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the technical journal
of the broadcast-
communications industry
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January, 1967

CONTENTS

Features

A Telephone System for On-The-Air Use
Wayne Jones

One station’s approach to the requirements of listener-participation programs is presented.

What You Should Know About ESSA

This report outlines the activities of a government agency of which broadcasters should be aware.

Symbol Standardization

Efforts are being made within the industry to standardize schematic symbols.

1966 Annual Index

Departments

Book Review 8, 39  Engineers’ Tech Data 59

Washington Bulletin 37  Advertisers’ Index 61

News of the Industry 50  Classified Ads 62

New Products 54

Schematic diagrams are vital to the technical phases of broadcasting and all electronics industries. Our cover scene calls attention to the report beginning on page 18.
What's new in Reelsville, man?

One repeater of an intercity color TV relay system that uses no tubes, no filaments, no high voltages, no mechanical relays.

Microwave Associates' all-solid-state MA-2A relay system owned by WTWO Terre Haute, relays both NBC and ABC programming from Indianapolis to Danville to Reelsville to Farmersburg near Terre Haute through a single feed line antenna system. More than that. The antenna system was already up there, with conventional klystron equipment. But when the second network came aboard, it was add another tube system with antennas, or change over to a solid-state system diplexed into the existing antennas. WTWO opted for the new technology. Color was one of the big reasons. In the MA-2A, the color-determining characteristics are controlled by highly stable semiconductor devices and solid-state circuitry. The system is completely free of the drift and degradation that is associated with thermionic components.

Money was another reason. Paralleling the existing system with new tube equipment, new antennas, new feed lines, rigging costs — would have been expensive. More than they cared to spend for equipment some consider obsolete. Reliability was still one more reason. Solid-state reliability. Sooner or later, tubes mean trouble. The ultimate solution is obvious. The MA-2A has no tubes.

What's new in Reelsville is also new at Rattlesnake Mountain, Washington; North Pole, New York; Bozrah, Connecticut and other famous places. Should it be near you?

<table>
<thead>
<tr>
<th>Model</th>
<th>Band MHz</th>
<th><em>Nominal RF Power</em></th>
<th>Nominal RCVR Noise Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>MA-2A</td>
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<td>MA-7A</td>
<td>6875-7125</td>
<td>.5 watt</td>
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Book Review

How to Build Speaker Enclosures:
Alexis Badmaieff and Don Davis; Howard W. Sams & Co., Inc., Indianapolis, 1966; 144 pages, $3.25.

In this book, it is stated, “Regardless of the quality of your sound-reproducing equipment, the quality of the final sound output is only as good as your speaker enclosures.” The statement is substantiated by an analysis, both graphical and mathematical, of the effects different enclosure types, materials, and construction have on the sounds emanating from the speaker-drivers.

The volume begins with an evaluation of the five basic enclosure types: infinite baffle, infinite baffle, bass reflex, horn projectors, and combination units. This is followed by a discussion on driver units, with statements regarding their limitations and the effects of changing sizes and types.

Next, speaker and enclosure placement are considered, with particular emphasis on phasing, efficiency, and equalization, both electronically and mechanically. This involves discussion of phasing and crossover networks, and how they are best related to individual components.

In the work are photographs, graphs, curves, and construction plans (including material lists) for many examples and combination units. Information in the book is sufficient to permit an individual to design the changes required for adapting any specific unit to the particular room or driver unit with which it will be employed.

Concluding chapters deal with crossover networks and how their design is achieved. Graphs and charts indicate frequency and power demands of various orchestral groups, and for the "coil winders" there is sufficient information to permit construction of networks in the workshop or home. The chapter dealing with constructing and testing describes the materials, tools, and methods by which the most satisfactory results can be obtained. Testing techniques, from simple arrangements to elaborate professional setups, are then presented.

This book has been written for a wide range of readership and essentially requires little knowledge that what a speaker is. Source material is from those who manufacture both enclosures and speakers of the professional type. The authors are engineers who have been engaged in the design of enclosures and speakers for commercial manufacture.
It's lovely to look at, delightful to hold ... and rugged as can be! Small wonder that Shure's new SM60 omnidirectional dynamic microphone was an instant success with both producers and engineers in advance field and studio tests and on subsequent programs with requirements as divergent as outdoor football telecasts and posh variety shows.

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BEAUTY: Lustrous, non-glare matte metallic finish, classic simplicity of line, and tailored-to-the-hand dimensions add up to stunning good looks and superior handability.

STRENGTH: The case front is machined steel! You can drop it right on its nose with no danger of case dents or damage to the internal structure. (In actual lab tests we drop the SM60's over and over from a height of 6 feet.)

PERFORMANCE: Built-in wind and "pop" filter eliminates or minimizes breath and wind noise. Windscreen and front end instantly removable for cleaning. Smooth and natural sound for both voice and music. Goes from stand to hand instantly.

ECONOMY: Priced competitively with conventional "workhorse" microphones. Why not check one out now? See your Shure Professional Products Distributor or contact Mr. Robert Carr, Manager of Professional Products Division, Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. 60204 — Phone 312-328-9000.

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Write today for our new Turntable Guide.
A TELEPHONE SYSTEM FOR ON-THE-AIR USE

By Wayne Jones*—A large amount of telephone on-the-air programming requires an elaborate installation.

Since its opening in December, 1959, Montreal radio station CKGM has featured daily “open line” programs, inviting listeners’ opinions, via their home telephones, on various topics. CKGM engineers, therefore, have spent considerable time developing the most functional and flexible system for airing the calls, keeping in mind the necessity for the best possible on-air sound, and for previewing the program (and when warranted, deleting objectionable material) during an actual broadcast.

Numerous installations have been tested during the past five years, but until now, all have been only partially satisfactory, while some left much to be desired. Most systems consisted of a key-set telephone, with the announcer using a handset, an operator’s headset, and most recently, a simple speakerphone arrangement.

The telephone equipment was connected to the broadcast console through a standard recorder connector supplied by the telephone company. This system, however, had several disadvantages. The announcer, at times, had to contend with both his regular on-air headset and the cumbersome telephone headset. His voice would often feed through the telephone, via the recorder connector, into the console, causing an objectionable filter effect. The effect could be reduced if the announcer positioned his mouthpiece away from his mouth and if the operator “rode levels” on the telephone mixer at the console. The operator also had to close this mixer completely whenever the announcer selected lines, in order to prevent the loud click from sounding on the air.

During programs, an operator answers and screens all calls before the announcer takes them on the air. Although visual indication was provided to the announcer in the form of steady or flashing lamps on his key set, it was often difficult for him to discern which line to take next. Occasionally, he would take a call on the air while it was being screened by the operator. Also, as the lines used for this program appeared on other sets throughout the station, a call on the air could be interrupted by an unsuspecting party elsewhere in the station.

To solve these and other problems, the following system was developed and installed in cooperation with the Bell Telephone Company of Canada.

The new system had to satisfy several conditions:

1. The announcer should not have to wear any headsets other than his normal broadcast headset.
2. There should be no objectionable filter effect in the announcer’s voice while using the telephone; that is, the output provided by the telephone company should contain only the distant party’s voice and not the announcer’s.
3. Some means must be provided whereby a call already on the air could not be interrupted, and conversely, the announcer should not be able to put on the air a line in use off-air, for example, a call being screened by the operator.
4. The equipment must be silent in operation, both mechanically and electrically; i.e., switches should not click, and it should be possible to leave the console mixer position for the telephone open while the announcer is selecting lines.
5. The equipment must be easy to operate and not allow “on-air” errors.
6. The equipment must be flexible. It should allow restricted conferencing and other special effects as the need arises.
7. The operator should retain overall control of the system and, from his position in the control room, be able to supervise its operation.
8. The equipment must be provided with a backup system in case the main system fails.
9. The aesthetic appearance of the studio must be maintained. Preferably, the equipment should be “built-in.”

*Engineering Department, CKGM, Montreal, Quebec.

![Fig. 1. A simplified schematic of the hybrid circuit used at Montreal’s CKGM.](https://www.americanradiohistory.com)
The telephone line is connected to a speaker; and a power transformer. The control unit containing plug-in amplifiers is composed of four items: a transmitter, with a built-in preamp; a speakerphone system. This is the familiar “hands-free” telephone supplied by the telephone company for commercial and private use.

Basically the speakerphone system is composed of four items: a control unit containing plug-in amplifier cards; a microphone, or transmitter, with a built-in preamp; a speaker; and a power transformer. The telephone line is connected to the control unit, where it is split by a hybrid coil into a transmit and a receive circuit. The transmit circuit consists of a series of amplifiers fed by a microphone, and the receive section is a series of amplifiers feeding a speaker. Because the hybrid is not 100% efficient, feedback would result if it were not for the unique feature of the speakerphone, its voice switching circuitry. Whenever sound above threshold level is presented to the microphone, the receive path is switched off and the transmit path is switched on, almost instantaneously. Because of this feature, information presented to the microphone appears on the telephone line and not at the speaker. The speakerphone is incorporated into the console by using the control-unit receive channel to feed the console. Thus the filter-effect problem is solved; that is, the announcer’s voice feeds the console only by means of the broadcast microphone and not by way of the telephone microphone.

The use of this voice switching circuitry is the key to the new system. An additional modification to the standard system was the inclusion of two transmitters, rather than the conventional single transmitter. This was found necessary to maintain an adequate transmit level to the caller when more than one person was present in the studio.

To provide a greater control of the transmit level and to make up for the loss which occurs when two microphones are used in parallel, a variable-gain amplifier was inserted in the transmit path.

The voice switching circuitry causes another effect: The announcer’s voice always takes precedence over the telephone caller. If both are speaking, the caller will not be heard. This may or may not be desirable in all applications, but it is helpful if the line is noisy.

Normally, speaker gain on the speakerphone is adjusted by means of a volume control on the transmitter chassis. This control was removed and relocated in the control unit. Adjustment of this control, and variable-gain amplifiers in the transmit path, permits the voice switching threshold to be varied over a limited range. In the “on-air” studio, it was found desirable to add a relay which operates simultaneously with the studio microphone on/off relay. This mutes the speakerphone speaker in the studio. At the same time, the relay transfers the speaker output to the telephone input on the console. Thus, the telephone output appears at the console only when the announcer’s microphone is on. There is a slight leak from the transmitter to the control unit output and, if this switch were not made, the announcer’s voice, via the telephone line, could appear on the air in spite of the fact that his announce microphone is off. The action of the muting relay permits the announcer to converse with callers prior to going on the air. The air—even if the operator has neglected to close the telephone pot.

In an early trial, the speaker was not muted with the announcer’s microphone so that the announcer could hear the caller without using his headset. It was found that this was not desirable, because the operator could cut off an unwanted caller off the air by simply closing the telephone “pot.” The caller would come through the announcer’s microphone. The speaker in the recording room is not muted, however, because immediate cutoff is not necessary.

An alternate to the speakerphone method is the use of a 4-wire terminating set. This device, basically a hybrid circuit, is used by telephone companies in toll circuits to change 2-wire lines to 4-wire lines.

A simplified schematic of the hybrid is shown in Fig. 1. By connecting the repeating coils as shown, it is possible to separate the two-direction (transmit and receive) pair into two single-direction pairs. This means that a signal presented to the transmit input will appear only on the telephone line and not at the receive output. Conversely, the receive output will contain only signals coming from the telephone line. This is accomplished by setting up a carefully balanced bridge circuit and nulling out the transmit signal from the receive section. The balancing network containing the vari-

---

**Fig. 2.** Input from console to the hybrid is fed through isolation transformer.
able capacitor is used to balance the bridge against the telephone line. An optimum value is selected because each line has different capacitive, resistive, and inductive characteristics. These parameters are a function of line length, cable type, intermediate equipment in the line, and the equipment at each end of the line.

As might be expected, the isolation between transmit and receive sections is not perfect. The leakage is, however, low enough to make the hybrid very useful in our application. No discussion of actual values in decibels will be given here because so many variables are involved.

In order to connect the radio-station equipment to the telephone-company equipment, an interface is required. On the receive portion of the hybrid, this interface takes the form of the standard recorder connector. This provides the isolation necessary and supplies a 1400-Hz beep at 15-second intervals to the caller as well. This is possible because the hybrid is not 100% efficient, and the beep presented to the receive leg is fed back to the caller.

The interface inserted in the transmit leg is used to ensure that the customer will not feed the telephone line with too much level, which would interfere with other circuits in adjacent cable pairs. The interface also provides the correct impedance match to the customer equipment.

The hybrid is connected to the console as shown in Fig. 2. Oscillation will take place if the gain of the console, a function of the telephone-pot setting, is equal to or greater than the loss between the transmit and receive sections. In practice, the loss should be sufficient to allow a satisfactory level from the caller. A somewhat better method of connection is shown in Fig. 3. It involves breaking into the internal circuitry of the console and could present problems in consoles with high-impedance, unbalanced circuitry.

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**Fig. 3.** Better method for connecting hybrid involves opening console circuit.

**Fig. 4.** Basic circuit of CKGM switching system shows only two line inputs for simplicity in explanation of operation.
We use the former method at CKGM. It is used in conjunction with an alternate back-up system to the speakerphone. It is also valuable in other ways; because it feeds anything going through the console to the telephone line, the announcer need not be in an adjacent studio to be heard by the telephone caller (as is true of the speakerphone system). He may be “on remote.” Thus, although a particular program may be on location, all the telephone facilities of the studio are retained without the use of telephone equipment at the remote location. Since various telephone contests, etc., form an integral part of our daily format, this feature is very desirable.

Fig. 5. Functional diagram of switching arrangement in Fig. 4. indicates relationship of various system elements.

It is difficult to indicate which of the two systems, the speakerphone or the hybrid, is better. The speakerphone is cheaper and easier to connect to the console, but the hybrid provides better quality to and from the caller and the other advantages enumerated.

The Switching System

Several switching arrangements are possible. Our primary system is similar in operation to the ordinary key-telephone set in that push buttons are used to select lines. (See Figs. 4 and 5.)

Figs. 6 and 7 show that the studio equipment consists of built-in, flush-mounted call directors. Six lines are associated with our system, four for receiving calls and two for placing outgoing calls. Each of the four incoming lines appears at two separate pickup buttons, a first pickup and a second pickup. The first pickup operates conventionally;
that is, the button locks and is used in conjunction with a standard telephone handset. In practice, this pickup is used by the operator (who is equipped with an identical call director) to answer and screen the calls. If a call is to be used, the line is placed on “hold,” and a transfer button is pushed. This excludes the line from all first pick-ups and transfers it to the second pickups. The second pickups appear at the studio call directors on non-locking, momentary-action push buttons. This type of button differs from a regular button in that it operates silently.

The reason for the transfer action is the prevention of interference with a line which is “on-air.” In addition, the announcer cannot put a line on the air prematurely; the operator must first transfer it.

We wished to have a conferencing circuit incorporated into the system. While the regulatory tariffs of the telephone company are “sticky” on this point, they do provide it as a standard accessory to a PBX and conferencing circuit, which allows a maximum of two outside trunks and three internal stations to be bridged in a conference.

The circuit provides for capacitive coupling of the lines. Since no amplifiers are used in the circuitry, transmission is not guaranteed between the two outside trunks. If one or both of the outside parties is at a considerable distance from the circuit, transmission between these parties will suffer. We were willing to tolerate this disadvantage, however, and a circuit similar to the one provided for the PBX was incorporated.

Any two lines may be bridged by simultaneously pushing the pickup buttons associated with the particular lines. The objective is to allow the moderator to converse with two people simultaneously, and it is seldom necessary for the two callers to converse between themselves. Therefore, the nonamplified conferencing does fall within the telephone-company tariffs.

Normally the four incoming lines are jammed, and an alternate method for placing outgoing calls had to be provided. Two out lines were incorporated in the system in a manner different from the in lines. As before, they appear on first pickups, but these lines may be placed on the air by simply pushing a single, momentary-action button instead of by using a transfer button. This action excludes the line from all first pickups and connects it, via the telephone dial, to the speakerphone. If the line is vacant (normally the case because these are unlisted lines), pushing the button will put dial tone on the speakerphone, and a call may be dialed. By using the second out line, a sec-

* Please turn to page 40.

Fig. 8. Alternate switching method is simpler to construct, does not require relays, but is not as smooth in operation.

January, 1967
When broadcasters think of government agencies, the set of initials that comes to mind first is bound to be “FCC.” This is only natural, since any regulatory agency is certain to make its presence known to the people whose activities it regulates. There are, however, other government agencies which are not of a regulatory nature but which do carry on activities related to broadcasting, and therefore of interest to broadcast engineers and technicians. Such an agency is the Environmental Science Services Administration (ESSA).

What Is ESSA?

Although ESSA itself is less than two years old, its component parts have long histories of service within the government. In July 1965, ESSA came into being within the Department of Commerce when the Weather Bureau and the Coast and Geodetic Survey were brought together into one agency. In October of the same year, they were joined by the former Central Radio Propagation Laboratory of the National Bureau of Standards.

The mission of ESSA is to study our natural environment and, in so far as possible, to predict its behavior. The President has described ESSA as providing “. . . a single national focus to describe, understand, and predict the state of the oceans, the state of the upper and lower atmosphere, and the size and shape of the earth.”

A simplified chart of the organization of ESSA is shown in Fig. 1. The function of the Weather Bureau—observing, reporting, and forecasting the weather—is well known to all broadcasters for broadcast stations have traditionally served as a vital link in disseminating weather information to the public. Likewise, most broadcast technical persons are familiar with the nautical and aeronautical charts prepared by the Coast and Geodetic Survey. Activities of this arm of ESSA also include measurements of the gravity, magnetic field, size, and shape of the earth. The Survey maintains a series of reference markers throughout the United States for use in mapping, surveying, and other projects.

Other work relates to earthquake studies, warnings of seismic sea waves, and oceanographic studies.

Perhaps less well known are the Environmental Data Service and the National Environmental Satellite Center. The Environmental Data Service functions as a central agency for receiving, storing, and disseminating information on the physical environment from all over the world. It serves commerce, industry, and the general public.

The National Environmental Satellite Center, as its name suggests, has as its function the planning and operation of environmental satellite systems. Data from satellites is collected and analyzed to learn more about our environment.

The four Institutes for Environmental Research carry on studies of the earth, the atmosphere, and space. Research by the Institute for Earth Sciences involves geomagnetism, seismology, geodesy, and related earth sciences. The Institute for Oceanography studies the ocean and its relationship to the total environment. The Institute for Atmospheric Sciences studies the behavior of the atmosphere so that weather forecasting can be improved and weather control ultimately may become possible.

Of most direct import to the broadcast industry are the activities of the Institute for Telecommunication Sciences and Aeronomy, and these will be the subject of the remainder of this report.

The Work of the ITSA

Although the ITSA became a part of the newly created ESSA in 1965, its predecessors date back to 1909. In that year, the National Bureau of Standards first undertook the study of radio-wave propagation. Four years later, the first NBS Radio Section was formed.

As the science and industry of

Many activities of ESSA are conducted in this building in Boulder, Colorado.
telecommunications advanced, so did the studies of propagation by the NBS. Its research led to the development of such systems and devices as the aircraft radio beacon and the ILS landing system.

In 1942, the Radio Section became part of the Interservice Radio Propagation Laboratory, which was set up within the NBS at the request of the combined Chiefs of Staff of the United States Armed Forces. After World War II, the functions of this Laboratory were taken over by the Central Radio Propagation Laboratory (CRPL), which became a Division of the Bureau in 1946. In 1964, the CRPL was designated one of the four research institutes of the NBS, and in 1965 it was transferred from the NBS to ESSA and renamed the Institute for Telecommunication Sciences and Aeronomy.

The new name is one which more fully describes the areas of responsibility of the organization. The primary mission of the Institute is support of the nation’s telecommunications activity—an activity representing an annual expenditure on the order of $20 billion.

From the primary mission has evolved a second one, study and forecasting of periods of solar activity and disturbance of the ionosphere. Thus aeronomy, the science of the upper atmosphere, becomes a natural and essential part of the work and name of the Institute.

**ITSA Laboratories**

For carrying out its missions, the ITSA is divided into four Laboratories, each of which pursues a specialized field of research.

**Ionospheric Telecommunications Laboratory**

The work of this Laboratory has to do with long-distance communication by way of the ionosphere. Activities to which the research is related include AM broadcast, navigational systems, and over-the-horizon radar and communications systems.

The Laboratory conducts a number of research programs and furnishes consulting and advisory services to industry and government. In general the research encompasses four broad areas.

The first area of study is the prediction of attenuation and phase delay of signals having frequencies below about 1.5 MHz. Quantities of interest include frequency, direction of propagation, latitude, time of day, season, electrical constants of the earth, and the ionospheric parameters on which predictions can be based. Related studies are concerned with the effects of abnormal ionospheric conditions on propagation at these frequencies.

Other research is directed toward determining the effects of the atmosphere and the terrain on signals transmitted by forward and back-scattered ionospheric propagation. Parameters of interest in this case are amplitude, phase, time delay, and angles of arrival.

Ionospheric predictions are of vital importance to many users of radio communications, both military and civilian. This service is a third area of involvement of the Ionospheric Telecommunications Laboratory. In this connection, a network of ionosonde observatories is employed to observe the state of the ionosphere. A facility at Long Branch, Illinois provides experimental transmissions to other ITSA and agency users.

The fourth area of research is communications technology. Its objective is stated as “... the development of information for improving telecommunications, and the utilization of the radio frequency spectrum.” Specific research includes antennas, information transmission, and frequency utilization. Information obtained is useful in the design and evaluation of equipment and systems for telecommunications.

**Tropospheric Telecommunications Laboratory**

This Laboratory, as its name implies, is concerned with propagation and... Please turn to page 44.
As a publisher in the electronics industry, Howard W. Sams & Co., Inc., has a vital interest in the standardization of schematic symbols. There is at present an industry-wide program to accomplish this. For many years now, each manufacturing company and sometimes, we suspect, each individual draftsman, had a different concept as to the proper method of symbolization.

The Electronic Industries Association (formed by participating electronics manufacturing concerns), in cooperation with the American Standards Association, has now published a list of graphical electronic symbols with the objective of simplification of symbols, reduction of drafting time, and a better understanding of schematics by all technicians.

We are reproducing a portion of the list as an aid to the technician. We feel that if all manufacturers and publishers were to adopt these symbols as standard, the time spent by technicians in interpreting symbols could be reduced greatly.

The Howard W. Sams & Co., Inc., is adopting these standard symbols in all of its publications.

Definitions and Interpretation of Symbols
Symbol—A symbol is the aggregate of all its parts, but to improve readability, parts of a symbol, such as a multisection capacitor, may be separated.
Orientation of Symbol—The orientation of a symbol one drawing, including a mirror image, does not alter the meaning of a symbol.
Arrow Heads—Unless otherwise noted, no significance is placed on open or closed arrowheads.
Angles of Lines—Generally, the angle at which a connecting line is brought to a graphical symbol has no particular significance unless otherwise noted.
Width of Lines—The width of the line does not affect the meaning of a symbol.

List of Symbols

1. Adjustability & Variability
   (a) Coils
   COIL ADJUSTED AT MOUNTING END.
   COIL ADJUSTED AT FREE END.
   DIRECTION OF ADJUSTMENT AT EITHER END.

   (b) Potentiometers—arrowhead parallel to symbol indicates direction of clockwise rotation viewed from knob, actuator, or mounted end.
   (c) Capacitors—arrowhead indicates variability.

3. Antenna
   3.1 General
   3.1.1 Dipole

3.1.2 Loop

3.1.3 Folded dipole

3.1.4 Ferrite antenna

3.1.5 Mono-pole
AUDIO SYSTEMS... SOUND THE RIGHT NOTE!
Completely transistorized...  
with modular construction and  
automatic operating features

RCA audio is the right choice for the bright sound!

AUDIO FOR AM, FM, TV
RCA's pioneering in space-age electronics has paved the way for a whole new generation of audio equipments. There's a complete line of cartridge tape equipment—and reel-to-reel recorders, new Universal turntable, audio relay switcher. Also a new line of audio amplifiers and an automatic programmer.

CONSOLETTES FOR FLEXIBILITY
Choice of four consolettes—from a four-mixer, 20-input equipment to the very versatile deluxe console for dual channel and FM stereo use. They all use plug-in chassis for custom-tailoring to needs and flexibility in operation.

TAPE RECORDERS WITH AUTOMATIC CUEING
Cartridge tape equipments have plug-in tape decks for versatility. They include tone-cue operation—a stop cue, end-of-message cue, and trip cue. And now, even the reel-to-reel types include these cue features, assuring semi-automatic operation between recorders. All these tape equipments are available in both monaural and stereo types.

AUTOMATIC PROGRAMMING
Designed to program fifteen events from any 18 program sources. Number of events may be increased with ease by adding these Programmers in series.

THE “NEW LOOK” IN AUDIO
This is the audio equipment with the RCA “New Look”. It costs less to install and less to operate... provides highest flexibility. You would expect the best from RCA with its years of experience in radio and television.

For further information about these RCA “New Look” equipments write RCA Broadcast and Television Equipment, Building 15-5, Camden, N.J. Or call your RCA Broadcast Representative.

The Most Trusted Name in Electronics

www.americanradiohistory.com
4. Arrester gap or spark gap

7. Battery
   The long line is always positive, but polarity may be indicated in addition.
   7.2 One cell

7.3 Two cells

7.3.1 Multiple cells

8. Capacitor
   8.1 General—If it is necessary to identify the capacitor electrodes, the curved element shall represent the outside electrode in fixed paper-, mica-, ceramic-, and plastic-dielectric capacitors; the moving element in adjustable and variable capacitors; and the low-potential element in feedthrough capacitors.

   8.1.1 Polarized capacitor (electrolytic)

   8.1.2 When multiple-section, electrolytic capacitors are diagrammed, each section must be identified with the appropriate symbol to correspond with the identifier used on the actual part.

   8.1.2.1 Nonpolarized electrolytic capacitor

   8.1.2.2 Multiple sections in common container.

   8.1.3 Adjustable or variable capacitor.

   8.1.4 Adjustable or variable capacitors with mechanical linkage of units.

   8.1.5 Feedthrough capacitor.

11. Circuit breaker

13. Circuit returns
   The rake symbol may be used to indicate accessible metal ground, earth ground, the chassis, or where chassis ground is different or isolated. The other symbols may indicate ground, chassis ground, or B—.

16. Coil, relay

18. Connector—disconnecting device.
   18.1 Female contact, commonly used for a jack or receptacle (usually stationary).
18.2 Male contact, commonly used for a plug (usually movable).

18.3 Separable connectors (shown engaged).

18.6 Communication (telephone) type connector.

18.6.1 Two-conductor jack.

18.6.2 Two-conductor plug.

18.6.3 Three-conductor jack with two break contacts (normals) and one auxiliary make contact.

18.6.4 Three-conductor plug.

18.8 Connectors of the type commonly used for power-supply purposes (convenience outlets and mating connectors).

18.8.1 Female contact.

18.8.2 Male contact.

18.8.3 Two-conductor nonpolarized connector with female contacts.

18.8.4 Two-conductor nonpolarized connector with male contacts.

18.8.5 Two-conductor polarized connector with female contacts.

18.8.6 Two-conductor polarized connector with male contacts.

18.9.1 Phono-type connector plug.

18.9.2 Phono-type jack.

18.9.3 Wire end of female socket (cap)
18.9.4 Pin end of male plug.

25. Core
25.1 General or air core
If it is necessary to identify an air core, a note should appear adjacent to the symbol of the inductor or transformer.

25.1.2 Adjustable core.

25.2.1 Laminated core.

25.2.2 Powdered-iron core.

25.3 Core of electromagnet.

31. Delay line.

36. Fuse.
36.1 General.
36.2 Special types

42. Inductor.
42.1 General
Use symbols as shown unless otherwise indicated or required by special considerations.

42.2 If it is desired especially to distinguish magnetic-core inductors.

42.3 Tapped air core.

42.4 Adjustable inductor: arrowhead points in direction of adjustment location. Bottom of coil is at mounted end.

42.4.1 Adjustable inductor, air-core: arrowhead indicates movable tap. Unless noted, coil mounting end not specified.

42.7 Saturable-core inductor (reactor).
Polarity marks may be added to direct-current winding. Explanatory words and arrow are not part of the symbol shown.

44. Lamp.
44.1 Ballast lamp (tube)
The primary characteristic of the element within the circle is designed to vary nonlinearly with the temperature of the element.
44.2 Lamp, fluorescent.

44.3 Lamp, glow, cold-cathode, neon.

44.4 Lamp, incandescent.

46. Machine, rotating.

46.2 Generator.

46.3 Motor.

46.12.1 Alternating current reversible motor.

46.12.2 Alternating-current clock motor with time switch.

46.12.3 Phono motor.

48. Meter—instrument.

Note—The asterisk is not a part of the symbol. Always replace the asterisk by one of the following letter combinations, depending on the function of the meter or instrument, unless some other identification is provided in the circle and explained on the diagram.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB</td>
<td>DB (decibel) meter</td>
</tr>
<tr>
<td>MA</td>
<td>Milliammeter</td>
</tr>
<tr>
<td>O</td>
<td>Ohmmeter</td>
</tr>
<tr>
<td>R</td>
<td>Recording meter</td>
</tr>
<tr>
<td>T</td>
<td>Tuning meter</td>
</tr>
<tr>
<td>V</td>
<td>Voltmeter</td>
</tr>
<tr>
<td>VOM</td>
<td>Volt-ohmmeter</td>
</tr>
<tr>
<td>VTVM</td>
<td>Vacuum tube voltmeter</td>
</tr>
<tr>
<td>VU</td>
<td>Volume indicator, audio level meter</td>
</tr>
<tr>
<td>W</td>
<td>Wattmeter</td>
</tr>
</tbody>
</table>

51. Microphone.

51.1 Ultrasonic microphone or transducer.
* Indicate type by note: ceramic, crystal, dynamic, etc.

51.2 Audio-frequency microphone.
* Indicate type by note.

56. Oscillator, signal generator, or unspecified alternating-current source.

58. Wiring.

58.5 Crossing of paths or conductors not connected. The crossing is not necessarily at a 90° angle.

58.6.2 Junction of connected paths, conductors, or wires.
58.8.1 Shielded single conductor.

58.8.3 Two-conductor cable.

58.8.4 Shielded two-conductor cable, shield grounded.

61. Pickup head.

61.1 General.

61.2 Magnetic recording head.

* Indicate by letter: Record, Playback, Erase.

61.6 Stereo pickup.


64. Receiver-earphone, headphone.

64.2 Headset, double.

64.3 Headset, single.

65. Rectifier, semiconductor.

65.1 General.

Note: Triangle points in direction of forward (easy) current as indicated by a DC ammeter, unless otherwise noted adjacent to the symbol. Electron flow is in the opposite direction.

65.2 Semiconductor rectifier.

66. Relay.

Fundamental symbols for contacts, mechanical connections, coils, etc., are the basis of relay symbols and should be used to represent relays on complete diagrams.

66.2 Relay coil.

66.3 Relay contacts.

68. Resistor.

68.1 General.

68.2 Tapped resistor.

68.3 With adjustable contact.
68.8.1 Symmetrical varistor, voltage-sensitive resistor, etc.

73. Semiconductor devices.

73.9.1 Semiconductor diode.

73.9.2 Capacitive diode.

73.9.3 Breakdown (Zener) diode.

73.9.5 Tunnel diode.

73.10.1 PNP transistor.

73.10.1.1 Transistor element connected to envelope.

73.10.2 NPN transistor.

73.10.3 Unijunction transistor.

75. Speaker.

76. Switch.

Fundamental symbols for contacts, mechanical connections, etc., may be used for switch symbols. The standard method of showing switches is in a position with no operating force applied. For switches that may be in two or more positions and for switches that may be operated by some mechanical device, clarifying notes may be necessary to explain position shown and position at which actuation starts.

76.1 Single throw, general.

76.2 Double throw, general.

76.2.1 Two-pole, double-throw switch.

76.6 Push button.

76.6.1 Circuit closing (make).

76.6.2 Circuit opening (break).

76.6.3 Two circuit (transfer).
"...CBS Volumax performs flawlessly. Please do not invent any more until we wear these out. At the present rate of deterioration, we will need to replace them by 2015 A.D."

This is what station WRNC in Raleigh, North Carolina, said about our equipment. They own both the Audimax Automatic Level Control and the Volumax Automatic Peak Controller. Station WIGS in Gouverneur, New York, wrote, "Enclosed find check for Volumax 400. You couldn’t get it back from us for twice the price . . ." KLIN in Lincoln, Nebraska, purchased Audimax. They told us, "It is an engineer’s dream for absolute level control". WAYB in Waynesboro, Virginia, tells us, "Purchased a Volumax and we are tickled to 99 and 44/100% modulation with it . . . Congratulations on a fine product". Station KHOW in Denver, Colorado, said, "It was surprising to receive equipment that exceeded specifications".

There isn’t enough space here to include all the letters we’ve received praising Audimax and Volumax. But judge for yourself. Like all CBS Laboratories equipment, they’re available for a 30-day free trial. Audimax $665. Volumax $665. FM Volumax $695. Write to us, or better yet call The Professional Products Dept. directly — Collect. Telephone (203) 327-2000. Maybe you’ll be in our next ad.
76.12 Selector or multiposition switch.

76.12.1 General.

86.2 Magnetic-core transformer.

86.2.1 Shielded transformer.

86.2.2 Transformer with magnetic core and shield.

76.12.4 Segmental contact.

86.3 One winding with adjustable inductance.

86.4 Each winding with separately adjustable inductance.

86.6 With taps, single phase.

86.7 Autotransformer, single phase.

79. Test point, recognition symbol.

79.1 General.
Used to emphasize test-point location.

79.2.1 Test-point recognition for test jack and circuit terminal.
* Reference designation. Not part of symbol.

84. Thermistor.
"T" indicates that the primary characteristic of the element within the circuit is a function of temperature.

84.1 General.
If You Haven't Seen the Polychrome Camera, You're Missing the Finest Color in Television

Not to mention the most advanced live color camera on the market

Here's why...

1 Choice of pickup tubes. Some broadcasters prefer the four-Plumbicon® type camera. Others lean toward the IO-Vidicon tube complement. May even be that the best answer is still to be developed. Makes no difference with the Tarzian Polychrome camera. It accommodates any present or contemplated pickup tube. How's that for flexibility? And you avoid costly obsolescence, too.

2 Color fidelity. Exceptional. Original optical design delivers superior color performance—limited only by the capability of existing pickup tubes. Separate luminance channel assures excellent color and monochrome results.

3 Design. Rugged magnesium housing trims size and weight down to what you'd expect to find only with monochrome equipment. Viewfinder is removable for added mobility and accessibility. Bold contemporary styling and textured door panels mark a fresh departure from old fashioned, bulky look.

4 Electronics. All camera and processing circuitry is fully transistorized with plug-in module construction throughout.

More? There's plenty. Like 10:1 zoom lens. Looks built-in, but detaches readily. Powered zoom, focus and remote iris for smooth control. The list is nearly endless.


* Reg. T. M. of N. V. Philips Co., Holland

Symbol of Excellence in Electronics
Broadcast Engineering

1966 ANNUAL INDEX

ALLOCATIONS

Channels
- clear assignments ............... Aug 13
- TV, sharing with land mobile .................. W Sep 53

AM
Antennas, directional, unwanted nulls .............. Jun 20
Applications, pending, list .................. L Nov 6
Channels, clear .................. W Jan 26
- proposals expected ................ W Jan 51
Frequency, finding .................. Aug 12
MEOV Rule, proposed ................ W Sep 54
Mexican treaty, negotiations ............... W Sep 54
Policy questions .................. W Oct 55
Power, minimum, increase ................ W Feb 37
Presunrise power-reduction system ................. Jul 15
Proof-of-performance, audio, transmission set for ........ Mar 31
Signal variations .................. Aug 16

Stations
- daytime, presunrise operation of .............. W Dec 31
- resisting of .................. W Jan 25
- .............. W May 53

ANTENNAS

Grounding .................. Feb 24
KCSM broadcast center .............. May 26

Lightening .................. Nov 11
- .............. Dec 26

ANTENNAS, AM
Current indicating meters. linearizing .................. May 48
Directional, feed parameters ............. May 18
Ground systems .................. Dec 33
- maintenance of .................. May 30
Presunrise power-reduction system ................. Jul 15

ANTENNAS, DIRECTIONAL
AM
- unwanted nulls ....................... Jun 20
- feed parameters ..................... May 18
Inspection requirements for AM ................ W Oct 56
MEOV Rule, proposed ................ W Sep 54

ANTENNAS, FM
Chrysler Building, on ....................... Jul 12
Field strength, predicting for ............. Aug 30

ANTENNAS, TV
Beam tilting for ITFS ....................... Nov 26
Beamwidth, vertical, requirements for ITFS ........ Nov 23
Mountaintop, KBYU-TV ............... Nov 34
Movement for maximum wind load ................. Dec 24
Polarization, to reduce

INTERNATIONAL
Canada, Central, broadcasters
meet ................. Feb 16
Micronesia, radio broadcasting
in .......... Apr 19
Mexico
—broadcasters meet in ........ Jan 17
—treaty with U.S., AM .... Jul 21
—new ............ W Apr 53
— ..... W Aug 36
W Sept 54
LICENSES
Operator. Element 3 revised ... N Feb 54
Station, applications, late
renewal ........... W Feb 37
LIGHTING
Beacon-flasher repair, 
emergency ............ E Jun 54
Color TV, for ............ Jan 19
—show ........................ Jun 24
Fixtures, quartz-iodine lamps, 
for ................ Jan 15
—converting for ........ Jan 16
Quartz-iodine ................ Jan 14
Studio, WMU ................ Dec 14
Temperatures, color, Kelvin ........ Jan 18
Tower ................ Mar 26
—monitor for remote reading E Dec 40
MAINTENANCE
Audio
—equipment, solid-state ........ Jul 18
—corrections ................ Sep 6
—patch panels, labeling .... Apr 26
—tinable .................. E Aug 43
Condensation in transmitter, 
protection from .................. E Nov 52
Difficulties ............ Mar 13
Fimant supply, emergency, E Aug 44
Function switch repair .... E Jul 10
Ground systems, AM ........ May 30
Lightning protection, fusing 
for .................. E Nov 52
National Electrical Code .......... Nov 40
Records, test ................ Nov 37
Shop, equipping ............. Apr 28
Socket, 866A, modification 
to ............ E Jul 44
Towers, painting and 
galvanizing ........ Apr 54
Tube-test short-cut ........ E Jul 40
Video, pulse-cross display, 
interpreting ................ May 16
MANAGEMENT
Investment Tax Credit on 
Equipment ........ Mar 50
Promotions, conduct of .......... W Apr 52
MATCHING NETWORKS
Antenna, AM
—directional, feed parameters, May 18
—power-reduction system, 
presunrise ............... Jul 15
Combining, splitting ........ Sep 16
MEASUREMENTS
Antenna
—AM directional, unwanted
—current ............ E Jun 54
—indicators, AM, linearizing, May 48
Camera, inexpensive waveform .......... Aug 24
C. N. for ITFS systems ................ Dec 24
Field strength, FM ................ Aug 30
Frequency-measuring services ........ May 34
Hertz, definition of ................ May 34
ITFS systems, on ................ Dec 22
Signal variations ................ Aug 16
Use of, in AM frequency 
searches ................ Aug 14
Vertical Interval Test Signals ........ Aug 20
Video quality ........ Oct 44
VSWR
—FM antenna, Chrysler Building Jul 13
—ITFS systems, in ........ Dec 22
METERS
Antenna current indicators, 
linearizing ........ May 48
Impedance measurement ........ E Jul 42
Maintenance, for ........ Apr 26
MICROPHONES
Choosing and using ........ Jun 13
Professional ................ Sep 18
—correction ............. Nov 6
Ribbon, repair to ........ E Aug 43
MICROWAVE
Antenna
—movement for maximum 
wind load ............ Dec 24
—positioning ........ Dec 22
Beam tilting for ITFS ........ Nov 26
Beamwidth, vertical, require-
ments for ITFS ........ Nov 23
C47. 14-GHz for ........ W Oct 55
C,N. ratios ........ Nov 21
—combining ........ Dec 19
ERP, computation of ........ Nov 23
Fading, 2500-MHz systems ........ Nov 21
Fresnel-zone clearance .......... Oct 36
ITFS equipment, manufacturers ... Sep 15
Level strength, 2500-MHz ........ Oct 38
Repeaters, active, C,N. ratios 
with ........ Dec 19
VSWR in ITFS systems .......... Dec 22
MISCELLANEOUS
Broadcasting, Forty-Five 
Years of .................. L Jan 6
Consulting Author dinner ........ Apr 48
Radio shows, recordings of 
old ........ L Dec 6
Safety in finding shorts ........ L Aug 6
Satellite, ABC, proposed .... May 54
MODULATION
Overmodulation, FM .......... Feb 14
—correction ........... L Jul 6
Percentage of, FM, determining .... Feb 15
—FCC method ........ Feb 44
MONITORS
Audio .................. E Apr 65
EBS, for .................. L Jun 6
Proof-of-performance, small 
budget, equipment for ........ Jun 16
Stereo and multiplex, new 
rules for .......... W Jul 33
32
BROADCAST ENGINEERING
www.americanradiohistory.com
Don Ellington has a stubborn streak. Try to set up a shipping schedule on an upcoming Memorex video tape product before Don has given it his okay. Can't be done. Not with any number of previous approvals—from lab performance trials, field tests or production line checks. Don's job is to make sure, beyond all doubt, that when you screen a reel of a new Memorex video tape, it will look as good on the monitor as it does on paper. It's no job for a yes-man.
Video, adjustment and calibration .................................................. May 66

PAS
Combining/splitting, audio ....................................................... Sep 16
Transmission set, fixed ......................................................... T-pad (corrections) ......................................................... L Aug 6

PROOF OF PERFORMANCE
Audio, inexpensive equipment ................................................. Jun 16
ITFS systems ........................................................................... Dec 22
Transmission set ................................................................. Mar 31
Fixed T-pad (corrections) ......................................................... L Aug 6
Transmitter ................................................................. ITFS ......................................................... Dec 24
TV (corrections) ................................................................. L Jan 6

PROPAGATION
AM frequency, finding ............................................................. Aug 12
C/N ratio, 2500-MHz systems .................................................. Nov 21
Curves, new, for FM and TV .................................................. Feb 37
Fading, 2500-MHz systems .................................................... Nov 21
Field strength, FM, predicting ................................................ Aug 30
Fresnel-zone clearances ......................................................... Oct 36
Level, signal, 2500-MHz systems ........................................... Oct 38
Polarization, use of, to reduce interference ................................ Dec 18
Presumire power reduction ...................................................... Jul 15
Repeaters ................................................................. —active, C/N ratios with .......................................................... Dec 19
—STL, passive ............................................................... May 13
Signal variations ................................................................. Aug 16

RADIO
Micronesia, broadcasting in .................................................... Apr 19
FM-SW Simulcasts ................................................................. N Sep 58
KCSM broadcast center ........................................................ May 28
Shows, recordings of old ....................................................... L Dec 6
Studios, WTMJ ................................................................. Dec 14

RECORDING, AUDIO
Angle, vertical cutting ............................................................. Nov 37
Cartridges, pickup ................................................................. Nov 36
Equalization, cartridge preamplifier ...................................... Nov 37
Distortion, disc playback, reducing ........................................ Nov 36
Pressure, stylus ................................................................. Nov 37
Record, test ................................................................. Nov 37
Tracking, playback .............................................................. Nov 36

TELEVISION
Antenna ................................................................. —mountain top .............................................................. Nov 34
—movement for maximum wind load ................................... Dec 24
—positioning ................................................................. Dec 22
—automation for station breaks ........................................... Feb 11
Beam tilting for ITFS ........................................................ Nov 26
Beamwidth, vertical, requirements for ITFS .......................... Nov 23
Cameras, color, live ............................................................. Oct 11
Channels, sharing with land mobile ....................................... W Dec 32
Chopper, solid-state, revisited ................................................ Oct 48
C/N ................................................................. —measurements, ITFS .................................................. Dec 24
—ratios ................................................................. Nov 21
—combining ................................................................. Dec 19
Equipment, ITFS, selection ................................................... Dec 20
ERP, computation ............................................................... Nov 23
Fading, 2500-MHz systems .................................................. Nov 21
FM interference to ........................................................... W Mar 93
Football, broadcasting in color ................................................ Mar 16
Installation, ITFS systems .................................................... Dec 22
KCSM broadcast center ........................................................ May 26
Lighting ................................................................. —color show, for ......................................................... Jun 24
—quartz-iodine .............................................................. Jan 14
—WTMJ, at ................................................................. Dec 16
Measurements on ITFS systems ........................................... Dec 22
Mobile services, test of channel sharing with ................................ W Aug 35
Polarization, to reduce interference ....................................... Dec 18
Program form, new ............................................................ W Dec 31
Proof-of-performance, transmitter (corrections) ..................... L Jan 6
Pulse-cross display, interpreting ........................................... May 16
Quality, video, measurements .............................................. Oct 44

SPECIFICATIONS AND STANDARDS
CATV, FCC Regulations for .................................................. Jun 32
Hertz ................................................................. May 34
National Electrical Code ....................................................... Nov 10
Towers, marking and lighting ................................................ Mar 26
US-Mexico Agreement ........................................................ Jul 21
Vertical-interval test signals .................................................. Aug 20

STL
Passive-repeater ................................................................. May 13
TV, for AM and FM use ........................................................ W Oct 56

SWITCHING EQUIPMENT
Audio ................................................................. —modifications to ......................................................... E Aug 42
—patch panels ................................................................. Apr 25
Function switch repair ........................................................ E Jul 40

TAPE CARTRIDGE EQUIPMENT & OPERATION
Automatic cueing for playback ................................................ L Jan 6
Modification to ATC units ..................................................... E Feb 50
Voltage surges, protection from ............................................... E Dec 36

TELEPHONE LINES
Checker for ................................................................. E Dec 40
Modification to ................................................................. E Jun 58

TOOLS
Maintenance shop ................................................................. Apr 25

TRANSMITTERS
FM ................................................................. —exciters ................................................................. Apr 15
—design ................................................................. Apr 15
—manufacturers .............................................................. Apr 17
—power ratings .............................................................. Apr 17
ITFS, selection for ................................................................ Dec 20
Neutralization ................................................................. E Jan 44
—scope, with ................................................................. E Apr 65
Proof-of-performance, ITFS .................................................. Dec 24
Visibility of ................................................................. W Jan 26

VIDEO EQUIPMENT
Chopper, solid-state, modifications to .................................... E Jan 48

VIDEO MEASUREMENTS
Pulse-cross display, interpreting ........................................... May 16

WIRING
Patch Panels ................................................................. Apr 25
Towers, NEC applications .................................................... Mar 92
**D-150** is a professional omni-directional microphone with high sensitivity and linear full-range response. It is ruggedly designed for hard use, and is attractive and inconspicuous because of its unusually small diameter. For public address, studio and on-location recording . . .

**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>30-20,000 cps.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>± 3 db</td>
</tr>
<tr>
<td>Directional characteristics</td>
<td>Omni-directional</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>−55 db</td>
</tr>
<tr>
<td>Impedance</td>
<td>200 ohm</td>
</tr>
<tr>
<td>Connections</td>
<td>Cannon XLR</td>
</tr>
<tr>
<td>Dimensions</td>
<td>5 ¼&quot; long x ½&quot; diameter</td>
</tr>
<tr>
<td>Weight</td>
<td>4 ounces</td>
</tr>
</tbody>
</table>

The remarkably small diameter of the capsule used in both these microphones has been developed without sacrifice of the sensitivity characteristics found in our finest professional dynamic microphones. This is another significant development from the research laboratories of AKG.

Send today for data sheets and prices.

**D-109** is an attractively styled Lavalier microphone . . . a smart, practical choice for inconspicuous use. Among other features—simple raising or lowering of the Lavalier attachment cleverly attenuates the frequency response curve to specific applications.

**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>50-15,000 cps.</td>
</tr>
<tr>
<td>Directional characteristics</td>
<td>Omni-directional</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>−56 db</td>
</tr>
<tr>
<td>Impedance</td>
<td>200 ohm</td>
</tr>
<tr>
<td>Dimensions</td>
<td>2¾&quot; long x ¾&quot; diameter</td>
</tr>
<tr>
<td>Weight</td>
<td>1½ ounces</td>
</tr>
</tbody>
</table>
YOU WON'T FIND A PANIC BUTTON ON A MAGNECORD!

When Magnecord engineered a long list of safety factors into their professional line of tape recorder/reproducers... they engineered the emergencies out! A sturdy die-cast mainplate, supporting the transport in every model, insures precise location of internal parts under the roughest operating conditions. Rigid die-cast head mounts eliminate alignment problems. Professional quality hysteresis synchronous capstan motor and individual reel drive motors are heavy duty models, and the capstan shaft assembly is reinforced for extra strength and longer life.

While you are taping, safe-guard operating features protect your thinnest tapes. With Magnecord you get top-notch performance and superb fidelity to keep your taping facility operating at maximum capacity, even after years of constant use. Ask a broadcaster who uses one... Magnecords are built to take it!

Write now for the full story on the complete line of durable quality Magnecord tape instruments. Magnecord 8+ Reels now available from Audiotape®. See your local dealer.

MAGNECORD MODEL 1028
Professional quality 2 channel (stereo) tape recorder/reproducer for recording master tapes. (10½" reel capacity) Available in ½- or ¾-track.

MAGNECORD MODEL 1048
Professional 2 channel (stereo) recorder/reproducer for use in main studio, production studio or conference recording. (10½" reel capacity) Model 1048 is available in ½- or ¾-track.

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DIVISION OF THE TELEX CORPORATION
P. O. Box 1526 / Tulsa, Oklahoma 74101
MANUFACTURER OF TELEX HEADSETS AND OTHER FINE ACOUSTIC DEVICES

Circle Item 11 on Tech Data Card

January, 1967

www.americanradiohistory.com
Late Bulletin from Washington

by Howard T. Head

Government Enters Dispute Over CATV vs. Rooftop Antennas

By a 4 to 3 vote, the FCC has denied a request by the Springfield (Massachusetts) TV Broadcasting Corporation for the issuance of a cease-and-desist order against a CATV operator in Ware, Massachusetts. The broadcasting firm had complained that the CATV operator, in its advertising for new customers, was offering a reduction in CATV installation costs if the subscriber would consent to removal of the rooftop antenna. In denying the request, the Commission emphasized that its refusal to issue an order did not constitute approval of this practice, but rather reflected its view that promotional activities of this nature were outside the scope of its authority. However, the FCC has referred the complaint to the Federal Trade Commission, which does have jurisdiction over matters of this nature, for whatever action the FCC may deem appropriate.

Commissioners Robert E. Lee, UHF's strongest supporter; Kenneth E. Cox; and Nicholas Johnson dissented.

Proposed Educational FM Changes

The Commission has proposed numerous changes in its Rules governing the allocation and operation of noncommercial educational FM broadcast stations. At present, these stations, which operate on FM Channels 201-220 inclusive (88 MHz - 92 MHz), are assigned on the basis of allocation standards much more flexible than those governing commercial FM stations. The Commission now proposes to establish three classes of educational FM stations -- Class A, B, and C -- corresponding to the classes of commercial FM stations. Existing 10-watt educational FM stations would be required either to conform to minimum Class A facilities, or to surrender their licenses.

Also proposed is a Table of Assignments which would make advance provision for educational FM channels in cities of various sizes. These would range from a single channel for cities with population under 50,000, to five channels for cities having a population of one million or more.

The Commission's Notice also expresses concern over interference to the reception of television Channel 6 (82 MHz - 88 MHz) from the operation of educational FM stations in the lower part of the band. Although the proposal contemplates protecting regular television broadcast stations on Channel 6 from FM interference, Channel 6 television translators would not be given such protection.

Land Mobile Services Continue to Seek Additional Frequencies

Pressures continue to mount from various land-mobile radio service users for additional frequency assignments. Proposals under consideration range from tests of sharing VHF television channels (see December 1966 Bulletin) to the
outright re-allocation of one or more television channels; the lower UHF
channels appear to be most vulnerable in the latter regard.

In a recent Department of Commerce report, the Department's Telecommunications
Science Panel has reviewed the increasing spectrum congestion, and proposed
the establishment of a long-range program to review present technology and
spectrum allocation, and to make plans for the future. A new organization,
with an annual budget ranging somewhere between $10 and $50 million dollars,
would be set up within the Commerce Department. In a counter-proposal, the
FCC, with the tacit support of the White House Director of Telecommunications
Management, has proposed a more modest study program (annual budget only $2
million) to be undertaken by the Commission.

Decision on Propagation Curve Case Expected Shortly

The Commission is expected to decide shortly whether to amend the curves of
field strength vs. distance now contained in the Commission's Rules for FM
and television broadcasting (see June 1966 Bulletin). Although there is gen­
eral agreement that the present UHF television curves are in substantial need
of revision, most engineers believe that new FM and VHF television curves
proposed by the Commission differ so little from previous curves that a change
would be unwarranted. Some engineers have insisted that the proposed new
VHF curves are a poorer fit to the data than the present ones.

Consulting engineers have also supported a proposal made to the Commission
by the licensee of a UHF television station in Ohio for a change in the Rules
governing the calculation of distances to contours. The present Rules re­
quire that these distances be calculated not on the basis of radiation toward
the contour, but instead using radiation in the horizontal plane, which in
most instances is well above the surface of the earth. The consequence of
this Rule has been that stations employing very high antenna gains and beam
tilt, with narrow vertical beams tilted as much as 2° below the horizontal
plane (principally UHF stations), find themselves obliged to calculate contour
distances on the basis of effective radiated powers only a fraction of the
actual maximum power. The proposed change in this Rule, together with new
field-strength curves, would bring about considerable improvement in the ac­
curacy of contour prediction for UHF stations.

Short Circuits

The Commission has recognized the term "Hertz" as a synonym for "cycles per
second"; the new usage is not mandatory, but Hz and c/s may now be used inter­
changeably . . . The Commission has removed all FM and television channel
assignments from the "radio quiet zone," an area of approximately 4,000 square
miles in Virginia and West Virginia centered roughly on two radio telescopes
at Sugar Grove and Green Bank, West Virginia -- only exceptions were a televi­sion
station already operating on Channel 3, and a special educational tele­
vision station with a highly directional antenna on Channel 51 . . . The Com­
mision has made final its proposal to relax the Rules for the identification
of television auxiliary stations (see December 1965 Bulletin) . . . The Com­
mission has refused to waive its carrier-current Rules to permit radiation in
excess of the carrier-current requirements along a Pennsylvania highway in a
proposal to provide traffic and scenic information.

Howard T. Head . . . in Washington
BOOK REVIEW


The authors have produced an instructive text which ranges from electronics and electricity, to electrical laws, circuits analysis, magnetism, reactance, meters, tubes, semiconductors, filters, and network theorems. Extensive appendixes, a bibliography, answers to the problems, and an index complete the book.

Numbered headings identify major topics in the text, and a chart-type summary and questions conclude each chapter. The book is adequately illustrated with line drawings, charts, graphs, schematic diagrams, and photographs.

If he studies this book thoroughly, the reader should be rewarded with a good understanding of basic electricity as it applies to electronics. The coverage of mathematics is not extensive; basic algebra will suffice for all computations.

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Video tape technician [ ] Studio supervisor [ ]
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SPECIFICATIONS

COMPARISON

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January, 1967

Circle Item 13 on Tech Data Card

39

www.americanradiohistory.com
Model AA-200

SOLID STATE AUDIO AMPLIFIER

Frequency Response:
±1db, 20 to 20,000 cycles at 100MW
±2db, 20 to 35,000 cycles at 100MW

Harmonic Distortion:
Less than 1%, 20 to 20,000 cycles at 100MW
Less than 2%, 20 to 20,000 cycles at 200MW

Input:
50 to 150 ohms balanced (mu metal shielded, permalloy core transformer)
2,000 or 100,000 ohms unbalanced

Gain:
70db, 50 ohm input, 8 ohm load
65db, 2,000 ohm input, 8 ohm load

Output: 500 and 8 ohms
(pain oriented transformer)

Circuit: 7 transistors, 1 thermistor

Controls: Locking volume control

Connections: Barrier strip

Power Supply: 9 volts DC, 100 MA
(accessory power supply available – Round Hill Model PS-200)

Construction: Brown enameled steel case

Size: 9"L x 2½"W x 3½"H

Weight: 28 ounces

$34.50 Including complete Technical Data and Schematic

Price: Send check or money order – we pay postage.

ROUND HILL ASSOCIATES INC.
A MILO ELECTRONICS SUBSIDIARY
434 Avenue of the Americas, New York, N.Y. 10011

Model PS-200

SOLID STATE POWER SUPPLY

An all-transistor general purpose power supply, the Round Hill Model PS-200 is particularly suited for use in applications requiring a stable, well-filtered DC source. It employs Zener referenced voltage regulation, and delivers 9 volts DC at loads up to 200 MA with complete dead short protection. A locking screwdriver-adjusted programming potentiometer permits the output voltage to be adjusted over a one-volt range.

Input Voltage: 105-125 volts AC, 60 cycles, 5 watts

Regulation: Line + load 5 MV

Ripple: Under full load 10 MV, peak to peak

Output Voltage: 9 volts DC
(adjustable over 1 volt)

Maximum Load Current: 200 MA

$24.50 Including complete Technical Data and Schematic

Price: Send check or money order – we pay postage.

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Conclusion

It is hoped that this article will aid the broadcaster planning an “open-line” program or one wishing to modify his facilities for this type of programming. The telephone equipment is a mutual project of the telephone company and the broadcaster. Careful analysis of needs by both should result in a flexible, functional, and reliable system.

Editor’s note: A new recorder connector, which supplies the filtered 1400-Hz beep in the caller direction only, has been developed especially for on-the-air applications for the Western Electric Company, and bears the part number KS-19645. It must be ordered through the local telephone company with the order number USOC-RCZ.

Give your tapes and mats a clean start!

New AE-100 Automatic Degausser erases 12" or less tape reel or up to 100 CUE-MATs mats in 50 seconds.

The AE-100 is motor driven and completely automatic. It provides uniform, complete erasure for ¼" tapes and mats without the guesswork of other degaussers. Shuts itself off automatically. Load it. Start it. Forget it.

What’s more, the AE-100 is compact, lightweight, and practically priced. Ask your distributor or write Ampex Corporation, 401 Broadway, Redwood City, Calif. 94063.

*TM-Ampex Corporation
How does this 7 FOOT MONSTER help solve your sound problems?

The giant microphone shown here is the biggest microphone in captivity! The Model 643 is also the most directional microphone sold today. It helped E-V win the first Academy Award for microphone design in 22 years.

But beyond this, the 643 has been one of our most effective field research tools, offering a far-reaching insight into the nature of directional microphones, and their applications.

An obvious result of 643 research is our unique Model 642. Same E-V Cardiline™ principle*, but only 18 inches long. It reaches up to twice as far as any other broadcast unidirectional microphone to give you better long distance pickups than were dreamed possible a few years ago.

And this same basic research stimulated the development of our new Model 668 cardioid microphone. It uses the Continuously Variable-D® cardioid principle (a creative development from our exclusive Variable-D patent*) to provide smoother cardioid action—plus more versatility—than any other boom microphone you can use.

But let's not ignore the most popular professional cardioid microphone of all, the Model 666. Here's where the Variable-D principle got its start. And since the introduction of our seven foot laboratory, the 666—and its companion, the 665—has been further refined to offer better performance and value than ever before.

From such startling microphones as the 643, come continuing basic improvements—and the tools you need to solve your most difficult sound problems. Only E-V provides this kind of design leadership. E-V microphones in your studio will give you a big head start toward better sound. After all, we're at least seven feet ahead of everybody!

ELECTRO-VOICE, INC.
Dept. 171V, 638 Cecil St., Buchanan, Michigan

Circle Item 18 on Tech Data Card
ESSA  (Continued from page 17)

through the lower atmosphere, or troposphere. Familiar examples of signals propagated by this means are TV and FM broadcasting.

The Laboratory's Consultation and Advisory Division is responsible for conducting and coordinating research and providing consultation on tropospheric propagation. As with the ionospheric research, an important aspect of the studies is prediction of transmission characteristics.

The research programs of this Laboratory include the following: The Tropospheric System Performance program area consists of studies of various modulation techniques and their effects on the performance of telecommunications systems. Optical Propagation and Laser Communications has as its purpose the evaluation of the optical-frequency portion of the spectrum for communications use. Data Reduction and Instrumentation provides specialized facilities to serve these functions. Electronic Interference Environment has to do with studying the characteristics and effects on communications of natural and man-made noise and other extraneous signals. Millimeter Wave Propagation is concerned with how waves of these lengths are affected as they travel through the troposphere. Tropospheric Propagation Predictions is a program aimed at learning how to predict the effects of the troposphere on communications systems. Spectrum Utilization Research seeks efficient use of frequencies affected by the troposphere and the terrain. Radio Meteorology has as its purpose the determination of how propagation depends on meteorological phenomena. Tropospheric Physics deals with the effects of the troposphere on waves at frequencies of 300 MHz and above; it includes studies of tropospheric refraction and signal phase modulation caused by the propagation medium. Atmospheric Spectroscopy concerns properties of the atmosphere relative to the transmission and emission of radiant energy; special attention is given to the infrared frequencies.

Space Disturbances Laboratory

As space exploration increases, so does the need for better knowledge of conditions in space as they affect both safety and communica-
not just color... COLOR

with new Jerrold 440 solid-state microwave

For your STL and other microwave applications, color transmission demands excellent differential phase and gain characteristics. New Jerrold 440 Solid-State Microwave, with differential phase of ±0.25 degree and differential gain of ±0.25 db, is the equipment to specify.

Compact, ultra-stable, with solid-state design and high-output klystron — the 440 Series by Jerrold is without a doubt the finest microwave gear available from any manufacturer at any price. We'll prove it — write today for complete technical data.

Features of Jerrold 440 (6-8 GHz)
1-watt (min.) transmitter output • Vapor-stabilized transmitter klystron • Frequency stability ± 0.005% • Solid-state receiver and local oscillator • 12 MHz baseband, flat within ±0.25 db • Individually self-contained power supplies • Modular construction throughout • Compact — only 10½ in. high.

Aeronomy Laboratory

As was mentioned earlier, aeronomy is the science of the upper atmosphere, and the work of this Laboratory supports the activities of the Ionospheric Telecommunications and Space Disturbances Laboratories. Some of the program areas include Geomagnetism, Sun-Earth Relationships, Ionospheric Structure Studies, Ionospheric Direct Measurements (using rockets and satellites), Consult and Advisory (to provide technical information and advice for government, industry, and universities), and Atmospheric Collision Processes. Still other areas are Instrumentation Research for Aeronomy, Laboratory Plasma Macroscopic, Ionsphere and Exosphere Studies by Scatter Radar, Equatorial Studies (of phenomena either existing only at or most easily studied near the magnetic equator), Upper Atmosphere and Space Physics, Optical Studies of the Airglow and Aurora, and Radio Transmission Properties of the Ionsphere and Exosphere. This impressive list gives some idea of the scope of the ITSA commitment to research.

ITSA Facilities and Resources

A scientific activity of the magnitude described here requires facilities and resources of comparable extent. These the ITSA has.

First is its staff of engineers, scientists, and supporting personnel. There are nearly 500 full-time and 100 part-time or temporary staff members. Over half of the full-time staff are professional personnel, and of this group about 13% have PhD
COLOR PROBLEMS?
These color processing accessories by TELEMET could solve most of your everyday color transmission problems—quickly and easily—during program time.

"ON AIR" ADJUSTMENTS

- STREAKING (tilt) positive or negative, low- and mid-frequency phase correction.
- BOOST chroma from program to program.
- EQUALIZE up to 2,000 feet of 75 ohm cable.
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- Four identical isolated outputs, phase adjustable 0° through 360° with respect to input.
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- Coarse and fine phase adjustments.
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degrees. About twice that number have MS degrees. A number of graduate and undergraduate college students are employed on a part-time basis.

To finance the ITSA operations last year, some $5.5 million was appropriated directly by Congress. Additionally, another 7 million (approximately) was transferred from other government agencies, such as the Department of Defense and NASA.

The majority of the ITSA's activities is centered in the main building of the Boulder, Colorado, Laboratories of the National Bureau of Standards. The NBS facility occupies a 217-acre campus donated to the federal government by the citizens of Boulder. Other Colorado facilities are the Table Mountain Field Site near Boulder, and the Fritz Peak Airglow Observatory near Rollinsville.

Not all research can be conducted in one locality, however, and the ITSA maintains field sites from Point Barrow to Antarctica; other sites throughout the world are operated for the ITSA under contract. One of the world's largest radar antennas—covering 22 acres—is located at the Jicamarca Radar Observatory near Lima, Peru.

Conclusion

When one visits or reads about ESSA and the ITSA for the first time, it is difficult to comprehend the scope of the work that is being done. In talking to the ITSA scientists and engineers, however, one philosophy seems to stand out: The electromagnetic spectrum is a natural resource, and the efforts of these people are directed toward conservation of that resource.

Every ITSA project is related in some way to some form of electromagnetic communication. Part of this work potentially could have profound effects on broadcasting. These effects will not be felt tomorrow, perhaps not for years, perhaps never, but the necessary knowledge will be available for those who make decisions. Basically, that is the priceless product of ESSA—knowledge.

---

Swabs are for babies; S-200 is for cleaning tape heads (even while tape is running)

If you've been cleaning tape heads with a twist of cotton on a toothpick—stop. Save time and do a better job with S-200 Magnetic Tape Head Cleaner. S-200 is a formulation of Freon TF® with other fluorocarbons in convenient aerosol cans. It thoroughly cleans tape heads, guides and helical scan slip rings in seconds, can be applied to running tape without interfering with transmission. And heads stay clean longer. Users report over twice as many passes of tape between cleanings with S-200 than with swabs. S-200 Magnetic Tape Head Cleaner is recommended by leading tape manufacturers. Available in 6 and 16-oz. cans.

Write on letterhead for literature and free sample.
Is there a swing to Norelco

Just ask these busy people

Better yet, ask the
3-tube Plumbicon* color cameras?

who build them.
people who are buying them.

Two major networks and dozens of stations now use Norelco 3-tube color cameras. Over a hundred of these "new generation" cameras are on the air today. And, just to keep up with orders, we've had to triple production personnel and quadruple the number of our factory test stations in less than a year.

Why the swing to Norelco 3-tube cameras? The big reason is superior performance through state-of-the-art innovations. Item: A sharper picture in both color and monochrome than with any 4-tube camera; Norelco's "contours out of green" system for both vertical and horizontal aperture correction provides that. Item: Lower noise, more detail in dark or shadowed areas with Norelco's superior gamma circuitry. Item: No lag because our beam split system is highly efficient; also, the light is split 3 ways, not 4. Item: Maximum stability and reliability because the Norelco 3-tube camera is inherently simpler (which also means fewer controls, less set-up time).

Briefly, that's why they're swinging to the Norelco camera. For technical details, call our sales representative, Visual Electronics.

Or call us. Be a swinger.
AES

The annual awards banquet of the Audio Engineering Society was held in the Barbizon Plaza Hotel, New York, on October 13. The banquet climaxed the annual East Coast convention, at which records for attendance and number of papers read (104) were broken. Highlighted in the papers were endless-loop and reel-to-reel tape cartridges, tape recording, and reproduction.

The John H. Potts Memorial Award was given to John E. Volkman, RCA Laboratories, in recognition of "... his elegant application of acoustic principles in the development of large-scale loudspeakers and sound systems."

Lawrence J. Scully, president, Scully Recording Instruments Corp., received the Emil Berliner Award for "... his many contributions to the art of cutting disc records, especially improvements and innovations in precision lathes."

The Audio Engineering Society Award, reserved for the person who has helped most in the advancement of the Society, went this year to Donald J. Plunkett, president of Fairchild Recording Equipment Corp., "... in recognition of time and effort contributed to problems large or small, national or local."

IEEE

A call for papers has been issued for the International Electronics Conference, sponsored by the Canadian Region of the IEEE. The Conference is to be held next September 25, 26, and 27 in the Automotive Building, Exhibition Park, Toronto. Nonmembers are welcome.

Twenty-minute papers on electronics and related subjects are sought. Deadlines are as follows: Title and 100-word abstract, including author name(s), company affiliation, and telephone number—March 15, 1967; a 500-word summary, or equivalent material suitable for reviewing the paper—March 15, 1967; for accepted papers only, a two-page digest of the paper—June 23, 1967.
All Collins transmitters could be sold for less.
• Corners could be cut on transformers (narrowing safety margins for continuous operation).
• Less shielding could be used against spurious radiation (sacrificing some degree of stability).
• Standards on components, wiring, cabling and switches could be lowered.
• Collins’ rigid testing could be bypassed.
• Money devoted to research and development could be saved.
• Collins’ 2-year warranty could be cut to the 1-year period of other manufacturers.

All these compromises could lower the price—as well as the quality, performance and reliability of the product—about 20%. But then Collins transmitters wouldn’t be known for their careful engineering, conservatively-rated components, and precision manufacturing techniques.

Collins gives the broadcaster a discount in the form of quality and service. And that’s worth a lot more than 20%.

For technical information on any FM transmitter ranging from 250w to 20kw, contact Collins Radio Company, Broadcast Communication Division, Dallas, Texas. Area Code 214, AD 5-9511.

COMMUNICATION / COMPUTATION / CONTROL
Introducing the Super B, today's truly superior cartridge tape equipment.

New Super B series has models to match every programming need—record-playback and playback-only, compact and rack-mount. Completely solid state, handsome Super B equipment features functional new styling and ease of operation, modular design, choice of 1, 2 or 3 automatic electronic cueing tones, separate record and play heads. A-B monitoring, biased cue recording, triple zener controlled power supply, transformer output ... all adding up to pushbutton broadcasting at its finest.

Super B specs and performance equal or exceed NAB standards. Our ironclad one-year guarantee shows you how much we think of these great new machines.

Write, wire or call for complete details on these and other cartridge tape units (stereo, too) and accessories ... from industry's largest, most comprehensive line, already serving more than 1,500 stations on six continents.

Here's the New Economy King

COMPACT 400-A

Don't let their low price fool you. New, solid state SPOTMASTER Compact 400's are second only to the Super B series in performance and features. Available in both playback and record-playback versions, these Compact models share the traditional SPOTMASTER emphasis on rugged dependability.

Top Quality Tape Cartridges

Superior SPOTMASTER tape cartridges are available in standard timings from 20 seconds to 31 minutes, with special lengths loaded on request. In addition, Broadcast Electronics offers a complete selection of blank cartridges, cartridges for delayed programming and heavy duty lubricated bulk tape. Prices are modest, with no minimum order required.

SUMMARIES AND ABSTRACTS

Summaries and abstracts should be sent to:
Dr. Rudi de Buda
Technical Program Chairman
International Electronics Conference
1819 Yonge Street
Toronto 7, Canada

SMPTE
Color television broadcasting will be the subject of a technical conference to be held January 27 and 28 in the Rackham Memorial Building at the Engineering Society of Detroit. Major technical papers will be presented by representatives of networks, manufacturers, and broadcasters.

The Detroit Section (Michigan-Ohio) will be host for the conference, which is sponsored by the Detroit, Toronto, Rochester (N.Y.), and Chicago Sections of the Society in cooperation with the University of Michigan. Program chairman is Fred Remley, University of Michigan Center, Ann Arbor. Further information about the conference can be obtained from Howard W. Town, N.E.T., Inc., 2715 Packard Road, Ann Arbor, Michigan.

Specific areas of discussion are to be: colorimetry, color film reproduction, color video tape, color staging and lighting, color live camera operation, color remote production, and color film recording. A list of proposed papers follows.

Video Tape Recording Standards—Why They Are Important to You—Charles Anderson
Specialized Techniques for Producing 35 mm Color Slides for Television—David Corley
Color Television Mobile Units—P. Corio and G. Hurtubise
Conversion of Television Plant System Facilities From Monochrome to Color—I. S. Rosner and N. Gorchoff
Color Conversion of Television Studio Facilities—N. R. Grover
Video Switching—Irv Moskovitz
Video Testing—George Petrilak
High Efficiency, High Intensity Luminaries for Color Television Lighting—S. F. Quinn
Engineering Economics of Color Conversion of VTR Machines—F. Rees and F. Bonvouloir
Color Film Reproduction—Canadian Telecasting Practices Committee, G. Robitaille
Contours out-of-Green as Applied to a Color Camera System—Charles E. Spicer
Color Fidelity in Camera Systems—Joseph F. Wiggin
THIS IS WHAT QUALITY **LOOKS LIKE.**
OVER 40 TV STATIONS IN THE U.S. KNOW HOW IT PERFORMS

You don't have to operate CDC video terminal equipment to appreciate that it's made by craftsmen who take pride in their work. You can see the quality. It shows, for example, in the orderly precision of the wiring—a far cry from the usual helter-skelter tangle. Every piece of CDC equipment is a precise, skilled interpretation of the most sophisticated designs in the industry. Naturally, quality of product is reflected in quality of performance. CDC custom-designed equipment meets or exceeds the most stringent performance specifications.

CDC video terminal equipment is crafted in Canada, sold and serviced in the United States by our own people. Over 40 TV stations in the U.S. have installed it in the past year alone. Ask any one of them how they feel about it. Then we're pretty sure you'll want to see us.

*Closest installation to your area supplied on request.*

**CENTRAL DYNAMICS CORPORATION**
HEAD OFFICE: 903 Main St., Cambridge, Mass. C2139

January, 1967

Circle Item 32 on Tech Data Card
ELECTRONIC ADVANCES
- Performance as yet unequalled
- Two years proven Solid State circuitry
- Extremely low noise electronics
- Etched circuit modules

TRANSPORT ACHIEVEMENTS
- Patented Electro-Magnetic Brakes never need adjusting
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- Precision Construction
- Low Wow and Accurate Timing

THESE ARE JUST A FEW OF THE OUTSTANDING FEATURES WHICH PROVIDE THE ULTIMATE IN-

QUALITY DEPENDABILITY PERFORMANCE

---

NEW PRODUCTS

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

Color Pulse Generator

A color pulse generator, Model 314A, has been developed by Video-metrics, Inc. It produces the modulated 20T-pulse test signal for measurement of luminance-chrominance gain ratio and envelope delay. It also produces a sine-squared T-pulse and window. The unit (top of photo) will operate in either a full-field or vertical-interval mode.

The color pulse test signal combines a modulated color subcarrier having sidebands of approximately ½ MHz with a low-frequency sine-squared pulse of 2.5 μsec half-amplitude width. Gain or delay variations between low and high frequencies (luminance-chrominance) produce wave-form distortions to the test signal which are observable and measurable using existing oscilloscopes.

The Model 314A generator is completely solid-state and contains its own regulated power supply. The unit measures 3 in x 8 in x 12 in and may be used as is, rack mounted in a 3½-in high rack mounting frame, or mounted in a special carrying case. A companion EIA sync generator, Model 308 (center of photo), is available for portable or remote operation.

SPOTMASTER

From industry's most comprehensive line of cartridge tape equipment.

Enjoy finger-tip convenience with RM-100 wall-mount wood racks. Store 100 cartridges in minimum space (modular construction permits table-top mounting as well); $40.00 per rack. SPOTMASTER Lazy Susan revolving cartridge wire rack holds 200 cartridges. Price $145.50. Extra rack sections available at $12.90.

Write or wire for complete details.

LANG SOLID STATE PROGRAM EQUALIZER

Unsurpassed in design, performance and versatility, the new LANG SOLID STATE PROGRAM EQUALIZER PEQ-2 incorporates the finest features found in quality equalizers,

PLUS THESE EXCLUSIVE FEATURES...
- Eight low boost shelf frequencies
- Four low droop shelf frequencies
- Eight high boost peak frequencies
- Six high droop shelf frequencies
- Frequency select switches and equalization controls for all boost and droop functions
- All controls and switches may be used simultaneously
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- Equalization "on" lamp indicates when equalization is taking place
- Engraved stainless steel panel blends harmoniously with other equipment
- Plug-in transistor amplifier and power supply cards
- Compact size: 3½x10½x10½

For complete details and new Lang Catalog write:

LANG ELECTRONICS INC.
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For all your audio needs—Look to Lang!
AUTOMATIC VIDEO LEVEL CONTROL
Maintains video peaks constant to a preset level, with reference to blanking.

CLAMPING
Sync tip clamps remove hum, tilt and other low frequency disturbances.

SYNC LEVEL
Sync level is maintained at a constant amplitude despite large variations in input.

EQUALIZATION
Accurately compensates for losses in up to 1000 feet of coaxial cable.

REMOTE CONTROLS
Automatic/Manual video gain
Sync Level
White Clip
Chroma Control
By-pass switch

WHITE CLIP
Adjustable sharp white clip remains fixed with respect to blanking.

CHROMA CONTROL
Chroma response continuously adjustable ± 4 db. from unity.

WHITE STRETCH
Stretch adjustments provide a high degree of flexibility to compensate for transmitter characteristics.

NON-COMPOSITE COLOR OUTPUT
Mono. or Color non composite output board in lieu of white stretch is available at additional cost.

APPLICATION
Wherever there is video and you want to assure:
- Constant levels
- Constant clean sync
- Elimination of tilt, hum and low frequency disturbances.

Price for the VI-500 $1,750.00 Remote controls $150.00 . . . Have you placed your order yet?

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January, 1967
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1KW TRANSMITTER
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EMCEE

Electronics Missiles and Communications Inc.
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Small-Space Fader With Unbalanced Bridged-T Network

A flat-fronted stud fader designed for use on existing and new studio consoles in broadcasting and recording applications is being produced by Painton of England. Designated type FM-1, the unit occupies ¾ in. of panel width and extends 2½ in. below the panel surface. Unbalanced bridged-T networks are in stock, and the first model offered has input and output impedances of 600 ohms. with a tapered attenuation in a maximum of 30 steps, plus off position. Cue lighting and switches are built in. External connection is made with a miniature plug and socket arrangement in the rear. Connector contacts are of the low-noise type, gold finished for reliability and long service.

Camera Pod

A lightweight camera pod is now...
available from Leopold Enterprises, Inc. The unit, designed to free a cam­
eraman’s movements, includes a hand­
adjusted device which tilts the camera
30º upward or downward, permitting
the operator’s back to remain upright.
Quick release for both the camera
and the harness is included, and pro­
vision has been made for a built-in
power supply. List price of the “Leo­
Pod” is $177.50.

Transfer Recording Channel

Westrex, a division of Litton Indus­
tries, is now manufacturing a record­

ic” Q-Crawl eliminates polarity revers­
sal and utilizes white-on-black typ­
ing. Stop frame action is optional.
The unit can be used to present stock­
market quotations, football scores, and other information in a vertical
manner.

Moving Title Display

A new model of the Q-Tv “Graf­

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- First with solid state monitors
- First with both professional and
general purpose solid state transistor monitors
- More transistor monitors in use than
all other monitor manufacturers

HURRY! OFFER GOOD FOR 90 DAYS! WRITE OR CALL COLLECT FOR DETAILS!

Circle Item 40 on Tech Data Card
ing channel built specifically to transfer the output of a high-quality magnetic tape reproducer to the company's 3D StereoDisk recorder. Known as the Westrex 2300, the new system consists of a stereo limiting amplifier with fast attack time, variable release time, and low distortion and noise; variable high-pass and low-pass filters; variable program equalizers; 20-step, 600-ohm balancing attenuator; 30-step, ganged recording attenuators; mono-stereo capability; and a complete monitoring and playback system.

Zoom Lens

A 10 x 9.5 Angenieux Zoom Lens for 16-mm motion picture cameras is now available from Zoomar International, Inc.

The new lens offers apertures from F/2.2 to F/22 and focal lengths 2.5 through 95 mm. This optic offers the advantage of short minimum focusing distances (29" from subject to film plane) and substantial depth of field, even at full aperture. When focused at the 29" minimum distance, objects only 22" from the film plane will be at the forward limit of the depth-of-field range.

Another valuable feature is the choice of either a 4:1 zoom crank or a new zoom lever. Models are also available with viewfinders.

Accelerated Film Service

Acme Film & Videotape Laboratories, Hollywood, has inaugurated an accelerated service in response to numerous requests for what amounts to "crash" delivery schedules. The extra-expedited service on transfers, dupes, and 16-mm prints is intended to cut days off normal lab delivery time.

No QRK Professional Turntable ever stands still...for long!

Each QRK is ruggedly built, tediously tested and timed to exceed N.A.B. Specs. Then it's guaranteed for one full year against any slip-up in material or manufacture. Despite all that, should something ever break, foul-up or wear out — a phone call to us will put the part on a plane same day. Don't settle for less. Install QRK.

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You owe it to yourself, your family, your future to get the complete details on our “proven effective” Cleveland Institute home study. Just send the coupon below for FREE book or write to Cleveland Institute of Electronics, 1776 E. 17th St., Dept. BE-34, Cleveland, Ohio 44114.

NEWS FOR VETERANS

New G.I. Bill may entitle you to Government-paid tuition for CIE courses if you had active duty in the Armed Forces after Jan. 31, 1955. Check box for complete information.

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Please send me your FREE book, “How To Get A Commercial FCC License.”

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January, 1967
**EIMAC**

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Openings exist for qualified engineers to fill power tube marketing and applications engineering positions in the San Francisco Bay Area.

**Positions require:**
- 3-5 years experience in power tube engineering, electronic or radio equipment design, or broadcast engineering, and a desire to enter marketing at a high technical level.
- BSEE or equivalent degree.
- Sound technical background.

**Responsibilities:**
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- Liaison between EIMAC and customer engineering staffs.
- New product planning and development of marketing programs.
- Technical and commercial support of field sales force.
- Negotiation of product requirements and specifications.
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For further information call Dick Reidburn (415) 592-1221 or send resume in confidence.

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**MOBILE RADIO & COMMUNICATIONS**


**POWER DEVICES**

88. HEVI-DUTY — Bulletin supplies data on line-voltage regulator using saturable-core reactor.

**RECORDING & PLAYBACK EQUIPMENT**


90. AUDIO DEVICES — Audiodiscs® recording blanks, Audiocassette tape® magnetic recording tape, and Audiopak® continuous-loop cartridges are subjects of literature.

91. GATES—Brochure illustrates and provides specifications on transcription turntables and accessories.

92. VIKING OF MINNEAPOLIS—Literature about Model 230 tape transport with RP120 amplifier is offered.

**REFERENCE MATERIAL & SCHOOLS**

93. 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.

94. HAYDEN BOOKS—Catalog contains list of texts, professional books, and references for scientists, engineers, and students.

**TEST & MEASURING EQUIPMENT**

95. HEWLETT-PACKARD—Application Note AN 77-2 explains how a vector voltmeter can be used to make high-resolution frequency comparisons quickly.

96. SECO—New test-equipment folder features Model 107-C voltage-regulated tube tester.

97. TRIPLETT—Catalog No. D-68-1 shows line of panel meters, shunts, and portable instruments.

98. VITRO—Subjects of leaflet are Nems-Clarke phase monitors, spectrum display monitor, field-intensity meters, FM re-broadcast receiver, and RF and video jack panels.

**TOOLS & SAFETY DEVICES**

99. AIR SPACE DEVICES—Brochure STCS-65-10M illustrates applications of “SAF-T-CLIMB” for safety in climbing structures.

**VIDEO EQUIPMENT**

100. CLEVELAND ELECTRONICS — A 52-page quick-reference step-down die-cut catalog covers complete information on vidicon, Plumbicon®, and image-orthicon deflection components.


102. GRANGER ASSOC.—Technical-data sheet contains information about infrared-sensitive TV system with 600-line vertical and horizontal resolution.

103. TELEVISION ZOOMAR—Literature describes Model 10x40C 10-to-1 zoom lens for image-orthicon cameras.

104. TROMPETER—Patching and delegate switching systems for broadcast and video distribution are covered in literature.

105. VITAL—Data sheets give specifications of Model VI-500 stabilizing amplifier, Model VI-10A video distributing amplifier, and Model VI-20 pulse-distribution amplifier.
Your time salesmen will wonder how they ever got along without it! Completely self-contained and self-powered, PortaPak I offers wide-range response, low distortion, plays all sized cartridges anywhere and anytime. It's solid state for rugged dependability and low battery drain, and recharges overnight from standard 115v ac line. Packaged in handsome stainless steel with a hinged lid for easy maintenance, PortaPak I weighs just 11 1/2 lbs. Vinyl carrying case optional.

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Personnel Dept.

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www.americanradiohistory.com
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www.americanradiohistory.com
Announcing... for color and black and white, the new family of RCA image orthicons with a big difference here that shows up big here

Now RCA brings you the "BIALKALI PHOTOCATHODE" in the new RCA-8673 and -8674 Image Orthicons. This major engineering innovation has greatly improved compatibility with its non-stick target, maintaining resolution and sensitivity over an extended tube lifetime and improving performance of existing color or black-and-white cameras. A simple change in a resistor chain provides proper voltages for a trio of these new Bialkali Photocathode Tubes. Wide-range, the 8673 and 8674 fit spectral requirements of all three channels... eliminating the need for another tube type for the blue channel.

Another big difference: the re-designed image section provides reduced distortion and freedom from "ghosts." These new tubes are available singly or as matched sets—a trio of 8673/S or 8674/S types for color service... types 8673 and 8674 for black and white. Main construction difference is in the target-to-mesh spacing. The closer-spaced 8673 enhances S/N ratio for quality performance under sufficient illumination. The 8674 has greater sensitivity under limited illumination. For complete information about the new RCA Bialkali Photocathode Image Orthicons, ask your RCA Broadcast Tube Distributor.

RCA Electronic Components and Devices, Harrison, N.J.

The Most Trusted Name in Electronics

USE THIS CHART TO SELECT REPLACEMENT TYPES FOR THE TUBES YOU ARE NOW USING

<table>
<thead>
<tr>
<th>UNDER SUFFICIENT LIGHTING LEVELS</th>
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<tbody>
<tr>
<td>For color pick-up,</td>
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<tr>
<td>If you're now using... You can replace with:</td>
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<tr>
<td>4513/S</td>
</tr>
<tr>
<td>7513/S</td>
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<tr>
<td>8673/S</td>
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<tr>
<td>For black &amp; white pick-up,</td>
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<td>If you're now using... You can replace with:</td>
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<td>4513</td>
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<tr>
<td>7513</td>
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<td>7513/L</td>
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<td>8093A</td>
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<td>8093A/L</td>
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<tr>
<th>UNDER LIMITED LIGHTING LEVELS</th>
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<tr>
<td>For color pick-up,</td>
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<tr>
<td>If you're now using... You can replace with:</td>
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<tr>
<td>4415S</td>
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<td>4416S</td>
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<td>8674S</td>
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<td>For black &amp; white pick-up,</td>
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<tr>
<td>If you're now using... You can replace with:</td>
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<tr>
<td>7293A</td>
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<td>7293A/L</td>
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</tbody>
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