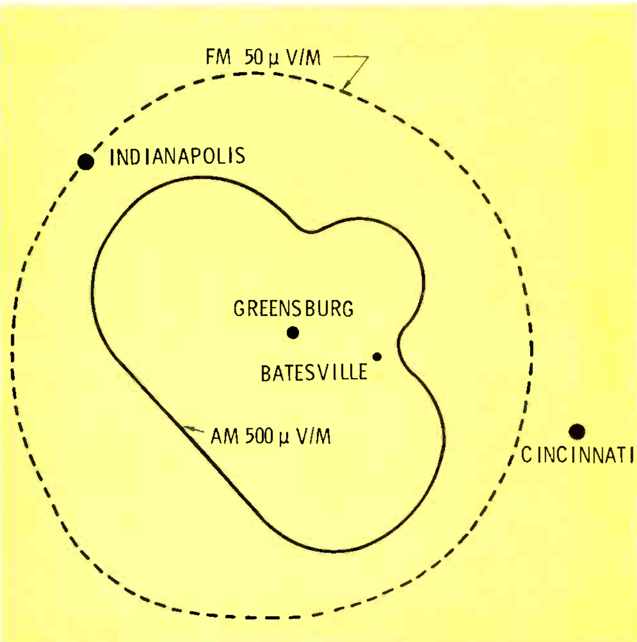
The New Facilities of

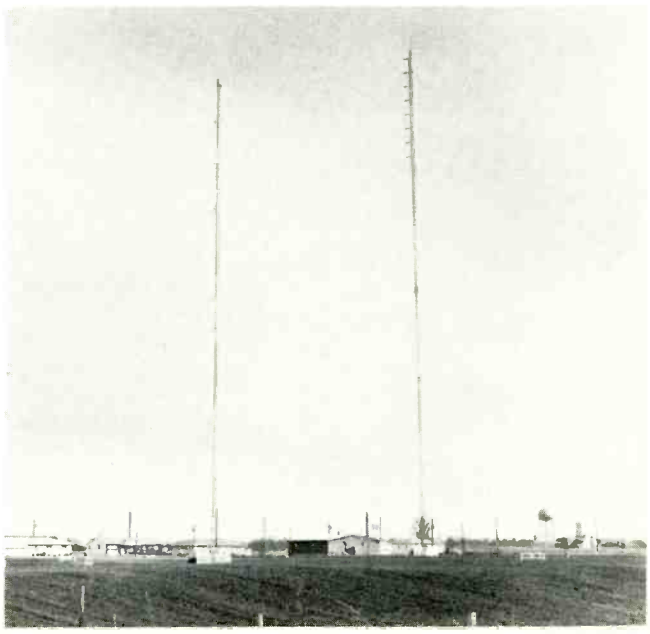


This attractive building at the edge of Greensburg, Indiana houses the operations of Radio Stations WTRE and WTRE-FM. The FM station has been serving the Decatur County community since 1962; it was moved recently to these quarters, built to accommodate the new daytime AM station.

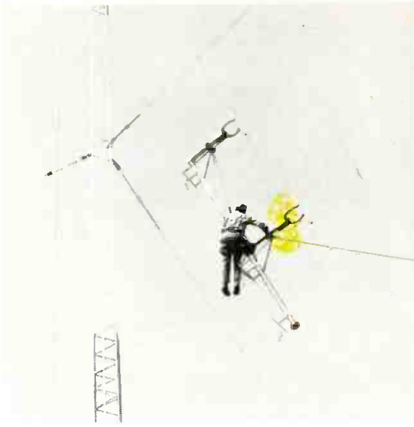
by James M. Moore and Carl F. Moeller

WTRE must protect three existing AM stations from interference, and its antenna must produce a pattern such as the one shown in the simplified contour map below. To do this, the two-element array shown below at the right was installed. The design calls for two 150-foot radiators. This, however, did not provide the desired height for the FM antenna, so an additional 150 feet was added to the tower nearest the building (at right in photo). Through the use of an insulator at the 150-foot level, only the lower half of this tower is active as an AM radiator. The other tower (left in photo) was built only to a height of 150 feet.



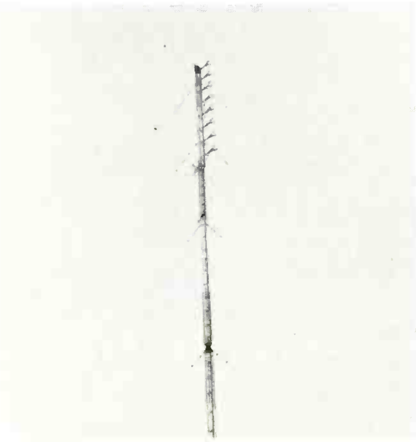






This sequence of photos shows stages in the erection of the main tower and the installation of the FM antenna.

(Photos Courtesy of WTRE)



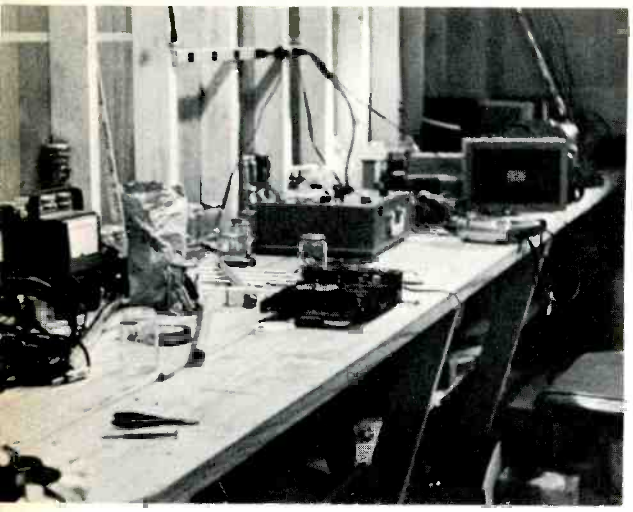

WTRE's 300-foot main tower (left photo) does quadruple duty. The lower half serves as one element of the directional array for the 500-watt AM station. The eight-element FM antenna evident in this view gives an erp of 3.5 kw, both horizontal and vertical, with the station's 1-kw transmitter. Just below the FM antenna is a 950-MHz antenna for a planned STL for an auxiliary studio in Batesville. At the very top of the tower is a 450-MHz antenna, used for remote pickups, which makes the overall structure height 312 feet.

At the former WTRE-FM location (right photo), the STL was used in conjunction with a remotely controlled main transmitter. Subcarriers were used for control functions, and frequency shift of a subsonic tone on the SCA channel was used for telemetry.

This special plow was made by WTRE for the installation of the AM ground system. Wire feeds from a reel at the top, down through a tube, and through the specially made plowshare which cuts a narrow furrow to receive the wire. The inner ends of the radials were attached to a chain around the tower foundation to hold them during the plowing-in process. In the photo at the right, station President Lloyd Kanouse drives the tractor as General Manager/Chief Engineer Jerry Preston checks operation of the plow.

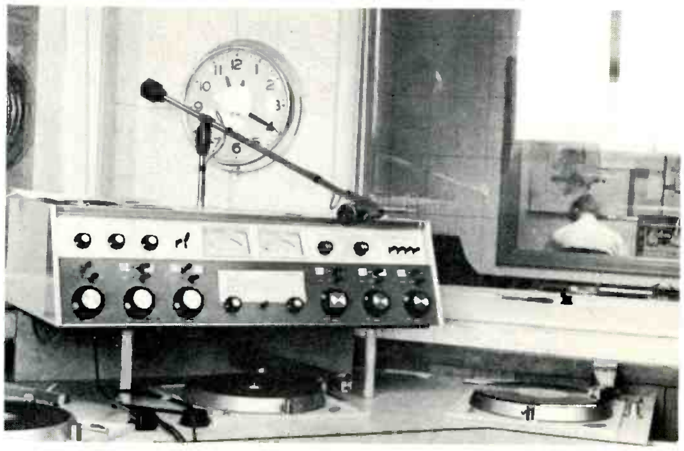
(Photos Courtesy of WTRE)





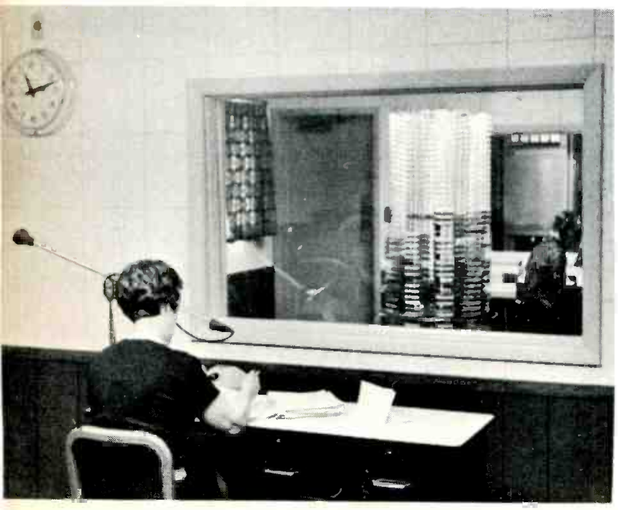
An enclosed shop area is located in the basement directly below the transmitter room. Transmission lines and other wiring pass through the ceiling of this area to the equipment in the room above.

Shown at the right is the operator's position in the main control room. At the left in the upper photo, a large window provides a view of both transmitters and the monitor rack. At the right (also see lower photo), the operator can see through the secondary control room into the news room.

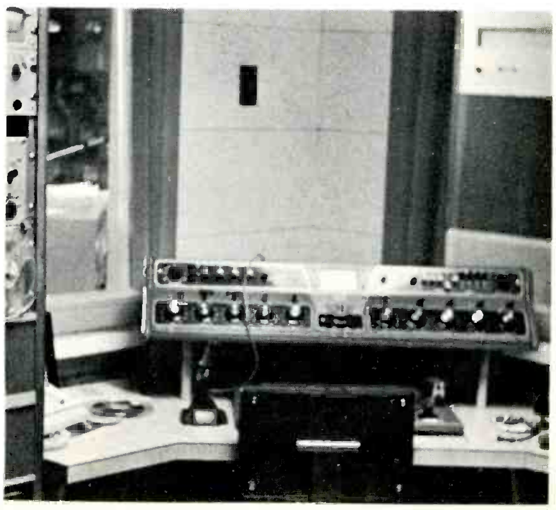


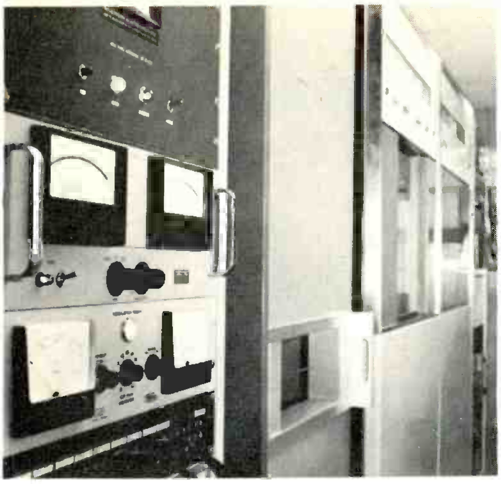
Note the location of the turntables. This arrangement is based on the theory that the majority of the day's programming originates from the turntables, and therefore they should be directly in front of the operator. Extensive use is made of tape cartridges, and reel-to-reel machines also are available.

The main studio is used for live programming. Here a telephone call-in show is in progress. Telephone-system capabilities include on-the-air feeds such as this, as well as intercommunication between locations in the building.



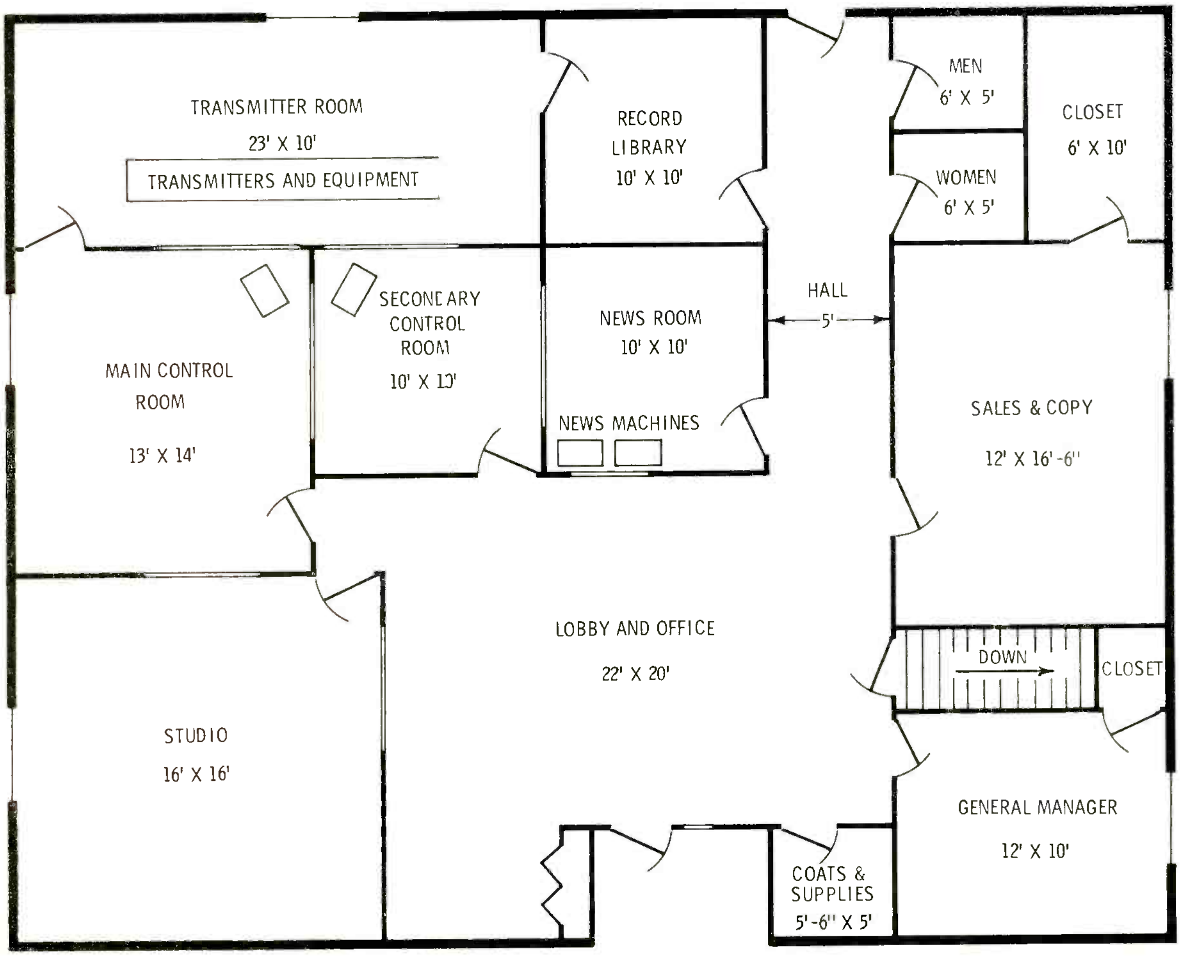
The secondary control room serves as a production area and also is available for use during periods of separate programming of the two stations. A full complement of recording, reproduction, and audio-control equipment is provided in this room.





The monitor rack, FM transmitter, AM transmitter, phasor, and a rack containing receivers and other equipment are lined up in the transmitter room. Windows provide visibility from both control rooms. This room is not heated or air-conditioned; thermostatically controlled louvres admit outside air through the back wall, and there is an exhaust fan in the ceiling.

Recordings are stored along one wall of the record library. The two-turntable remote unit is available for auditioning recordings.



An attractive paneled lobby area greets clients or other visitors as they enter the building. The window at the extreme left gives a view of the studio. The window at the right permits looking into the news room; news broadcasts can be made directly from this room, with the news-service printers providing a background sound.

The full basement serves, among other purposes, to garage the station's mobile unit. Also here are the shop, heating and cooling equipment, and an employee-lounge area.

Preview Highlights of the

Audio Engineering Society 34th Convention

April 29-May 2, 1968

Hollywood Roosevelt Hotel, Hollywood, California

Agenda

Registration

(Mezzanine)

Monday, April 29 through Thursday, May 2

9:30 a.m.-8:00 p.m.

Banquet

(Aviation Room)

Wednesday, May 1

6:30 p.m. Social hour
7:30 p.m. Banquet
Awards
Citation: Marvin R. Headrick
Fellowships: C. Paul Boner
Carl S. Nelson

Technical Sessions

(Aviation Room)

Note: For abstracts of papers, see page 44.

Monday, April 29

10:00 a.m. Amplifiers, FET
1:30 p.m. Amplifiers, General
7:30 p.m. Transducers

Tuesday, April 30

9:30 a.m. Tape-Cartridge Systems
1:30 p.m. Recording
7:30 p.m. Sound Reinforcement

Wednesday, May 1

9:30 a.m. Acoustics and Hearing
1:30 p.m. Instrumentation

Thursday, May 2

9:30 a.m. Recording and Broadcasting
1:30 p.m. Music and Speech
7:30 p.m. Audio Applications

Exhibits

Monday, April 29, and Tuesday, April 30
1:00 p.m.-9:00 p.m.
Wednesday, May 1, and Thursday, May 2
1:00 p.m.-5:00 p.m.

Blossom Room (Booths 1-30)
East-West Room (Booths 32-41)
Mezzanine Private Demonstration Rooms:
Boulevard Room
Rooms C, E, F

Exhibitors

Altec Lansing (Booths 9, 10, 11)
Ampex Corp. (Room C)
B & K Instruments, Inc. (Booths 13, 14)
R. T. Bozak Manufacturing Co. (Booth 15)
Dolby Laboratories (Booth 12, Room F)
Electrodyne (Booth 17)
Electro-Voice, Inc. (Boulevard Room)
Fairchild Recording Equipment Corp. (Booth 2)
Gauss Electrophysics, Inc. (Booths 7, 8)
General Radio Co. (Booth 32)
Gotham Audio Corp. (Booths 21, 22)
HAECO (Booth 25)
Harvey Radio Co., Inc. (Booth 39)
Hewlett-Packard Co. (Booth 41)
JBL (Booths 34, 35)
Langevin, Div. of Scientific Industries, Inc. (Booths 29,30)
Lipps, Inc. (Booth 16)
Magnetic Recorders Co. (Booth 24)
McMartin Industries, Inc. (Booth 33)
Melcor Electronics Corp. (Booth 5)
3M Co. (Booths 36, 37)
R. A. Moog (Booth 40)
Nagra Magnetic Recorders, Inc. (Booth 38)
North American Philips Co., Inc. (Booth 1)
Scully Recording Instrument Corp. (Booths 26, 27, 28)
Sennheiser Electronic Corp. (Booth 3)
Shure Brothers, Inc. (Booth 4)
Spectra Sonics (Booth 23)
Taber Manufacturing and Engineering Co. (Booth 6)
Universal Audio (Booths 19, 20)
Vega Electronics Corp. (Booth 18)

When engineers get together, the conversation turns to pickups.

PHOTOGRAPHED BY FRANZ EDSON AT THE CAPITOL TOWER, HOLLYWOOD.

It's an irresistible topic.
Especially since Stanton came out with the Model 500 stereo cartridge.
That's an engineer's pickup, if there ever was one.
Beautiful curve—within 1 db from 20 to 10,000 Hz, 2 db from 10,000 to 20,000 Hz.
Fantastically small moving system to trace the wildest twists in the groove.
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And, of course, Stanton's legendary quality control.
No wonder engineers use the Stanton 500 for critical broadcasting and auditioning applications.
And to impress other engineers with their pickupmanship.
(Available with 0.7 or 0.5-mil diamond, $30; with elliptical diamond, $35.
For free literature, write to Stanton Magnetics, Inc., Plainview, L.I., N.Y.)

STANTON

Circle Item 17 on Tech Data Card

Abstracts of Papers

Amplifiers, FET

Monday, April 29, 10:00 a.m.

Chairman: James F. Kane, Motorola, Inc., Semiconductor Products Div.

FET Temperature Characteristics

John C. Sinclair, Zenith Radio Corp.

FET temperature characteristics are described so that the designer may use the characteristics of the device itself in minimizing temperature effects in the junction-gate FET.

A Self-Contained Condenser Microphone Using a Solid Electrolyte Battery for Permanent Polarization

Alan Dauger and Charles F. Swisher, Vega Electronics Corp.

Polarization voltage for the subject cardioid condenser microphone is provided by a solid-electrolyte battery intended to last for twenty years. Discussion of the low-noise FET preamplifier and transient response of the microphone will be included.

The "Bi-FET" and Its Circuit Applications

David R. Pryce, Amperex Electronics Corp.

The "Bi-FET" is a monolithic integrated circuit consisting of an MOSFET input stage followed by a bipolar transistor stage on a single silicon semiconductor chip. Characteristics to be discussed include high immunity to voltage transients, high minimum transconductance, high input impedance, and low noise at high values of source resistance.

The Audio Behavior of Integrated MOS Devices

James F. Kane, Motorola Inc., Semiconductor Products Div.

The gain, intermodulation distortion, and noise behavior of several P-channel MOS circuits and one complementary MOS circuit are to be discussed. Also, some design equations will be developed, and consideration will be given to the possibility of using MOS structures in conjunction with bipolar integrated amplifiers.

Amplifiers, General

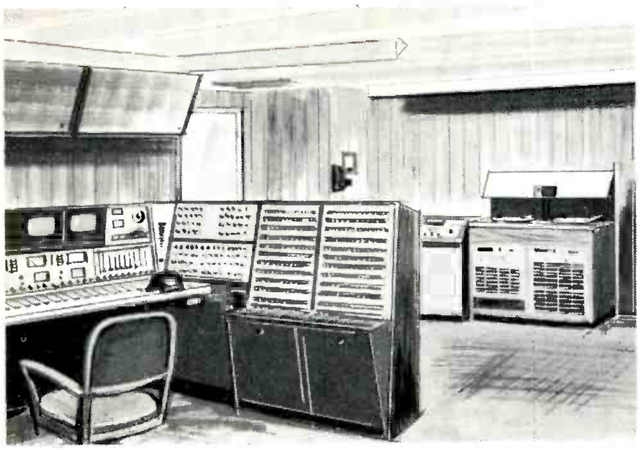
Monday, April 29, 1:30 p.m.

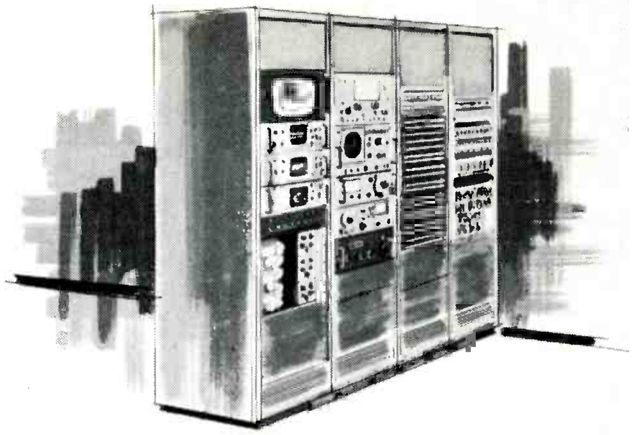
Chairman: James L. Noble, Altec Lansing, A Division of LTV Ling Altec, Inc.

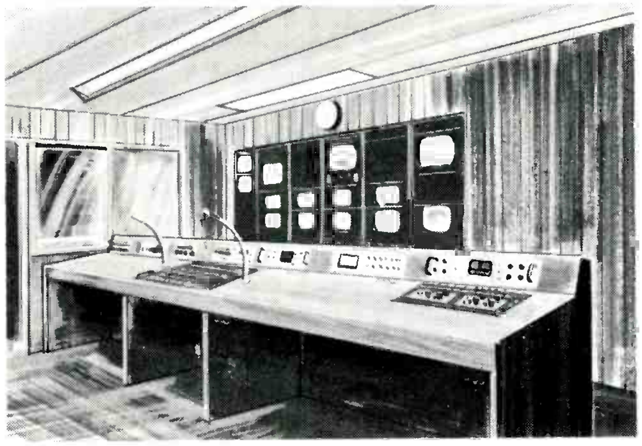
Frequency Controlled AGC in Small Signal Audio Amplifiers

William H. Greenbaum and Iraj Gharib

The application of automatic gain control in low-current, low-voltage, small-signal audio amplifiers will be the subject of this paper. A brief ex-







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ITT

Circle Item 19 on Tech Data Card

planation of normal AGC is to be followed by a discussion of amplifier frequency-controlled AGC, its characteristics, and its effects on the amplifier.

New Solid State Amplifier for the Recording Industry

Vernon B. Bushway, Jr., RCA Broadcast and Communications Div.

The amplifier to be described is intended for use in consolettes or custom-built audio systems. Primarily designed as a microphone preamplifier, it may be used also as an isolation or bridging amplifier. Design objectives included high ouptut capability, low distortion and noise, and broad frequency response.

Modular Transistorized Volume Limiting Amplifier

Walton N. Hershfield, Nelson Hershfield Electronics Co.

This paper will present technical details on a modular 60-dB volume-limiting amplifier designed for commercial communications applications. It can be used with other modular components to assemble systems accepting from one to sixteen microphones and providing power output from 25 to 250 watts.

Applications of the Audio Operational Amplifier To Studio Use

D. L. Richter, Melcor Electronics Corp.

Suggestions, schematics, and performance specifications for the use of operational amplifiers in audio control consoles will be presented. An audio console using only one type of amplifying module throughout is to be described.

A Low-Noise Amplifier With an FET Compression Circuit

David L. Campbell, Fairchild Semiconductor, Inc.

This paper shows the design of a compressor circuit which employs the linear or low-voltage region of the drain characteristics of junction FET's as elements(s) in a variable attenuator. Design considerations for the amplifiers and their associated feedback networks are included.

Modern Music—Rock, Jazz, Pop—and the Amplifier Designer's Dilemma

Paul B. Spranger, Altec Lansing

This paper outlines the problems involved in the design of sound systems to handle the high average levels and the resultant peak requirements imposed by modern musical-instrument groups. Possible solutions to minimize undesirable effects of peak clipping are included.

Operational Amplifier Applications for Audio Systems

B. J. Losmandy, Opamp Labs

The application of microminiature and miniature operational amplifiers to audio systems will be described through the use of actual examples.

A Highly Refined Lamp-Photocell Automatic Level Control Device Having Fast Attack Time, Instantaneous Transient Release and Low Distortion

William Ross Aiken, Vega Electronics Corp.

To be presented is an approach to the design of a compressor/limiter circuit to provide the advantages of conventional lamp-photocell operation, but augmented with several patented features to eliminate the drawbacks.

Transducers

Monday, April 29, 7:30 p.m.

Chairman: George L. Augspurger, James B. Lansing Sound, Inc.

Dragon—A Pyroacoustic Transducer

James S. Arnold and Vincent Salmon, Stanford Research Institute (Mr. Arnold is now affiliated with McDonnel Douglas Corp.)

This paper will present the following conclusion: If the gas in a modulated-air-stream loudspeaker is replaced by a combustible mixture that is burned after modulation, the acoustic output can be increased as much as 18 dB beyond that for air modulation alone. The order of magnitude of gain to be expected has been verified experimentally, and information for preliminary designs is available.

Speaker System Design Using a Reverberation Chamber

Victor Brociner, H. H. Scott, Inc.

Measurement of speaker performance in an anechoic chamber does not yield in readily usable form certain kinds of information necessary for multispeaker system design. The reverberation chamber does furnish this information in graphical form. The calibration and instrumentation of such a chamber are described in this paper, together with examples of its use in design work.

Frequency Modulation Distortion in Loudspeakers

Paul W. Klipsch, Klipsch and Associates, Inc.

This paper explains how listening comparison and tests of two speakers led to the tentative conclusion that only FM distortion could account for the relative difference in "cleanness" between the speakers. A spectrum analyzer revealed the presence of FM sidebands of computed magnitudes.

Recent Speaker System Developments to Meet the Dynamic and Power Requirements of Amplified Musical Instruments

William L. Hayes, Altec Lansing

This paper considers some of the problems, and their solutions, involved in designing speakers for use with the high-power (100 watts rms and above) musical-instrument amplifiers employed today.

Methods of Rating Power Capacity of Cone-Type Loudspeakers

Bart N. Locanthi, James B. Lansing Sound, Inc.

This presentation points out that the increasing requirements for very high acoustic levels from speakers make meaningful power capacity ratings essential. Present published power ratings, it is stated, represent widely divergent, and often unknown, test procedures. Comparisons between the most commonly used rating methods are presented, together with a suggested approach to more logical ratings.

Long Time Sensitivity of Foil-Electret Microphones

G. M. Sessler and J. E. West, Bell Telephone Laboratories

Results of studies to determine the long-time behavior of the sensitivity of foil-electret microphones will be reported. Measurements on units made of fluorocarbon foil, taken over a period of four years, show no decay in sensitivity under normal conditions of temperature and humidity. From extrapolations of the time constants obtained at elevated temperatures, it is concluded that fluorocarbon and polycarbonate systems should have lifetimes of the order of 100 years.

Electret Condenser Microphones of High Quality and Reliability

Preston V. Murphy, Thermo Electron Corp.

The history of the development of a reliable electret for high-voltage biasing is reviewed, and some of the problems are noted. A report is made on recent developments, in both electret fabrication and electret cartridge design, which have led to substantial improvement in reliability. The performance characteristics, under various environmental conditions, of prototype electret microphone systems are described.

A 3-Way Columnar Loudspeaker System

R. T. Bozak, The R. T. Bozak Mfg. Co.

This paper describes a high-quality columnar speaker system intended for producing relatively high sound intensities. The discussion will cover the practical problems encountered, common objections offered, and advantages of the columnar speaker. An ultra-high-quality, 3-way columnar system employing a low-level cross-over will be discussed, and performance data will be given. A brief demonstration will be a feature of this presentation.

Tape Cartridge Systems

Tuesday, April 30, 9:30 a.m.

Chairman: Pell Kruttschnitt, Capitol Records

A 150-mil Slave Transport for Cassette Duplication

Donald Kahn, 3M Co.

The subject of this paper is the use of the 3M Brand professional audio recorder to create a slave transport for duplication of 150-mil tapes. Included are descriptions of modifications of the transport control logic and tape guiding to accommodate the more delicate tape.

Mass Production of Prerecorded Tapes

Thomas D. Everett, Ampex Corp.

This article is concerned with the design and implementing of manufacturing facilities for producing prerecorded music at reasonable cost, quality, and delivery. Although no ultimate in manufacturing techniques is described, some common elements in mass-production requirements are discussed.

Design Considerations and Objectives in the Design and Development of an Automatic Stereo Cassette Changer and a Compact Stereo Cassette Playback Unit

Edward R. Hanson, North American Philips Co., Inc.

Refinements and broadened applications of the compact cassette system include a new, compact synchronous motor, a miniature player deck, and an automatic changer. Design objectives, problems encountered, and safeguards created for these developments will be discussed.

The Newell Principle in Tape Cartridge Systems

C. W. Newell, Newell Industries

This paper will discuss the application of the Newell principle in self-threading audio tape recorders. Equipment demonstrations will show a professional self-threading reel-to-reel recorder using NAB flanged reels, an automatic consumer-type tape player employing 15 "cartridgeless" reels in a magazine, and a cassette-style industrial recorder.

High Speed .150" Tape Duplication System

R. Millward, Ampex Special Products Dept.

A field-tested system for producing 10,000 cassette albums a day is to be described.

Recording

Tuesday, April 30, 1:30 p.m.

Chairman: Charles Pruzansky, RCA Victor Record Div.

The Scanning Electron Microscope—Tool in Disc Recording Research

J. G. Woodward, M. L. Coutts, and E. R. Levin, RCA Laboratories

A description of the scanning electron microscope (SEM) will be given, and its suitability for use in disc-recording research and development will be related. Photomicrographs of details of recording and playback styli and of new and worn walls in record grooves will be shown.

Splicing Tapes and Their Proper Applications

Delos A. Eilers, 3M Co., Magnetic Products Laboratory

The design considerations involved in the development of splicing tape, the tests associated with its evaluation, and its proper application are discussed.

Polyester and Acetate as Magnetic Tape Backings

Delos A. Eilers, 3M Co. Magnetic Products Laboratory

A report will be made concerning the results of comparative testing of both cellulose acetate and polyester materials for use as magnetic recording-tape substrate. These results show some interesting differences; conclusions are presented which indicate advantages to the user.

An Improved, Low Crosstalk Recording Head Designed for Sync Playback

Warren B. Dace, Lipps, Inc.

Problems associated with recording, reproducing, and rerecording on a single head stack are the subject of discussion. A method for improving interchannel crosstalk is offered, together with a comparison of results with those for standard shielding techniques.

Remote Control of the Overdub or Sync Operation of a Multichannel Recorder

Dale Manquen, 3M Co.

This paper tells of a switching system that has been devised to allow remote control of the electronics modules of the 3M Brand professional audio recorder. The system is intended to provide an increase in ease and speed of operation when used in conjunction with the standard deck remote control. Special "Cue" and "Instant Playback" modes are described.

New Compact Electronics for the 3M Brand Professional Audio Recorder

Dale Manquen, 3M Co.

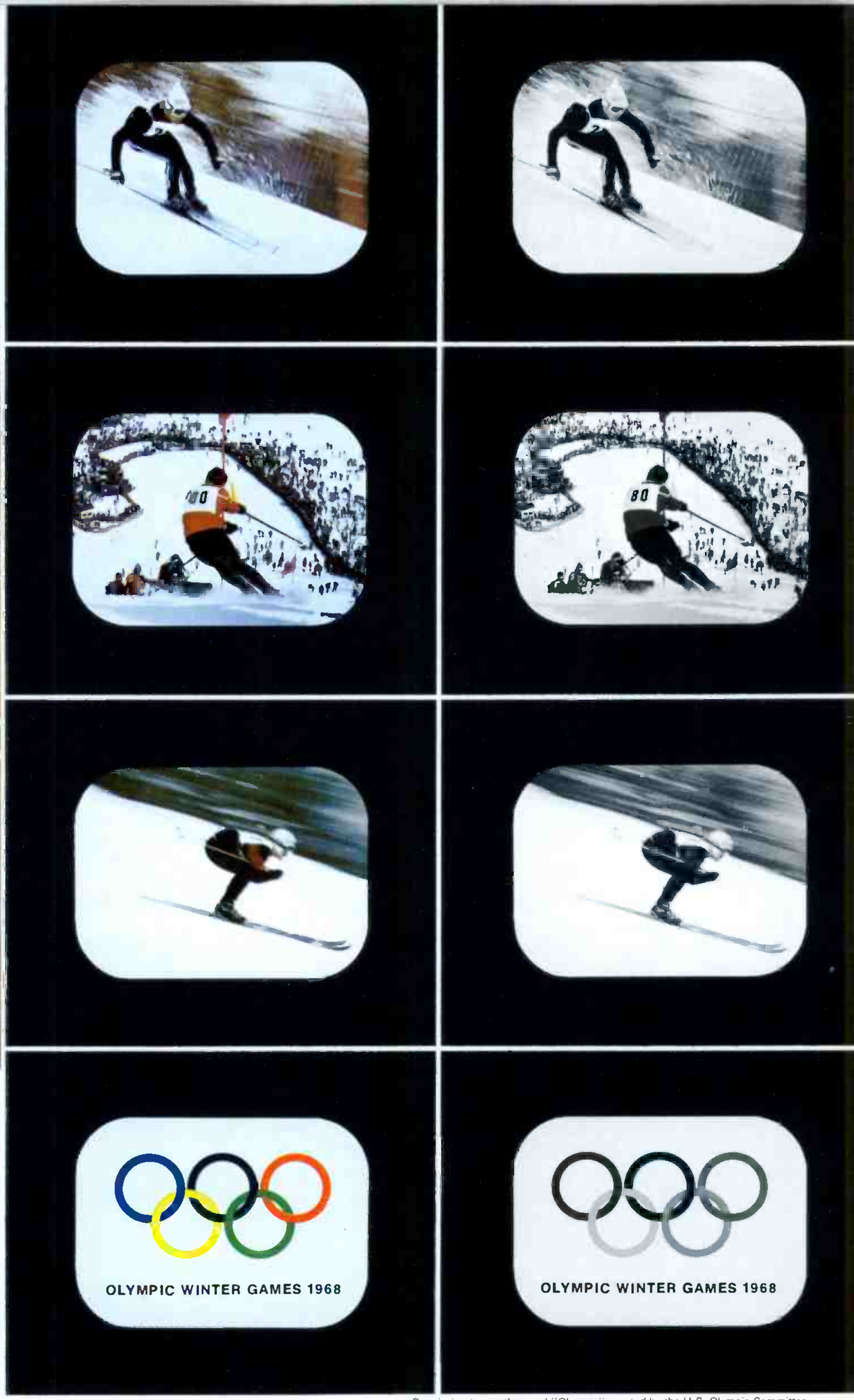
Circuits and performance specifications are presented for the new electronics module for the 3M recorder. The module features two plug-in assemblies for ease in servicing such previously inaccessible components as switches and gain controls.

Precision Alignment and Quality Control Techniques for Many Channel Recorders Operating at Short Wavelengths

Keith O. Johnson, Gauss Electrophysics, Inc.

This paper states that conventional methods of aligning master recorders can become awkward and inaccurate when systems having many tracks or operating at low tape speed are involved. Rapid sweep frequency techniques, frequency- and amplitude-selective gate circuits, and movable precalibrated reproduce and record amplifier head assemblies are discussed as means to simplify and im-

When the record's being broken,



Permission to use the word "Olympic" granted by the U.S. Olympic Committee.

the tape must not fail.

Some things don't happen twice.

And if you don't record it the first time, you don't record it at all.

Take, for example, the Olympic games at Grenoble.

When a champion comes charging to the finish, he creates a dazzling moment that can never be recreated.

Except on something like tape.

Wouldn't it be a shame to miss it with tape that couldn't handle the video or the sound?

That's why we designed 78V as carefully as we did. It captures once-in-a-lifetime events the second they happen. Faithfully.

And that's why ABC chose 78V to tape the Winter Olympics at Grenoble.

78V, the high-chroma tape for critical applications. The non-fail tape.

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MEMOREX

prove alignment. It is also stated that chromium dioxide and other advanced tape-coating materials have been found to have improved stability and output at short wavelengths, permitting rapid daily recorder alignment at standard operating level, even for the lower tape speeds.

Synchronous Sound for Motion Pictures
Ronald R. Cogswell, Ryder Magnetic Sales Corp.

Quarter-inch magnetic audio tape with a sync signal is widely used in producing motion pictures. This paper will describe modern systems for recording and transferring or resolving from the original tape to sprocketed magnetic film or other tapes.

A "How-To" Review of Disc Recording Practices—Stereo and Mono
Stephen F. Temmer, Gotham Audio Corp.

This paper places special emphasis on the new digital integrated pitch/depth control system for use in making 33-minute stereo sides.

Sound Reinforcement

Tuesday, April 30, 7:30 p.m.

Chairman: Rolf Hertenstein, DuKane Corp.

Professional Quality Sound Systems for School Auditoriums
W. R. Torn, DuKane Corp.

This presentation will illustrate the application of professional-quality audio equipment at a typical high school in Texas. Acoustic and electronic improvements and advantages will be outlined and detailed.

Trends in Sound Reproduction Research
Harry F. Olson, RCA Laboratories

Trends to be discussed will include: reduction of nonlinear distortion by complementary means, the use of subjective characteristics of hearing to provide the listener with the best resemblance to the live performance possible, and the reduction of the bandwidth in speech transmission by means of a code obtained from extracting the information content of the speech signal.

A 1/3-Octave Filter Set for Equalization of Sound Reinforcement Systems
Don Davis, Altec Lansing

This paper will relate the experiences and philosophy that led to the development of a variable notch filter equalizer. The discussion will include the technique of using feedback threshold measurements to adjust the filter, and illustrations will be used to show the substantial increase in acoustical gain that can be expected through the use of this equalizer.

New Method of Evaluating the Effectiveness of Sound Amplification Systems in Reverberant Spaces
J. Jacek Figwer, Bolt Beranek and Newman Inc.

This paper will describe a test for obtaining information concerning the sequence of arrival of sound impulses and the distribution of sound energy in time. The method is based on pulse techniques and permits measuring the increase in the early-to-reverberant sound ratio, due to the operation of the sound system, which results in increased intelligibility.

Audio and Acoustical Instrumentation as Used by a Sound Contractor
Carl Colip, Jr., Commercial Electronics, Inc.

Illustrations, from actual major installations, will be part of a presentation about the techniques used by a sound contractor for acoustical tests of the room, set-up, and final adjustment of the sound system.

The Effects of Detailed Equalization on Contemporary Sound Reinforcement System Design
Don Davis, Altec Lansing

This paper states that increased acoustic gain results in significantly higher power output requirements for sound reinforcement systems. It is also stated that detection of faults in sound reinforcement systems with inadequate distribution, power output, or time-space relationships is made easier when the systems are "tuned," because the faults are magnified.

Sound Reinforcement System for the New York Philharmonic and Metropolitan Opera New York City Parks Concerts
Christopher Jaffe, Christopher Jaffe and Associates Inc.

This paper will deal with the design of the acoustical shell, stage, and sound reinforcement system required by the program plans of the New York Philharmonic and the Metropolitan Opera. Included will be an evaluation of the results of the first season's tour, the refinements added to the system, and an evaluation of the system in terms of current capabilities.

Acoustics and Hearing

Wednesday, May 1, 9:30 a.m.

Chairman: A. R. Soffel, LTV Research Center

Statistics of Delayed Reflections
Michael Rettinger

In this paper, delayed reflections will be discussed on a statistical basis by grouping them into classes of first-, second-, etc., order reflections. Analysis of the sets of reflections is carried out in terms of the resultant produced by the sound rays, with a random phase relationship in frequency assumed. Evaluation of the sets is made with respect to the time interval between a resultant and the direct sound.

Reverberation Measurement by the Automatic Decay Rate Meter and Other Methods
F. K. Harvey, Bell Telephone Laboratories, Inc.

The operating principles of the automatic decay-rate meter will be explained. This direct-reading, wide-range instrument is designed for the measurement of fast sound decay rates encountered in conference rooms. Examples of reverberation times indicated by the meter will be compared with results obtained by several oscilloscope methods.

Instant Recording Studios Using Prefabricated Acoustical Panels
Allan P. Smith, Naval Training Device Center, Orlando, Florida

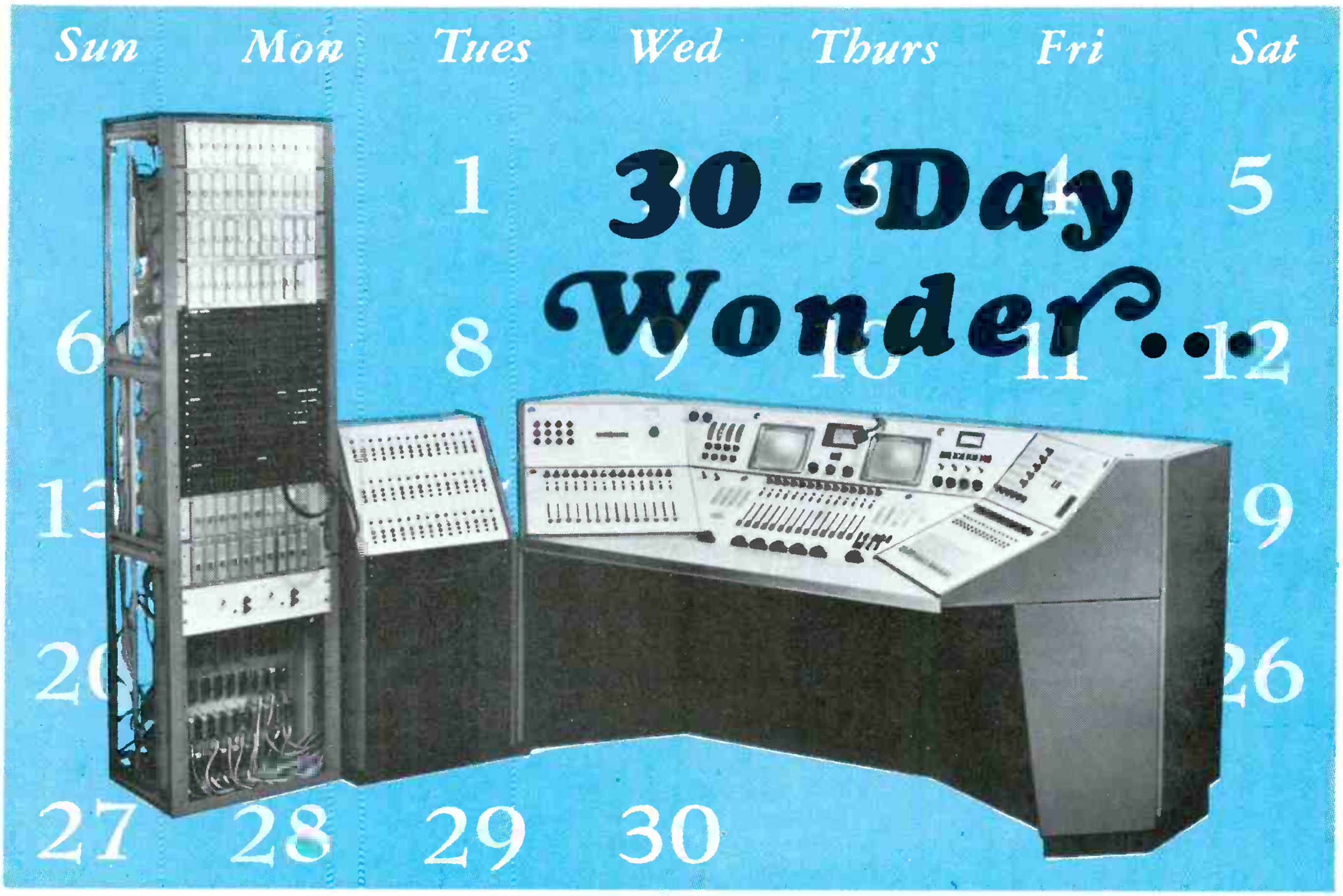
Considerable time and expense are often involved in the design and construction of sound-isolated recording studios. The use of prefabricated acoustical panels to form complete room enclosures will be described. Information on the techniques of construction and the acoustical performance available from such a system is to be included in the presentation.

Image Fusion Requirements of the (Haas) Precedence Effect
Mark B. Gardner, Bell Telephone Laboratories

The single-image aspect of the (Haas) precedence effect in sound localization will be the subject of this paper. The effect is described as very compelling when one listens to complex sounds which are alike in level and quality and which follow each other in rather close sequence. If the requirements for "sameness" and arrival time are met fully, complete fusion occurs, and the observer hears a single sound image at an apparent single location. However, if either requirement is met only partially, then only partial fusion results. A presentation will be made of examples, with associated degrees of image blending.

Noise Rating and Hearing Impairment
Aram Glorig, M.D., Callier Hearing and Speech Center

This paper will discuss noise rating by octave bands and dB A as it relates to the risk of impairment of hearing in the general population. The presentation will include distributions of hearing loss and impairment as a function of octave band and dB A levels to show the amount of added



New Fairchild Integra II Remote Control Custom Audio Console!

A major TV network selected FAIRCHILD RECORDING EQUIPMENT CORPORATION, from among several of the largest broadcast equipment manufacturers in this country, to design and construct a 42-input audio mixer console. Not only did FAIRCHILD deliver a remote control mixing console in substantially less than the required time, but the network's audio engineers were so deeply impressed with the INTEGRA II console's performance and compactness that additional consoles were ordered . . . the next INTEGRA II console was constructed and delivered in thirty days. These consoles were installed and in operation within a matter of days after delivery.

NO AUDIO IN THE CONSOLE

There is actually no audio in the INTEGRA II console, with the exception of the audio lines assigned to peripheral effects equipment such as effects equalizers, VU meters etc. The INTEGRA II audio system, by removing the audio from the console area, eliminates the need for audio equipment to be located adjacent to the control area, thereby providing far greater design latitude.

THE SECRET OF FAIRCHILD's INTEGRA II CONCEPT

The secret of the speed in which FAIRCHILD INTEGRA II consoles are constructed is inherent in the advanced modularized solid state design. By combining several audio functions – amplification, attenuation and switching – in a complete system of plug-in cards, the construction of simple or complex consoles is implemented in short periods of time. In addition, a considerable savings in space and cost is also achieved.

The FAIRCHILD INTEGRA II remote control audio consoles and components are more compact, easier to install and maintain; are far superior in performance and reliability.

IF YOU ARE A PROGRESSIVE BROADCAST OR RECORDING STUDIO, with an eye to the future, look to FAIRCHILD for INTEGRA II consoles or components today. Write for complete details and brochure.

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Circle Item 21 on Tech Data Card

risk of hearing loss sustained over that which occurs in subjects not exposed to noise.

Some Effects of Interference on Speech Intelligibility

William B. Snow, The Bissett-Berman Corp.

The first portion of the paper will have as its object a description and demonstration of the effects on speech intelligibility of selected noise spectra that emphasize basic phenomena. It is found that a "most-efficient" noise spectrum exists for use in intentional disruption of intelligibility (for example to combat eavesdropping). The method of making the measurement, called a threshold of understanding test, will be outlined, and the resulting spectrum will be shown. Consideration will be given to additional types of interference.

Instrumentation

Wednesday, May 1, 1:30 p.m.

Chairman: Allen E. Byers, United Recording Electronics Industries

Solid State Condenser Measuring Microphone as Assembly

W. T. Kapuskar, Research and Development, Hewlett-Packard GmbH

During the evolution of new acoustical instruments at Hewlett-Packard GmbH (Germany), the need for state-of-the-art 1" and ½" condenser microphone systems was recognized. The preamplifiers designed to fulfill this need will be the subject of this paper.

A One Third Octave Universal Frequency Response Shaper

Bernard Katz, B & K Instruments, Inc.

This paper will give information about a variable bandpass and reject audio-frequency filter. The filter consists of 36 independent 1/3 octave adjustments with visual indicators and mechanical memory. The design considerations, capabilities, and applications of the instrument will be detailed.

Transmission Measuring Sets

Arthur C. Davis, Audio Controls

The role of the transmission measuring set as a fundamental laboratory tool will be emphasized, and the need for providing properly calibrated source signals of proper impedance, balance, level, and electrical isolation will be shown. Use of a transmission measuring set to avoid common errors in measurements will be illustrated.

High Speed Automated Test System

Daniel A. Roberts, Gates Radio Co.

A high-speed system for checking amplifier operating parameters, flat or equalized, is the subject of this paper. Coverage will be given to the entire system, with its associated low-distortion oscillators, high-pass filters, closed-loop reference systems, high-resolution presettable limits, and go/no-go readout.

Methodology for Acoustical Data Gathering

Benjamin B. Bauer, Bert A. Bodenheimer, and Edward J. Foster, CBS Laboratories

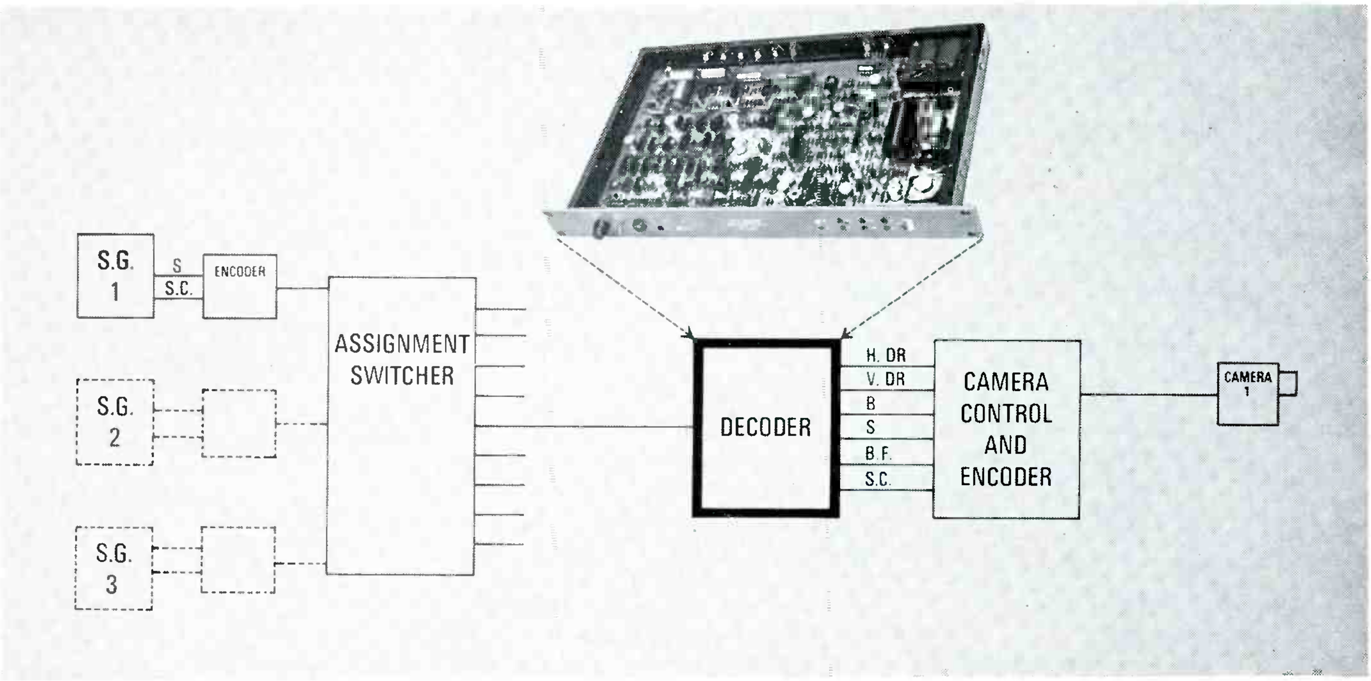
Making a comprehensive acoustical field survey poses certain problems which require modifications and adaptations to commercially available equipment. Wind, rain, long cable runs, and atmospheric discharges make necessary the use of special microphone enclosures and amplifiers. Maintenance of amplitude and phase linearity and the level reference is of special concern. The authors of this paper tell about the equipment and methods developed at CBS Laboratories to cope with these problems.

The Need to Hear Ourselves as Others Hear Us

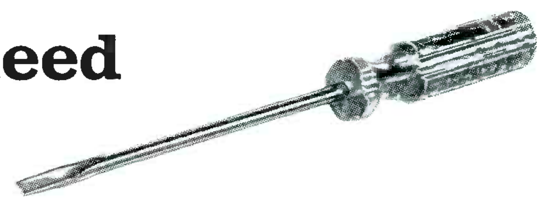
Richard W. Burden, Richard W. Burden Associates

This paper makes the observation that the technical quality of a broadcast station can be lost because of inability to monitor faulty program

This is our new 2200 "Sync-Line" pulse distribution system



and this is all you need to adjust it



Here's a totally new timing distribution system—as far removed from the usual unwieldy octopus as simple arithmetic from calculus. It does this:

1. Reduces the complexity of the pulse assignment switcher from six levels to one.
2. Reduces to a single line the cable from the pulse distribution system to the camera.
3. Makes system planning easier. Sophisticated design enables all pulses to be advanced/retarded relative to incoming signal—a UNIQUE FEATURE.
4. Makes installation easier, by eliminating delay line equalization and cable length trimming.
5. Saves you money, both in capital cost and in installation.

We'll be happy to talk it over with you. In fact, if you'd like to discuss your systems problems with people who really understand them, give us a call—or drop us a line.

The "SYNC-LINE" is another example of craftsmanship by Central Dynamics—international leader in terminal equipment of advanced design.

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Circle Item 23 on Tech Data Card

material and detect the improper adjustment of supporting technical equipment. A proposal is made for the use of the proper tools and techniques to upgrade the overall listening quality of the broadcast medium.

Recording and Broadcasting Facilities

Thursday, May 2, 9:30 a.m.

Chairman: William G. Dilley, Spectra-Sonics

A High Performance Control Console with Flexibility

Allan P. Smith, Naval Training Device Center, Orlando, Florida

This paper gives details of a solid-state mixing console developed to satisfy a variety of research and development recording assignments. Design features include six microphone inputs for either of two studios, six line/utility inputs, two-channel operation with graphic equalization and peak limiting for each channel, and an amplifier-overload indicating system.

Active Isolation "Transformers" in Studio Console Design

William G. Dilley, Spectra-Sonics

This paper is about the development of an active isolation "transformer," contained integrally within a solid-state amplifier. Discussion will include theory, derivation, application, and implications with respect to such system considerations as electronic performance, physical size and weight, and cost.

A Functional Audio Control System That Meets the Professional Audio Engineer's Responsibility to the Industry

Hardy Martin, Sambo Sound Studios

A specially designed audio control system is to be described. Design features include utilization in one unit of equalization, complete channel selection, compressor/limiter, four-channel master, two-track and mono mix-down, and a selective monitoring system.

Versatile Audio Control Console

Donald McLaughlin, Electrodyne Corp.

The subject of this paper is an integrated-circuit audio control console designed to handle completely eight-track recording. Features of the console include 16 microphone or line inputs, expandable to 20; six-position equalization with echo send and cue on each channel; independent eight-channel, two-channel, and monophonic output; two stereo pan pots; illuminated push-button switches; and monitor switching and level controls.

A Mobile Electro-Acoustic Laboratory

Allan P. Smith, Naval Training Device Center, Orlando, Florida

This paper will provide a description of a mobile sound laboratory installed in a 40-foot trailer. The unit contains a control room/laboratory, a suspended narration studio, and a workshop. The laboratory features sound insulation of all rooms and a self-contained temperature and humidity control system.

Music and Speech

Thursday, May 2, 1:30 p.m.

Chairman: M. V. Mathews, Bell Telephone Laboratories

Some Time Dependent Characteristics of Cornet, Oboe, and Flute Tones

James W. Beauchamp, University of Illinois

Harmonic amplitudes and relative phases were obtained as functions of time for a number of musical-instrument tones. Slow-motion films of harmonic line spectra will be presented for several tones in order to illustrate their time dependence. Discussion will include some features of the attack characteristics of cornet, oboe, and flute tones, the importance of relative phases for oboe vibrato, and the separation of cornet spectra into effects produced by an intensity-dependent excitation function and frequency-dependent filter.

Sound Production in the Wind Instruments

John Backus, University of Southern California

This paper examines the wind instruments as self-excited acoustical oscillators utilizing the regenerative mechanism of the instrument reed to maintain complex oscillations. The paper explores how the harmonic structure of this complex vibration, and hence the emitted sound, is affected by the amount of deviation of the resonance frequencies of the air column from the frequencies of the harmonics of the air-column vibration.

An Algorithm for Segmentation of Connected Speech

D. R. Reddy and P. J. Vicens, Computer Science Department, Stanford University

This paper tells how smoothing and differencing operations on a digitized acoustic waveform give rise to parameters which are used in determining whether the characteristics of the sound are changing or similar. Parts having similar parameters are grouped together to form sustained segments and parts with changing parameters form transitional segments, resulting in the segmentation of connected speech into parts approximately corresponding to phonemes.

Preprocessing of Speech for Added Intelligibility in High Ambient Noise

Ian B. Thomas and Russell J. Niederjohn, University of Massachusetts

A report will be given on experiments in which the intelligibilities of preprocessed and normal speech are compared in the presence of a high ambient noise level. Preprocessing involves removal of the first formant of the speech prior to infinite amplitude clipping. The paper states that under high noise conditions the intelligibility of the resulting clipped speech is considerably greater than that of normal speech at a comparable average sound level.

A Symbolic Approach to Musical Composition

L. Knopoff, Institute of Ethnomusicology, University of California

This presentation relates to an investigation into the possibility of generative communicable music by constructions using a symbolic form of composition. In the computer-performed pieces to be heard as examples, the number of symbols is three; each symbol controls an identical group of sounds each time it occurs. Also in this presentation, the generation of a musical style will be discussed and exhibited.

The Relevance of Musical Theory to Musical Data-Processing

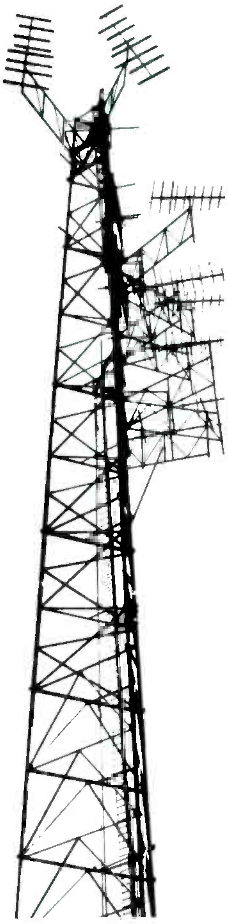
Michael Kassler

This paper will contrast the current state of computer processing of musical data with a more advanced state that would result from further development or analysis of existing musical theories.

The Stanford System for On-Line Generation of Sound by Computer

David Poole, John Chowning, and Leland Smith, Stanford University

Development of a flexible and general system for producing and manipulating sound with a digital computer is to be discussed. The implementation utilizes a general-purpose time-sharing system; it provides visual and auditory



interaction with the user in the generation of arbitrarily complex sounds. The initial work to be described has been with artificial reverberation and simulated movement of sound sources.

Music Signal Processing for Fun and Profit

Robert A. Moog, R. A. Moog Co.

This paper will deal with electronic circuitry that transforms the waveform and envelope of monophonic musical sounds, but preserves their pitch and timing. Examples will be presented.

Audio Applications

Thursday, May 2, 7:30 p.m.

Chairman: Keith O. Johnson, Gauss Electrophysics, Inc.

Improved Performance Capabilities of Wireless Microphones

Charles F. Swisher, Vega Electronics Corp.

Recent improvements in the reliability of wireless microphones will be discussed. A number of sophisticated applications for this type of microphone will be listed, together with the solutions to some of the operational problems that may be encountered. Predictions for the future of the wireless microphone will be made.

Two Inch 16 and 24 Track Master Recorders

R. Harshberger, Ampex Special Products Dept.

This paper is to be about multitrack, multifeatured master recorders that use 2-inch tape.

Random Access Audio System

M. Kuljian, Ampex Special Products Dept.

The system to be described is a computer-activated magnetic tape system using high-speed access, retrieval, duplication, and playback technology for student education.

Audio Quality and Its Deterioration: Electronic and Subjective

Moderator: Keith O. Johnson, Gauss Electrophysics, Inc.

Panel: Allen E. Byers, United Recording Electronics Industries; John M. Eargle, RCA Victor Record Div.; John T. Mullin, Mincom Div., 3M Co.; Carl S. Nelson, Capitol Records

This panel discussion will attempt to explain how types of electrically measurable distortion cause subjective sound changes or deterioration. The discussion will be informal. ▲

ENGINEERS' EXCHANGE

Eliminating Noise From Cartridge Machine

If your control operators leave the console switches and pots of frequently used channels in the "on" position, this information may be of interest to you. In our case, a very noticeable low-frequency "thump" was heard whenever the load lever of a cartridge playback machine was moved to the "ready" position. This was caused when the rather abrupt action of the pinch roller suddenly forced the tape against the face of the playback head. The amplitude of this noise was so great that it would actually override the program on the air, resulting in a momentary absence of signal.

Examination of the circuit diagram revealed that in this machine a controlled solenoid voltage of 120 volts DC is present whenever the start switch is depressed; the voltage remains until the machine stops. It was decided to use this controlled DC voltage to operate a 110-volt, low-current DC relay. A P & B KRP-11DG DPDT relay was selected. The normally open contacts are used to break the circuit from the output of the playback amplifier to the output connector of the machine. Thus, the amplifier output cannot get into the console input until the start switch is depressed.

There was adequate space within the cartridge-machine cabinets to install the relay. A standard octal socket is required for this installation, together with a couple of spacers or standoffs for securing the socket.

—Leonard J. Dupree

Erratum

There is a typographical error in the article "Maintenance of the Directional Antenna" (February, 1968 BROADCAST ENGINEERING, page 30). On page 33, the eleventh line from the bottom of the page should read, "35 foot candles). If the lighting control uses tubes, . . . ," and not "3 foot candles . . ." as printed.

Early Canadian
RADIO BROADCASTING

by Len Spencer—*

This story tells about the beginning of the broadcasting industry in Canada.

It was in 1901 that the first transatlantic radio signal was received in Newfoundland, marking the beginning of the commercial application of electronics to communication. The Marconi Wireless Telegraph Company of Canada was formed in 1902 with its base of operations in Montreal, and by 1904 it had set up coastal land stations for "wireless" communication with ships at sea. It was from one of these stations at Cape Race that the sinking of the *Titanic* on April 14, 1912 was "flashed" to the world. This tragedy aroused public interest, and it led to legislation compelling sea-going ships of a certain size to be equipped with "wireless telegraph" equipment.

Pioneer Equipment

World War I created the impetus for greater research which led to the practical application of vacuum tubes—the major breakthrough to modern electronics. Before the invention by Lee DeForest of the grid-controlled vacuum tube, the greatest problem in the development of radio telephony was an efficient method of modulation. In 1906, Poulsen succeeded in using continuous waves generated by an arc to broadcast speech and music a distance of 300 miles. To do this, however, he had to use water-cooled microphones connected directly into the antenna circuit, with the result that the antenna power depended directly on the capacity of the microphones to carry the current.

By the 1920's, this problem had been solved by the use of the modulating circuits of E.H. Colpitts and R. Heising. The Western Electric Company had voice communication from Arlington, Virginia to the Eiffel Tower in Paris in 1918. From 300 to 500 "power" tubes were operated in parallel to produce about 60 amperes of antenna current at 6000 meters. (This current produced about 9 kilowatts of power.) The tubes had to be replaced frequently, and an operating cost of about $10,000 per month was experienced.

As early as 1915, Dr. Irving Langmuir describes, in the *Proceedings of the IRE*, a "pliotron radiophone transmitter" using an AC power supply with a multiple transformer for filaments and plate supply for the rectifiers.

*BROADCAST ENGINEERING Consulting Author, Montreal, Quebec.

Fig. 1. A CKAC studio in 1922; note the 'magnetic' microphone on the stand.

In the '20's, microphones employing a double carbon button and stretched aluminum-alloy diaphragm were in use in Canada. This type of microphone was based on a stretched skin diaphragm invented by E. Berliner in 1878. In 1921, R. Scantlebury began the development of a dynamic microphone with its resonant point as low as possible. The final result was a rubber diaphragm on which was attached a small voice coil suspended in a magnetic field. This field was supplied by a soft-iron frame wound with many turns of wire and excited by two six-volt automobile-type storage batteries. (See Fig. 1.)

Fig. 2 shows a receiver of the type used in the '20's. Note the speaker horn. This was basically a voice coil in a magnetic field, the power for which was supplied by automobile batteries. This was a quite costly and messy arrangement, but it gave excellent results for that time.

Pioneer Stations

It was in 1918 that "radio telephony" was broadcast from the Marconi Company "test room" on William Street in Montreal. This first experimental broadcasting station used the call letters XWA. In 1919, regular programs were transmitted under the present call letters, CFCF.

The second private broadcasting station to be established in Canada was CKAC, whose inaugural program was broadcast September 28, 1922. The transmitter was Heising modulated and self-excited. Fig. 3 shows three MT-6 tubes that were used in parallel as oscillators (top row); the bottom three tubes were modulators. The tube attached to the side of the rack was added later as a fourth modulator.

A feature of Canadian broadcasting in the 1920's was the "phantom" station. This was an arrangement whereby a company not owning the physical assets of a radio station could operate under a phantom license during specified hours, being responsible for the program material but not for the technical operation of the equipment. One of these phantoms was the Government-owned Canadian National Railways, which used the technical equipment of CKAC three days per week. When, however, the Canadian Government (in 1932) decided to enter the broadcasting field, it changed the call letters to CRMC and built its own station in 1936 under the call letters CBM. Today CBM is the key station for the Canadian Broadcasting Corporation in Montreal.

In 1929, CKAC moved its transmitter from the roof of the *La Presse* newspaper building and increased its power to five kilowatts. To do this, however, meant going 20 miles from the center of the city, since it was claimed by the authorities that serious "blanketing would occur from the use of such high power." Fig. 4 shows the 5-kw transmitter, which used DC generators for all power supplies and employed water-cooled tubes in the final. The audio control bay in Fig. 5 shows the huge power supply at the right and a paper-cone speaker on the wall. The double-button carbon-granule microphone was standard equipment at that time.

In 1929, a 5-kilowatt transmitter was considered in the newspaper headlines as "super power," and Figs. 6 and 7 reveal the reason why. They show the power panel, rectifier bay, and modulators, and the power supply and water pump used for cooling the two final power tubes. A 5-kilowatt radio station was, in those days, a very large installation.

Two self-supporting steel towers 330 feet high supported a flat-top "T" antenna that was directly coupled to the final stage.

When, in 1940, CKAC decided to try air-cooled power tubes, it was with some misgiving. Many "experts" predicted that such powers would result in melting the glass or destroying the filaments because, "You can't cool 5 kw of power by blowing on it." But the new trans-

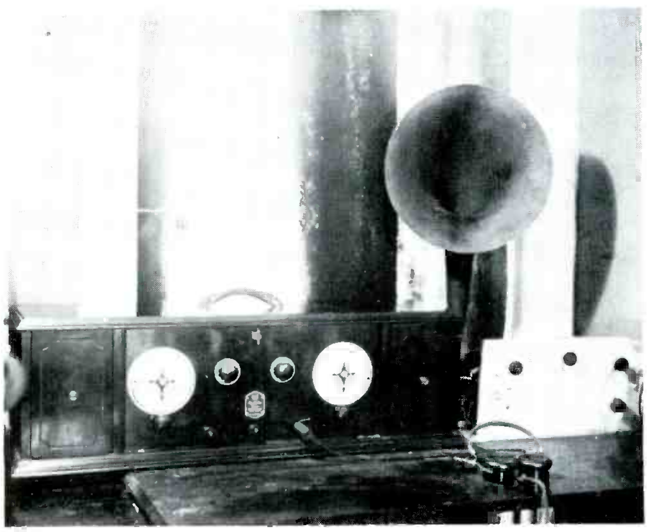


Fig. 2. Receiver and its battery-powered dynamic speaker.

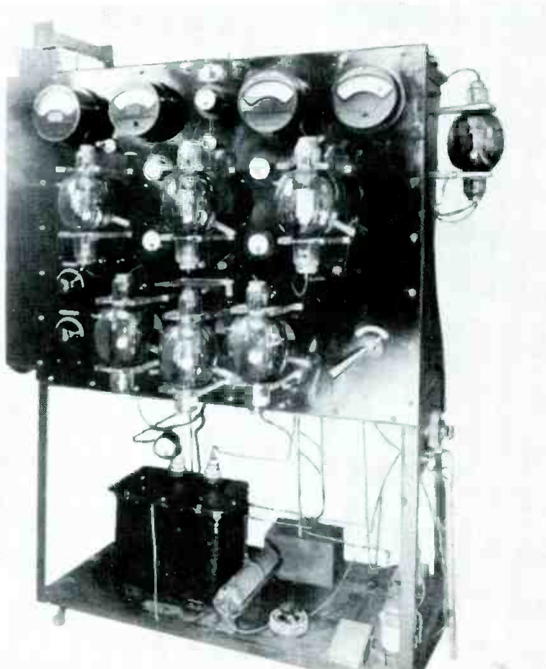


Fig. 3. Modulated-oscillator transmitter of the early 1920's.

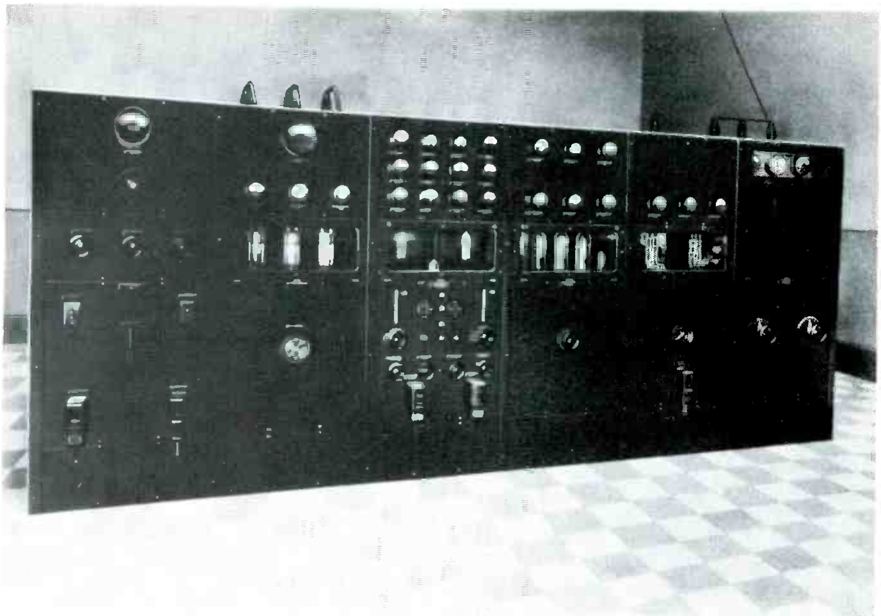


Fig. 4. A five-kilowatt AM transmitter of the type used in the late 1920's.

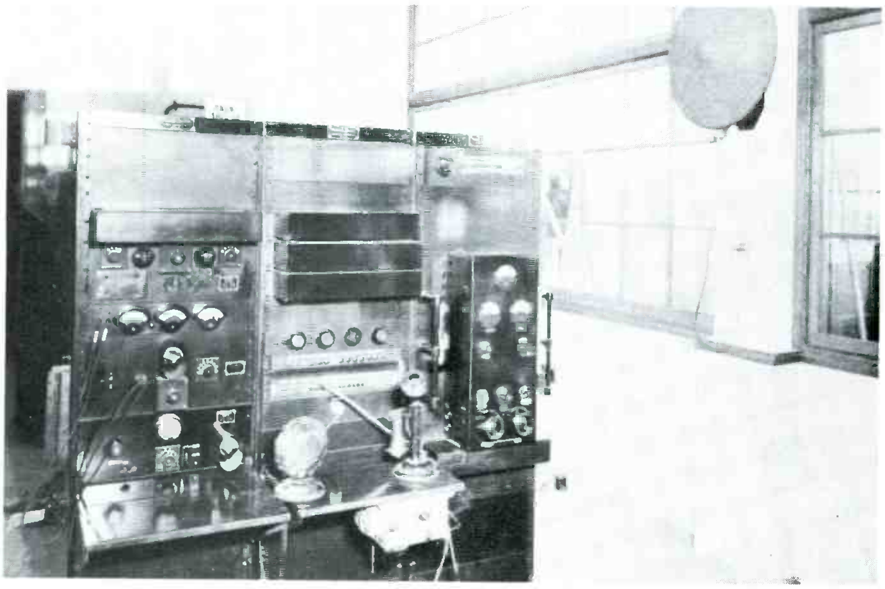


Fig. 5. The audio control bay of a five-kilowatt radio station. Circa 1929.

mitter did away with leaky venturi tubes and the continual worry of getting a supply of distilled water. Those skeptics would be somewhat amazed at the present 50-kilowatt transmitter that is entirely air cooled.

After 1923-24, Canadian broadcasting, in the large centers of population, followed in general the development in the United States, with the first broadcast from an outside point, from an airplane, from a submarine, etc.

Experimental television began at CKAC in 1926, when a drum scanner was used. This was followed by a 45-line scanner system in 1931. This pioneer television station operated under the experimental call letters VE9EC. As the station progressed from the "flying spot" type of pick-up (Fig. 8), which required the studio to be in almost total darkness, to the 60-line scanner using its own photocell and four 1-kw DC lights, regular programs were broadcast twice per week from July 20, 1931 until 1934. Dr. V. K. Zworykin's "iconoscope" ended the mechanical-scanning period of television and ushered in the television marvels of today.

The first work as a commercial station in Canada and the introduction to the art belong to the Marconi Company, and the first private company to buy a complete radio broadcasting station was *La Presse,* the large French-language newspaper

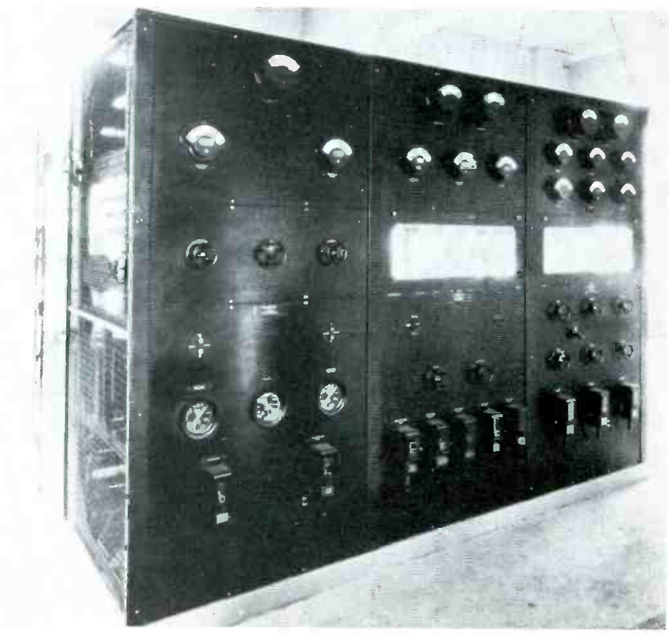


Fig. 6. Power units of the CKAC 5-kw transmitter (1929).

that owns CKAC. However, it must not be thought that Montreal was the only place in Canada where radio broadcasting was pioneered. Out west, W. W. Grant built an amateur station that operated from High River, Alberta; this was in 1921. Following the example of *La Presse*, the Western newspapers got into the broadcasting business; G. A. Rice of the *Edmonton Journal* and H. G. Love of the *Calgary Herald* were operating stations in late 1922. George Chandler of Vancouver's CJOR and A. Hooper of CKCK, Regina, are among the many western pioneers.

In 1922, there were only 39 stations in all of Canada, but they were established from Halifax to Vancouver. The minimum power was 10 watts, and the maximum was 2000 watts. Many of these stations were built by radio amateurs out of spare parts obtained from wireless operators, or parts bought from the few amateur-radio supply houses in the United States. Of these 39 original stations, 17 did not survive a year, and in 1923 only 22 of the pioneers were left. Later, other stations took the vacated frequencies so that by 1924 there were 50 stations in operation. Today there are over 229 AM, 67 FM, and 175 television stations in Canada.

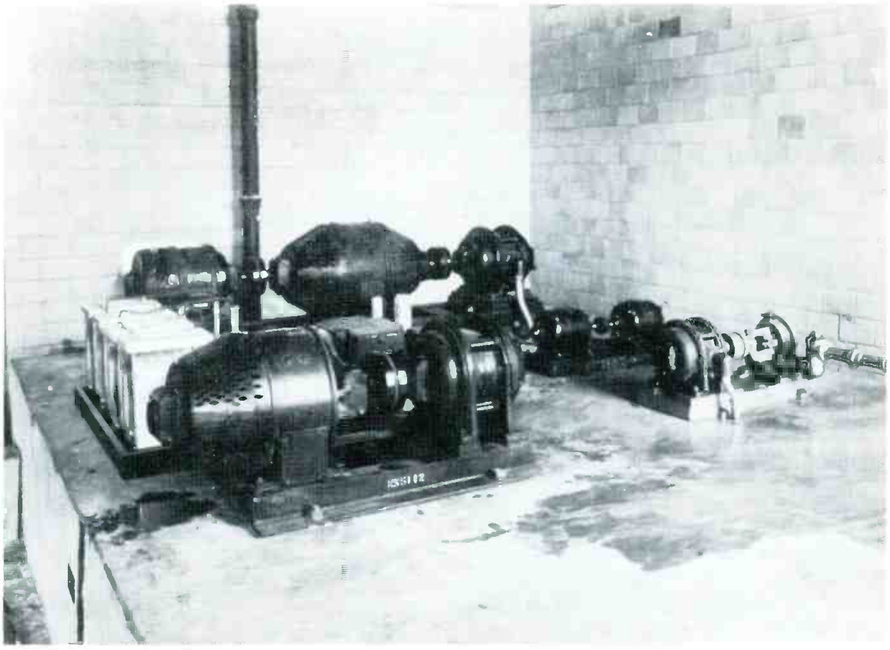


Fig. 7. Motor-generator sets, water pump in power plant for 5-kw transmitter.

The Government

When there is a controversey over public affairs in Canada, it is customary to create a "Royal Commission," the equivalent of a "Senate Investigating Committee" in the United States. The broadcasting industry has been the subject of considerable controversy at times, and Canadian "Radio Enquiries" or Commissions have occurred as follows: "Aird Report," 1929; Massey Report," 1951; "Fowler Report," 1957; "Glassco Report," 1963; "White Paper," 1966. These are the "big" ones, but as the Government-owned and -operated radio and television networks must apply annually for operating and capital funds, there is an "open" season each year for the proponents of complete State ownership and program control to battle with those who opt for a private-enterprise system.

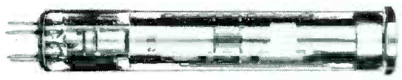
Conclusion

It has not been possible in one article to name all the pioneers nor to trace the complete history of Canadian broadcasting from the beginning to the present. However, it is hoped that these highlights will give some idea of what broadcasting was like in those early days. And, perhaps this story will provide some measure of recognition for those pioneers without whose efforts our industry would not exist today. ▲

Fig. 8. Flying-spot TV scanner used at CKAC 1931-1934.

NEW PRODUCTS

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



Electrostatic Vidicons
(89)

A series of 1-inch electrostatically focused **EEV** vidicon tubes for use in transistorized film and live color cameras is available from **Visual Electronics Corp.** Since the Type 8134 tube series utilizes an electrostatic focusing electrode, no focus coil is used. This design is intended to offer advantages in terms of bulk and power consumption.

For color applications, the tubes will be supplied in matched sets. Characteristics listed for the tubes include freedom from "S" distortion and focus-induced image rotation, and uniform "beam landing."

The tube types are designated 8134 for monochrome applications; 8134-V1 and 8134-VB for color film cameras; and 4493, 4494, and 4495B for live color cameras.

FM Monitors
(90)

Three new FM monitors have been introduced by the **Gates Radio Co.** The Model GTM-88S (top photo) stereophonic modulation monitor is intended to measure all modulation characteristics of an FM signal in accordance with FCC requirements. Modular silicon solid-state circuitry is used throughout the monitor, and integrated circuits are used for the purpose of improving reliability while keeping total physical component count low. Provisions are included for adding an adapter to measure SCA modulation characteristics. Test instruments (oscilloscopes, etc.) may remain connected to the stereo monitor. The left-channel instrument output is switchable to either channel by a front-panel control.

Also offered is the Type GTM-88M monophonic modulation monitor (similar in appearance to top unit in photo). This monitor can be converted to stereo operation at any time by adding appropriate modules and filters and then calibrating for stereo operation. Solid-state and integrated circuits are used in this monitor also.

All controls are accessible from the front of the monitors. Each is supplied calibrated to the specified operating frequency.

Pulse counting techniques are used to provide FM-transmitter frequency measurements in the Model GTM-88F frequency monitor (bottom photo). This all-solid-state instrument is designed to provide measurement accuracy of 0.001% or better over the entire FM broadcast band.

Coaxial Cables
(91)

A line of coaxial cables, the "9800" Series, has been introduced by **Alpha Wire**, a division of **Loral Corp.** The line is intended to make it possible for the user to select a coaxial cable that is engineered and designed especially for applications including CATV, color and black-and-white TV, CCTV, MATV, FM, ETV, and others. There are 13 different cables in the line, providing a variety of jacket, shield, and dielectric types. Quality-control checks listed by the manufacturer include 100% sweep testing of all cable lengths. Other listed quality-control measures on production runs include electrical-property tests; corona extinction, concentricity, aging, and flow tests; and exposure tests.

75-Ohm Patching System

(92)

A line of 75-ohm patching equipment for use in TV, microwave carrier, and general communications coaxial-cable systems has been announced by **Trompeter Electronics, Inc.** Included are standard and miniaturized patch-panel jacks, patch plugs, and accessories compatible with existing Western Electric types. Also available are 75-ohm cable fittings in BNC and TNC versions.

RF Directional Wattmeters

(93)

The 4110 series *Thruline* RF directional wattmeters are palm-sized power meters for use in servicing communications equipment in the 2-175 MHz range. The one-pound **Bird Electronic Corp.** units are built to provide ±5% accuracy.

The wattmeters measure 2"x3"x 4½" and can be switched from forward to reflected power on the blow-protected front panel. The 50-ohm instruments do not require batteries, line power, charts, or plug-ins. Three different units are the Model 4113, 1000/100W, 2-30 MHz; Model 4112, 200/20W, 2-30 MHz; and Model 4111, 150/15W, 25-175 MHz.

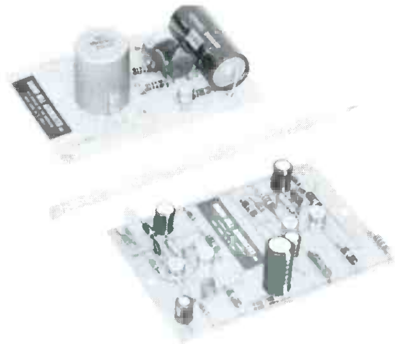
Connectors are available for this series in UHF, BNC, or N (female N standard). An overall insertion VSWR below 1.10 is specified. The price is $93.

Flexible Waveguide for ITFS Band

(94)

A new size of *Heliax* elliptical waveguide has been developed by the **Andrew Corp.** for use in ITFS applications in the 2.5-2.7 GHz band. Overall bandwidth of Type EW20 flexible waveguide is 1.9-2.7 GHz.

Listed characteristics for lengths up to 200 feet include attenuation of 0.43 dB/100 feet in the 2.5-2.7 GHz range, average power rating of 23.5 kw, and maximum VSWR of 1.15:1. Type EW20 is available in continuous lengths up to 1000 feet and may be formed to a 26-inch installed E-plane bending radius.



Solid-State Modules
(95)

Two additions have been made to the **Round Hill Associates, Inc.** line of solid-state circuit boards.

A minimum voltage gain of 70 dB is specified for the AA-500 preamplifier (bottom in photo), designed for broadcast and recording studio applications. Specifications for this unit include: frequency response, ±1 dB, 20 to 20,000 Hz; harmonic distortion, less than 0.5%, 20 to 20,000 Hz; IM distortion, less than 0.05% 60/6000 Hz; input impedance (at 1 kHz), 48,000 ohms; output impedance, 5000 ohms design center (may be loaded down to 1000 ohms with only 6-dB loss in gain); voltage gain, 70 dB; undistorted output, as much as 5 volts rms; noise, better than −60 dB; power supply, 40 volts, 5 ma; size, 4½"x3"x 1¼"; weight, 2 ounces.

With the exception of a 25,000-ohm volume control (not supplied), only signal and power connections are required for installation. Price is $23.95.

Three basic versions of the AA-500 preamplifier are available: Type AA-500 has a flat frequency response; Type AA-500-R has RIAA equalization; Type AA-500-N has NAB equalization.

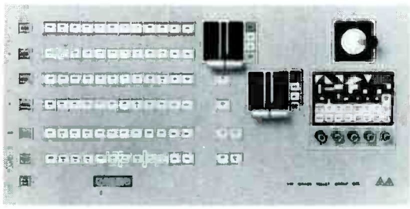
The second unit is the OS-100 oscillator (top of photo), which utilizes two transistors in a push-pull arrangement designed to produce a sine-wave output having less than 1% harmonic distortion. Frequencies from about 20 kHz to over 150 kHz can be generated, and a tapped output transformer provides a variety of possible output voltages. The OS-100 is intended for applications such as supersonic signalling, biasing of tape-recorder heads, and supplying power for tape erasing. Input terminals on the unit provide a means for amplitude modulating the oscillator signal. A DC supply of approximately 100 ma at 18 to 22 volts is required. The unit measures 5"x3"x2" and weighs 4 ounces. Its price is $21.95.

Zoom Lenses
(96)

A solid-state electronic speed-control system for **Zoomar, Inc.** ITV lenses has been designed to operate over a broad range of infinitely variable speeds, while maintaining high torque quality. Zoom, iris, and distance settings are independently controlled by switch-type knobs which change the speed according to the angle of rotation.

This control system measures 2½" x 5" x 6" and is intended for standard rack mounting or table-top use. The units are interchangeable with existing Zoomar control models.

The Zoomar-Variospeed-Hightorque-Control has a list price of $350.



Video Switcher
(97)

An all-solid-state switching system with optional automatic features, designed by the **Grass Valley Group, Inc.**, is to be sold by **Gravco Sales, Inc.** The system is designed to reduce operator error and fatigue by eliminating the need for critical decisions. When a source is selected, logic circuitry automatically processes the signal to make it suitable for use in the desired bus. Mixers, special effects, color keying, and other options may be incorporated into the system. A modular approach permits construction of systems of various sizes with expansion capabilities.

Solid-State DC Amplifier
(98)

The new **Rust Corp.** Model DCA-1 is a general-purpose printed-circuit DC amplier for use in a variety of metering and monitoring applications. Its very high input impedance is intended to make it suitable for bridging circuitry. A self-contained power supply operating from standard AC line voltages makes the amplifier independent and isolated from ground for use in amplifying off-ground signals. The amplifier gain is changeable from the standard gain of 25. An internal zero-set control is included; it may be used to offset the amplifier output. This feature is useful in converting from a "zero-center" sample source to a "zero-left" output (such as in remoting or logging a frequency monitor). It may also be used to suppress a reading to obtain an expanded-scale effect. A combination of the DCA-1 DC amplifier and the Rust DCT DC isolator may be used to read remotely the Hewlett-Packard 335B monitor. The DCA-1 DC amplifier is available as an uncased unit or in single or multiple rack-panel cases. Uncased dimensions of the amplifier are 6.7"x2.5"x1¾".

Envelope-Delay Correction Network
(99)

An envelope-delay correction network, designed to permit color video signal transmission corrected to meet FCC specifications, is available from **Kappa Networks Inc.** Delay of the unit is specified as constant to ±40 nsec up to 3 MHz, then decreasing linearly to −170 ±20 nsec at 3.58 MHz and −350 ±40 nsec at 4.18 MHz. The network occupies less than 8 cubic inches overall, and the electrical specifications include a reference frequency of 100 MHz, signal amplitude constant ±1 dB or less, and impedance of 75 ohms.

The unit is contained in a hermetically sealed brass case filled with foam epoxy resin. It can be mounted by means of its two 6/32x1/2" studs; the terminals are UHF or BNC. ▲

PERSONALITIES in the Industry

MANUFACTURING

O. A. (George) Lively has been appointed to the newly established position of manager of marketing research and planning for the Visual Communication Products Department of **General Electric Company.**

In his new position, Mr. Lively will be responsible for surveying market potential for Department products to meet customer needs and marketing planning. He was formerly sales manager for the Company's Distribution Protective Equipment Department in Pittsfield, Mass.

Theodore Baum has been elected president of **Vikoa, Inc.** Mr. Baum previously was executive vice-president of Vikoa. Mr. Arthur Baum, former president, will retain his position as chairman of the board.

Marvin B. Jacobs has been named as head of the Television Lens Dept. at **Century Precision Optics,** North Hollywood, Calif.

Mr. Jacobs brings to Century 20 years of experience in the television industry as an optical engineer and zoom-lens servicing consultant. He holds a degree in optical science from the University of Jena, Germany. His work in special optical effects has earned him several industry awards.

The appointment of **Bruce K. Frazier** as southwestern regional manager of **Entron, Inc.** has been announced. He will headquarter in Ft. Worth, Texas and be responsible for sales and services in the states of Texas, Oklahoma, New Mexico, Louisiana, Arkansas, Missouri, and Kansas.

Stephen Prigozy has been appointed as vice president-engineering of **Robins Industries Corp.** Mr. Prigozy's responsibilities include **Genarco, Inc.,** a manufacturing subsidiary of Robins, as well as the company's magnetic tape, perforator tape, and audio and data processing product divisions.

Mr. Prigozy was formerly chief engineer at Trygon Electronics, Inc. He also had been with Airborne Instruments Laboratory and Simmonds Precision Products.

Paul Spranger has been promoted to chief engineer of electronics for **Altec Lansing,** a Division of **LTV Ling Altec, Inc.** Spranger, who has been senior engineer, joined the company a year ago.

APRIL, 1968

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Please check BOTH your business and occupation

- A. ☐ AM Radio Station
- B. ☐ FM Radio Station
- C. ☐ Television Station
- D. ☐ Network
- E. ☐ Consulting Engineer
- F. ☐ Manufacturer or Distributor
- G. ☐ Recording Studio
- H. ☐ Government Agency, Library, School
- J. ☐ Owner, Manager, Officer
- K. ☐ Engineer, Technician
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He has been active as an electronic engineer for 18 years. Prior to joining Altec Lansing he was director of research and development with a major manufacturer of electronically amplified musical instruments.

Thomas J. Nicholson has been appointed Executive Vice President and General Manager of **Vega Electronics Corporation.** Nicholson has been Executive Vice President of M. V. R. Corporation in Palo Alto for the past several years and was previously with Ampex and General Electric.

William S. Sadler, director of the Miratel Division of **Ball Brothers Research Corporation,** has been named director of long-range product planning for Ball Brothers.

Following engineering positions with KPIX-TV and KRON-TV in San Francisco, and KSTP in Minneapolis, Sadler founded Miratel Electronics Company in 1955. He served as the firm's executive until it was acquired by Ball Brothers Research Corporation in June of last year. He is an active member of the Electronic Industries Association.

William Robinson has been named southeast regional sales manager for **Anaconda Astrodata.** He will remain in Atlanta and will take over responsibility for sales of the company's CA-TV products in the southeastern states.

The appointment of **Aaron R. Wall** as president of **TelePro Industries, Inc.** has been announced. Mr. Wall joined TelePro Industries early in 1967 as general manager.

John E. Nelson has joined the engineering staff of **Michigan Magnetics.** He formerly was chief engineer at Arvin Industries, and has been a project engineer at Control Data and an engineer at IBM.

Gaylord G. Rogeness has been appointed director of research at **Anaconda Astrodata Co.** Mr. Rogeness earned his MSEE from the University of Illinois, and prior to joining Anaconda Astrodata he was director of engineering at Ameco, Inc. Earlier positions included those of consultant at Goodyear Aerospace Corp. and project engineer at Interstate Electronics.

Joseph M. Engle, Jr. has recently been promoted to the position of regional sales manager for **Gates Radio Co.** Since joining Gates in 1957, Mr. Engle has served as sales engineer in the Denver, Colorado territory, and district sales manager for the New York City area. Prior to that time he held engineering positions with Crosley Broadcasting Co. and with WDAF-TV in Kansas City, Missouri.

Gravco Sales, Inc., a subsidiary of the **Grass Valley Group, Inc.,** has announced the appointment of **Donald H. Hansen** as Southwest area sales manager. Mr. Hansen has extensive experience in the broadcast field and was connected with KING-TV in Seattle for almost 20 years. He will be responsible for the sales of the Grass Valley Group's video switching and studio equipment and CEI patching equipment, for the states of California, Arizona, and Nevada. He will also handle sales of Canon lenses in California and Nevada.

BROADCAST

Roy F. Hoover, engineering supervisor at **KDKA-TV,** Pittsburgh, has been promoted to chief engineer, it has been announced by Glen Lahman, engineering manager at the station. Hoover joined KDKA-TV in 1953 when the station was known as WDTV and is an associate member of the Society of Motion Picture and Television Engineers (SMPTE).

H. B. Holtman, formerly assistant

chief engineer of **WAVE Radio and Television**, has been named chief engineer of the station. He will replace Wilbur Hudson, who retires May 1 after more than 35 years with WAVE.

The station also promoted WAVE engineering supervisors Robert Roth and Norman D. Preston to assistant chief engineers.

Appointment of **Daniel R. Wells** as director of engineering services for the **CBS Television Stations Division** has been announced by Hal Hough, vice-president of Program services for the Division.

In his new post, Mr. Wells will advise and assist the CBS owned television stations in their engineering and technical activities. In addition, he will represent the stations in their dealings with the CBS Television Network Engineering and Development Department.

W. C. Wiseman has been named Manager of Engineering for **WUAB-TV**, Lorain-Cleveland, Ohio, it was announced by John A. Serrao, Vice President and General Manager of United Artists Broadcasting, Inc.

Mr. Wiseman is now directing construction of the WUAB-TV facilities, with an air date of early fall.

Don Holland has been made assistant chief engineer of **WKBW-TV**, Buffalo, New York. Mr. Holland was formerly associated with WXRA and WKBW Radio in Buffalo.

CATV

Robert Wheatley has been named operations manager for the CATV Construction Department of **Jerrold Electronics Corp.**, it was announced by Earl C. Fletcher, department manager.

In his newly created position, 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 CATV turnkey construction contracts.

Wheatley has had broad experience in the CATV field. Prior to his new assignment, he was a project manager for the department. He joined Jerrold in 1956 as an installation technician; from 1960-62, he served as an assistant estimator. He also has been a technician with Television Cable Corp. in Kingsport, Tenn.

George W. Henderson has joined **Kaiser CATV Corp.** as field engineer, according to a recent announcement by Robert W. Behringer, executive vice-president and general manager.

Mr. Henderson has been in CATV for the past six years as a field engineer for Ameco and Jerrold, and most recently as chief engineer for Cable TV of Santa Barbara.

GOVERNMENT

Peter P. Viezbicke, Jr., has been appointed Acting Chief of the NBS Frequency-Time Broadcast Services, at the NBS Laboratories in Boulder, Colo.

Mr. Viezbicke, an electronics engineer, joined the National Bureau of Standards in June 1946. Author and coauthor of nearly a dozen technical reports on antenna design and performance, Mr. Viezbicke is a member of the Institute of Electrical and Electronics Engineers and is a professional engineer of the state of Colorado.

OBITUARY

Mr. Bert Williamson, president of **QRK Electronic Products, Inc.**, died of an acute heart attack January 11, 1968 in Hawaii, during an extended vacation to help him recover from a heart attack suffered in October of last year.

QRK Electronic Products, Inc. will continue to operate under the management of Mr. Arthur H. Cake, general manager. ▲

Engineers' TECH DATA

ANTENNAS, POWER & TRANSMISSION LINES

100. ANDREW—Dehydrators are described in technical bulletins TB263 and TB180.
101. DELHI—Twelve-page catalog concerns towers and masts for Citizens-band and similar applications.
102. JAMPRO—New catalog of circularly polarized FM antennas with power gains up to 16.6 is offered.
103. RF SYSTEMS—Literature describes 20′ and 30′ parabolic antennas and ruggedized Yagi antennas for head-end equipment.

AUDIO EQUIPMENT

104. ALTEC LANSING—Brochure describing Model 9200A user-assembled console and data for M49-50 condenser microphones are offered.
105. ATLAS SOUND—Form PP-1840 describes microphone stands, microphone booms, and studio accessories.
106. AURICORD—Information describing the new Model TF1000 tape deck is available.
107. FAIRCHILD RECORDING—Technical bulletin describes new Model 610 monitor amplifier.
108. McCURDY RADIO—Complete loose-leaf catalog of audio consoles and amplifiers is offered.
109. SHURE—Eight-page professional products catalog lists microphones, circuitry, cartridges, tone arms, and microphone accessories.
110. UNIVERSITY—28-page Commercial Sound Product Catalog lists speakers, horns, drivers, microphones, and sound columns; includes sound-system design chart, formulas, and technical data.

AUTOMATION EQUIPMENT

111. CHRONO-LOG—Four-page bulletin describes their system for TV switching automation.
112. INTERNATIONAL GOOD MUSIC—Series 600 audio control systems are detailed in a six-page brochure.
113. MOSELEY ASSOCIATES—Bulletin 221A describes Model ADP-101 automatic data printer for transmitter logging.

CATV

114. AMECO—"Tech Topics" is a regular feature of monthly PROFIT PACKAGE mailing.

COMPONENTS & MATERIALS

115. CLEVITE PIEZOELECTRIC DIV.—Bulletin 94025 describes ceramic filters.
116. INDUSTRIAL ELECTRONIC HARDWARE CORP.—Information about a new hyperbolic-contact connector is available.
117. KAPPA—Bulletin 68-1 describes the new 552 series of low-pass filters.
118. METRO-TEL—Equalizers and delay lines are described in Bulletin 21.
119. MICROLAB/FXR—Catalog Supplement 17A describes coaxial connectors, splitters, samplers, terminators, etc.
120. SWITCHCRAFT—New Product Bulletin 173 describes two new audio adapter connectors. A 25-page short-form catalog is also available.
121. TROMPETER—Catalogs T-7 and M-4, listing coax, twinax, and triax products for patching, switching, and matrixing, are offered.

FILM EQUIPMENT

122. HOUSTON FEARLESS—A brochure describing the "Mini-Color" news-film processor is offered.

123. KALART/VICTOR—Form 2588A describing the Model STV-TB projector is offered.

124. SPINDLER & SAUPPE—A preliminary data sheet on the Spectrum 32 color slide projector and literature about Models 322 and 332 slide projectors are offered.

125. TRAID—The Model 16N/TV stop-action projector is described in a new "Spec/Data" sheet.

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

MICROWAVE & STL

127. MICROWAVE ASSOCIATES—Brochure SF-9501R describes intercity, STL, and TV-pickup microwave systems. Brochure SF-9501 describes similar equipment for CCIR applications.

MISCELLANEOUS

128. AEL—The availability of a new 75-page general catalog, listing antennas, solid-state switches, filters, frequency multiplexers, instruments, and amplifiers, has been announced.

129. ZERO MFG.—New, 24-page catalog R-68 describes 10 series of blowers and cooling equipments for electronic cabinets.

POWER DEVICES

130. PROSSER INDUSTRIES—The Model 2511A, 2500-watt, 60-Hz alternator for mobile operation is the subject of specification sheet F-2511-1.

RECORDING & PLAYBACK EQUIPMENT

131. JOA—Prices and data are given for new tape cartridges and for cartridge-reconditioning service.

132. GATES—The availability of a new brochure about automatic tape control, cartridge tape, and accessories is announced.

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

134. RYDER MAGNETIC SALES—Literature describing Nagra recorders, Sela audio production mixers, and the Talmak footage counter is offered.

135. SPARTA—Tape-cartridge accessories, including cartridge-storage racks, erasers, and tape-head demagnetizers, are the subject of a product guide.

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

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

REFERENCE MATERIAL & SCHOOLS

138. 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.

TELEVISION EQUIPMENT

139. CANOGA—Application bulletins describe a weather-briefing system, an underwater CCTV camera, and the CH-2800 self-contained, solid-state, vidicon camera for CCTV.

140. CLEVELAND ELECTRONICS—A 52-page quick-reference catalog gives information on vidicon, **Plumbicon,** and image-orthicon deflection components.

141. COHU—Data sheets 6-488, 6-470, and 6-464 give specifications for the 2610/2620 series black-burst generator, drive generator and colorlock, and chroma detector, respectively.

142. COLORADO VIDEO—Preprint No. 102-25, "A Magnetic Disc Video-Scan Converter," presented at the 102nd SMPTE Technical Conference, is offered.

143. DYNAIR—Short-form catalog describes the line of equipment for video and pulse distribution, video switching, video transmission, and head-end service, and also the new, "Mini-Line" series.

144. INTERNATIONAL NUCLEAR—A color black-burst generator and a transistorized, clamping video amplifier are the subjects of technical data sheets.

145. TELEMATION—The Multicaster video control center for ETV, CATV, and CCTV, combining switching, pulse distribution, video processing and control, and an output amplifier, all in a desk-top unit, is described in a four-page data sheet.
146. TV ZOOMAR—Literature covers H.T.S. studio equipment, Newsbreaker 400 color-film processor, and **TV Colorgard** meter to balance color TV monitors.
147. VITAL—Model VIX-108, new integrated-circuit, vertical-interval switching system, and Model VI-1000 video processing amplifier are subjects of literature.
148. WINSTON RESEARCH—A dynamic video-noise suppressor is described in a technical data sheet.

TEST & MEASURING EQUIPMENT

149. BALLANTINE—Price list and twelve-page 1968 catalog are offered.
150. B & K—Bulletin No. 8-016 describes the Model 2006 frequency-selective voltmeter.
151. BARKER & WILLIAMSON—Specifications and descriptions of test equipment, coaxial switches, dummy loads, RF filters, and RF components are included in an eight-page sales bulletin.
152. DATAPULSE—Technical Bulletin 110B describes the Model 110B, 50-MHz pulse generator.
153. DELTA—Information sheet has as its subject the Model RG-1 receiver/generator for use with antenna-impedance bridges.
154. NORELCO—50-page comprehensive catalog describes the newly introduced line of test equipment.
155. SENCORE—Eight-page catalog and four-page supplement describing the test-equipment line are offered.
156. TEKTRONIX—December, 1967 issue of SERVICE SCOPE features an article on the Type 520 NTSC vectorscope.
157. TRIPLETT—New catalog 52-T describes the complete line of VOM's.
158. WEINSCHEL ENG'G—Line of barretters and thermistors is subject of four-page publication.

Engineers' Exchange

Off-Air Monitoring With Headphones

In most broadcast audio consoles, the headphone jack is connected across the output line. This presents two problems for the operator: lack of gain control, and the inability to monitor the off-the-air signal. By rewiring the jack to the output of the monitor amplifier, both of these problems are eliminated. The volume at the headset will now be controlled by the monitor-amplifier gain control. And, since most console monitor amplifiers have an input selector switch to permit monitoring the console output line, audition line, and an off-the-air signal, all of these signals are now available at the headphone jack. In order to equalize the volume of the headset and monitor speakers, it may be necessary to remove one or both of the resistors found in series with the headphone jack, or to install a series pot for initial balance. —*Barry Atwood*

Advertisers' Index

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Applications and Field Engineering
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PRECISION FREQUENCY
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AMPEX HEAD ASSEMBLY RECONDITIONING SERVICE for all Ampex professional model recorders. This professional service features precision relapping of all heads for maximum head life. Your assembly is thoroughly cleaned and guides are replaced as required. Price includes optical and electrical inspection and complete testing on Ampex equipment in our plant. Full track or half track assemblies . . . $35.00. One to two day service. "Loaner" assemblies available if necessary. LIPPS, INC., 1630 Euclid Street, Santa Monica, California 90404. (213) EX 3-0449. tf

CRYSTAL AND MONITOR SERVICE — Frequency change and repair service for AM monitors including G.R., RCA, Gates, W.E., and Doolittle; also H-P 335B FM. AM monitors bought and sold. What have you, what do you need? New or regrinding of AM crystals for RCA, Gates, Bliley, W.E., and J-K oven holders, repairs, etc. Fastest service, reasonable prices. Over 25 years in this business. Eidson Electronic Co., Box 96, Temple, Texas 76501, Phone 817 773-3901. 2-67-tf

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VIDEO TAPE RECORDER AUDIO HEAD ASSEMBLY SERVICE
Precision relapping of all heads and supporting posts, including cleaning and testing. Ampex head assembly with "cue" tracks, $75.00 complete. RCA units also relapped. One to two day service. LIPPS, INC., 1630 Euclid St., Santa Monica, Calif. 90404. (213) EX 3-0449. tf

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Advertising rates in the Classified Section are fifteen cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra.

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Scully tape recorders as low as $13.55 weekly. Three Spotmasters, one record/playback, and two playbacks, all three, $38.25 monthly. Multiple units. Spot Five, $47.25 monthly. Two QRK or Russco deluxe turntables, $10.80 monthly. Lower payments with trade. Write for list. Purchase your cartridges from us, we ship freight prepaid. Audiovox, Box 7067-55, Miami, Florida 33155. 4-68-tf

BROADCAST EQUIPMENT REBUILDERS . . . your headquarters for tape cartridge reconditioning, all work fully guaranteed! Write Quin Morrison about your used equipment needs. New Address: Box 276, Hickory, N.C. 28601. 11-67-tf

Coils, Contactors, Switches, Complete ATU systems. Top Quality, Lowest Prices, Fast Delivery, No Duty. Write for catalogue: Geleco Electronics Ltd., 2 Thorncliffe Pk. Dr., Toronto 17, Ont. 416-421-5631. 11-67-12t

SALE! General Radio 1800A Vacuum-Tube Voltmeters. $125.00. Mirror scale, 2% accy., .01-150V DC, .1-150V AC and RF. RF input is good to 500 MHz and meter can be used to measure RF voltages in AM & FM transmitters and receivers. Supplied complete with adapter to connect RF probe to G.R. 874 coaxial systems, 50-ohm RF terminating resistor, and new AC cord. Units are used, government surplus, in good operating condition, checked and calibrated before shipping. OTHER SPECIALS: General Radio 1606A RF Bridge, late model with the new grey finish, calibration excellent, complete with carrying case, $795.00. ALSO Hewlett-Packard 650A test oscillator, (audio-video), 10Hz to 10MHz, $325.00. ALSO Ampex 351-2 stereo recorder, just overhauled, brand new Nortronics heads, 30960 series electronics, $1495.00. All equipment F.O.B. San Francisco. HUNTER ENGINEERING, 2175 44th Ave., San Francisco, 94116, 415-731-9197. 3-68-2t

"AUDIO EQUIPMENT — Whatever your needs, check us first. New and used. Ampex, Altec, AKG, EV, Fairchild, Neumann, Langevin, Rek-O-Kut, Uher, Viking. Send for equipment list." Audio Distributors, Inc., 2342 S. Division Ave., Grand Rapids, Michigan 49507. 6-66-tf

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Completely reconditioned and guaranteed. Spotmaster Model 500 Record/Playbacks, $350.00. Model 505 Playbacks $250.00. 30-day money-back guarantee on all equipment.
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(301) 926-4600 3-67-tf

Everything in used broadcast equipment. Write for complete listings. Broadcast Equipment and Supply Co., Box 3141, Bristol, Tennessee. 11-64-tf

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

TK26 Color Film Camera available, ideal for low budget color. Contact Jim Lockerd, Chief Engineer, KSWO-TV, P.O. Box 708, Lawton, Oklahoma. 355-7000. 4-68-1t

For Sale: Several reconditioned, recalibrated, and excellent AM frequency monitors to your frequency. Eidson Electronic Co. Box 96, Temple, Texas. 4-68-1t

IDECO Tower Sections. Six 20 foot, one 12 foot sections, four foot triangle, solid welded steel construction, three 325 foot ¾ inch guy lines with 21 Locke insulators, six vacuum fixed condensers, two variable vacuum condensers. Radio Station KSO, 3900 N.E. Broadway, Des Moines, Iowa 4-68-1t

FOR SALE—Sound Level Meter GENERAL RADIO 1551-B with power supply in new condition. Mr. Donald Roller, Department of Physiology, Indiana Medical Center, 1100 West Michigan, Indianapolis, Indiana 46202. 4-68-1t

YOUR NEXT REMOTE CAN BE AS CLOSE AS YOUR CAR! Get news and special events on the air faster with 2-way FM Mobile Radio. Largest distributor of used Mobile Radio equipment: GE—Motorola—RCA. All types, VHF and UHF. Mobiles and bases. Catalog on request. GREGORY ELECTRONICS CORP. 249-K Rt. #46, Saddle Brook, N. J. 07662 (201) 489-9000. Ask for Doug Channel. 4-68-1t

FOR SALE: 2 E-V 666 mikes, $90.00 each; 2 Neumann U67 mikes with wind screens, $298.00 each; 2 Westrex (just rebuilt) 2B cutters, $1,095.00 each; 1 Heaco 2B driver amplifier, $685.00; 1 Westrex 2B driver amplifier, $450.00; 8 Cinema Engineering 101 AX pre-amp with trays, $40.00 each; 2 Heathkit amplifiers 30 watt, $20.00 each. Contact: Hank Waring, 1456 Cahuenga Blvd., Hollywood, Calif. 90028 or call HO 3-9804. 4-68-1t

Complete AUDIO PROOF KIT: tabulated data, response distortion curves, hum noise tests, statement and chart including FCC requirements neatly bound $3.50 postpaid. Specify AM or FM. Broadcast Services Company, P.O. Box 2605, Corpus Christi, Texas 78403. 4-68-1t

AMPEX VR-1000C videotape recorder/reproducer for monochrome broadcast. Refurbished. Rebuilt quad head. Picture, waveform, and audio montiors, $10,500. Write Box 203. 4-68-1t

USED BROADCAST VIDEOTAPE RECORDERS

AMPEX VR-1000B, VR-1000C, VR-1100

RCA TR-4, TR-22

Accessories available for some units. Priced from $7,500 to $30,000. Write:

Box 204

TOWERS, lights and accessories AM FM communication, CATV, sales, erection and complete service, world wide. Write Dixie Steeplejack Company, 2832 Riverview Blvd. West, Bradenton, Florida. tf

Equipment Wanted

We need used 250, 500, 5K & 10K Watts AM Transmitters. No Junk. Guarantee Radio Supply Corp., 1314 Iturbide St., Laredo, Texas 78040. 3-66-tf

Wanted: Fairchild conax-1 mono, 1 stereo; Westrex 3C cutters (need not be in working order): 1 V.P. Scully lathe. Contact Hank Waring, 1456 Cahuenga Blvd., Hollywood, California 90028 or phone HO 3-9804. 4-68-1t

Employment

IMMEDIATE OPENINGS—Qualify for any of the following positions: Technicians for RCA Closed Circuit Television equipment, Cameramen, Maintenance men, Video Tape men, Video Engineers, Sales Engineers. RCA Rep. 143-08 94th Ave., Jamaica, New York, or (212) 297-7344. 7-67-tf

We have openings in all phases of the broadcast industry for men with electrical engineering degrees. Openings are with TV, Radio Stations, CATV Systems, Broadcast Equipment Manufacturers and allied fields. Send resume to Nationwide Broadcast Personnel Consultants, 645 N. Michigan Avenue, Chicago, Illinois 60611. No fee and confidential. 1-68-tf

Leading Northeast educational TV station needs experienced maintenance engineer. Send resume. Box 200, BROADCAST ENGINEERING. 3-68-2t

Job Headquarters for all Radio and Television Engineers. Immediate openings exist in 9 western states and elsewhere for qualified engineer and technical personnel. All categories from trainees to experienced transmitter maintenance, chief, assistant chief, live color video maintenance and technical operations. Send us your complete resume now. The AMPS Agency, 3924 Wilshire Blvd., Los Angeles, California 90005. Telephone DU 8-3116.
By Broadcasters—For Broadcasters 11-66-tf

ENGINEERS

We have an opening for a particular type of engineer. The man we are looking for has been in television for several years, he is capable and resourceful, he knows television and is looking for a chance to become a specialist in an area that he likes. He is probably working in a small or medium market station and wants the opportunity to move up to a major market VHF station that has the equipment and the plant to allow him to do his job properly—a station that insists on quality and will go all out to get it. If this sounds like you, call or write me today—what can we lose by talking? Larry Messenger, Technical Manager, WHYY-TV, Philadelphia, Pa. (215) EV2-9300. 4-68-1t

MAINTENANCE TECHNICIAN—To work on VTR's, film and live cameras. Installing color equipment. Experience desired. First class license required. Send resume with salary requirements to Chief Engineer, WTTW, 5400 North St. Louis Avenue, Chicago, Illinois 60625. 4-68-1t

"New UHF Station in growing market with four-season recreation requires broadcast engineers with color, VTR, and control-room experience. First Class License required. Send resume to WVNY-TV, P. O. Box 22, Burlington, Vt." 4-68-1t

WANTED—Audio maintenance technician to handle installation, repair, maintenance, and some operation of quality audio equipment. Strong maintenance background mandatory. Send resume to James Gundlach, State University College, Oneonta, New York 13820, or call 607-431-3316. 4-68-1t

Opening for 1st Class studio engineer. Color experience desirable, but will consider aggressive learner. Call or write Arthur Bone, WJRT-TV, P.O. Box 12, Flint, Michigan. 313-239-6611. 4-68-tf

Engineer wanted. Daytimer adding FM. Position immediate and permanent. WRMF, Titusville, Florida. Phone 305-267-1121. 4-68-1t

THE GRASS VALLEY GROUP

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are needed for all areas.

Sales experience helpful but not essential.

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First phone through tape recorded lessons at home then one week personal instruction in Minneapolis, Atlanta, Washington, Detroit, Denver, Seattle, or Los Angeles. Sixteen years FCC license teaching experience. Proven results. 95% passing. Bob Johnson Radio License Preparation, 1060D Duncan, Manhattan Beach, Calif. 90266. Telephone 379-4461. 4-68-tf

Position Wanted

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COMPLETE COVERAGE

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TAA1 Preamplifier

The TAA1 Preamplifier is a completely transformerless audio line amplifier with highly desirable characteristics. Input: 150 or 600 ohms balanced, or bridging. Output: 150 or 600 ohms balanced. Gain: 40 db. Response: flat through 20 kHz. Distortion: less than ½%. Power: 18 DBM. It is shown above in the module rack which occupies only 5¾ inches of rack space. The TAA1 sells for $130.00 and the mounting frame sells for $100.00 F.O.B. Nashville, Tennessee. For complete information, write to:

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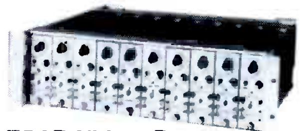
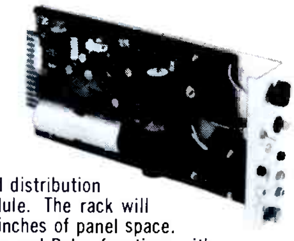
Circle Item 80 on Tech Data Card





TDA7 Video/Pulse Distribution Amplifier

The TDA7 is a completely transistorized distribution amplifier constructed as a plug-in module. The rack will hold 10 TDA7's and occupies only 5¼ inches of panel space. Each plug-in unit handles both the Video and Pulse functions with the flip of a switch. Provision is made to add a sync-adding circuit directly to the TDA7. This should be specified as TDA9. The individual TDA7 plug-in units are $295.00 each F. O. B. Nashville and the mounting frame, which accommodates up to 10 units, sells for $270.00. For complete specifications and information on other accessories, write:

INTERNATIONAL NUCLEAR CORPORATION
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Circle Item 81 on Tech Data Card

TC1 Clamping Amplifier

The TC1 Clamping Amplifier employs tip clamping to remove low frequency signal deficiencies without disturbing burst and other chrominance information in or about back porch levels. The clamped stage utilizes a field effect transistor driven by a balanced bridge circuit. This advanced design technique produces highly effective and stable clamping. The TC1 Clamping Amplifier sells for $325.00 F. O. B. Nashville. For complete information, write to:

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Circle Item 82 on Tech Data Card

TCA3 Transistorized Camera Amplifier

The dependable TCA3 has almost become standard equipment in all image orthicon cameras. It replaces the vacuum tube preamplifier and is designed so it may be quickly mounted within available space in the camera without permanently disabling the vacuum tube amplifier. This cool little amplifier, about the size of a package of cigarettes (101 mm), can add years to the life of cameras. The TCA3 sells for $295.00 F. O. B. Nashville, Tennessee. For complete specifications and information write:

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608 NORRIS AVE. • NASHVILLE, TENN. 37204 • PH.: (615) 254-3365

Circle Item 83 on Tech Data Card

TBG2 Black Burst Generator

The brand new TBG2 Black Burst Generator allows you to go to black and back with perfection. The TBG2 has two outputs available for added versatility, and each has burst phase and burst amplitude adjustments so the two feeds can be matched under any condition. The TBG2 has the industry's only continuously rotatable phase control, and it's accurate to within one degree. All the controls are on the front panel and can be locked. The unit is small, compact and lightweight. So is the price . . . $475.00 F. O. B. Nashville, Tennessee. For complete information, write to:

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Circle Item 84 on Tech Data Card

TVA1 Transistorized Video Stabilizing Amplifier

The TVA1 Stabilizing Amplifier with its associated plug-in units offers the highest level of performance and versatility for studio and transmitter use. The TVA1 removes all low frequency disturbances such as hum, bounce and tilt by sync-tip and back-porch clamping. The compact TVA1 chassis accepts 4 plug-in units. Five plug-in units are available covering the entire range of needs from input amplifiers to stripped video units. The TVA1 Stabilizing Amplifier (less plug-ins) sells for $1380.00 F. O. B. Nashville, Tennessee. Plug-in units range from $240.00 to $450.00 each. Write for complete information to:

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Circle Item 85 on Tech Data Card

TDA2D Video/Pulse Distribution Amplifier

The now-famous TDA2 Distribution Amplifier, in use at most television stations and networks, has a recently added feature. The "D" stands for Differential Input, which we added to the TDA2. And not only did we add a differential input, we subtracted $30.00 from the price. Instead of $325.00, we're selling the new improved TDA2D for $295.00 F. O. B. Nashville, Tennessee. The compact TDA2D fits neatly into 1¾ inches of panel space and produces virtually no heat. Write for complete information to:

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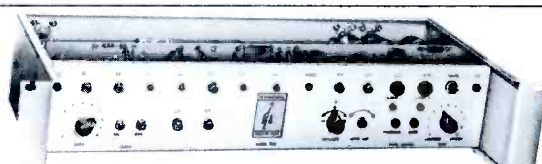
Circle Item 86 on Tech Data Card



TSA1 Clamping/Equalizing Video Amplifier

The TSA1 Clamping/Equalizing Video Amplifier is completely transistorized and designed with the most modern circuitry. It is designed to process signals from microwave, mobile gear, master control or feed-corrected signals to the input terminals of a television transmitter. It has a self-contained regulated power supply. Tip clamping is employed which does not disturb burst and other chrominance information in or about blanking or back porch levels. The TSA1 sells for $850.00 F. O. B. Nashville, Tennessee. Write for complete specifications and information to:

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Circle Item 87 on Tech Data Card

"When you buy Telemet's Color Processor you get a sync generator FREE OF CHARGE!"

That's because our color processing amplifier includes an EIA sync generator complete with outputs—ready to use.

FEATURES:

RESHAPED SYNC MODE for processing signals containing jitter

REGENERATED SYNC MODE for complete replacement of sync

SET-UP ADJUSTMENTS on both reshaped and regenerated modes

FRONT PANEL ADJUSTMENTS include sync level; burst level; burst position; burst width; burst phase; white clip.

OUTPUTS:

composite video (2); non-composite video (2); sync; blanking; H drive; V drive; burst flag; sub-carrier.

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