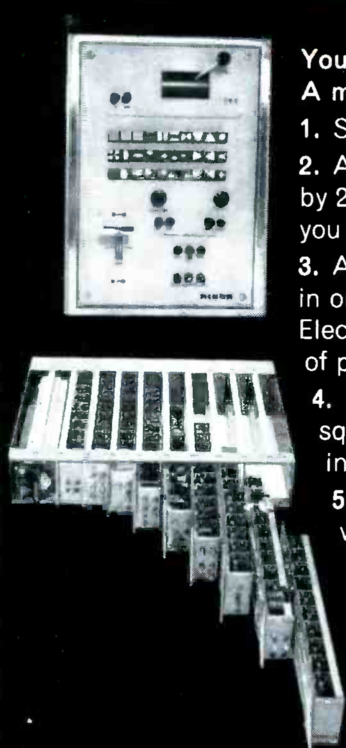
A HOWARD W. SAMS PUBLICATION

JUNE, 1968/75 cents

Broadcast Engineering

the technical journal of the broadcast-communications industry

how to build a versatile special effects system on a not-so-versatile budget.



You build it the Riker way. Inexpensively. Cleverly. A module at a time. Like so . . .

1. Start with our basic 9-wipe system. Very handy. Very useful.
2. Add a waveform module and you've increased your wipe capacity by 29. And by pressing two or more buttons simultaneously, you can create an infinite number of waveform combinations.
3. Add an insert keyer and subjects being keyed are easily wiped in or out. Title inserts can be wiped from one to the next. Electronic masking and montage effects become simply a matter of pressing the right buttons.
4. Add a "Joy Stick" positioner. Now you're able to set circles, squares, diamonds and other wipe patterns to move or appear in any portion of the picture area.
5. Add a mixer-fader and you now have the world's most versatile special effects system.

Incidentally, you don't have to buy a Riker Special Effects System a module at a time. You can always splurge and get the whole works all at once. It's really more fun that way. For details write or call Riker—the one company in the TV broadcast industry offering a complete line of all solid-state instrumentation for video analysis, simulation and control.

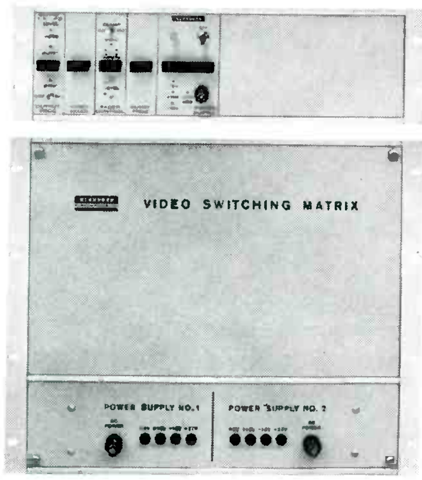
RIKER

PRODUCTS FOR VIDEO ANALYSIS, SIMULATION & CONTROL

RIKER VIDEO INDUSTRIES, INC., 100 Parkway Drive South, Hauppauge, Long Island, N.Y. 11787 (516) 543-5200

Circle Item 1 on Tech Data Card

- accepts composite or noncomposite signals
- cut is standard on Mix, Effects, and Preset/Program Buses
- automatic inhibit of non-synchronous dissolve
- fade to black with automatic cut
- automatic sync insertion
- no mid-fade color drop when fading to monochrome
- input over-voltage protection to ±300 volts



All performance specifications lead the state of the art; all components used are selected from the latest proven lists. Cohu's new 9300 Series Video Switcher does it all...and does it now.

No single failure can disable the 9300 because of redundant power supplies and sectional fusing. Test points are easily accessible from the front. Cards are interchangeable plug-ins. Adjustable, preprogrammed delay sections provide interchangeable output amplifiers.

Designed specifically for broadcasting, the 9300 Series Video Switcher features integrated circuits and modular construction with a convenient form factor for typical studio requirements and expansion capabilities. For more details, contact your nearest Cohu representative, or call Bob Boulio direct at 714-277-6700 in San Diego. But do it now! Box 623, San Diego, California. TWX 910-355-1244.

Cohu's New 9300 Series video switcher does it all... Now

COHU
ELECTRONICS, INC
SAN DIEGO DIVISION

Circle Item 2 on Tech Data Card

publisher
Howard W. Sams
publications director
J. J. Lieland
editor
William E. Burke
managing editor
James M. Moore
associate editor
Carl F. Moeller
regional editors
George M. Frese, Northwest
Howard T. Head, Wash., D.C.
Robert A. Jones, Midwest
research librarian
Bonny Howland
production manager
Susan M. Hayes
photography
Paul A. Cornelius, Jr.
circulation manager
Pat Osborne
advertising sales manager
Roy Henry
Howard W. Sams & Co., Inc.
4300 West 62nd St.
Indianapolis, Ind. 46206
(317) 291-3100
regional sales managers
midwestern
Tom Mowry
Howard W. Sams & Co., Inc.
4300 West 62nd St.
Indianapolis, Ind. 46206
(317) 291-3100
eastern
Alfred A. Menegus
Howard W. Sams & Co., Inc.
3 West 57th St.
New York, N.Y. 10019
(212) 688-6350
southwestern
Martin Taylor
P.O. Box 22025
Houston, Tex. 77027
(713) 621-0000
advertising sales representatives
western
LOS ANGELES OFFICE
G. R. Holtz
The Maurice A. Kimball Co., Inc.
2008 West Carson St., Suites 203-204
Torrance, California 90501
(213) 320-2204
SAN FRANCISCO OFFICE
The Maurice A. Kimball Co., Inc.
580 Market St., Room 400
San Francisco, California 94104
(415) 392-3365
foreign
LONDON W.C. 2, ENGLAND
John Ashcraft, Leicester Square
WHitehall 0525
AMSTERDAM
John Ashcraft, Herengracht 365
Telefoon 24 09 08
PARIS 5, FRANCE
John Ashcraft, 9 Rue Lagrange
ODeon 20-87
TOKYO, JAPAN
International Media Representatives
Ltd., 2-4, 6—Chrome,
Akasaka, Minatoku,
Tokyo, Japan

BPA   AIA

BROADCAST ENGINEERING is published monthly by Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206. SUBSCRIPTION PRICES: U.S.A. $6.00, one year; $10.00, two years; $13.00, three years. Outside the U.S.A., add $1.00 per year for postage. Single copies are 75 cents, back issues are $1.00.

the technical journal of the broadcast-communications industry

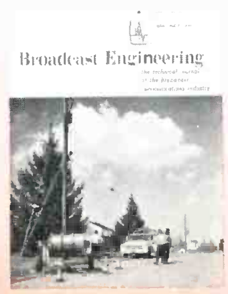
Broadcast Engineering

Volume 10, No. 6 June, 1968

CONTENTS

Features

Departments



Partner, adjunct, or competitor to the broadcasting industry—only time can reveal the ultimate role of CATV. One thing is certain, the CATV methods and technology of today are a far cry frrom those of a decade ago. Our cover shows the construction of a trunk line in Lancaster, Pennsylvania. This scene promises to become increasingly familiar throughout the counrty. (Cover photograpn courtesy of Entron, Inc.)

Color it red, green or blue but above all— color it true!

The rhyme may be pretty corny, but take our word for it, the results you can expect with our new Model 538 Chromax Masking Processor aren't. Whether it's Campbell Soup Red, Oasis Blue, or even Lucky Strike Green, Chromax delivers true color fidelity from your telecine chain.

The new CBS Laboratories development electronically corrects color distortion caused by optical color filter overlap and the response characteristics of camera pick-up tubes. You get true color fidelity — automatically — without adding noise to the picture.

Come to think of it, you really don't have to take our word for anything. You can call us collect anytime (203) 327-2000 for details on how you can try one in your PE-240 chain. If you're not in too much of a hurry for a better color picture, then write the Professional Products Department at CBS Laboratories for more details on this Masking Processor and others now being designed.

PROFESSIONAL PRODUCTS
CBS LABORATORIES
Stamford, Connecticut. A Division of Columbia Broadcasting System, Inc.

Circle Item 3 on Tech Data Card

NEWS OF THE INDUSTRY

NATIONAL

Microwave Systems Sold to TV Stations

Microwave Associates, Inc. reports receipt of a contract from **KBYU-TV,** Provo, Utah, educational television station of Brigham Young University, for delivery of dual STL and TSL equipment with color capability. Other recent ETV station installations by Microwave Associates include **WSBE,** Providence, R.I. (STL); **WBGU,** Bowling Green State University, Ohio (TV Pick-Up); **KUAT,** University of Arizona, Tucson (STL); **KAET,** Arizona State University (STL); **KLRN,** University of Texas at Austin (TV Pick Up), and **WEDH-WEDN** Hartford-Norwich, Connecticut (STL/intercity relay).

Also, a new turnkey contract has been signed with Wometco Industries' station **WTVJ,** Miami, for dual automatic-switchover STL, TSL, and intercity relay from Ft. Lauderdale to the Miami studio. In addition, **KIRO-TV,** Seattle, Washington, has signed for dual STL and TSL links. The station previously purchased a portable link for greater-Seattle live TV van pick-up and coverage of marine sports events from boats.

Two New ETV Systems

A new instructional television system will be in operation this September when the **Monroe Community College,** Rochester, N.Y., opens its doors to students at its new campus. The system will enable the college to originate programs on 12 RF, 5 video, and 2 subcarrier TV channels and distribute them over a coaxial-cable system to every teaching station on campus—156 classrooms, lecture halls, laboratories, and learning carrels. The system has the capability of providing up to 17 simultaneous TV programs.

In addition, programs can be originated from any point on campus, and then fed back through the cable by means of the subcarrier channels to the college TV distribution center for recording and taping purposes.

The ITV system was engineered to the specifications of Professor Eugene Edwards, chairman of the Instructional Services Department of Monroe, by the Educational and Communication Systems Division of **Jerrold Electronics Corp.** Fabrication and installation of the master distribution system and head-end were handled by Professor Leslie M. Wetherbee, chief television engineer.

Northeastern University is constructing a new four-channel 2500-MHz instructional television system. The system uses Jerrold color and black-and-white transmitting and receiving equipment. Programs originating in the university's studios will be transmitted via microwave to its downtown-Boston campus and its Burlington, Mass., campus approximately 12 miles away. At the various buildings, the signals will be converted to VHF and delivered to each classroom through a cable TV distribution system. In addition to two program-origination studios, many of the classrooms are equipped to originate programs.

Handwriting Over FM

The transmission of handwriting with voice was presented at the annual convention of the National Association of FM Broadcasters by the **Victor Comptometer Corp.** In addition to normal FM voice broadcast, the Victor Electrowriter Remote Blackboard (VERB) system provides the speaker with a means of transmitting handwritten notation normally made on a classroom chalkboard.

The Electrowriter signal can be transmitted on the FM station's SCA subchannel. The audio broadcast is received in the normal way; the writing information is recovered from the subchannel and reproduced by the Electrowriter equipment on a large screen.

MATV-ITV Technical Session

Thirty-five engineering contractors, educational television broadcasters, and electronic distributors recently completed a three-day technical training course on master antenna and instructional television conducted by the Educational and Communication Systems Division of **Jerrold Electronics Corp.** The course, held at Jerrold headquarters in Philadelphia, drew representatives from 14 states, the District of Columbia, and Puerto Rico. Similar schools are to be held this year in Atlanta, San Francisco, and again in Philadelphia. The school in San Francisco will cover, in addition to MATV and ITV, the subject of Instructional Television Fixed Service (ITFS).

ETV for Kentucky

Now undergoing final tests are twelve TV transmitters which **RCA** is supplying the State of **Kentucky's** new educational TV network. The transmitters are designed for UHF television service, and when used with the appropriate antenna, each is capable of radiating 1,000,000 watts of effective radiated power. The transmitting equipment is scheduled to be in operation next fall.

New Division is Formed

Formation of a new Information Systems Division has been announced by **Visual Electronics Corp.** The Division immediately will begin local operations in the metropolitan New York and northern New Jersey area.

Products incorporated in the systems provided by the new Division will include equipment for conversion of digital data to television-screen information displays, electronic character-generation units, display composers for information-handling terminals, "Ready-File" for random-access data storage, "Master-File" for high-capacity instant-access data storage, monochrome TV cameras for closed-circuit surveillance and educational applications, and color equipment including cameras and videotape recorders.

Plans call for early expansion of the New York operations to New England and, later, throughout the United States.

To Receive President's "E" Award

Memorex Corp. has been designated by Secretary of Commerce C. R. Smith to receive President Johnson's Export "E" Award for its success in promoting foreign sales of U.S. products. The company was founded in 1961 and opened its international markets in 1964. In three years, export sales volume has increased to one-quarter of total sales.

The "E" Award consists of a citation signed in the name of President Johnson by Secretary Smith, an "E" flag, and "E" lapel buttons.

Dealer Announced

Arrow Electronics, Inc. has been selected by the **Ampex Corp.** as a franchised dealer for the metropolitan New York area. Arrow will be handling the entire Ampex line of professional audio products, with the ex-

Q. what video distribution amplifier has all these features...

- Lowest cost per output
- Six identical source terminated outputs
- Cable equalizing for LF and HF compensation
- Hum bucking input for 46 db ground loop rejection
- Available with sync adding facility
- Built in power supply
- BNC source-terminated test output on front panel
- Plug-in module; silicon semi-conductors throughout
- Excellent performance characteristics

?

A. only Ward video distribution amplifier Type TA-901

Your best buy—feature for feature, dollar for dollar . . . 72 outputs in 5-1/4" rack space—at less than $45 per output.

The Ward TA-901 Video Distribution Amplifier is a high performance, multi-purpose amplifier for distributing color or monochrome video signals in TV systems. Each TA-901 plug-in module, with built-in power supply, provides six source-terminated outputs. Twelve TA-901 amplifiers can be accommodated in a standard F-800 5-1/4" rack frame. Write or call for complete details.

WARD ELECTRONIC INDUSTRIES

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

Circle Item 4 on Tech Data Card

ception of magnetic tape. Last year, a broadcast division was established as an adjunct to Arrow's industrial sales department. Its function is the administration of sales to major networks, audio specialists, and sound-system contractors in the broadcast field. The broadcast division makes its headquarters at the company's main facility in Farmingdale, New York. Ampex professional audio products also are available through Arrow sales distribution centers in Manhattan; Norwalk, Connecticut; Totowa, New Jersey; and Mineola, Long Island.

New VTR Division

Consolidation of the **Sony Corp. of America** Industrial and Commercial video tape-recorder divisions into one division has been announced. The new VTR Division will be under the direction of Vice-President Bruce L. Birchard, who has headed the Industrial Division since it was formed in 1963. Mr. Birchard is also president of Videoflight, Inc., a Sony tape-duplication subsidiary. Sony will have two sales managers, Richard F. O'Brion and Harold L. Johnson, to supervise the company's full line of Videocorders

New Plant Opened

Advance Industries is now operating from new facilities at 2301 Bridgeport Drive, Sioux City. The 20,000-square-foot facility is the first to be located in the "Bridgeport Industrial Park." The factory and offices are located on a 5-acre tract of land in this area.

National Distribution of Video Tape

Irish Electronic Enterprises, Inc. has announced that national distribution of Irish video tape has been achieved. Irish markets a line of video tape in both the one and one-half inch sizes. It is manufactured in the United States for use in home recording, sales training, and special industrial applications.

Miniature *Plumbicon* Camera Tube

A miniature *Plumbicon* camera tube has been developed by scientists at the **Philips Research Laboratories** in Eindhoven, the Netherlands. The tube is five inches long with an external diameter of 5/8 inch, which is one half the diameter of the present standard *Plumbicon* employed in color television cameras. Since pick-up-tube dimensions are a significant factor in the design of compact cameras, the size of this miniature tube should have an important bearing on the successful development of small color cameras for a number of applications in addition to television broadcasting, such as attachments to microscopes, endoscopes, surgical lamp units, etc.

A prototype lightweight color camera has been developed as a test bed for the miniature tube and to evaluate its potential for small color-television cameras. Compared with that of the present day *Plumbicon* color-studio cameras, the overall performance of this small, experimental camera is reported to be surprisingly good. Color rendition is comparable and the lag is actually less due to lower tube-target capacity.

This experimental portable color camera is comparable in dimensions and weight to a 16-mm movie camera. The camera itself weighs about six and a half pounds, and the associated electronic circuits in a portable case or backpack housing weigh less than nine pounds. A zoom lens weighs another two pounds, as does a small electronic viewfinder. The total weight for the camera head, therefore, is ten and a half pounds.

INTERNATIONAL

Mexican Subsidiary Formed

Jampro Antenna Co. has announced the formation of a new subsidiary in Mexico City. Jampro is a division of **Computer Equipment Corp.** The Mexican subsidiary, **Jampro de Mexico, S. A.,** will design and manufacture television and FM broadcasting antennas. Other products include vestigial-sideband filters, harmonic filters, and diplexers.

Marketing and sales of products manufactured by Jampro de Mexico will be done exclusively by **Visual Electronics S. A.,** Mexico City, a wholly owned subsidiary of **Visual Electronics Corp.** This office is headed by Miguel Pereyra, formerly with Telesistema Mexicana.

South American Microwave System

A new microwave communications system linking Argentina and Uruguay has become operational according to an announcement by **General Telephone & Electronics International, Inc.** The 155-mile network, which will be utilized primarily to carry telephone calls, also makes possible the transmission of television programs between the two countries. TV programs were not transmitted previously between countries in South America because the existing international telephone cables did not have sufficient capacity to carry them.

The microwave system was installed by GT&E International for the governmental telecommunications agencies of the two countries. The work was performed under contracts totaling approximately $2 million. The network was constructed across generally flat terrain subject to the strong "pampero" winds which sweep eastward from the Andes Mountains across the pampas, or plains. For this reason, the four microwave relay towers in the system were designed to withstand winds of up to 130 miles per hour. The unattended relay stations are all located in Uruguay, at Canelones, San Jose, Rosario, and Colonia. The last "hop," between stations in Colonia and Buenos Aires, spans the 30-mile-wide Rio de la Plata, which separates Uruguay and Argentina.

Microwave radio, carrier multiplex, and switching equipment for the system were supplied by **Societa Generale di Telefonia ed Elettronica S.p.A.** (Italy), a GT&E International subsidiary. Voice-frequency telegraph equipment was provided by **Lenkurt Electric Co., Inc.** Lenkurt and GT&E International are subsidiaries of **General Telephone & Electronics Corp.**

Computer To Aid in Detecting Unlicensed Dutch Set Owners

Dutchmen who neglect to pay licenses for operating their television and radio sets will find a formidable opponent working to detect them. The "detector" is a new UNIVAC 418 Real-Time Computer System, supplied to the **Netherlands Postal and Telecommunications Services** (PTT) by the **Sperry Rand Corp.** UNIVAC Division.

To discover unlicensed owners, the computer will make rapid checks of registered set owners against a file of all cities, streets, and houses. From this comparison, a list of addresses will be prepared showing those homes where no radio or TV sets are registered. The list will then be given to PTT officials for investigation.

In common with many European countries, Holland licenses all radio and television sets operated in the country. Twice each year, each set owner receives a prepunched, preprinted card prepared on Univac card-punching machines, with which to pay his license fee at any post office or by a cash transfer from a

bank checking account. A large part of this revenue is then distributed to the five Dutch broadcasting companies.

STATION ACTIVITY

Station Equipped for Emergency Power

Installation of power generators for emergency operation of the studios and transmitter of **WABC**, New York has been completed to make it possible for the station to remain on the air through emergency periods such as the power failure of November 1965.

A 35-kw generator has been installed in a separate fireproof concrete room in the ABC Building in downtown New York. This room is equipped with its own ventilating system. The generator will take over within 6 seconds after a commercial power loss, and its fuel-tank capacity allows it to run for approximately 8 hours. Refueling of the tank is done by a hydraulic pump operated from the generator power source. The generator will not shut itself off until all three phases of commercial power have proven themselves stable for a period of 30 minutes.

At the Lodi, New Jersey WABC AM transmitter site, a 200-kw 3-phase, 2400-volt generator is capable of operating both the 50-kw transmitter and the 10-kw transmitter plus all auxiliary equipment and building lighting. The generator also can provide the power needs of a fallout shelter which contains all the necessary broadcast equipment to originate normal programming from that location.

Station Sold

Subject to the approval of the Federal Communications Commission, the assets of Radio Station **WYSI**, Ypsilanti, Michigan, licensed to the **Ypsilanti Broadcasting Co.** have been sold to **Robert Koch** of Bloomfield Hills, Michigan. The president of Ypsilanti Broadcasting Co. is Craig Davids, who als oowns KCKY, Coolidge, Arizona. The station sold for $135,000.

20th Anniversary

Radio station **WJCW-FM**, Johnson City, Tenn., celebrated its 20th anniversary recently. WJCW-FM went on the air with the call letters WJHL-FM and a power of 3000 watts. It duplicated the programs of WJHL-AM, a 5000-watt facility. In 1956, the power of the FM station was increased to 9600 watts. Both stations were sold in 1960 to **James C. Wilson,** the present owner, who raised the FM power to 65,000 watts. In recent years, WJCW-FM has operated indepently from WJCW-AM, with its own announcing and sales staff.

ORGANIZATIONS

AES

The 1968 Fall Convention and Exhibit of the Audio Engineering Society will be held October 21-24 at the Park-Sheraton Hotel in New York City. Technical Sessions will be devoted to: Disc and Tape Recording, Broadcast and Communications Audio, Electronics and Musical Instruments, Sound Reinforcement, Solid State Transducers, Audio Apparatus and Applications, and Audio in Medical Practice and Reasearch.

In addition to the Technical Sessions, several special features are being planned to commemorate the 20th year of the AES.

Members and friends of the Society are invited to submit 60-word abstracts of papers for consideration for presentation at the Convention to the Convention Chairman, J. G. Woodward, RCA Laboratories, Princeton, New Jersey 08540, before June 1, 1968.

NAB

The National Association of Broadcasters has asked the Federal Communications Commission to hold up its approval of a cable television system in Colorado until a U.S. Court rules on the validity of the FCC's decision. Douglas A. Anello, NAB general counsel, said in a statement filed with the Commission that the FCC "erred in granting without evidentiary hearing" an application for permission to build a CATV system that would import multiple TV signals into an area already served by all three television networks.

In an earlier filing, NAB had asked that this and three other CATV applications in the same part of the state be considered as one.

NCTA

A former chairman of the Federal Communications Commission has called for creation of a cabinet-level Department of Communications and an overhaul of the nation's communications laws "to bring together into a single useful fabric the loosely knit ravelings of our present patchwork communications program."

Frederick W. Ford, president of the National Cable Television Association, offered the proposals as part of a five-point program which he said is necessary to "lead us out of the communications jungle." The CATV spokesman addressed a Telecommunications Symposium sponsored by the Broadcast Advertising Club of Chicago.

Ford's five-point program called for:

(1) A step-up in the "pathetically small sums" now spent by government and private industry on research designed to increase effective use of the electromagnetic spectrum.

(2) Creation of a cabinet-level Department of Communications, "to assure the growth and progress of the nation's telecommunications industries."

(3) Revamping and revitalization of the communications laws, "to meet the growing needs of our defense establishment, to accommodate the public interest," and to bring about needed reforms in the policies of such agencies as the FCC, which, he noted, has "severely restricted" the growth of CATV.

(4) "An integrated approach that makes optimum use of all our communications resources—both commercial and educational television, the cable industry, land-mobile services, satellites, and all other communications capabilities."

(5) "A new sense of purpose and direction" assuring that the nation's communications program "meets other national objectives . . . operates always in the public interest, and . . . remains free of monopolistic influence and negative tendencies."

SMPTE

The appointment of Denis Courtney as executive secretary of the SMPTE has been confirmed by the Society's Executive Committee. Mr. Courtney has been serving as acting executive secetetary.

CATV

Color System for CATV

A live color studio package is slated for installation at **Coachella Valley Cable TV,** Palm Desert, Calif. The cable system is owned by **Dr. David Palmer,** of Palmer Broadcasting, Davenport, Iowa, and managed by **Daniels Management Co.**

The new color equipment includes **International Video Corp.** cameras and video tape recorders, and **Tele-Mation** multiplexing equipment, sync generators, and other video systems components. ▲

ACCESSIBILITY

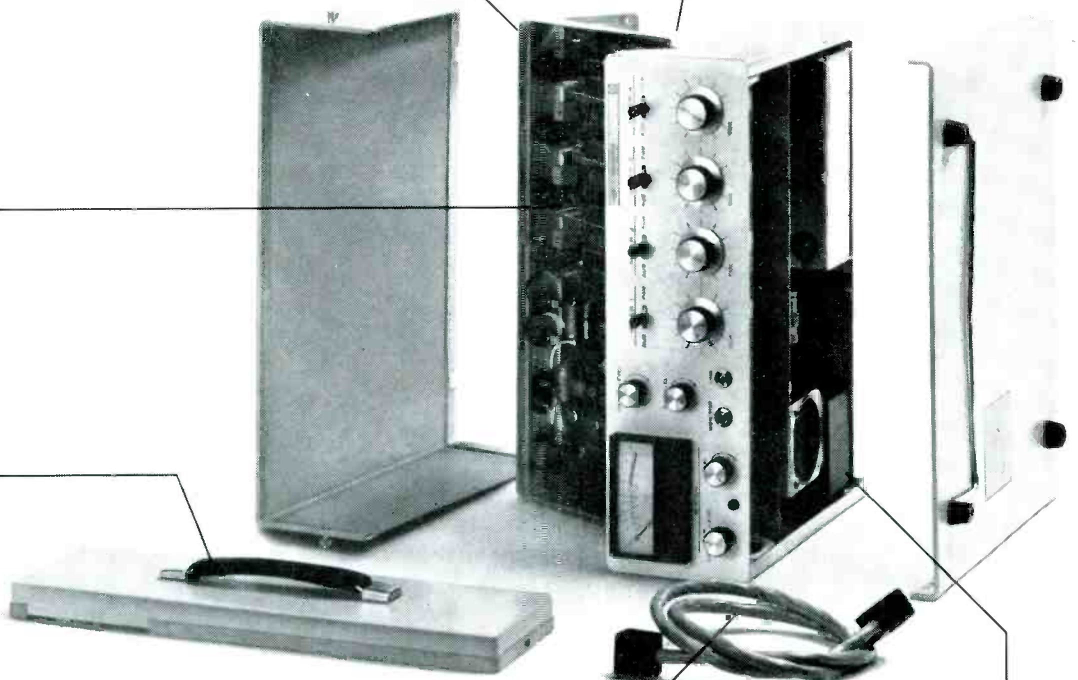
Top and bottom covers removed individually to expose all components. Circuit board hinged for easy access to reverse side and cables.

FLEXIBILITY

- 4 switch-selectable inputs: hi-level/mike/equal phone cannon XL connector/barrier strip input.
- External studio and local speaker.
- P. A. output (public address).
- Muting relay contacts on barrier strip.

ELECTRONICS

- Etched-epoxy circuit board
- Plug-in silicon transistors
- 4 preamplifiers (each normal on equal RIAA phono).
- 1 program amplifier.
- 1 monitor amplifier.
- Speaker muting relays for local and studio speakers.
- May be strapped to operate from any mixer.
- Two-speaker muting



PORTABILITY

Weight: 28 pounds.
Height: 5".
Width: 14".
Length: 17".

PARALLEL OPERATION

Optional plug-in cable allows parallel operation of two 212J-1's. Arrangement provides 8 input channels (hi-level/mike/phono), two metered program output channels, and two switchable input monitor channels.

OPTIONAL POWER SOURCE

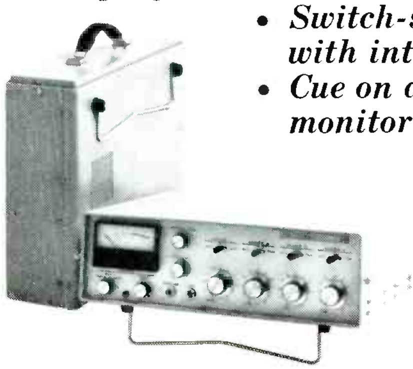
Self-contained power supply that operates the unit on AC also serves as charger for optional internal nickel-cadmium 12-volt battery. Unit switches automatically to battery in the event of an AC power loss. Unit also operates on external 12-volt battery.

a studio production console and remote pickup amplifier in one unit

That's the combination you get in Collins' new 212J-1 Console. Produce spots, conduct remote pickups, or operate the control room in emergency situations.

Completely solid-state, the 212J-1 offers:

- ***Four input channels, each with selectable switches for hi-level, microphone, or phone (RIAA equalization).***
- ***One program output channel.***
- ***Switch-selectable monitor amplifier with internal speaker.***
- ***Cue on all mixers overriding into monitor channel.***
- ***Local and studio speaker muting.***
- ***Public address system feed with level control.***



COMMUNICATION / COMPUTATION / CONTROL

COLLINS

Circle Item 7 on Tech Data Card

June 1968

Late Bulletin from Washington

by Howard T. Head

Presidential Task Force Report Due Soon

A special Presidential Task Force on communication policy (see October 1967 Bulletin) is working to meet an August deadline for submission of its report to the White House. This Task Force, conceived originally for the primary purpose of inquiring into international space communications, is also actively studying the role of broadcasting, together with the use of their frequency-spectrum allocations by broadcasting and other services.

Concentrated attention is being given to complaints by the land mobile-radio services of increasing spectrum congestion. These interests are stepping up their fight for the reassignment for land-mobile use of channels now assigned to UHF television broadcasting.

The Commission is planning to commit a substantial portion of the $600,000 in research funds allocated for the current fiscal year (February 1968 Bulletin) for studies to determine improvements which can be made in the present methods of allocating and assigning land-mobile frequencies. These studies will include an investigation of the use of computer techniques in making channel assignments.

AM Transmitter Move Can Involve Complications

FCC permission to move AM transmitters to new locations ordinarily is routine, and without complications approvals may be obtained within 60 days after an application is filed. There are some pitfalls, however, which can increase this time substantially.

For example, if your transmitter move involves a change in contour overlap (interference) with cochannel or adjacent-channel stations, the Rules must be waived even to permit acceptance of the application, and processing time is increased. Applications requesting power or radiation increases, or changes in directional-antenna patterns, go to the foot of the Commission's regular processing line. These applications are now being acted on about one year after filing, for applications involving essentially no complications; interference complaints or other protests often add many months to this figure.

Commission Acts, Stalls, on Television Contour Locations

In a recent case involving a CATV system in Menominee, Michigan, the Commission ruled that in establishing television-station coverage contours for CATV purposes, the predicted contours must be laid out using distance predictions only in the eight directions specified by the Commission's Technical Standards. In this case, a showing based on additional terrain data toward Menominee was specifically ruled out, the Commission stating that all parties involved must rely on coverage data already on file.

The Commission is expected to act favorably on a proposal (see January 1967 Bulletin) to calculate distances to Grade A and Grade B contours using the radiation at the pertinent vertical angle, rather than in the horizontal plane as is now required. This change will be of particular benefit to UHF stations employing high-gain antennas where the rated power in the horizontal plane is often substantially less than that in the direction of maximum radiation.

There appears to be little immediate prospect that the Commission will adopt new VHF and UHF television propagation curves previously proposed (see June 1967 Bulletin). Both VHF and UHF licensees opposed the new curves on the grounds that their use would reduce the predicted coverage areas of virtually all stations.

Comments on a proposal to permit the introduction of measured service contours in FM and television cases (see May 1968 Bulletin) are being studied by the Commission.

Short Circuits

The Commission continues to make numerous new FM channel assignments; the FM "25-mile Rule" (permitting unused FM channel assignments to be shifted to other cities which are within 25 miles but which lack assignments) has been amended to reduce the mileages to 15 miles for Class B/C assignments, and 10 miles for Class A. . .A Florida AM station has been informed by the Commission that the broadcasting of paid political spot announcements (for an election in the Bahama Islands) intended only for a Bahamian audience is inconsistent with the terms of the station's license. . .A 1-kw UHF ETV translator (the third in the state) has been authorized at Strasburg, Virginia, and a 100-watt commercial VHF translator has been authorized at Miles City, Montana, on an unused ETV channel. . .Commissioners Lee Loevinger and Robert E. Lee have called on the Commission to review its clear-channel policy to determine whether additional stations are to be permitted on the clear channels. . .The Commission has asked for comments as to whether Class IV AM stations on local channels should be permitted automatic power increases to 1 kw daytime, or whether existing interference rules should be rigidly enforced; some 150 Class IV stations, many near the Mexican and Canadian borders, are still operating with less than the permitted 1-kw power.

Howard T. Head. . .in Washington

Facts About

SPEAKERS and ENCLOSURES

A speaker and its enclosure need not be a mysterious entity; here are some basic facts about these systems.

*by Bill Brandt and Don Davis**

One of the most common fallacies about loudspeaker enclosures is that the enclosure is some sort of musical instrument—that it should "resonate" or have "tone." Various types of woods are thought to be more suitable because "they are used in musical instruments," or various shapes are chosen because "they are shaped like a timpani" or a "piano sounding board."

The first distinction that must be made, then, is that speaker systems are not musical instruments and they do not generate musical tones. They are more accurately defined as precision reproducers of musical tones. This means that ideally they will add no tonal coloration of their own, but will remain neutral, responsive only to the controlling input signal. The loudspeaker and its enclosure should be as impersonal as a mirror. The startling effects should be generated by the performers, not the sound system.

The Functions of an Enclosure

The first, and always foremost, function of the loudspeaker enclosure is acoustical. This acoustical function can be divided into two parts:

1. The enclosure must baffle the loudspeaker. This means that it must either totally isolate the rear pressure wave of the cone from the front pressure wave generated by the same cone, or else change the phase relationship of the waves to give a useful addition. These two pressure waves are out of phase by 180 degrees and, if allowed to meet, they cancel each other.

* This article was adapted from an article appearing in *STEREO/FM*, a Howard W. Sams publication.

2. The enclosure, in addition to its function as a baffle, must, if designed properly, help the loudspeaker cone move as much air per stroke as possible. Good bass response demands high sound pressure levels (SPL), and this, in turn, demands either large cone-surface areas or a means of causing the existing cone surface to influence a larger volume of air.

Factors to Consider

In buying or building a loudspeaker enclosure, two factors must be considered in conjunction with each other:

1. The loudspeaker or driver, and,
2. The baffle or housing in which the driver is mounted.

The driver, usually chosen first when optimum performance is sought, largely determines the most suitable type of enclosure. If decor is of concern, it is usually wisest to determine how much physical space can be allotted to enclosures and let this parameter suggest the range of drivers most likely to be suitable.

Basic Enclosure Types

A loudspeaker, as already mentioned, causes interference with its own output if not properly enclosed or baffled. There are five basic forms of baffles, several of which also improve the loudspeaker loading (that is, they help the cone move more air per stroke).

1. *Finite baffle*—flat boards, openbacked cabinets. These are characterized by partial baffling of the rear pressure wave with little or no loading assistance.
2. *Infinite baffle*—walls between rooms, or else very large or very small, totally sealed enclosures. These enclosures provide complete baffling but provide no loading assistance to the cone.
3. *Bass reflex*—wherein the radiation from the rear of the cone is added usefully to the radiation from the front of the cone by means of a port in the enclosure which changes the phase of the rear pressure wave. With proper design, the port area can be made equal to the cone area, effectively doubling the amount of air moved by each stroke of the cone at the lower audible frequencies. (In practical, commercial models, the port area is always smaller than the cone area.)
4. *Horn projectors*. Normally, a horn-loaded loudspeaker eliminates the pressure wave from the rear of the driver cone. The small area of the front of the cone is coupled to a much larger cross section of space through an acoustical transformer known as a horn. This allows each stroke of the driver to move all of the air at the mouth of the horn with a significant increase in sound. (The familiar megaphone is a rudimentary horn which improves the coupling between the vocal cords [the driver] and the atmosphere.)
5. *Combinations*. In our competitive world, it should startle no one to hear that, once the basic fundamentals were at hand, many clever designers have combined these various types to obtain still better performance. Today, the horn projector combined with the bass-reflex baffle is widely used in professional applications.

Finite Baffles

Finite baffles, typically consisting of a board about 2-feet square with the loudspeaker mounted in the center, are most commonly encountered in furniture-type console radios and TV's. This baffle forces the back pressure wave from the cone to travel a slightly longer path to reach the front pressure wave before causing cancellation. The larger the board used, the lower the cutoff or cancellation frequency. The cutoff frequency can be calculated as follows:

$$F = \frac{1140}{D}$$

where,

F = the cutoff frequency, and
D = distance from the rear of the speaker, around the edge of the baffle, to the front of the speaker.

With this formula, it can be seen that a baffle board 38 feet in diameter is required to reduce the cutoff frequency to 30 Hz.

Infinite Baffles

If the loudspeaker were mounted on a board of infinite length and width, the back radiation of the cone would never meet the front radiation, and no cancellation could take place. Then, the only determining factor would be the ability of the driver to move enough air at low frequencies to be audible.

In a practical sense, an infinite baffle can be any totally enclosed space with sufficient size to prevent significant rear compression against the cone movement. In enclosures heavily lined with absorbent material, internal volumes as low as 15 cubic feet can be used quite successfully. Closet doors, properly gasketed, make excellent mounting boards for drivers; the closet, contents included, becomes an infinite baffle.

Today, the purchaser is faced with a variation of the traditional infinite baffle that requires careful consideration on his part before purchase. If his preferences and listening room allow, he should take a look at the so-called acoustic-suspension infinite baffle. Some designers have constructed loudspeaker drivers whose cones travel as much as four times farther per stroke, thus "grabbing hold" of more air per stroke with the same cone area. The improvement in bass efficiency of the speaker is comparable to what would be expected by providing up to four times the cone area. The designers also found that they could replace the mechanical suspension of the driver with the compressibility of the entrapped air in a very small sealed enclosure—acoustic suspension. Unfortunately, while this resulted in very acceptable infinite baffles of 1.5 to 2 cubic feet that fit on bookshelves, it also resulted in drastically reduced efficiency that dropped as low as .06% in one case; *i.e.*, for 1 electrical watt in, only 6/100 of an acoustical watt came out. This unhappy condition resulted because the cone had to be heavily weighted in order to achieve resonance at a very low frequency.

While these small infinite baffles represent fascinating design exercises, they also prove you still can't get something for nothing.

Bass-Reflex Enclosures

The basic problem with infinite baffles is that of engaging enough air at very low frequencies. A cone loudspeaker can be likened to a canoe paddle. As the frequency decreases, the paddle slowly changes to a small teaspoon. The traditional solution has been to start with a bigger paddle in the first place (up to four 12″ woofers). A second solution has been to sweep further with each stroke of the paddle (the increased cone excursions of the acoustic-suspension advocates). Still another solution would be a paddle that grew bigger instead of smaller as the frequency decreased.

The bass-reflex enclosure, or as it is more properly called, the phase-inversion enclosure, puts the rear pressure wave to work as the frequency is lowered toward cone resonance. A bass-reflex enclosure is made just like an infinite baffle with the exception of a second hole cut in it. (The first hole is the one in which the driver is mounted.) In optimum designs, this second hole usually is located within 2 inches to 1 foot from the cone opening and can have an area equal to that of the cone, although it is usually somewhat smaller. When the port area is made equal to the cone area, a "drone" (undriven cone) usually is used in the port.

The interior volume of the enclosure is determined by the cone resonance of the driver. Then, as the driver approaches resonance, it also resonates the enclosed air volume entrapped in the port opening to radiate in the same manner as the air in front of the cone itself. Due to the delay exhibited by the entrapped air volume, the radiations from the port area are in step with the radiations from the front of the cone, and instead of cancelling, they add together to renforce each other.

Bass-reflex enclosures can double quite effectively the bass output of a driver near its resonant frequency. One temptation is to try to make the port twice as large as the cone for some more free bass, but as the port area gets larger than the cone area, it unbaffles the cone more than is desirable. The size of a bass-reflex cabinet of optimum design is determined by the low-frequency cone resonance of the driver chosen and is usually between 10 and 15 cubic feet. If the bass-reflex enclosure is made smaller than this theoretically optimum size (which is perfectly acceptable), then the port area must be reduced in proportion, if the enclosure is to remain tuned. The penalty paid for reducing the size of the enclosure is reduced bass output, and enough reduction finally brings one to the point where the output cannot be discerned from that of an infinite baffle of similar size. The best commercial models usually reduce enclosure volume to one-half of the optimum size, and the port is adjusted accordingly.

For those interested in construction of an enclosure, the infinite baffle and the bass-reflex enclosure offer the most advantageous design possibilities.

Horn Projectors

Where absolute maximum performance is desired, and where a large listening area is available, the large horn-loaded loudspeaker is the optimum choice. Either the large professional theater-type horn system or one of the folded corner-horns should satisfy the most critical listener.

When a horn is attached to the front of a cone, the bass response is increased substantially. The old Edison phonographs had a diaphragm about the size of a dime. When the large "morning glory" horn was attached to the small diaphragm, each motion of the dime-sized surface was transformed from a small-area radiation into a large-area radiation as the sound gradually passed up the horn. This means that horns act as acoustical transformers.

Such transformers can take many shapes, such as conical, hyperbolic, catenary, parabolic, and exponential (See Fig. 1.) In all types of horns, the effect is to present the small diaphragm, or cone, at the throat of the horn with a high, but consistent, acoustical impedance. The high-pressure, low-velocity energy from the surface of the cone is transformed to low-pressure, high-velocity energy with a low impedance which matches that of the air in the room.[1] This consistent high impedance at the throat of the horn can be maintained as long as twice the square root of the mouth area times pi is greater than the wavelength required. In other words, the horn is useful when the following expression holds true:

$$2\sqrt{A_m \pi} \geq \frac{1140}{F}$$

where,

A_m = area of the cross section of the horn at its mouth, and

F = the required frequency.

From this it can be seen that to have a usable low-frequency horn, large dimensions are required. For 50 Hz, a mouth area, A_m, of 45 square feet would be needed. "Folded" corner horns can reduce materially the enclosure dimensions required to achieve such a

1. John H. Newitt, *High Fidelity Techniques*, Rhinehart & Company, Inc., 1953—Pages 108-132.

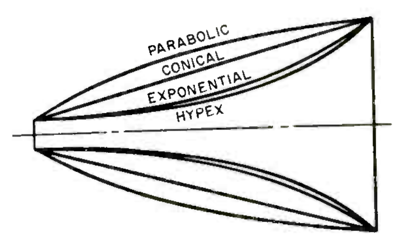


Fig. 1. A comparison of the four most popular rates of flare which are used in the design of horn projectors.

large mouth area by "folding" the horn back and forth before using the corner of the room as the final flare to the mouth of the horn. Horn-loaded drivers exhibit the highest efficiency of any enclosure design.

Unless you are already professionally engaged in acoustics, construction of a horn projector is an extremely difficult project. Therefore, where you buy one, rather than how you build one, becomes the important consideration.

While a large-horn woofer can demonstrate its superiority over the bass-reflex loudspeaker if a live source consisting of a mammoth pipe organ and a massed choir were picked up in the next room by an exceptionally high-quality microphone and fed directly to a superior power amplifier, this is not a situation likely to occur. When listening to phonograph records in an average-sized room, at loudness levels substantially reduced as compared to the original, the most expert listener would be hard pressed to tell the horn from the bass-reflex, if he were blindfolded. Consequently, the majority of enclosures which are acceptable from the standpoint of size and cost, as well as performance, employ some combination of the four fundamental types. Various popular combinations include:

1. *The acoustical labyrinth.* This enclosure provides increased useful loading of the cone at low frequencies. It has the disadvantage of sharp drops in output at some frequencies. (See Fig. 2.)
2. *Back-loaded horn.* This is really a bass-reflex enclosure that has a horn attached to the port. It offers increased bass response, but it does not always maintain flat response at the higher frequencies. This is also true of the acoustical labyrinth. (See Fig. 3.)

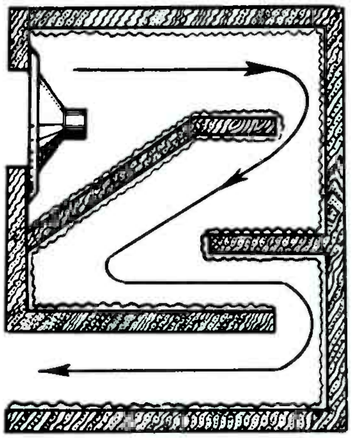


Fig. 2. This example of a combination enclosure, the acoustical labyrinth, increases low-frequency loading.

3. *Horn loading at front of woofer, bass-reflex loading at back of woofer, and a straight-axis, high-frequency horn.* This particular combination dominates the professional sound field and allows proper phasing, high efficiency, and extremely low distortion. It has the disadvantage of having to be large for best results.

Loudspeaker Efficiency

In choosing a loudspeaker system, care must be taken to obtain the following characteristics:

1. The smoothest frequency response over the widest range at a usable efficiency.
2. Low harmonic, intermodulation, phase, and transient distortion.
3. Uniform polar characteristics, *i.e.*, even distribution of the sound over a reasonable listening area at all frequencies.

Most of these characteristics will be determined primarily by the careful choice of drivers and their

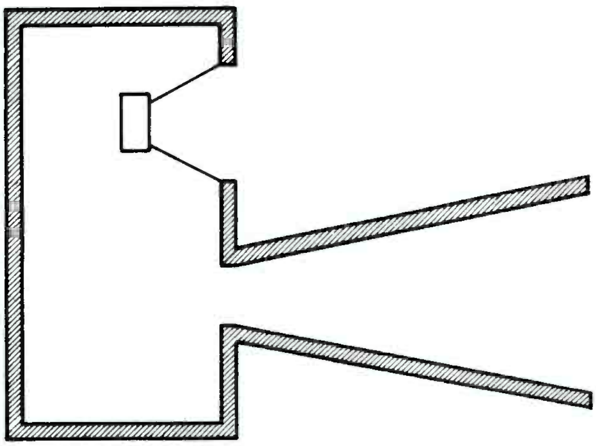


Fig. 3. Shown schematically is a bass-reflex enclosure with a back-loading conical horn attached to its port.

Norelco cameras are used for top shows on 2 of the 3 major networks ...there must be a reason

ABC's Lawrence Welk Show is enjoyed by millions each Saturday night... televised with Norelco Plumbicon color cameras.

associated crossover networks.[2] However, one factor—efficiency—will depend almost entirely on the influence of the enclosure. Efficiency is seldom discussed and little understood in its importance to loudspeaker systems. It is widely assumed that one can easily compensate for any lack of efficiency with relatively "cheap" amplifier power. However, since the advent of the midget, acoustic-suspension infinite baffle, loudspeaker systems vary in efficiency from 0.06% to 40%, and compensating for poor efficiency is more easily said than done.

Just what real meaning does the efficiency argument have for the listener, and where does the point of diminishing returns become important? The size of the enclosure, the basic principle it employs, and the location you give it in the listening room are all related to its efficiency. While one loudspeaker system can deliver a pleasing level of sound in a small room with only 8 watts of electrical power, another system, costing about the same amount, requires 200 watts to deliver the same amount of acoustical power!

The more efficient loudspeaker in the example cited below weighs 90 pounds and measures 24″ x 39″ x 16″. The second system weighs 55 pounds and is 25″ x 14″ x 11½″. So efficiency, while it is not all-important, cannot be ignored in the search for small size. This is why acoustical experts stress the importance of large enclosures. The small enclosure has its place, but be sure you understand just where that place is.

Assuming a 90° spherical angle of coverage, a loudspeaker system that reaches 117 dB, SPL, measured at a point 4 feet in front of the loudspeaker, with an electrical input power of one watt, is 100% efficient. That is, one electrical watt of input produces one acoustical watt of output. Loudspeakers for domestic use, with wide frequency response and low distortion, range in efficiency up to almost 40%. Efficiencies usually are not given by manufacturers as percentages, but rather as the number of dB, SPL, produced by one electrical watt of input power with the pressure reading taken 4 feet from the loudspeaker on its 0° axis (directly in front of the loudspeaker).

Chart 1 converts this SPL reading to a percentage of efficiency with quite acceptable accuracy. One caution should be borne in mind. While manufacturers of professional sound equipment state efficiency as described above (dB, SPL, at 4 feet, with 1 watt of electrical input power), another group of manufacturers uses the EIA standard employed for table model radio and TV/phonograph combinations. The EIA rating method measures the number of dB, SPL, at 30 feet with one milliwatt of electrical input power. To convert an EIA rating to the 4-foot one-watt rating, add 47 dB to the EIA rating.

A well-circulated testing-service report of the mid-1950's discussed the efficiency of a small infinite-baffle loudspeaker system in the following manner: "While we are on the subject of efficiency, if a speaker is to have flat response, a little thought will show that its effi-

2. Alex Badmaieff and Don Davis, *How to Build Speaker Enclosures,* Howard W. Sams & Co., Cat. No. 20520, second printing.

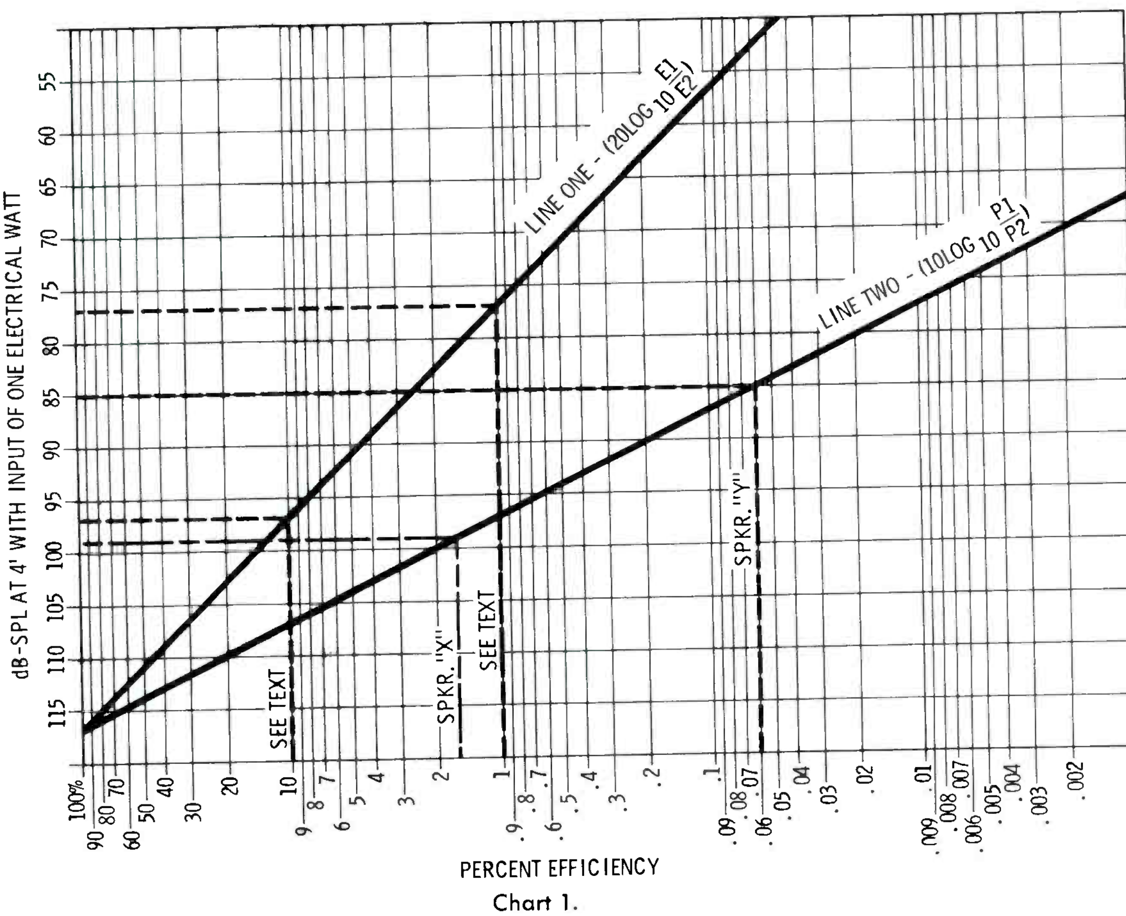


Chart 1.

ciency can be no better than its lowest efficiency value within its claimed passband. Assume a speaker system with 10% efficiency at 100 cycles, but only 3% at 40 cycles, and 1% at 30 cycles. *The response of such a system will be down 10 dB at 40 cycles and 20 dB at 30 cycles relative to its 100 cycle output.*" (Italics are our own.) This report then went on to label the efficiency of the system it was discussing as "almost 1%."

The loudspeaker being tested specified an EIA rating of 38 dB (or, at 4 feet, one watt, 85 dB). Starting at the left of Chart 1, locate 85 dB. Follow the dashed line across until it intersects line one. This is the line for finding voltage percentages which vary 6 dB each time the power is doubled or halved. From Chart 1, it can be seen that the earlier statement of 10% efficiency at 100 Hz means that a 1% efficiency at 30 Hz would represent 20 dB. This conclusion is reached as follows: Move up from the efficiency scale at 10% and intersect "line one." Proceed toward the left scale and read 97 dB. Next, proceed upward from 1% on the efficiency scale and intersect line one again. Proceed to the left scale and read 77 dB. It is apparent that 97 − 77 = 20 dB. Therefore the report used the voltage-change formula ($20 \log_{10} \frac{E_1}{E_2}$). But, efficiency is the power ratio, not the voltage ratio! Therefore, the line should have been projected from 85 db on the left scale to "line two." Then it would have been found that the true efficiency of the loudspeaker was .06% instead of the "almost 1%" quoted. Much of the evaluation of low-efficiency loudspeakers has stemmed from similar failures to get the acoustical facts straight.

To illustrate better the practical role of efficiency as applied to choosing a loudspeaker enclosure, two currently available, low-efficiency loudspeaker systems in a similar price range will be examined. For convenience, one speaker system will be called "X" and the other "Y." The specifications of interest are listed in Table 1.

Table 1. Speaker Specifications

Speaker X	
Size:	31″ x 24″ x 16″
Weight:	90 lbs.
Volume:	6.8 cubic feet
Output (SPL, at 4′ and 1-watt input):	99 dB
Efficiency:	1.5%
Speaker Y	
Size:	25″ x 14″ x 11.5″
Weight:	55 lbs.
Volume:	2.3 cubic feet
Output (SPL, at 4′ and 1-watt input):	85 dB
Efficiency:	.06%

Assume the listening room to be used has the listening area 10 feet in front of the loudspeakers (a small room), and the maximum level to be reproduced is 100 dB, SPL. (110 dB is more realistic, but, for the purpose of this comparison, assume the smaller room and lower volume.)

On Chart 2, "10 feet" is found on the upper horizontal scale. Dropping down to the "A" line and then

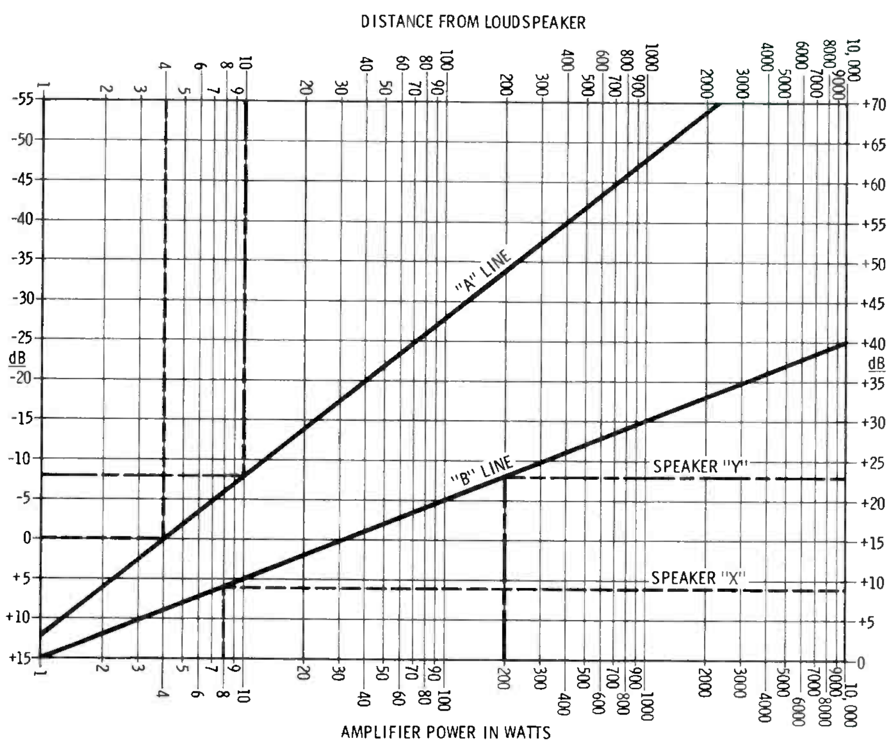


Chart 2.

proceeding across to the left-hand vertical scale indicates that, if the listening point is moved from 4 feet in front of the loudspeaker to 10 feet in front of it, 8 dB must be subtracted from the 4-foot SPL figure.

Speaker X at 10′/1w input: 91 dB SPL
Speaker Y at 10′/1w input: 77 dB SPL

Now, it is desired to achieve 100 dB, SPL, at this 10-foot distance.

Level of Speaker X:	91 dB at 10′/1w
Needed power increase:	9 dB
Level of Speaker Y:	77 dB at 10′/1w
Needed power increase:	23 dB

The required power may be computed, or read from Chart 2 as follows: Find 9 dB on the right-hand vertical scale, proceed across the chart horizontally until you intersect the "B" line, and then project downward to the reading of 8 watts. Next, go to 23 dB on the right-hand vertical scale and follow the same procedure until you find the reading of 200 watts.

Speaker X needs 8 watts electrical input for 100 dB, SPL, at 10 feet.

Speaker Y needs 200 watts electrical input for 100 dB, SPL, at 10 feet!

The cost of reducing physical size and weight from 6.8 cubic feet and 90 pounds to 2.3 cubic feet and 55 pounds is 192 watts. Unfortunately, Speaker Y cannot handle anything near that amount of power, making it impossible to reach a satisfactory level of volume in the first place.

To put these results in perspective, consider a theoretically perfect, 100% efficient, loudspeaker system and an optimum, 30% efficient, system:

30%-Efficient Speaker

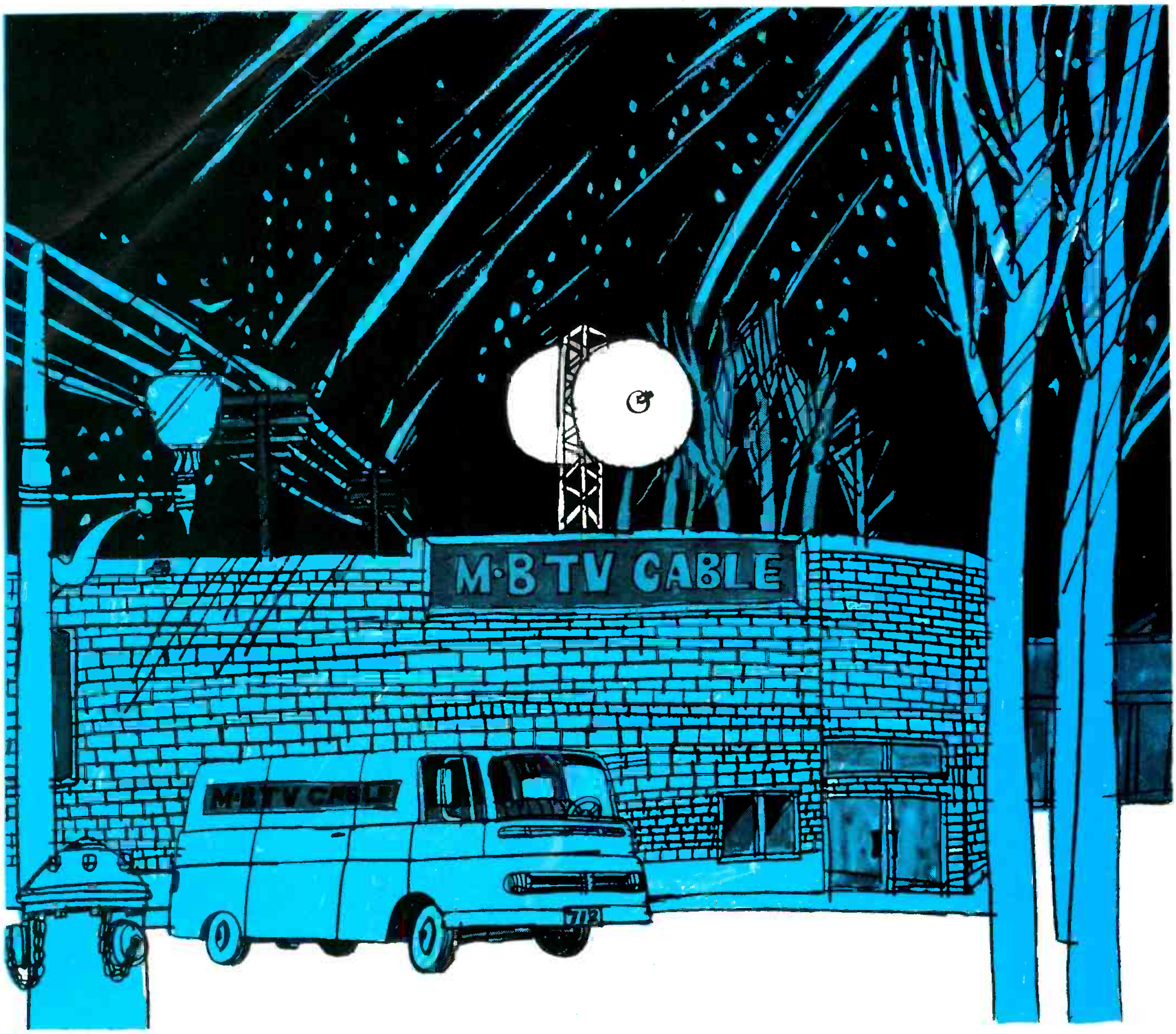
Output at 4′ with 1w input: 112 dB, SPL
Less correction for 10′ distance: −8 dB
Output at 10′: 104 dB, SPL
Power change required for 100 dB, SPL: −4 dB
Power input required: 0.4 watt

100%-Efficient Speaker

Output at 4′ with 1w input: 117 dB, SPL
Less correction for 10′ distance: −8 dB
Output at 10′: 109 dB SPL
Power change required for 100 dB, SPL: −9 dB
Power input required: 0.125 watt

Therefore, an improvement in efficiency from 1.5% to 30% would yield a saving in amplifier power of 7.6 watts, and, even if a perfect speaker were possible, the power saving would be less than 8 watts.

It may be concluded from these examples that, while efficiency is not all important, it cannot be ignored. The effects of efficiency should be considered in the selection of any speaker system, but especially if the listening area is large or the efficiency of the speaker is low (less than 1 or 2 percent). An inspection of the charts shows, for example, that increasing the listening distance to 30 feet instead of 10 increases the power requirement more than 9 dB (8 times). Under these conditions, "Speaker X" would be unsatisfactory just as "Speaker Y" was unsuited for the first application. ▲



The weather may be unpredictable. But that doesn't mean your microwave has to be.

With Lenkurt's 76E microwave radio system, you can always forecast reliable video transmission.

That's why major networks have used it for years for studio-to-transmitter links. And that's why you can rely on it to get the best video through to your CATV and ETV customers.

The 76E operates in the 12.2–13.25 GHz frequency range. Its r-f manifold is factory tuned to the frequency you specify—and it never needs retuning. Drift is no problem. And differential phase and gain are better than industry standards—giving you consistently superior color transmission.

So if you'd like predictable transmission for your customers, call or write Lenkurt Electric Co., Inc., San Carlos, California.

LENKURT ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

Circle Item 10 on Tech Data Card

DIGITAL CIRCUITS FOR BROADCASTERS

by J. L. Smith*

Logic types and the application of digital circuits in systems are considered.

Conclusion of a four-part series.

This is the fourth and last in a series of articles presented to acquaint the broadcast engineer with the basic elements of digital circuits. Part 1 covered elementary binary notation. Part 2 covered the gate circuits which are the workhorses of digital circuits. Part 3 covered the bistable circuit and its variations and provided an initial entry into combinations of logic blocks which perform logic functions. This fourth part will deal more with the systems aspects of digital circuits and give a brief insight into the various types of logic.

Fan-Out

The output of a gate or flip-flop may feed more than one input. There is a limit on the number of inputs that may be fed, of course, because of the loading effect of each. The maximum number of inputs that may be fed from the output of a logic device is termed the "maximum fan-out" of the device. Depending upon the type of logic circuits employed, the maximum fan-out may be from 5 to 10.

Fan-out is a design consideration. If modifications are being made on the equipment, great care should be given to this subject.

Delays

An input pulse experiences a certain amount of delay in propagating through flip-flops and gates. This becomes important when synchronous data are being handled; *i.e.*, if the data must accurately coincide with a clock pulse, etc. These delays are very small, typically in the order of a few nanoseconds, but they are cumulative and can add to a significant value, especially if very short data pulses are being handled at high data rates. The delays generally take the form of increased rise time and extended fall time of the data pulse.

Boosters and Drivers

A booster is generally a single transistor stage which has a low output impedance and which is capable of driving more than the usual number of inputs. The booster stage is an inverting stage if a single transistor is used and gives the increased drive capability in addition to performing the NOT function. Consideration is given to this inversion in the logic design, and the circuit is made to accommodate the inversion. It is entirely possible that an increased fan-out is needed and an inversion cannot be permitted; in this case a NOT may be used following the booster, or two boosters may be cascaded.

It is common to require a logic level to operate a lamp or relay, and the power requirements of these devices may exceed that which can be supplied by the logic level alone. In this case, the lamp or relay is placed in the collector circuit of a transistor, and the logic level is used to drive the transistor base. When used in this application, the transistor is called a lamp driver or relay driver.

Fig. 1 shows typical booster and driver circuits. Applications may be to drive relays which provide a closure when a comparator experiences coincidence of its input and reference, or perhaps when a readout light must be lighted with a logic level, etc.

*Manager, Broadcast Systems Engineering, Collins Radio Co.

NAND/NOR Logic

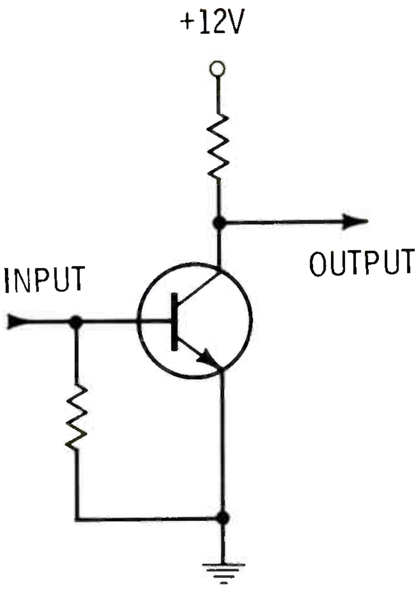
A NAND gate is the equivalent of an AND gate followed by a NOT. This gives the logic function "NOT AND," which has been shortened to simply NAND.

A NOR gate is the equivalent of an OR gate followed by a NOT. This gives the function "NOT OR," or simply NOR. NOR logic is very popular because it is easily fabricated in integrated circuits. Fortunately there are other advantages, such as large fan-out, and since a transistor is used in each logic element, gain is present at each stage. Fig. 2A shows a simplified schematic of a typical NOR circuit. If any of the three inputs, A, B, or C, is at logic 1, its associated transistor will be saturated, and the output will be logic O.

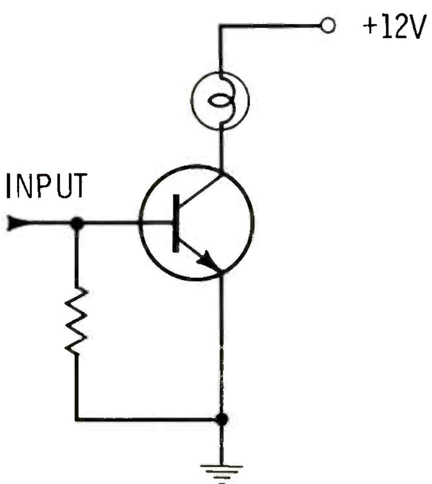
Schematically the NOR is represented as an OR with a small circle placed at its output, as shown in Fig. 2B. The NOR gate can be used as an inverter (or NOT) by using only one input.

A NOR gate can be made to perform an OR function by following the NOR with a NOT.

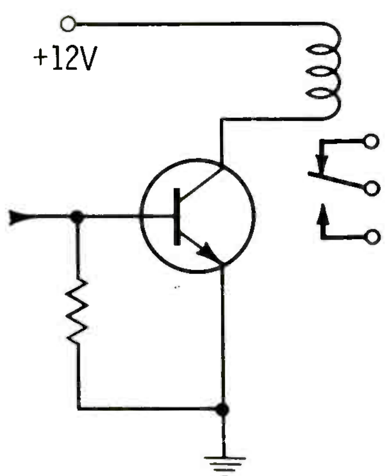
A NOR gate can be used to perform an AND function by inverting the inputs. Refer to Fig. 3. Both the schematic and truth table are shown for this circuit. Notice that the truth



(A) Inverting booster

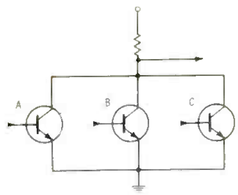


(B) Lamp driver

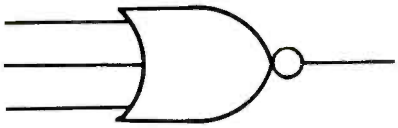


(C) Relay driver

Fig. 1. Booster and driver circuits, used when load requirement is large.



(A) Schematic

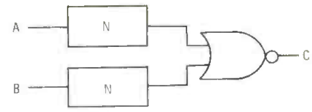


(B) Symbol

Fig. 2. The schematic and symbol for a typical 3-input NOR gate are shown.

table shows the same result that would be obtained for an AND circuit. The reader may trace through the circuit to verify the truth table by assuming logic levels at A and B and tracing through the NOT, NOR gate, etc.

Fortunately, the NOT and NOR gate can be the same circuits schematically. This fact permits design of equipment using a minimum of different kinds of parts and enables the user to keep only a minimum number of spares on hand.



(A) Diagram

TRUTH TABLE

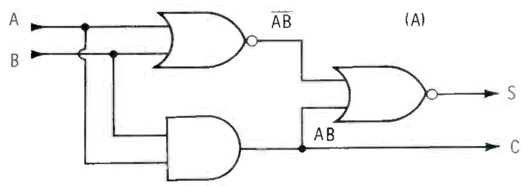
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

(B) Truth table

Fig. 3. The AND function results when inputs to the NOR gate are inverted.

Basic Binary Computations

Actual electronic calculations with binary numbers are done by those who are concerned with computor circuitry, and those in the broadcast field are not touched directly by these techniques. It is, however, worthwhile to examine briefly the methods used; while these computations may not be done directly in many types of equipment, the principles involved are

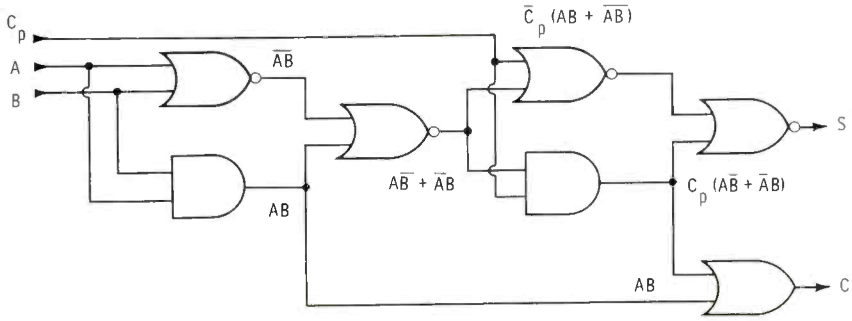


A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$S = A\bar{B} + \bar{A}B$

$C = AB$

(A) Half-adder



$S = C_p(AB + \bar{A}\bar{B}) + \bar{C}_p(A\bar{B} + \bar{A}B)$

$C = AB + C_p(A\bar{B} + \bar{A}B)$

A	B	Cp	S	C
0	0	0	0	0
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1
0	0	1	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1	1	1

(B) Full adder

Fig. 4. Addition function is implemented as shown by these diagrams and tables.

used in many ways. The basics of the binary adder and subtractor will be shown, and the procedures for multiplication and division will be discussed.

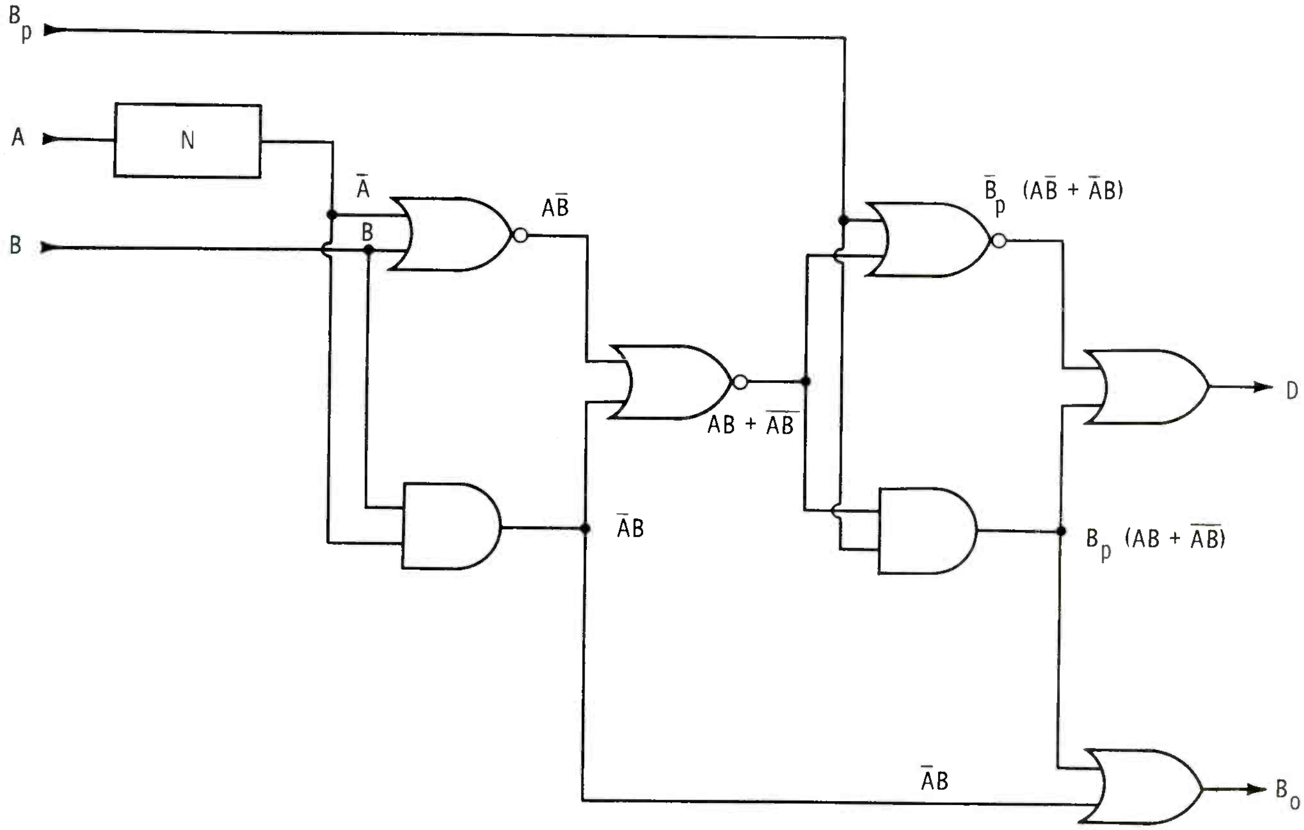
Adder

To make a binary adder, it is necessary to devise the logic circuitry which will perform the operations defined by the rules of binary addition. It should be recalled that the addition rules are:

0+0=0
1+0=1
0+1=1
1+1=0 with 1 to carry.

There are two types of adder, the half-adder and the full adder. The half-adder has two inputs and two outputs. It can add two binary digits and determine the sum digit and a carry. It cannot receive a carry from the preceding column, however. A full adder, on the other hand, has three inputs and two outputs, and thus has the ability to receive a carry from the preceding stage. The logic diagram and truth table of the half-adder are shown in Fig. 4A. The Boolean expressions for the intermediate steps are shown with the logic diagram. It is very helpful to include these intermediate expressions on logic diagrams, since they contribute to the ease of understanding. The reader may compare the Boolean expressions for the sum and carry with the truth table and the rules of addition to obtain a better understanding of this circuit.

The full adder (Fig. 4B) is little more than two half-adders in cascade. In effect, the second half-adder has as its inputs the carry from the previous, less significant stage, Cp, and the sum output of the first half-adder. The carry outputs of each half-adder OR together to make a single carry forward.



$$D = B_p(AB + \overline{AB}) + \bar{B}_p(A\bar{B} + \bar{A}B)$$

$$B_o = \bar{A}B + B_p(AB + \overline{AB})$$

A	B	Bp	D	Bo
0	0	0	0	0
0	1	0	1	1
1	0	0	1	0
1	1	0	0	0
0	0	1	1	1
0	1	1	0	1
1	0	1	0	0
1	1	1	1	1

Fig. 5. Method for performing binary subtraction is illustrated by diagram, truth table, and Boolean expressions above.

Subtractor

The subtractor performs the function A − B. This circuit resembles the full adder; Fig. 5 shows its logic diagram. The main differences are the inclusion of an inverter stage in the A input to provide $\bar{A}$, and the change of the last NOR gate to an OR gate.

The rules for subtraction are:

0−0=0
1−0=1
1−1=0
0−1=1 and borrow 1

By following the diagram, it may be verified easily that the circuit performs the logic necessary to conform with the rules of subtraction.

Multiplication

The process of multiplication is merely a process of repetitive addition. A brief look at decimal multiplication should make binary multiplication easy to understand. Consider the product of 56 × 23. This can be written as:

$$56(20+3)$$

Also, the expression can be further factored to:

$$(56\times 10\times 2) + (56\times 3)$$

In terms of sums this is:

```
  56
  56
  56
 560
 560
----
1288
```

Binary multiplication is handled in a similar manner, although it is simplified by the fact that there are only two digits in the binary system. To illustrate, the numbers 56 and 23 will be multiplied in the binary system.

```
     111000 →   56
     010111 →   23
     ------
     111000
    111000
   111000
  000000
 111000
000000
-----------
10100001000 → 1288
```

In machine multiplication, the multiplicand is added according to the digits of the multiplier and shifted in the register according to the bit position. If the digit in the multiplier is 1, the multiplicand is added; if it is 0, only a shift in position occurs when adding the effect of the next bit. This process of shifting and summing is continued to obtain the product.

Division

Division is a process of repetitive subtraction. For example, the operation 3612 ÷ 3 is performed as follows:

```
   3612
 − 3000 ____ 1
   ----
    612
 −  300 }
 −  300 } ____ 2
    ---
    120 ____ 0
 −   30 )
 −   30 )
 −   30 ) ____ 4
 −   30 )
    ---
    000
```

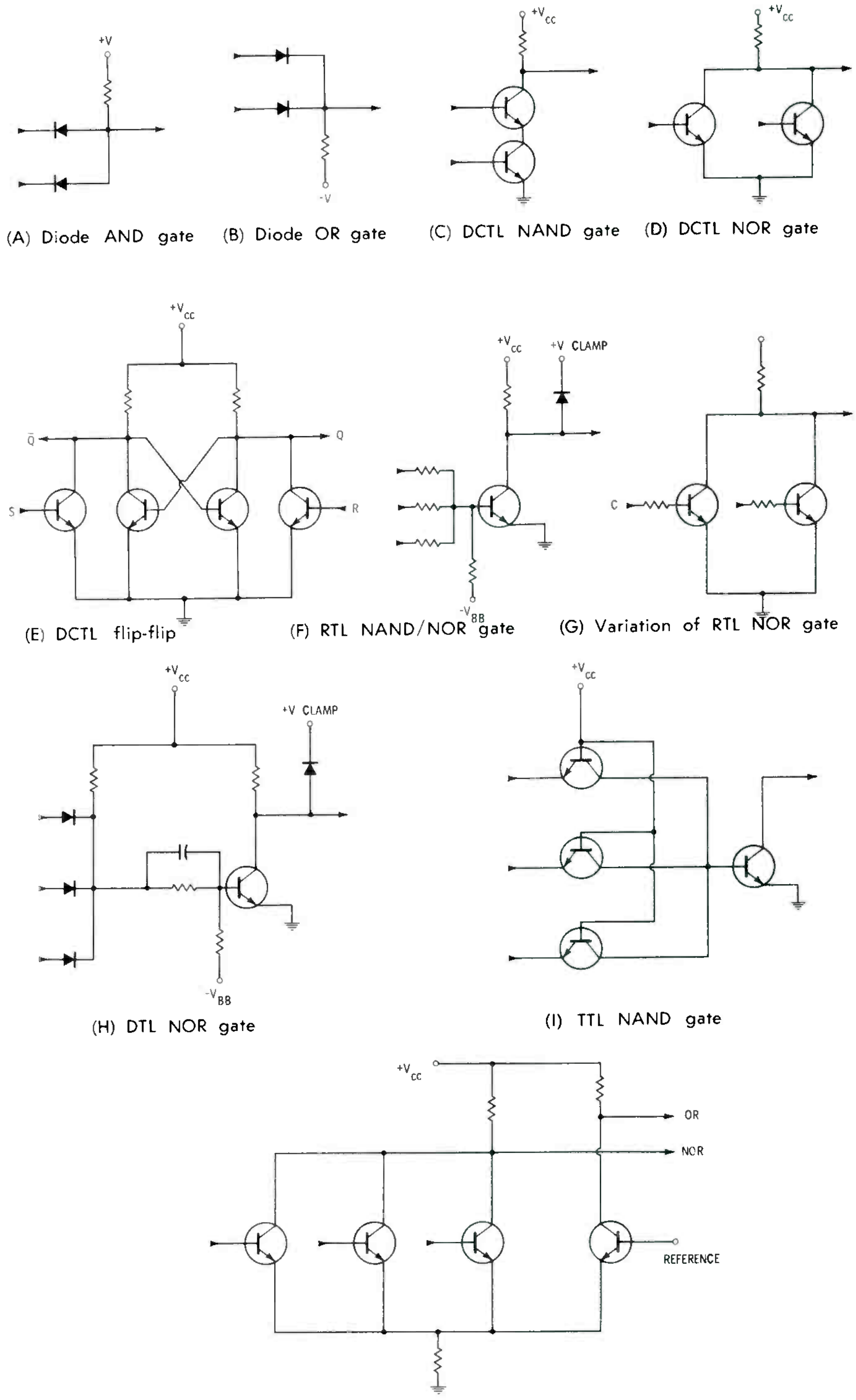


Fig. 6. Typical integrated-circuit logic elements which find application in digital Circuits are shown by schematics.

First it was determined how many times 3000 could be subtracted from the dividend, in this example, only once. Next it was determined how many times 300 could be subtracted from the remainder, how many times 30 could be subtracted from that remainder, etc. (In this case 30 could not be subtracted from the remainder, so a zero was placed in the quotient, and the remainder was multiplied by 10.) The quotient is the accumulation of the factors that are obtained.

The same results may be obtained by using the binary equivalents. The net result is that division becomes a process of subtraction and shifting. These operations can be performed with subtraction circuits and shift registers.

Integrated-Circuit Logic Elements

The availability of integrated-circuit logic elements has made it possible to design equipment of a complexity which could not be achieved with discrete components. There are several types of logic circuits which are well suited to fabrication by integrated-circuit techniques, and each has characteristics which are favorable to certain applications. Some of these circuits are described in the following paragraphs, and some of the advantages and disadvantages are discussed.

Diode Logic

This logic is suitable only for AND gates and OR gates. Figs. 6A and 6B show representative schematics of these circuits. The obvious advantage of this logic is its simplicity. The application is limited, however, by virtue of the fact that it is not possible to create flip-flops with diodes only. The fan-out capability of these circuits is limited, and this further restricts their applications. However, there are many uses for which these circuits are adequate, and they will be found in many different kinds of equipment.

Direct-Coupled Transistor Logic

Direct-coupled transistor logic (DCTL) is illustrated in Figs. 6C, 6D, and 6E. This type of logic is characterized by the fact that only one kind of circuit element, the transistor, is used. Fortunately, it is easily fabricated with integrated-circuit techniques. The power-supply requirements are quite simple, and the circuits consume little power. The propagation time through these circuits is reasonably short. DCTL elements do suffer from the disadvantages that the transistor parameters are somewhat critical, and, especially in the case of the NOR gate, the circuit is somewhat subject to current hogging. The fan-out ability of these circuits is moderate.

Resistor-Transistor Logic

Fig. 6F shows the schematic of the basic resistor-transistor logic (RTL) circuit. This circuit may function either as a NAND gate or a NOR gate, depending on the definition of the logic signals employed. If positive logic is used, the circuit is a NOR gate. If negative logic is used, it functions as a NAND gate. This type of logic circuit allows the use of a larger logic level than does DCTL. It is simple and inexpensive. The series resistors eliminate the problem of current hogging. The circuits are well suited for integrated-circuit construction and are flexible in their usage; they do suffer from long fall and rise times and are, therefore, relatively slow devices. They possess moderate fan-out ability and immunity to noise.

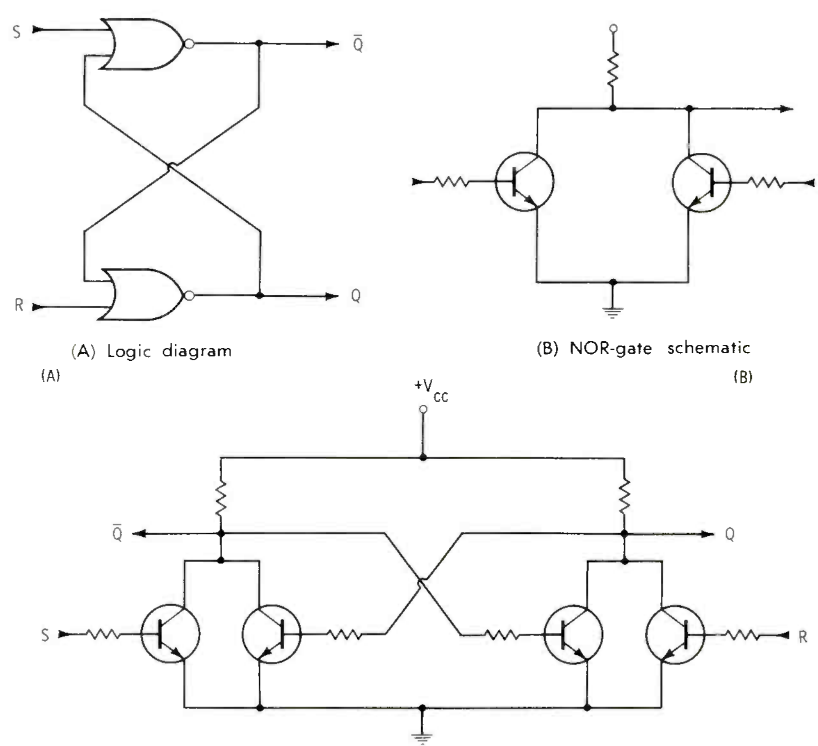
A variation of RTL is shown in Fig. 6G. This is somewhat of a cross between DCTL and RTL and proves to be an excellent choice of logic circuit when high speed is not required.

Diode-Transistor Logic

Fig. 6H illustrates the diode-transistor logic (DTL) element. This circuit is reliable, and its component values are not critical. Also, it may handle high logic levels and consequently enjoys a reasonable freedom from logic noise. The circuits are somewhat restricted in fan-out, and they require the use of multiple power supplies.

Transistor-Transistor Logic

Transistor-transistor logic (TTL, or T^2L) is a popular form of logic when high speed is required. The schematic shown in Fig. 6I represents a positive-logic NAND gate. Only one power supply is required, and the circuits are very flexible in



(A) Logic diagram

(B) NOR-gate schematic

(C) Flip-flop schematic

Fig. 7. The use of NOR gates to make an RS flip-flop as illustrated above.

their usage. The fan-out characteristics are excellent. These circuits are somewhat subject to current hogging, and the noise margins leave something to be desired.

Emitter-Coupled Logic

Emitter-coupled logic (ECL), shown in Fig. 6J, offers the unique advantage of providing both the logic level and its complement. It is a high-speed circuit with good fan-out characteristics. However, it does not possess very good noise immunity, and it does require two power supplies.

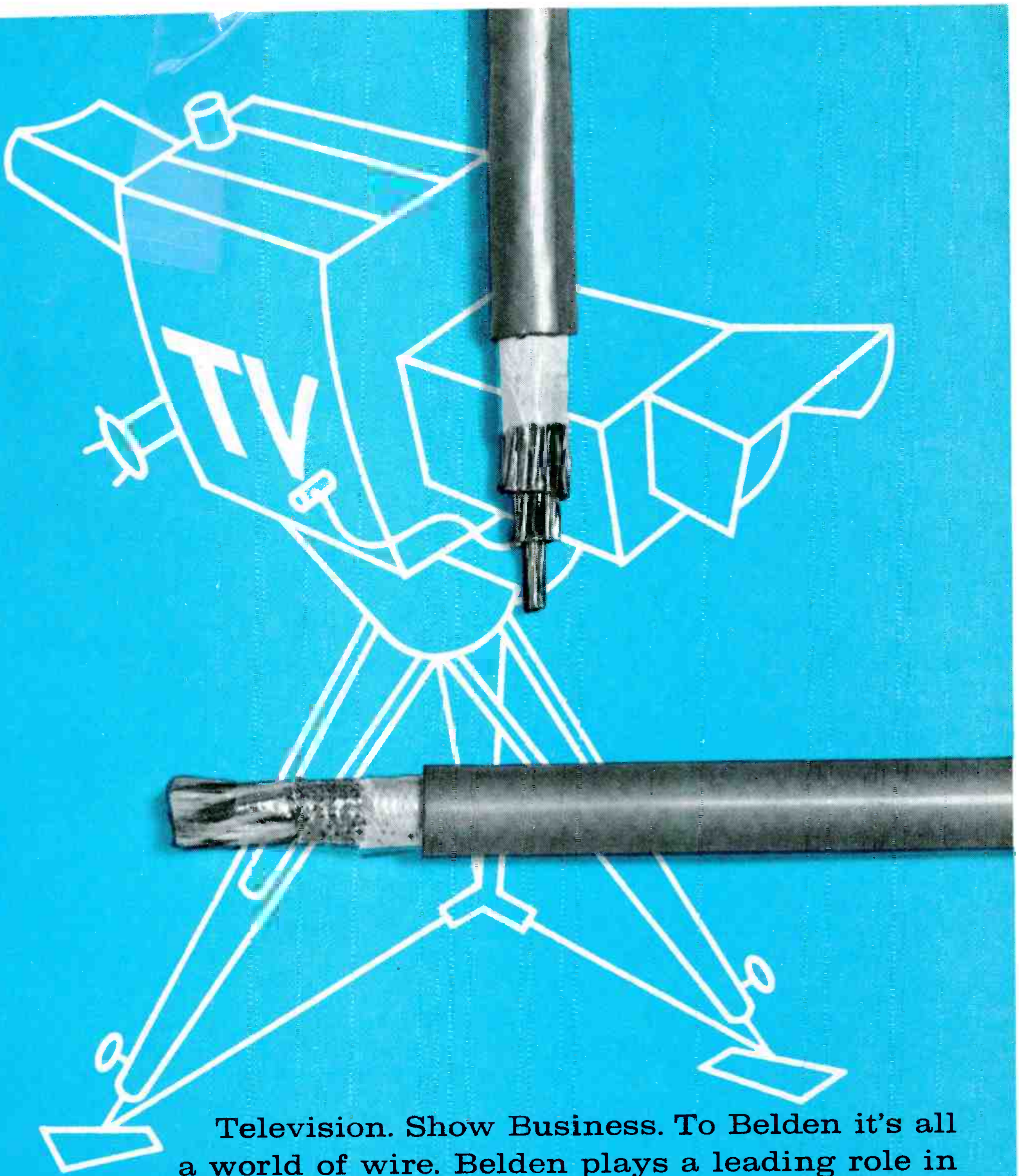
NOR-Logic Flip-Flop

The NOR gate is one of the most versatile of all logic elements. By application of DeMorgan's theorem, it may be used as an AND gate. The various forms of the flip-flop may be derived by interconnecting the NOR gates as shown in Fig. 7. Fig. 7A shows the logic diagram of an RS flip-flop made from NOR gates. Fig. 7B shows the basic NOR gate, and Fig. 7C, the schematic of the total circuit, illustrates how the circuit evolves. If AC coupling is used, a multivibrator is formed, and if AC coupling is used on only one side, a one-shot is formed.

Conclusion

This series of articles has attempted to provide an introduction to the subject of digital circuits. It is extremely difficult to cover a subject as broad as this with such a brief treatment. The author has no illusions that this series stands complete in itself, but it has been presented with the thought that it is good to go over a subject lightly at first to get an understanding of the nature of the subject and to learn the terminology. With this initiation complete, the reader may have increased his desire to dig more deeply into this very important phase of electronics.

There is no question but that digital circuits are one of the more important classes of electronics. Integrated circuits are being used more and more frequently in equipment. Application of these circuits in the broadcast station will follow naturally as their usages become apparent. ▲



Circle Item 13 on Tech Data Card

Human Engineering for the Disc Jockey

Here is a somewhat unconventional approach to improving radio-station operating efficiency.

by William Wokoun

The half-hour program was progressing beautifully when it happened. For the second week in a row, listeners heard the unexpected tinkle of network chimes—right in the middle of the commercial. But before you blame the "carelessness" of the luckless master-control engineer, consider what really caused the mistake. The chime key was just below several frequently used controls. Each time the engineer adjusted them, he had to reach past the unprotected key. In a very real sense, he didn't even make an error; it was almost inevitable that somebody's sleeve would brush the chime key some day. The error had already been built into the equipment itself.

Once the trouble was recognized, it was easy to place a guard around the key. But how much better it would be to anticipate these problems in time to prevent them, rather than merely correcting them after they become crises. That is the goal of a relatively new science called "human engineering," a team effort of engineers and psychologists, who pool their knowledge to develop simple, error-free equipment that almost anyone can learn to use with a minimum of training.

Good human engineering always has been important, but it becomes critical when performers must double as their own engineers. We tend to think that more complicated equipment is better equipment. Yet, many announcers and disc jockeys have very little technical training. In dad's day, good human engineering made the seasoned engineer's job easier and more pleasant. Today it is the crucial factor that determines whether nontechnical talent can deliver a smooth show. This article examines how human engineering can streamline a DJ's console to fit his specialized requirements.

Design Requirements

The first step is analyzing the operator's job and listing what he has to do. A DJ at a small radio station must cope with a wide diversity of tasks: reading news, announcements, and commercials; cueing and playing records; inserting and playing tape cartridges; threading and playing reel-to-reel tapes; keeping logs; and sundry other chores. In many cases, the DJ is expected to operate as much equipment as can be crammed into his studio.

It often is assumed that audio consoles can be made as wide as desired, so long as they are wthin a man's arm span—which, even for a small man, is a roomy 65 inches. But in reality, people cannot possibly operate efficiently over anything like such a wide range.

Consider how the DJ's job affects his position and his movements. True, he is free to wander where he chooses part of the time. Yet, when he announces, he is essentially frozen into position, because he must face his microphone from a fixed distance while watching a clock, reading from his copyboard or notebook, and checking his VU meter.

The farther back the DJ is from his console, the more of it he can see. Assume he moves back so that he can just reach his controls comfortably (an unrealistic assumption, because the microphone mounting often requires him to stay closer). At best, the small man will be about 29.5 inches from his console, and a small woman will be about 27 inches from it.

Without turning his head, a determined DJ can scan a bit more than 30° to either side of center—but only with difficulty. Realistically, we cannot expect him to scan more than 15° to either side in a single fixation, or 30° altogether. This means that consoles should not be more than about 17 inches wide for a small man or 15.6 inches wide for a small woman. With wider consoles, the DJ will have to turn his head, or his visual speed and accuracy will suffer.

Shown here are several good reasons why Altec audio equipment is being used by more and more recording and broadcast studios and auditoriums. And for all sound reinforcement applications.

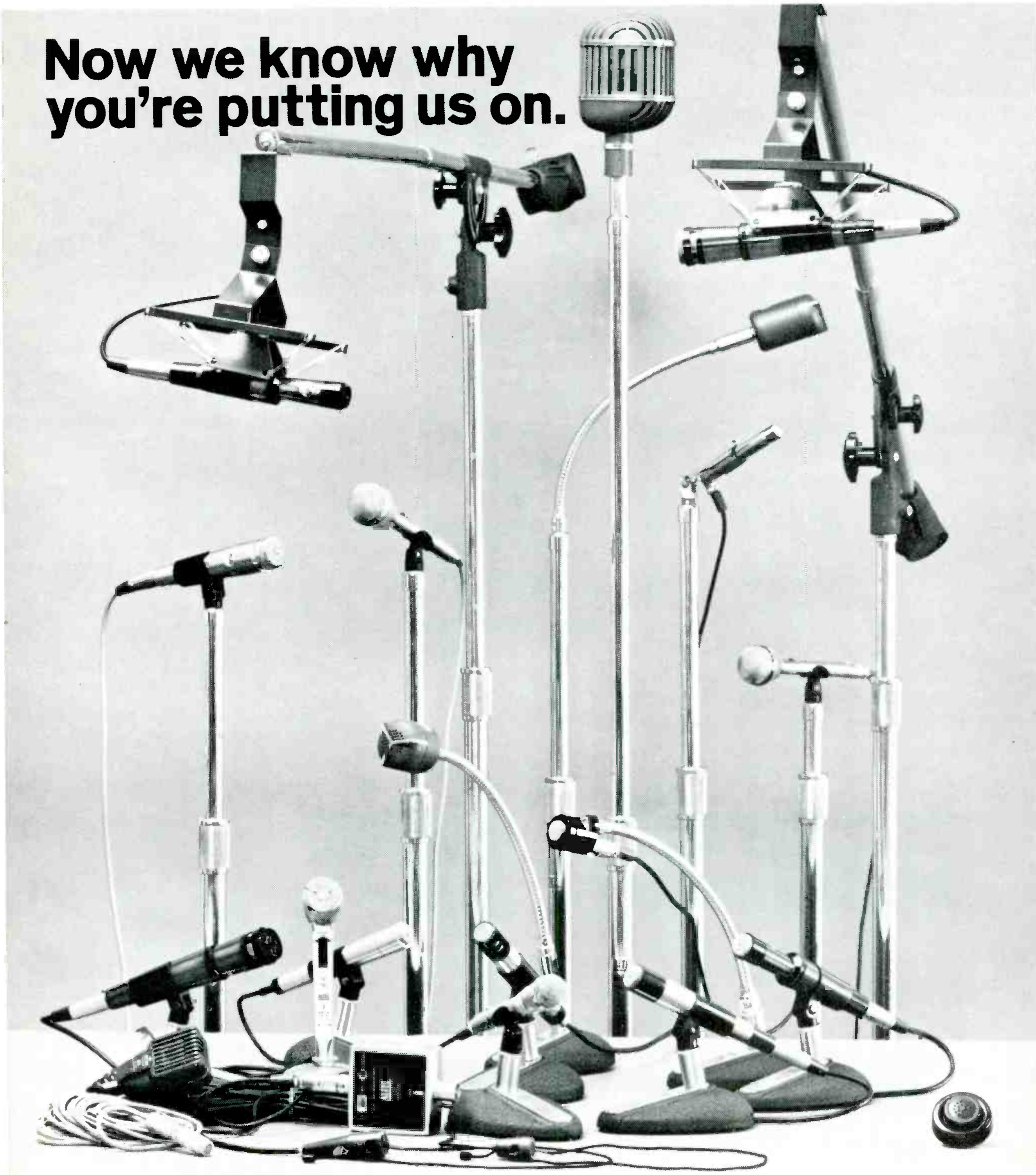
Altec microphones are engineered and manufactured to the same high standards of quality that have made "Voice of the Theatre"® speaker systems, Altec audio controls, monitors and other sound equipment the standard of the industry for so many years.

Take our Solid State Condenser Microphone Systems (M49 Series), for example. Extremely wide, smooth frequency response. Front-to-back discrimination of 20 dB. Omnidirectional or cardioid types. Battery or AC operated. Lightweight but rugged, with power supplies to match. Altogether, these fine, precision-made instruments are the most advanced professional mikes on the market today.

The M49 is typical of the complete Altec mike line, which includes selectable pattern types, miniature lavaliers, close-talking models and other solid-state condenser types. Plus mounts, wind screens and accessories.

So go ahead and put Altec on. Why not start by asking your Altec Sound Contractor for complete technical data? He's listed in the Yellow Pages under "Sound Systems." Or, if you prefer, write direct to us at 1515 S. Manchester Ave., Anaheim, Calif. 92803.

ALTEC LANSING®
A Division of LTV Ling Altec, Inc.



World's Largest Manufacturers of Sound Equipment Exclusively: Stereo Receivers, Speakers, Speaker Systems, Stereo Ensembles for the Home / Microphones, Control Consoles, Amplifiers, Speakers, Speaker Systems for Public Address Systems / Acousta-Voice Equalization / Audio Controls, Consoles, Amplifiers, Microphones, Monitors for Professional Broadcast, Recording & Motion Picture Studios & Theatre / Telephone Amplifiers & Associated Wire & Microwave Transmission Equipment / Power Supplies & Transformers / Doctors, Nurses & Hospital Call Systems.

Circle Item 14 on Tech Data Card

Vertically, people see best between eye level and some 60° below it. The upper limit, seated eye height, is about 46 inches for a small man, but only 42 inches for a small woman. The lower limit depends on the height of a table, which typically is 30 inches. Thus a console never should be higher than 16 inches above the table top; if women use it, or if the DJ must see beyond it, the console should not be higher than 12 inches.

The inescapable conclusion is that whatever the DJ has to see and reach must be fitted into a prime visible area roughly the size of a standard 12″ x 19″ relay-rack panel. If displays are outside this area, the DJ cannot see them easily, and he may not be able to see them at all. If controls are outside this area, he will find them by blind feeling, which not only is awkward and distracting, but also inevitably in conducive to mistakes.

These space limitations may seem severe. They are, but they also are realistic. And, they emphasize that displays and controls must be pared down to the bare minimum the DJ actually needs. There is simply no room for unnecessary extras within his prime visible area.

To determine which components the DJ really needs, it is necessary to catalogue his jobs in more detail. He is busiest—and most restricted—while making announcements. Most important, he must face his microphone from the proper distance while reading copy. He must monitor output level by checking the VU meter and, sometimes, a gain-reduction (GR) meter. He must pace his delivery by watching the clock. Near the end of his announcement, he must find the control that selects the next input and turns it on, as well as the control that turns his microphone off.

The prime displays, giving the operator the basic information he needs to do his job, include the VU meter and GR meter. Audio consoles seldom have incorporated copyboards, yet the operator must have one, and he must be able to see it easily. If the prime visible area is occupied by other useful, but less necessary, objects, the DJ must put his copyboard above the prime area, where it will be more difficult to see.

Although there may be good reasons (*i.e.*, noise) for omitting the clock from the console, the DJ must add his own, and another important display strays outside the prime visible area.

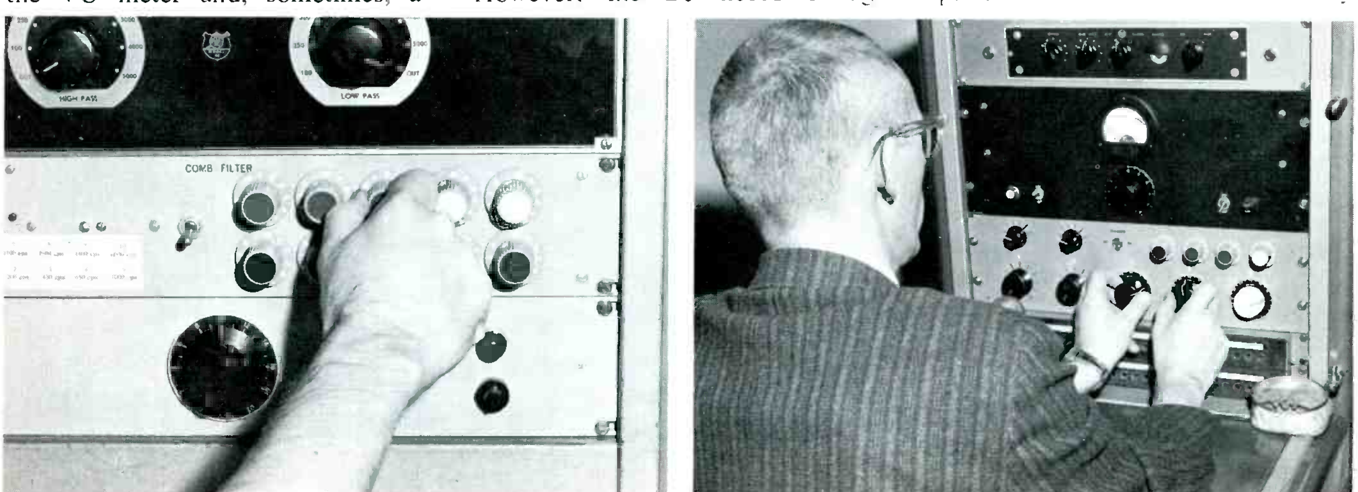
All of these prime displays belong in the console, even though some of them have nothing to do with the way it processes signals, because the operator cannot do his job properly without them.

The most important controls are the ones that select inputs, turn them on and off, fade them in and out, and start and stop the reproduction equipment. The typical DJ works with at least five input sources: his microphone, two turntables, and two cartridge machines. Since he also needs a master gain control, this adds up to a row of six faders on a conventional console. However, the DJ needs enough clearance to use these faders without snagging fingers on (and disturbing) adjacent controls (Fig. 1). Each fader requires at least three inches of space, even with smaller-than-average knobs. If you use standard two-inch knobs, you will have to space faders even farther apart. And often the DJ has still more inputs: network, reel-to-reel tape decks, other microphones, and so forth.

Clearly, it is easier to think of additional inputs than it is to find space for them within the prime visible area. For practical purposes, a row of five rotary faders will completely fill the width of the prime area. The newer, and narrower, straight-line faders allow more inputs within the same width, but they also are more susceptible to accidental operation.

The audition-program key opens the door to many interesting mistakes, too. We have all heard a DJ introduce his next hit—followed by a total silence because he forgot to flip the key from audition to program. These mistakes can be eliminated by combining the two controls, that is, by using faders with a snap-cue position. But many DJ's have found an even simpler solution; they set the fader once, then forget about it and use only the key.

Most of the DJ's input sources deliver a reasonably consistent output level which is well within the operating range of present-day AGC amplifiers. Wide use of these amplifiers has made faders unnecessary



(A) Close spacing.

(B) Better spacing.

Fig. 1. The size and spacing of knobs affects convenience.

(A) Cartridge insertion is blind.

(B) Wrong push button may be pressed.

Fig. 2. Awkward location of tape machines causes errors.

for the average DJ, and often he does not use them at all. This fact suggests substituting keys, a single master fader, and AGC for the usual bulky faders to lighten the DJ's work load. With fewer controls to choose from, he can find the correct one more easily. And, since keys are more compact, more inputs fit into the prime area.

To allow the DJ to override other inputs when he makes announcements, simply set the microphone level at the mixer network 12 to 15 dB higher than the turntable and cartridge-machine levels. This higher level will cause greater compression during announcements, fading the other inputs to background level. After announcements, other inputs will fade up again automatically as the gain of the AGC amplifier returns to normal.

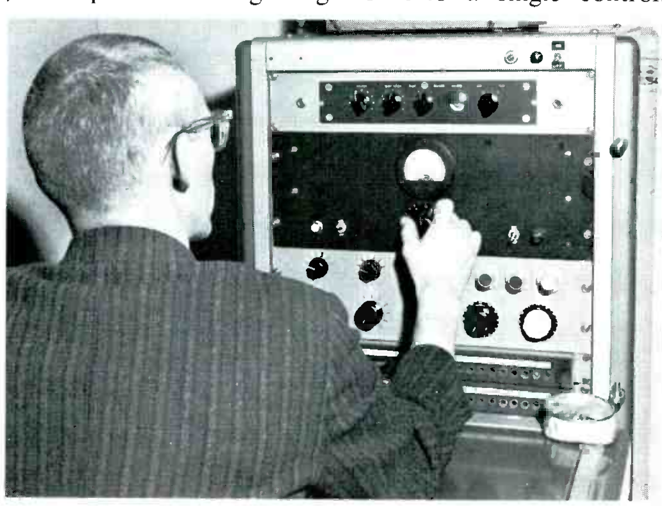
It may be desirable, or even necessary, to have level-set controls for each channel. However, these controls are intended for the engineer's occasional use; the DJ should not disturb their settings. Reduce both clutter and mistakes by locating these controls behind the panel, where the DJ won't even see them.

The other basic controls are the off-on switches for the reproduction equipment; these switches are provided on the units themselves. In the days before tape, the DJ usually had a turntable at each side of his audio console. With only two units to control, it was not too inconvenient to reach for the switches on these units. But modern radio stations have added tape units as well, often to the operator's side or even behind him (Fig. 2). As the DJ finishes reading an announcement, he must reach blindly for the push button that will start the tape machine, and even if he finds a push button, it may not be the right one. What is even worse, silent push buttons have short travel and little "feel," so the DJ is likely to operate them prematurely while he is trying to locate them. If tape units must be mounted where the DJ cannot see them, he should have remote controls in his prime visible area. Most manufacturers of cartridge-tape players make remote control panels.

Even if remote controls are provided, the DJ will have trouble inserting and seating cartridges in the machines by feel. Wherever possible, cartridge players should be mounted near the DJ's normal line of sight. Since the usual arrangement places one turntable to each side of the prime visible area, the most likely locations would be above the two turntables.

But the best answer to the problem of on-off controls, for both turntables and cartridge players, is combining functions that necessarily go together into a single control.

(A) Arm hides meter.



(B) Control below meter.

Fig. 3. All indicators should be visible during adjustments.

There is already a key for each input source; simply wire two of the key's program-position contacts to operate a relay that starts the unit. When the DJ flips the key to audition, he can use the motor switches on the units themselves, as usual. But when he flips the key to its program position, this one motion both opens the input and starts the motor. Why make the DJ operate two controls—which requires two hands—when one centrally located key can do both jobs?

Once the critical functions have been isolated and the most suitable component has been selected for each of them, it is relatively easy to arrange these components within the prime visible area. The basic rule is that displays are grouped at the top of the panel, and controls at the bottom (Fig. 3). This arrangement assures that the operator's hands will not block his view of the displays. It also allows him to rest his forearm or elbow on the table top while operating the controls.

Controls should be arranged so that either right-handed or left-handed operators can use them. If that proves impossible, the design should be made for the right-handed operator, since more than 90% of people are right-handed. Thus, if a display and a control must be placed side by side, the display should be at the left of the control so that most people's hands will not cover it.

Sample Design

A human-engineered panel design is shown in Fig. 4. The upper, or display, part of the panel is divided into halves. One half is the copyholder; the other has a clock centered at its top, with VU and GR meters side by side below the clock. Since horizontal eye movements are easier than vertical ones, this arrangement helps the DJ check his three displays while reading copy.

Assuming the DJ is right-handed, the copyholder probably should be placed on the right side. However, it would be very desirable to make it and the display panel as separate units, so the DJ could interchange their positions if he wished.

Because letter-size paper is 11 inches high, the top of the copyholder extends somewhat beyond the prime visual area. This should not pose a problem, because the top of the sheet usually contains a

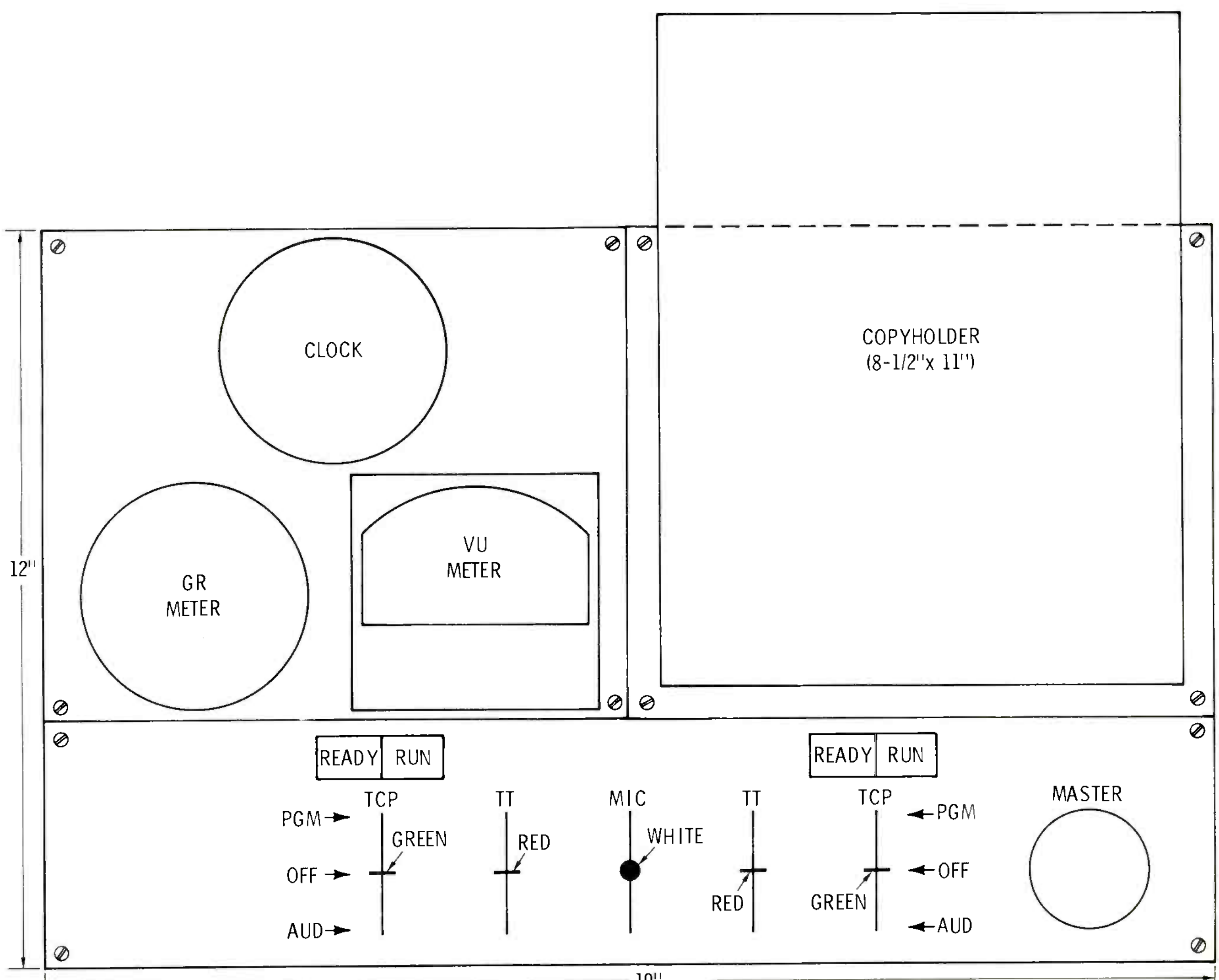


Fig. 4. Human-engineered console groups controls below indicators; the copyholder and meters are grouped near eye level.

letterhead and scheduling information that the DJ will not read aloud. To save space, another possibility would be using rings at the top, together with shorter sheets or 5″ x 8″ cards, which would fold up and back.

The lower, or control, area of the panel has the bank of vertically mounted keys controlling inputs; the master gain fader is located at the far right. The key knobs have been color-coded to reduce the DJ's hunting time, and their positions are related to the locations of the equipment they control: leftmost key for left cartridge player, next key for left turntable, and so forth. The center key, for the microphone, has a round white knob; this is the only key with a round knob, and the only white knob, so that the DJ can find it easily by either sight or touch. Just above the two cartridge-player keys are illuminated legend lights that show the status of these machines.

Note, incidentally, that the program position for each key is upward, audition is downward, and off is the center position. This takes advantage of the usual expectation that flipping a control up should turn something on.

Conclusion

Because this console is tailored to the DJ's special requirements, it simplifies his job and reduces the number of mistakes he can make. Even more important, almost anyone can operate it without technical background or extensive training.

It must be emphasized, however, that this concept answers a requirement which is specialized, even though it is very common. This console obviously cannot supplant more complicated facilities in situations that require real finesse. When recording a symphony orchestra, or a dramatized commercial with several characters, music, and sound effects, you will need the flexibility of a more conventional console. Nevertheless, a human-engineered console like this one can handle much of a small radio station's daily operation, perhaps freeing more sophisticated equipment for recording commercials and other work more suited to it. ▲

A Solid-State Control Board

This station built its own audio board to meet its particular requirements.

*by Ronald Pesha**

Station KOFA, Honolulu, required a control board of simplified design, with a minimum of controls, for the benefit of nontechnical operators. The board described in this article was designed and fabricated to meet that need. The original stereo design adapts easily for monophonic use, and any configuration of inputs should work equally well.

Features

Simplification comes mostly from incorporating only essential features. The exclusive use of transistors helps, too, as matching for constant impedance is not necessary. All transistor types are silicon, most costing less than one dollar each. No unusual parts are required, although the transistors and printed-circuit supplies probably will not be stocked by any but the largest parts distributors.

Except for the power supply, the board is self-contained. Power amplifiers to drive monitor and cue speakers are not included, but any conventional amplifiers can be used. The board was built entirely with ordinary hand tools and a ¼-inch electric drill.

Basic Design

The basic overall schematic is shown in Fig. 1. For a monophonic board, eliminate the right channel and use single rather than dual-ganged potentiometers.

Fig. 1 shows three types of input channels—microphone, phono, and high-level. For more than one of each type of input, simply add identical input channels, all connectd to the mixing bus. Since the mixing bus is not of constant impedance, any number of input channels up to about twelve (possibly more) can be connected to it.

Only the microphone channel has an on-off switch. The operator merely turns other potentiometers up or down as necessary. This simplifies operation for nontechnical operators who are occupied with logs, spots, etc. To add switches, install lever switches in the audio lines preceding the potentiometers. For mono, use an SPST N.O. switch; for stereo, a DPST N.O. switch should be used.

Mixing

The simple nonconstant-impedance mixing used here has its penalty: heavy mixing loss. However, the program amplifiers have adequate gain to compensate for the loss, provided the peak input to each potentiometer is about 1 volt. The preamplifiers provide this much level, and most external signal sources used by broadcast stations, such as tape-playback machines, can provide 1 volt. Lower-level signal sources may require preamplification. The microphone-preamplifier design can be used for this purpose, with the preamplifier preceded by a pad to avoid overloading.

Potentiometers

The potentiometers in the original board were assembled with individual resistors on 22-position shorting-type rotary switches (Centralab PA-4000 series) with the detent action removed. The 10,000-ohm, linear-taper pots are heavily loaded with 680-ohm resistors from arm to ground. This causes each pot to operate with an audio taper. It also helps swamp out poor tracking between the two ganged pots in each pair used for stereo.

A standard SPST switch (DPST for stereo) feeds the audio to the cue channel through isolating resistors when the potentiometer is turned all the way down. In stereo, the two channels are connected together for a monophonic cue feed.

Chassis

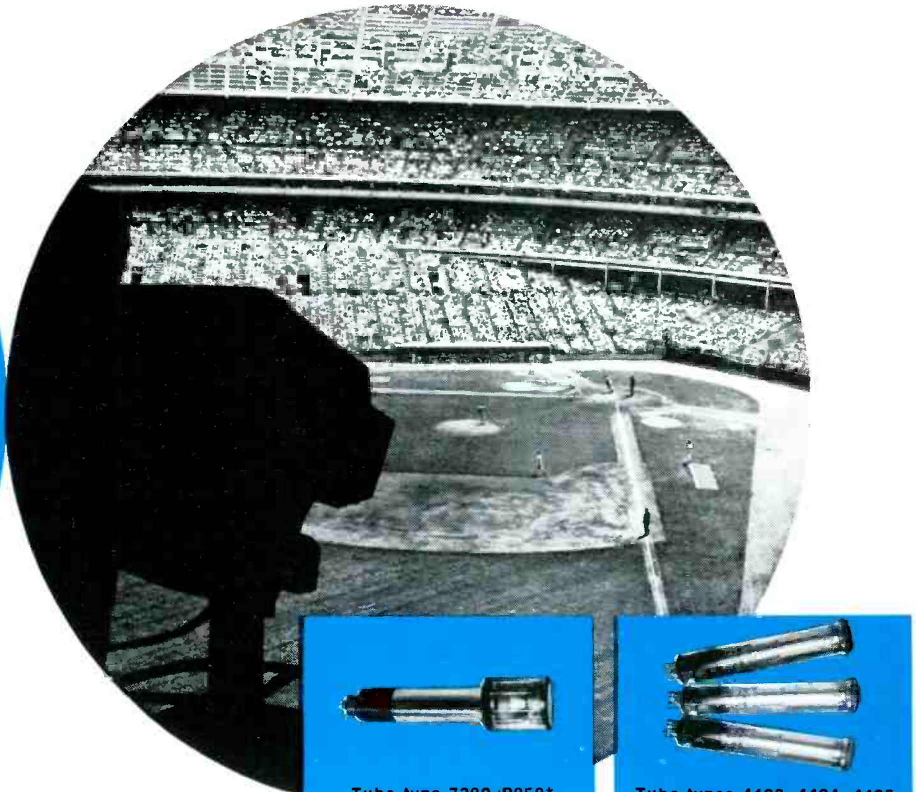
The board is built inside two standard 3″ x 17″ x 11″ aluminum chassis bases, which are turned upside down and bolted end to end. Each chassis is modified by sawing a wedge-shaped piece from the front corners; this change allows the front to be bent back for a sloping panel. Alternatively, a sheet-metal fabricator can produce a suitable chassis cabinet to order.

A sheet of ⅛-inch aluminum is attached to the sloping panel with the control nuts. This panel should be drilled and then painted with a can of spray lacquer before mounting. Rectangular holes for the VU meters may be cut with an electric drill, files, and lots of elbow grease. The VU meters mount behind these holes with simple clips of scrap aluminum.

Rubber chassis feet on the bottom of the assembly allow sliding the entire board into its wooden case. A sheet of aluminum obtained from a sheet-metal contractor (a maker of heating and cooling ductwork) is used to cover the exposed top of the board for shielding.

*Radio Station KFOA, Honolulu, Hawaii

VISUAL...
your major source for advanced AM/FM/TV products



Tube type 7389/P858*

Tube types 4493, 4494, 4495

TUBE-UP WITH EEV FOR THE BASEBALL SEASON
and be ready for the election campaigns

Right now is the time to check your tube line-up for the current baseball season — and the political conventions and elections — and get *improved color, improved system sensitivity* from your remote cameras. How? Re-tube with:

EEV 4½" ELCON Target Image Orthicons. These improved ELCON no-stick target tubes offer a minimum S/N ratio of 40dB at 4 volts with no significant loss in resolution or sensitivity. They handle highlights without compression and maintain constant gamma, sensitivity and resolution throughout their life. 'Knee' sensitivity of the P858 is in the region of 12ft-lamberts scene brightness at f/5.6.

EEV 1" Electrostatic Focus Vidicons. Available in matched sets, they incorporate electrostatic focusing which requires virtually no current . . . and no magnetic focusing unit. The result is deflection field strength as low as one quarter of normal requirements, freedom from "S" distortion in focus-induced image rotation and much more.

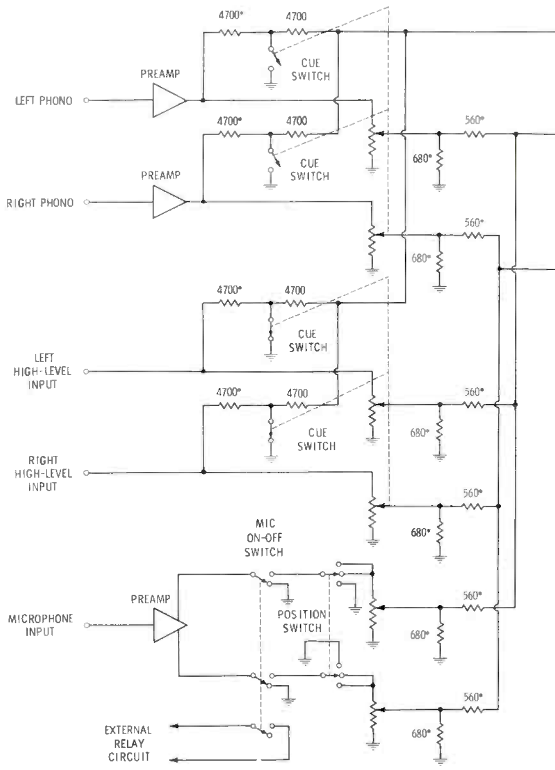
Tune-up *your* color cameras now with these superb English Electric Valve tubes—state-of-the-art products from Visual Electronics!

**The improved-performance direct replacement for 4536V1.*

the Blue Ribbon Line

VISUAL ELECTRONICS CORPORATION
356 west 40th street • new york, n.y. 10018 • (212) 736-5840

YOUR MAJOR SOURCE FOR ADVANCED AM/FM/TV EQUIPMENT



NOTES:

1. Cue switch on phono channel shown in "cue" position.
2. Cue switch on high-level input shown in out-of-cue position.
3. Microphone on-off switch shown in "off" position
4. Microphone-channel position switch shown in "center" position.
5. Stereo position switch: 2-pole, 3-position (Switchcraft 3037L or similar).
6. Microphone on-off switch: for stereo, 3-pole, 2-position (Switchcraft 60012 or similar); for mono, 2-pole, 2-position (Swiftcraft 30004L or similar).
7. Potentiometers are 10,000 ohms, linear taper, dual ganged units for stereo.
8. Cue switches attached to potentiometers are SPST for mono, DPST for stereo.
9. All resistors are 10%, ½-watt units.
10. *Denotes matched pairs for stereo.

Fig. 1. Overall schematic diagram shows operation of the control board in the stereo configuration. One input channel of each type is shown; others may be added.

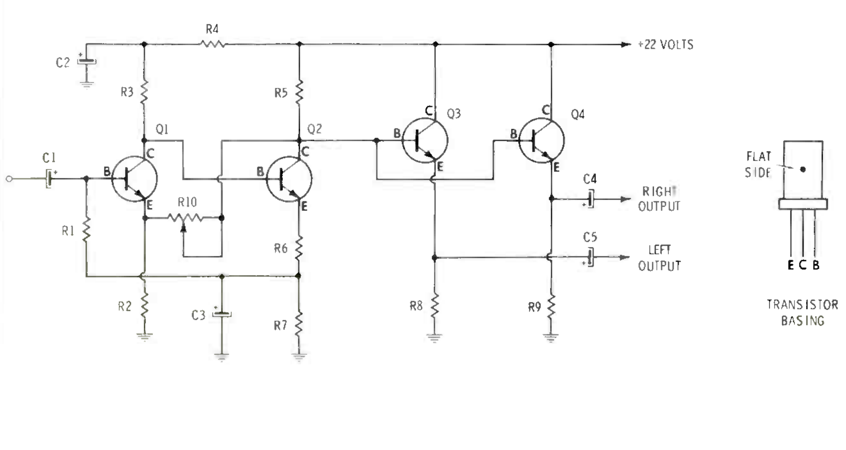
The Preamplifiers

The microphone and phono preamplifiers use inexpensive silicon transistors in circuits similar to those of units described in the *GE Transistor Handbook*. The microphone preamp (Fig. 2) uses two emitter followers as parallel output stages. This arrangement provides isolated outputs to the two stereo channels. For monophonic use, Q4, C4, and R9 should be omitted. The microphone preamplifier includes a trimmer potentiometer in the AF feedback line for adjustment of gain.

The phonograph preamplifier (Fig. 3) resembles typical high-fidelity component designs more than traditional broadcast practice. The cartridge feeds the preamp directly, with no passive equalization network. RIAA equalization is provided in the AF feedback line. The 82,000-ohm input resistor in parallel with the input impedance of the first stage provides a 47,000-ohm cartridge load.

Program Amplifier

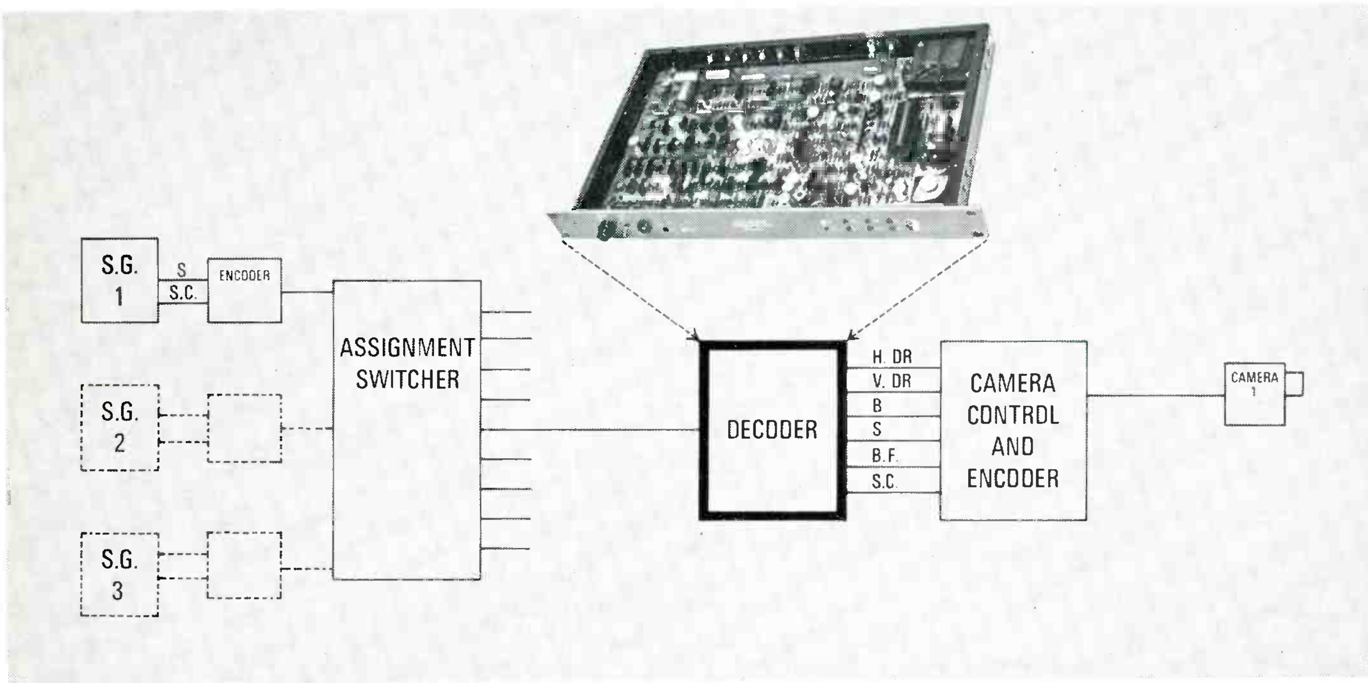
The program amplifier (Fig. 4) features a conventional Class-B complementary-symmetry circuit. Voltage gain exceeds 100 over a bandwidth almost perfectly flat from 10 Hz to 35 kHz. Distortion measures less than 0.5% THD at all frequencies, up to an output of 5 volts rms—about +16 dBm.



R1 300,000 ohms, 5%
R2 47 ohms
R3 51,000 ohms 5%
R4 4700 ohms
R5 10,000 ohms
R6 82 ohms
R7 1000 ohms
R8 4700 ohms
R9 4700 ohms
C1 50 mfd, 6 volts
C2 10 mfd, 25 volts
C3 100 mfd, 3 volts
C4, C5 10 mfd, 15 volts
R10 500,000-ohm trimmer potentiometer, IRC Type U201 or Mallory Type MTC-4
Q1 2N3391A
Q2 2N2924
Q3 2N2924 or 2N2925
Resistors are ½ watt, 10% unless otherwise noted.
Capacitors are tubular electrolytic.

Fig. 2. Three-stage microphone preamplifier has two inputs driven in parallel.

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



and this is all you need to adjust it

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

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

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

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

CD corp

CENTRAL DYNAMICS CORPORATION

HEAD OFFICE: 903 Main St., Cambridge, Mass. 02139

Circle Item 19 on Tech Data Card

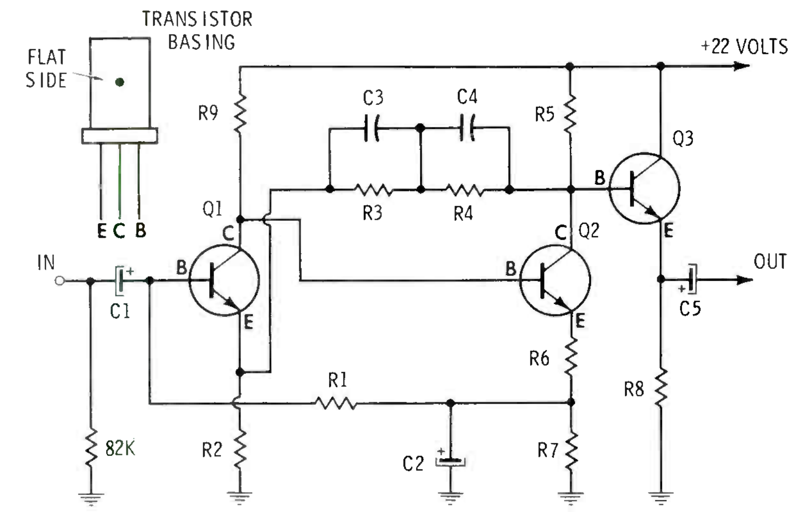


Fig. 3. Phono preamplifier achieves RIAA equalization through the use of feedback network between first two stages.

R1 180,000 ohms
R2 220 ohms
R3 27,000 ohms
R4 470,000 ohms
R5 10,000 ohms
R6 82 ohms
R7 1000 ohms
R8 4700 ohms
R9 62,000 ohms, 5%
C1 50 mfd, 6 volts
C2 100 mfd, 3 volts
C3 .003 mfd, 600 volts, disc ceramic
C4 .01 mfd, 600 volts, disc ceramic
C5 10 mfd, 15 volts
Q1 2N2925
Q2 2N2924
Q3 2N2924 or 2N2925
Resistors are ½-watt, 10% unless otherwise noted.
Capacitors are tubular electrolytic unless otherwise noted.
82,000-ohm resistor is not on etched circuit board; mount across input connector.

Resistor R6 controls the idling current of the output stage. The DC voltage at the positive side of output coupling capacitor C3 should be half the supply voltage, that is, about 19 volts; if it is not, change the value of R1. Trimmer potentiometer R9 adjusts the gain within narrow limits; in stereo it may be used to balance the gains of the two channels. Other than R9, no "master gain" control is incorporated into the board. If desired, a master gain control may be added ahead of the program amplifier.

Audio Output Circuitry

No output transformer is used, on the theory that a board usually works into the input transformer of the device it feeds (or into a telephone-line repeat coil), and there is no advantage to having two transformers in tandem. The load can have any impedance from 500 ohms up without disturbing the program amplifier. If a transformer is desired, connect it to the output of the program amplifier, and ground one side of the primary. Because of output coupling capacitor C3 (Fig. 4), there will be no DC through the primary, which should have an impedance of 500 ohms or higher.

No isolation pad is used at the output of the program amplifier. The measured source impedance of the amplifier is on the order of 20 ohms at most frequencies, so its performance should not be affected by variations in a load which has a nominal impedance of 500 ohms or more.

The Etched Circuits

The etched-circuit amplifiers are unusual in that the components are mounted on the same side of the board as the copper "wiring." This results in amplifiers much more accessible for servicing, since the components and etched wiring are visible simultaneously. Component leads require no holes through the board. Instead, the leads are bent into tiny mounting feet, and these feet are soldered to their respective mounting pads. (See Fig. 5.) This method of construction makes future component replacement easy, too. The process of pulling a lead from a mounting hole on a conventional board and pushing a new lead through the hole frequently damages the mounting pad or lifts the copper from the board. With the construction used here, the component drops off with a touch of the soldering iron.

Full-size layouts for the etched circuit boards are shown in Fig. 6. A commercial photographer or a lithographer can make negatives of these layouts; a lithographer is available in most cities and towns as small as 15,000. You will need same-size *negatives* of these layouts. In other words, the copper areas will be clear on the negative, and the areas to be etched will be opaque. Ask a photographer for a "high contrast" negative; ask a lithographer for a "line" negative.

Processing of the etched boards requires only two chemicals, which may be handled easily in a kitchen sink. No darkroom is necessary, for the photo-sensitized boards may be handled in subdued room light.

You will need one 3″ x 3″ board for each preamplifier and program amplifier. You also will need developer, etchant, two glass or ceramic trays, a sheet of plate glass large enough to cover a board, and a photoflood bulb (from a photography store). The boards and chemi-

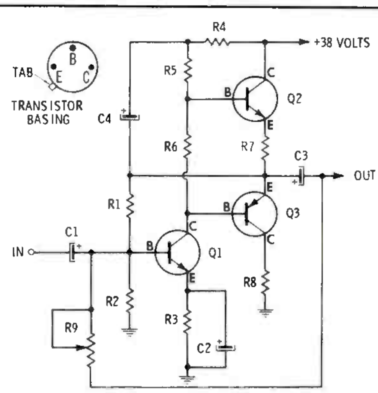
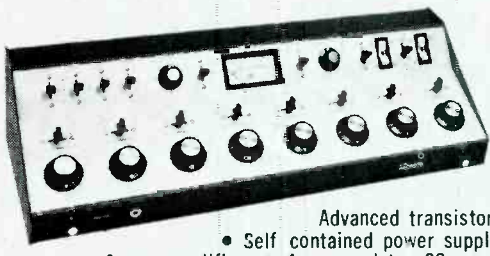


Fig. 4. Program-amplifier circuit makes use of an NPN and a PNP transistor in complementary-symmetry output stage.

R1 47,000 ohms
R2 5600 ohms
R3 270 ohms
R4 1000 ohms
R5 4700 ohms
R6 470 ohms
R7, R8 82 ohms
R9 100,000-ohm trimmer, IRC Type or U201 or Mallory Type MTC-4
C1 10 mfd, 6 volts
C2 100 mfd, 3 volts
C3, C4 100 mfd, 25 volts
Q1 40317 (NPN)
Q2 40314 (NPN)
Q3 40319 (PNP)
Resistors are ½ watt, 10%.
Capacitors are tubular electrolytic.
Jumper on etched circuit board from X to X.

SPARTA'S new look is here!

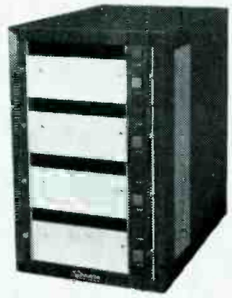


A-20 8 CHANNEL MASTER CONTROL CONSOLE

Advanced transistorized design • Self contained power supply • Monitor & cue amplifiers • Accommodates 22 separate inputs.

MULTI CARTRIDGE SYSTEM

Each deck module is independent from the others with separate direct drive/capstan drive transport • Monaural and stereo models. • 19" rack or custom cabinet mounting.



A-15 CHANNEL CONSOLE

Modestly priced, but offers a wide range of features usually found only in larger consoles • Speaker muting • Self contained monitor/ cue speaker system • 14 audio inputs

300C SERIES CARTRIDGE SYSTEM

Solid state plug-in electronics • Super silent operation • Continuous duty rated • Rack or custom cabinet mounting.

AS-30 STEREO 5 CHANNEL CONSOLE

Ultra flexible • Completely transistorized 5 channel • 9 stereo inputs incl. mic. turntable & aux. sources. All channel cue system.

800C SERIES CARTRIDGE SYSTEM

Ultra modern design with advanced transistorized circuitry • Direct motor/ capstan drive transport • Plays any size endless loop NAB tape cartridge.

TURNTABLES

Heavy duty professional quality • Positive 3 speed lever control.
12" & 16" models.
• Choice of motors.
Instant acceleration.

CD-15 CARTRIDGE TIME DELAY UNIT

Unique device for censorship of live programming • Delays 3 sec. to 31 minutes • Also produces "echo" and reverberation effects.

This is only a glimpse of SPARTA'S NEW LOOK of professional audio equipment.

WRITE OR CALL NOW FOR OUR NEW PRODUCT BROCHURE.

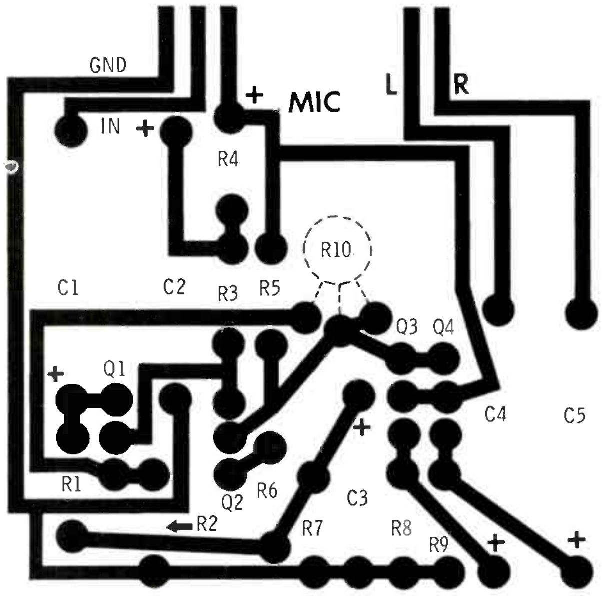
SPARTA

ELECTRONIC CORPORATION

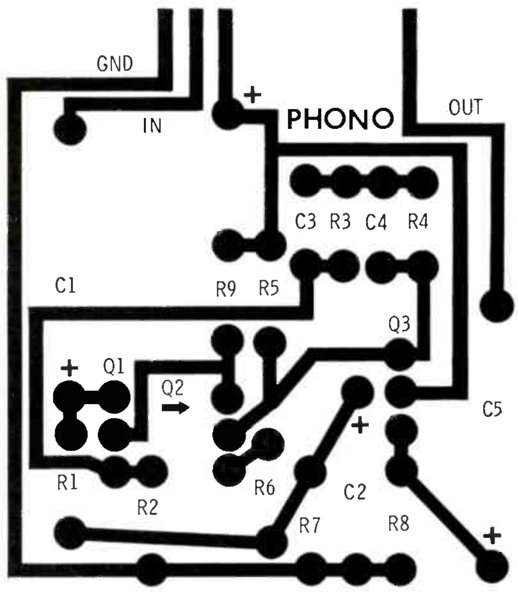
5851 FLORIN-PERKINS ROAD SACRAMENTO, CALIFORNIA 95828

A DIVISION OF COMPUTER EQUIPMENT CORPORATION

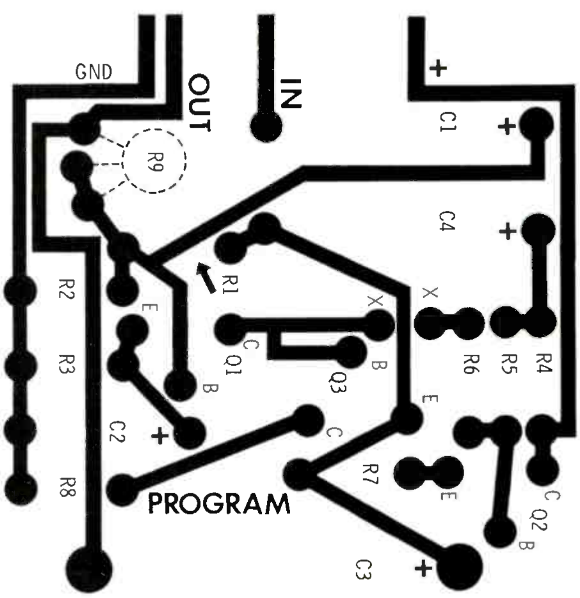
Circle Item 16 on Tech Data Card



(A) Microphone preamplifier



(B) Phono preamplifier



(C) Program amplifier

Fig. 6. Full-size patterns for three circuit-board types described in the text.

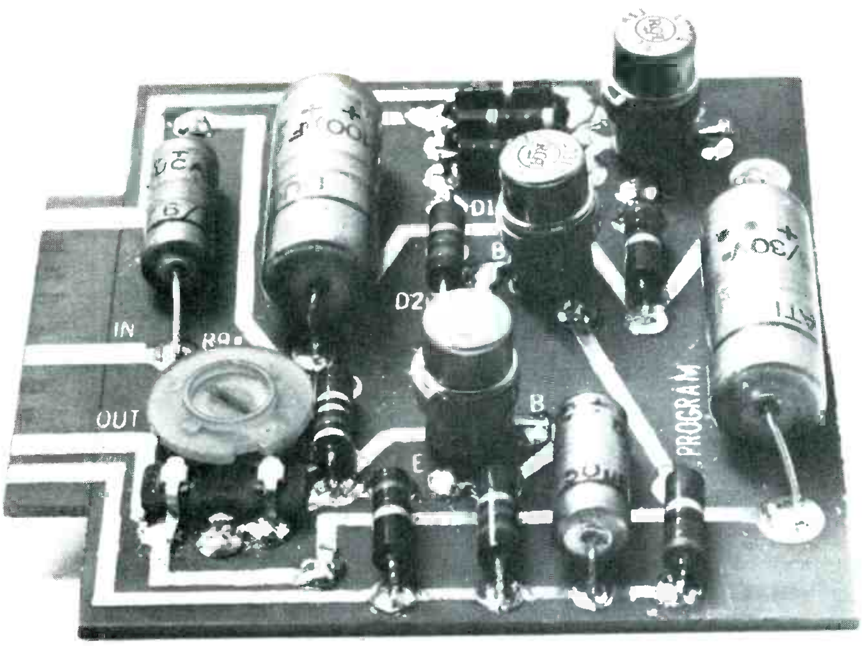


Fig. 5. Board for program amplifier; note method of soldering leads to board.

cals are listed in major parts catalogs. Order copper-clad boards which are one-sided and photo sensitized. Either bakelite or glass-fiber boards are satisfactory.

Complete processing instructions are packed with the boards. Usually, a pint of etchant is sufficient for 3 or 4 boards, and a pint of developer may be used for at least a dozen boards.

Amplifier Construction

Using the symbols on the etched boards as guides, refer to the schematics and assemble the components on the boards. Using needle-nose pliers, bend the component leads to make mounting feet as shown in Fig. 6. Cut off excess leads so that the feet fit within their mounting pads. Hold each component with pliers as the first lead is soldered, and then solder other leads. Very little heat should be required for soldering when this method of mounting components is used.

Note that the preamplifier transistors are soldered directly to the boards, but the program-amplifier transistors in TO-5 cases use sockets. The sockets are not really necessary, and these transistors may be soldered in place if desired. If sockets are used, bend their leads outward to form mounting feet.

With a hacksaw, cut notches in the corners of the circuit boards so that the boards fit their plugs. This is done best on a cut-and-try basis; use a file for final fitting.

Wiring the Board

At KFOA, all input and output connectors are standard phone jacks. Of course, any type of connector,

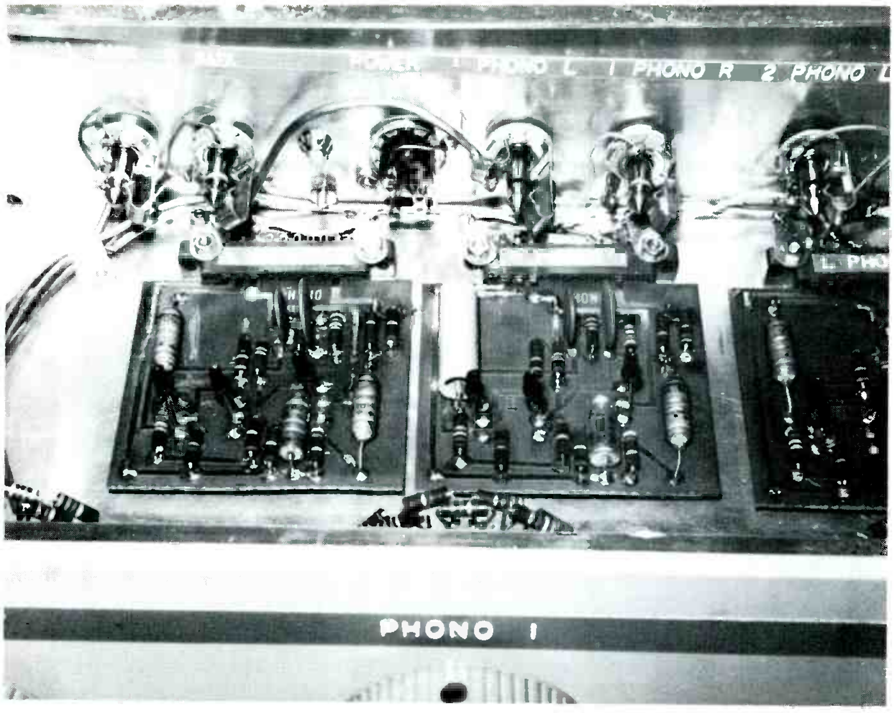


Fig. 7. Inside view of stereo board shows circuit cards and input circuits.

barrier strip, or solder terminal may be used. One advantage of constructing a board is that connectors most suitable for the other wiring in a station can be used.

The etched-circuit amplifiers fit Cinch-Jones 50-10A-20 or Amphenol 143-010-01 plugs. Drill new mounting holes at the ends of each plug in order to bolt it flat against the inside bottom of the chassis (Fig. 7). Alternatively, the plugs can be affixed with epoxy-type cement.

Shield the leads to preamplifiers and potentiometers. The low impedance of the mixing bus permits the use of unshielded point-to-point wiring there without noise or cross-talk problems. Since the power supply is external, all grounds can be attached to the chassis without hum from circulating ground currents. Solder the ground end of each potentiometer directly to its case.

Power Supply

The power supply (Fig. 8) is conventional in every respect. Build it in an external case or cabinet, and connect it to the board with a four-conductor cable and suitable connector. All attempts to build the power supply inside the board resulted in excessive hum because of induction, ground loops, etc.

Regulated voltages don't seem necessary. However, silicon-transistor biasing varies more with varying supply voltage than does germanium-transistor biasing. Therefore, supply voltages to the amplifiers should be within a volt or so of the nominal values. Adjust the values of the series resistors according to the magnitudes of their respective loads, as determined by the number of each type of amplifier used. The phono preamps draw about 3.5 ma; the microphone preamps draw about 6.5 ma in the stereo version and 3.5 ma in the mono version; the program amplifiers require about 10 ma resting.

Since failure of the supply kills the entire board, it is a good idea to build a spare supply.

Additional Facilities

Extra contacts on the microphone on-off switch allow use of an external power supply to operate external relays for speaker muting, warning lights, and other station requirements. Isolate the relay power supply from the board, and ground this supply only to the main station ground. This practice avoids inducing clicks into the board.

For stereo, a position switch in the microphone channel places the announcer at the apparent left, right, or center.

Connect a standard VU meter across the output of each program amplifier. Standard high-impedance headphones (2000 ohms or higher) may be connected across the program-amplifier output also.

Conclusion

Few types of business have so many individual variations as broadcasting. But, with juggling of the amplifier arrangements, number of input and output channels, etc, this basic board design should meet the unique requirements of almost any station.

Even a simple board with few channels and limited facilities becomes a major construction project when the possible ground loops, RF pickup points, and other potential trouble spots are considered. Nevertheless, any competent technician should be able to build a high-quality, low-distortion board. Just plan carefully, and allow sufficient time to handle the "debugging" which seems inevitable on a project of this size. ▲

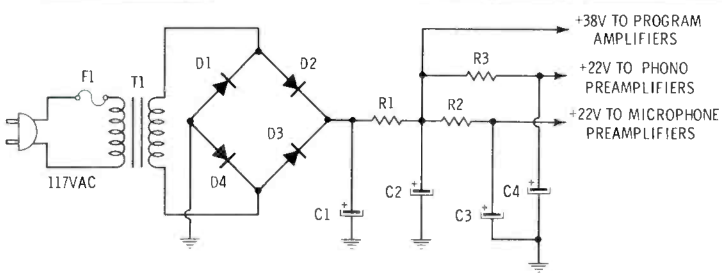


Fig. 8. Schematic diagram of power supply shows three sources of voltage for amplifiers in the audio control board.

T1: 24-volt, ¼-amp (or better) filament-type
F1: ¼-amp fuse
C1-C4: 500-mfd, 50-volt electrolytic capacitors
R1-R3: Values and rating chosen to supply indicated voltages; depend on load (number of program amplifiers and preamplifiers used).
D1-D4: Silicon diodes, 200 p.i.v. at 100 ma (or better), or full-wave bridge rectifier of similar rating).

When engineers get together, the conversation turns to pickups.

PHOTOGRAPHED BY FRANZ EDSON AT THE CAPITOL TOWER, HOLLYWOOD.

It's an irresistible topic.
Especially since Stanton came out with the Model 500 stereo cartridge.
That's an engineer's pickup, if there ever was one.
Beautiful curve—within 1 db from 20 to 10,000 Hz, 2 db from 10,000 to 20,000 Hz.
Fantastically small moving system to trace the wildest twists in the groove.
Light weight (only 5 grams!) to take advantage of low-mass tone arms.
And, of course, Stanton's legendary quality control.
No wonder engineers use the Stanton 500 for critical broadcasting and auditioning applications.
And to impress other engineers with their pickupmanship.
(Available with 0.7 or 0.5-mil diamond, $30; with elliptical diamond, $35.
For free literature, write to Stanton Magnetics, Inc., Plainview, L.I., N.Y.)

STANTON

Circle Item 18 on Tech Data Card

Determining Spurious-Frequency Components by Computer

The digital computor makes practical the voluminous calculations necessary to determine spurious frequencies.

by Serge Bergen*

The growing problem of generation of spurious frequencies is an unfortunate by-product of the increasing congestion in all frequency bands, and it is not likely to improve. The presence of undesired signals is at best an aural or visual nuisance which degrades the reproduction of sound or pictures. At worst, if a spurious frequency occurs in one of the vital links, such as aeronautical communications or an international distress frequency, it could be an outright menace.

Computer Procedure

In areas with a moderate to great number of AM, FM, TV, or other stations, the manual compilation of all the various frequency combinations becomes prohibitively cumbersome. The mathematical effort is approximately proportional to the square of the input; *i.e.*, the number of stations and number of harmonics considered. The number of computations rapidly accumulates into thousands and tens of thousands.

An electronic computor is an ideal device to use in accomplishing the necessary calculations. Because of its speed, it is able to provide the desired solution in a fraction of the manual time, and with greater reliability since the problem of psychological fatigue does not arise. In the procedure described here there are two programs, the first to be used mainly in the lower frequency bands, the second version mainly for television and FM stations and higher frequency bands. In the following text no distinction is made between spurious frequencies generated externally or internally within the receiver. The computation results are applicable in both cases.

*Consulting Engineer, Fairfax, Va.

The Federal Communications Commission in Part 2 of the Rules lists frequencies in kHz up to 25,000 kHz, and higher frequencies (in the area of interest here) in MHz. This is an arbitrary dividing line which does not preclude overlapping use of either program, provided frequencies are expressed in correct units.

In the course of the computation, it is necessary to consider all the combinations between the sums and differences of all the harmonics of the frequencies entered. In addition, the harmonics themselves have to be accounted for. The comupter then proceeds to single out the combinations which are equal, or nearly equal, to the spurious frequency. The reason for the "nearly equal" provision is that sometimes the exact value of the spurious frequency may be uncertain. Therefore, it is desirable to introduce a variable parameter, namely, the bandwidth within which the various combinations will be recognized. The procedure provides added flexibility. In the programs described here, Harmonic No. 1 is always defined as the fundamental frequency.

The first program is illustrated by the computer printout in Fig. 1.

```
SPURIØUS FREQUENCY, KHZ: 2120
HIGHEST HARMØNIC CØNSIDERED: 3
BANDWIDTH, +-KHZ: 0

STATIØN          FREQUENCY
  NØ.               KHZ
   1    .....      1010
   2    .....      1060
   3    .....      1120

HARMØNIC 2    ØF 1060     = 2120
EXTEND HARMØNIC RANGE ØR BANDWIDTH ØR ADD STATIØNS
```

Fig. 1. Computor print-out shows one spurious frequency for given conditions.

Three stations were entered to determine the combinations for the spurious frequency of 2120 kHz.[1] Only one result was obtained, the second harmonic of Station No. 2. Since a combination frequency was not obtained, the computer prints a message of insufficient input to solve the problem.

In Fig. 2, the number of harmonics was extended, a bandwidth of ±10 kHz was introduced, and other stations were added. Within the listed bandwidth, six new combinations are printed out, including the composition of the values. If the most accurate value of the spurious frequency is obtained, it is possible to ignore the combinations which do not apply.

Although these two examples show the solution of a problem in the broadcast band, the program can be applied to problems extending from power frequencies to shortwave frequencies and beyond, without limitations.

In case of interference between television stations and FM stations, as well as any other stations in the higher frequency bands, it is necessary to account for the fact that each television station has a visual and an aural transmitting source. It would be impractical to read and enter the assigned frequencies from a tabulation, since this procedure is cumbersome and could lead to entry errors. Instead, in the second version of the computer program, all television stations are entered by channel number. The computer recognizes any VHF or UHF channel; it then proceeds to retrieve the appropriate visual and aural frequencies for the given channel number. The visual frequency considered is the "nonoffset" value. Although in each particular case the exact value can be entered, an offset of ±10 kHz generally is not expected to alter the results if a bandwidth in excess of that value is used. All other stations are entered by frequency in MHz, randomly intermixed; this enables additional stations to be entered later without disruption.

In the computer printout, Fig. 3, the TV channels and FM stations are shown in the order entered, under "Channels." The appropriate visual and aural frequencies for all television stations are then listed for reference. After the parameter table is printed, all radiation sources and their total number are accounted for; note that with 13 entered stations there are 19 radiation sources.

In the first case, only one combination is registered. When the bandwidth is increased to ±0.5 MHz, and the number of harmonics is raised to 5, eight additional combinations are given (Fig. 3, lower portion). Since no additional stations were entered, the computer bypasses the printing of the station list on the second run. Again, a more accurate value of the spurious frequency would eliminate the unwanted combinations.

The second version of the program also can be used in any frequency range without limitations.

Applications

Although this procedure normally would be intended to resolve existing interference problems, it also can be used to predict theoretical situations, as shown in the following examples.

At times it is necessary to make broadcast-station field-intensity measurements in the immediate vicinity of other transmitters in the same band. In the presence of strong fields from such transmitters, a spurious reading could be indicated by the measuring device, and the field intensity of the measured distant station would appear to be higher than its actual value. Before the measurements are made, a spurious-frequency analysis can be carried out, with considerations given to the frequencies of all other transmitting facilities located along the radial, and with the frequency of the station to be measured entered under "spurious frequency." From the results of the analysis, it is possible to predict whether the value of any of the combinations is in the neighborhood of the frequency to be measured. The engineer then is made aware of possible difficulties.

A location for a receiving facility, such as the input of a television translator, could be considered in the presence of other established TV and FM services. Here again, it is possible to predict whether the existing services will affect the re-

```
SPURIØUS FREQUENCY, KHZ: 2120
HIGHEST HARMØNIC CØNSIDERED: 5
BANDWIDTH, +-KHZ: 10   FRØM 2110    TØ 2130    KHZ


STATIØN         FREQUENCY
  NØ.              KHZ
   1     .....    1010
   2     .....    1060
   3     .....    1120
   4     .....    1170
   5     .....    1210
   6     .....    1300
   7     .....    1420
   8     .....    1460
   9     .....    1500
  10     .....    1560

HARMØNIC 2    ØF 1060     = 2120
HAR. 1     ØF 1120    = 1120    +HAR. 1    ØF 1010    = 1010    = 2130
HAR. 3     ØF 1210    = 3630    -HAR. 1    ØF 1500    = 1500    = 2130
HAR. 2     ØF 1560    = 3120    -HAR. 1    ØF 1010    = 1010    = 2110
HAR. 5     ØF 1010    = 5050    -HAR. 2    ØF 1460    = 2920    = 2130
HAR. 5     ØF 1300    = 6500    -HAR. 3    ØF 1460    = 4380    = 2120
HAR. 5     ØF 1560    = 7800    -HAR. 4    ØF 1420    = 5680    = 2120
```

Fig. 2. Added frequencies and specifications of bandwidth yield six spurious frequencies in addition to those of Fig. 1.

[1]In this and subsequent examples, the sequence of frequencies entered is fictional and does not refer to any specific city.

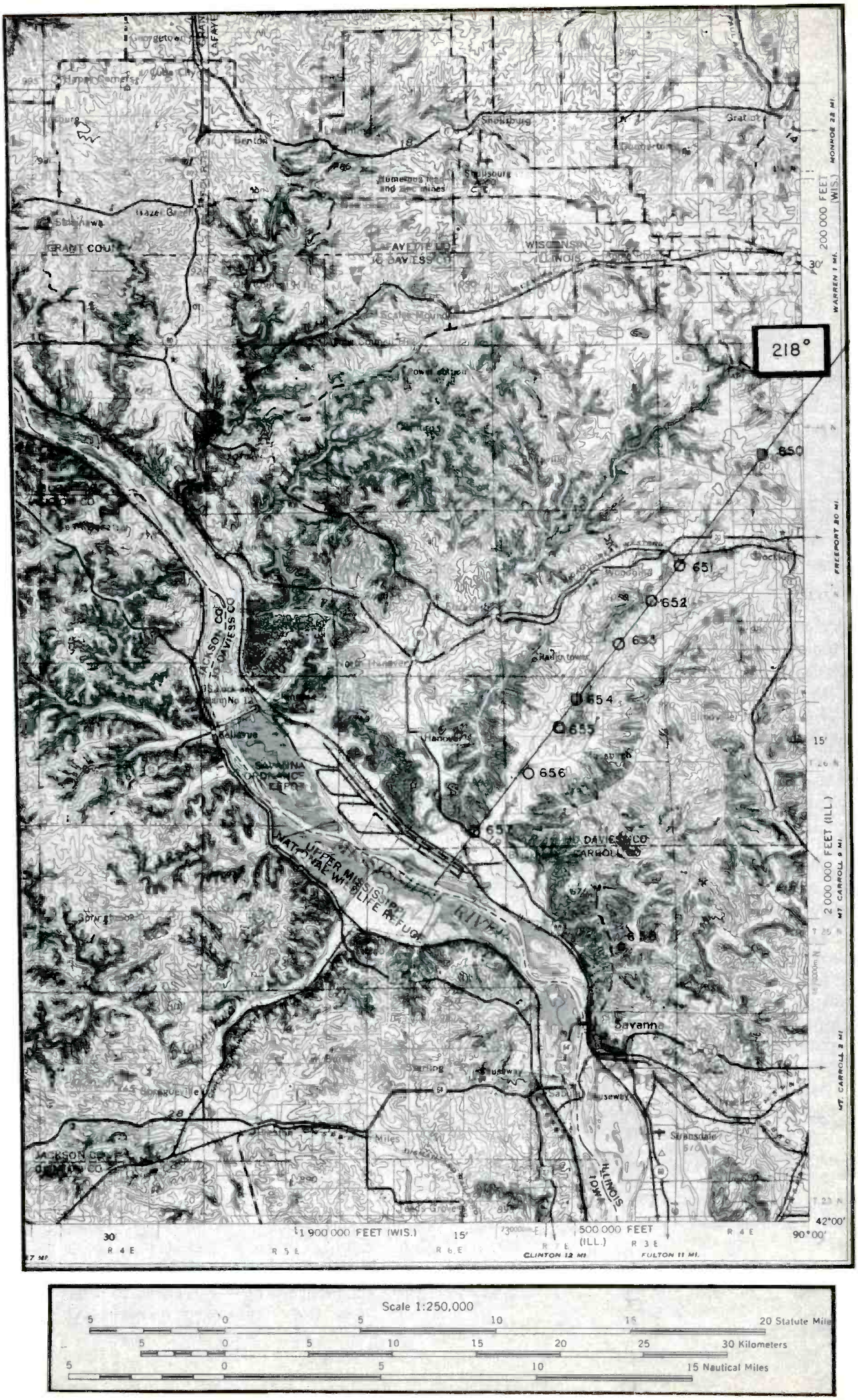


Fig. 1. Map shows region in which measurements were made on the WLKE test signal to establish the ground conductivity.

frequency. A study of 1180 kHz showed that no existing stations on this channel would place any significant signals in the area in which we had to measure.

An 1180-kHz crystal was purchased and installed in the No. 2 crystal socket in the WLKE transmitter. By use of the front-panel switch, the operator then could switch quickly between 1170 and 1180 kHz. The next step was to adjust the transmitter tuning to compromise settings of "Plate Tune" and "Plate Loading." The WLKE nondirectional antenna employs a broad-band antenna coupler; hence, no re-adjusting was necessary there. Since the WLKE transmitter was a 250/1000-watt type, and because 1-kw signals in the area of overlap would be twice as strong as for 250 watts, and therefore easier to measure, we requested site-test permission for 1-kw power. The licensed antenna current is 2.2 amperes for 250 watts; for 1000 watts, this current would be 4.4 amperes.

Normally, WLKE operates by remote control. We decided it would be more convenient to place an operator, in this case the owner of the station, at the transmitter for the duration of the site test. This arrangement would be easier and less expensive than to modify the remote-control equipment to change both power and frequency. As can be appreciated, the use of an operator at the transmitter is a positive way to be certain the power and frequency have been changed each time, and it provides a more accurate way to record the plate voltage, plate current, and antenna current each time.

Each fifteen minutes during the site-test period, the announcer at the WLKE studios made a short announcement to the effect that WLKE would interrupt its normal programming for approximately 20 seconds to conduct a special site test. At this cue, the transmitter operator would change the transmitter crystal and the power switch. As soon as this was accomplished, the man at the studio would announce the site-test call letters, the frequency of 1180 kHz, and the 1-kw power. At the end of the 20-second period, the transmitter operator would switch back to the 1170-kHz crystal and return the power to normal.

We selected fifteen-minute intervals so that we would have sufficient time to record the data, look at the map, and drive from one measuring location to the next. Since most of our locations were about five miles apart, this allowed us ten minutes for driving, two minutes for setting up and taking down equipment, and a minute or so to take the reading and calibrate the equipment.

Some simple suggestions may be helpful to others who may employ this new technique. All these have to do with the very short period of time the test carrier is on the air, about 20 seconds. First, a tripod or a measuring table is needed (Fig. 2); the field-intensity meter can become awfully heavy while you are waiting for the test signal. Second, a compass helps align the antenna loop in the direction of the expected maximum signal. This preliminary direction setting saves time in orienting the loop for a maximum after the signal is on the air. Third, a good watch is a must for predicting the time at which to expect the site-test signal. In the area close to the site, this will not be necessary, because there one can monitor the normal station frequency (1170 kHz in the case of WLKE) and hear the switching cues. Eighty to 100 miles or more out, the time method is the only way. Fourth, it is recommended that the field-intensity meter tuning dial be "locked," as can be done with some of the newer units. If you use one of the older type, it is best to record the logging-scale setting. Since prior to the site-test signal there is no carrier to use in tuning the field-intensity-meter receiver, the expected tuning point must be known ahead of time. Finally, it is recommended that the calibration of the field-intensity meter be checked both before and after the twenty-second signal, to be certain the gain did not drift.

Fig. 2. A measuring table (top) was used to support the meter (bottom).

Standard procedure is to check the loop orientation for maximum during the time the signal is on the air. If this is done conscientiously, there will be little time left. In our WLKE site test, we found that twenty seconds was quite adequate for these steps. In some other cases, where signals might be weaker or more interference might be present, longer time periods (30 or 40 seconds) could be needed. At each location, we recorded the usual information, such as time, location number, distance, description of the location, etc. We did add one extra bit of information in the case of WLKE. This was the recording of the signal strength for 250 watts on 1170 kHz as well as the site-test 1-kw signal on 1180 kHz. The reason for this was to check the two-to-one field-intensity ratio we should find with this four-to-one power ratio.

One final suggestion is offered in connection with taking the field data: Within the first two miles, where FCC Rules call for field measurements at one-tenth mile intervals, it would be too time consuming to wait 15 minutes between readings. So for this part of our test, we took readings at five-minute intervals.

Understandably, the foregoing method may not be used often in normal FCC allocation problems. But, it does serve to point up the fact that nothing is impossible to measure, if a little ingenuity is used. ▲

SILENCE SENSOR for AUDIO MONITORING

This station-built device sounds an alarm whenever modulation is lost.

by John A. Burtle*

Here is a silence sensor for monitoring your automatic audio programming or alerting you to transmitter failure. In operation at the stereo FM facilities of KCRC, the original unit has provided quite satisfactory performance.

Circuit Description

Tube V1 (Fig. 1) is used in two straightforward audio stages. Tube V2 controls relay K1. When audio is present at the input (terminals 1 and 2 of TB1), C4 charges through diode D1. A negative voltage is placed on the grids of V2, and that stage is held near cutoff; thus K1 is not energized.

When audio is lost, C4 discharges through R8; V2 then conducts, pulling in relay K1. With K1 energized, the START COUNT lamp glows, and 120 volts AC is applied to time-delay relay K2. After a predetermined delay (from 1 second to 3 minutes as set by the delay control on the relay), K2 then pulls in. (Note: the discharge time of C4 and R8 adds 3 seconds to the time-delay setting of K2.) Contacts 1 and 3 of K2 complete the external alarm circuit, and contacts 6 and 8 allow C10 to discharge through the coil of K3, the automation-advance relay. As soon as C10 discharges, K3 drops out, having provided a momentary closure of contacts 1 and 3 to the automation-advance circuit.

When audio is applied again to the sensor, C4 charges, K1 drops out, the voltage is removed from across K2, and this relay drops out. When K2 de-energizes, the external alarm goes off and C10 starts to recharge. This completes the cycle of operation. For test purposes, S2 may be used to apply voltage to K2 regardless of the state of K1. Switch S3 determines whether or not an advance pulse is applied to the automation programmer when K3 operates.

A charge of 18 volts or more on C10 will pull in automation-advance relay K3 when contacts 6 and 8 of K2 are closed. It takes 20 seconds for C10 to charge to this voltage; therefore, as long as the time-delay relay (K2) is set for 20 seconds delay or longer, K3 will pulse each time the delay relay is energized. (Of course the charging time of C10 can be changed to suit individual requirements.) The capacitor will reach a full charge of 34 volts if allowed to charge for 4 minutes or longer (usually the case). An interesting characteristic of this circuit is that it will advance the automation programmer only once for each time K2 pulls in, regardless of how long K2 remains energized. However, the external alarm will continue to sound until audio is received at the sensor input or S2 is placed in the "Off" position.

The B+ power supply is a voltage doubler to provide 340 volts DC from the 120-volt transformer secondary. The rectifier and filter circuit across the 6.3-volt filament winding is also a doubler, used to provide 14 volts DC to operate the aural alarm and a remote warning light.

Adjustments and Voltage Measurements

Adjustment of the sensitivity and audio-level controls is accomplished by the following steps. First, set sensitivity control R9 and level control R4 fully counterclockwise. Then remove and reinsert relay K1 in its socket (leaving K1 in the de-energized position). With K1 now de-energized, slowly advance sensitivity control R9 until K1 pulls in. (This setting should be approximately at the midway position of R9. Under normal operating conditions, it may be desired to advance the sensitivity control slightly from this position.) Now with the anticipated normal audio input applied, advance the audio-level control until the relay de-energizes.

Voltage measurements of the power supply and the 12AX7 are indicated on the schematic (Fig. 1). The voltages measured on the 12AU7A for its two modes of operation are shown in Table 1.

Construction and Use

The chassis we used measured 12″ x 7″ x 3″. A top view of the chassis is shown in Fig. 2, and a view of the front-panel controls and indicators is shown in Fig. 3.

Terminals 5 and 6 of TB1 are connected to the remote-advance

Table 1. Voltages on 12AU7A

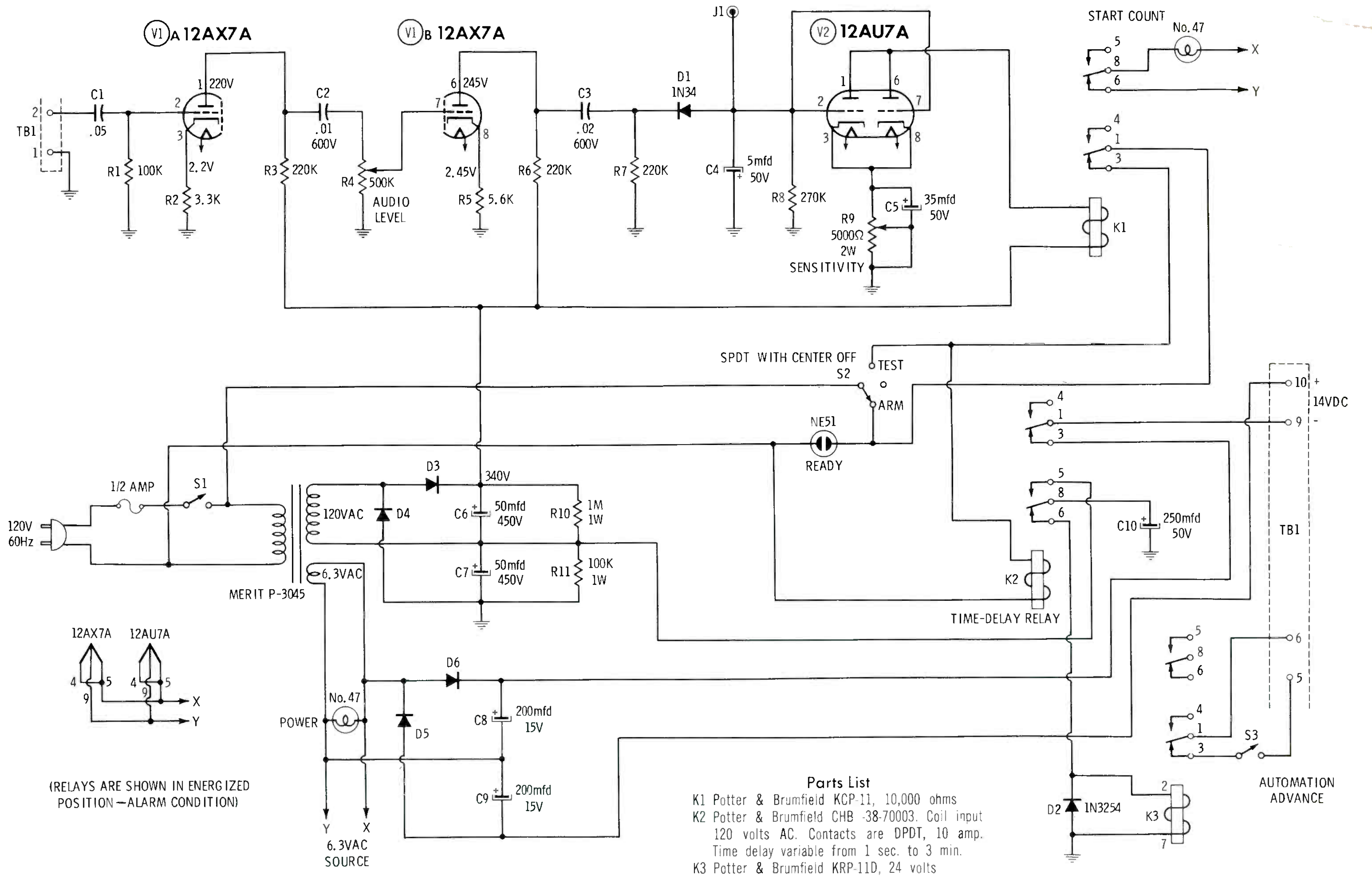
Sensitivity control fully counterclockwise and K1 de-energized
Sensitivity control advanced unitl K1 just pulls in

Pins	DC Volts
3 and 8	17
2 and 7	0
1 and 6	305
2 and 7 of K1	35

Voltages measured (without signal) with a 20,000 ohms/volt VOM. Negative meter lead to chassis ground..

Pins	DC Volts
3 and 8	16
2 and 7	Slightly negative
1 and 6	295
2 and 7 of K1	45

*Chief Engineer, KCRC AM-FM, Enid, Okla.



Parts List

K1 Potter & Brumfield KCP-11, 10,000 ohms
K2 Potter & Brumfield CHB -38-70003. Coil input 120 volts AC. Contacts are DPDT, 10 amp. Time delay variable from 1 sec. to 3 min.
K3 Potter & Brumfield KRP-11D, 24 volts
D3 - D6 600 PIV at .5 amp

Fig. 1. Schematic diagram of silence sensor; information about relays and rectifier diodes is contained in parts list.

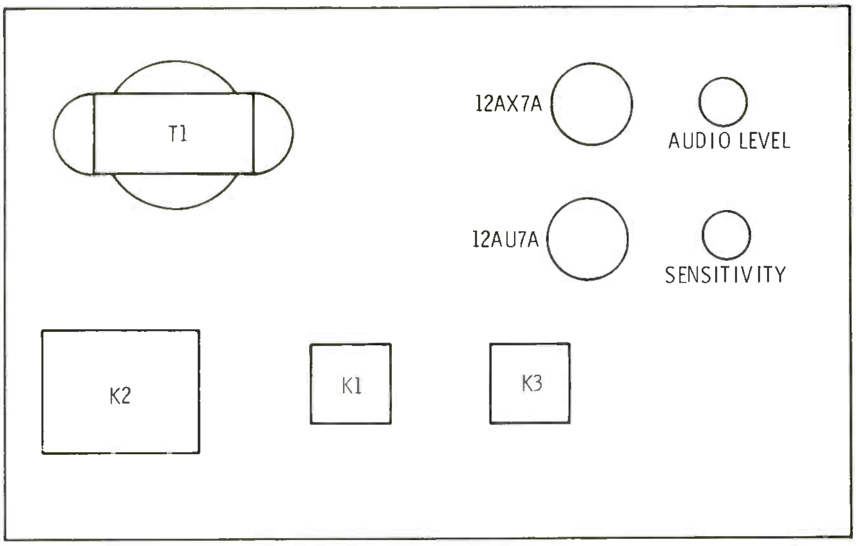


Fig. 2. Top view of chassis shows locations of the major components.

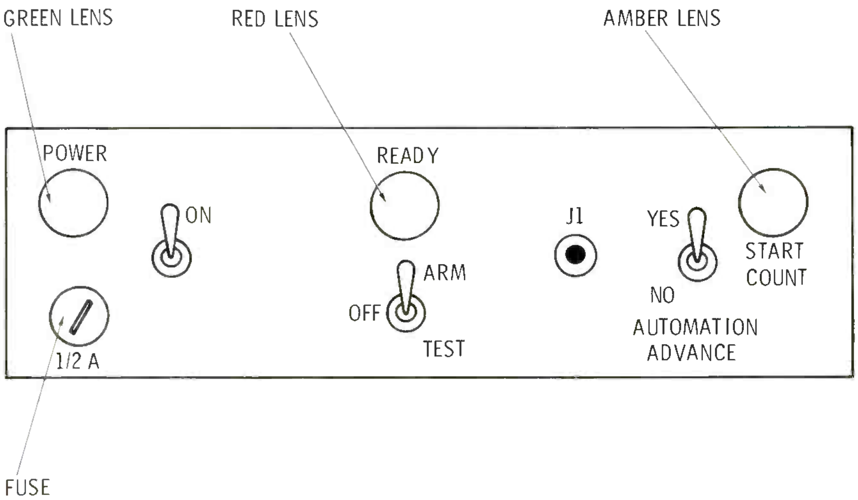


Fig. 3. Front view of chassis shows the front-panel controls and indicators.

terminals of the automation programmer. Terminals 9 and 10 provide 14 volts DC to operate a bell or buzzer aural alarm and a No. 1892 14-volt pilot light, which in our case is mounted in the AM control room.

Terminals 1 and 2 of TB1 present a high impedance to the audio input. Both the left and right output channels of the stereo modulation monitor are connected to the sensor input through the connecting network shown in Fig. 4. This network provides isolation between channels and allows the unit to monitor the total audio output of the stereo modulation monitor. ▲

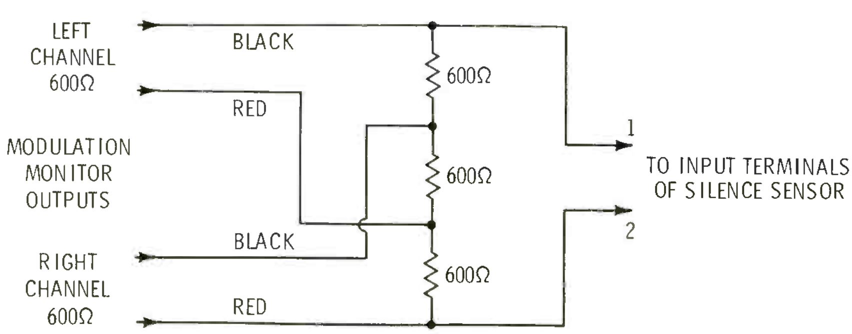
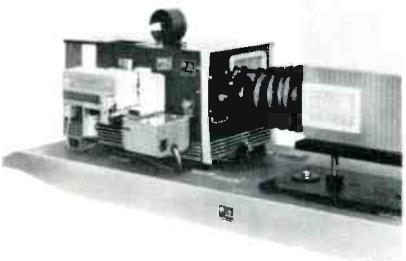


Fig. 4. Sensor input is obtained from modulation monitor through this network.

NEW PRODUCTS

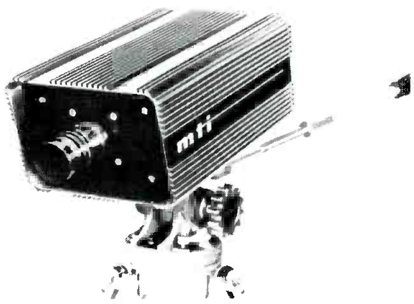
For further information about any item, circle the associated number on the Tech Data Card.



Projectors
(50)

Two projectors are being marketed by **Technical Material Corp**. The Model BCPS-1 (illustrated) "sound-strip" still projector features a patented "sound-on-film" system in which sound is optically recorded on the adjacent frame. The unit also shows conventional 35-mm film strips and 2" x 2" slides. It includes provision for manual or automatic timing, projection onto a screen or into a TV vidicon, and remote control.

Model BCP-16 is a 16-mm sound projector for use in television film chains. Features include a field rate of 50 or 60/sec (switchable), 4000-foot reel capacity, remote control facilities, solid-state sound system, and optical or magnetic sound.



Vidicon TV Camera
(51)

A low-light-level vidicon television camera with self-contained EIA synchronization is sold by **Maryland Telecommunications, Inc.** The camera is designated the MTI Model VC-41. The internally generated synchronization in the VC-41 is designed to meet or exceed all pulse widths and timing criteria of EIA Specification RS-170, Sections 3.3.3 to 3.3.10, to permit the VC-41 to be used in either broadcast or closed-circuit applications.

Operating controls for beam current, target voltage, electrical and optical focus, and power on-off are located on the camera. The single-unit, 13-pound VC-41 features solid-state regulated circuitry and special electrical-focus circuitry to compensate automatically for warm-up time. Resolution of 800 lines is specified. Solid-state circuitry is used throughout with the exception of the vidicon tube and the video preamplifier, which employs a *Nuvistor* cascode circuit.

The VC-41, complete with MTI Type S-V-110 preselected vidicon tube, is priced at $2495.

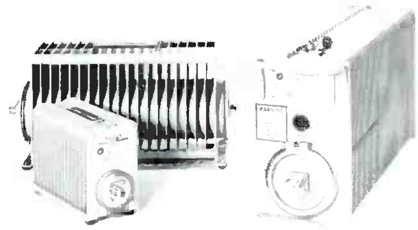
Self-Contained Television Camera
(52)

The 3200-series self-contained **Plumbicon** television camera is being produced by **Cohu Electronics, Inc.** Available with or without viewfinder, the camera is designed for use in remote and studio broadcasting or in closed-circuit systems. The unit weighs 32 pounds with viewfinder and features modular solid-state circuitry for all video-organization functions.

Specified performance includes 600-line resolution, production of a usable picture with 0.1 footcandle of illumination on the pick-up tube face, and production of all ten shades of gray on an EIA test pattern when 0.25 footcandle of highlight illumination is applied to the tube face.

Circuit assemblies for the camera are mounted on interchangeable plug-in boards, and controls are protected against accidental movement by a hinged rear door. EIA synchronization is by means of a plug-in sync generator or external sync source. The basic 3200 camera may be transformed into a general-purpose studio unit with the addition of a five-inch, snap-on viewfinder.

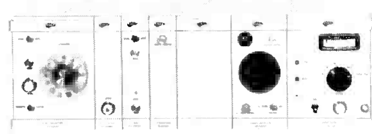
Base price of the camera (with viewfinder) less tube, lens, and cable is $3375.



High-Power RF Attenuators
(53)

Three new units have been added to the **Bird** family of high-power RF attenuators. They are Model 8321 (50 watts), Model 8322 (200 watts), and Model 8327 (1000 watts). Maximum rated deviation of the new units and the earlier *Tenuline* 500-watt and 2000-watt attenuators is ±½ dB from DC to 500 MHz, which can be corrected to within 0.2 dB at six calibration frequencies and at DC by use of a table. Electrically equivalent to symmetrical T-pads, these attenuators are unidirectional; *i.e.*, each resistance element in the T configuration is selected to dissipate only its share of the total input power. All *Tenuline* high-power attenuators also can be used as RF coaxial load resistors with a rated maximum VSWR of 1.10—with or without a small termination at the output connector.

Bird **Quick-Change** connectors on input and output provide for mating with all standard RF connectors without the use of adapters.



Solid-State TV Demodulator
(54)

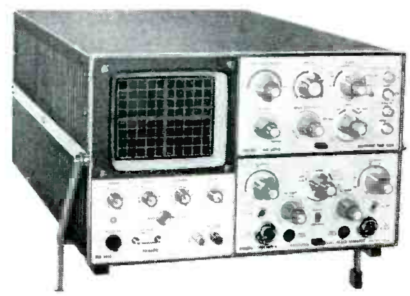
The Model RX-4000A TV demodulator features plug-in modular construction to allow use of optional modules for special receiving requirements, such as off-the-air reception for microwave relay, broadcast transmitter monitoring, remote control, and CATV and ITV head-ends. The **Dynair Electronics, Inc.** product includes a tuner for reception of all VHF channels; an optional single-channel crystal-controlled tuner also is available. An external converter may be added to allow reception of UHF channels. The equipment has been designed to offer the frequency response, differential phase and gain, AGC, and envelope-delay characteristics necessary for both color and monochrome performance. Military-type RF shielding is used on each module.

Several simultaneous outputs are available. In addition to the regular 75-ohm video and 600-ohm audio outputs, a combined 75-ohm video and 4.5-MHz aural output is available for CATV microwave applications. The sound section also includes a built-in speaker to allow monitoring of the 600-ohm audio output.

Switch-selectable metering is provided on the power supply for monitoring B+ and B− voltages, RF level, IF level, video level, percentage of aural modulation, and VU level on the 600-ohm audio output.

Vidicon Deflection Assembly
(55)

The Deflection Components Division of **Cleveland Electronics, Inc.** is producing a new one-inch-vidicon deflection assembly for applications in compact TV camera heads. The all-magnetic assembly contains a long yoke, focus coil, and alignment coil. The outside diameter is 1.62 inches, and the weight is 6 ounces. Specifications include resolution capabilities in excess of 600 TV lines, and geometric distortions within ±1% total. Some specifications for the component shown in the photograph are: yoke inductances, .300 mhy; 100-ohm focus coil capable of producing 40 gauss with 100-ma focusing current; and alignment coils designed at 130 ohms per pair and capable of handling up to 20 ma if required.



New Series of Oscilloscopes
(56)

A new series of solid-state oscilloscopes has been introduced by the newly established Electronic Measuring Apparatus group of **Philips Electronic Instruments,** a division of **Philips Electronics and Pharmaceutical Industries Corp.** The line comprises a 1-gHz sampling oscilloscope with real-time measuring facilities (Type PM 3410) and two portable, general-purpose oscilloscopes (Type 3221 and Type 3230).

The Type 3410 oscilloscope (in photo) incorporates sampling or real-time plug-in amplifiers and time-base generators. Features and specifications of this instrument include 100x magnification of horizontal sweep; Y/T flatbed record output available on the front panel; stable triggering from 10 mvolts at 1 gHz; maximum sensitivity of 1 mvolt/cm, and provision of a position on the horizontal scan, to scan the vertical input by manual control—the flatbed recorder can be scanned at the same time.

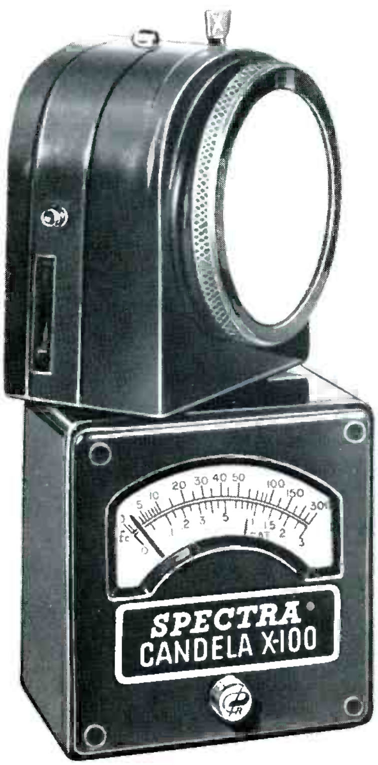
All power supplies in the main frame are regulated and stabilized with automatic overload protection; once the overload condition is removed, the oscilloscope resets itself automatically. The control circuits of the various power supplies are mounted on removable printed boards. Both the horizontal and vertical amplifiers are fully transistorized and are designed to provide deflection of the CRT from DC to 15 MHz.

Overall dimensions of the sampling oscilloscope frame are 13-½" × 20-½" × 8-½". Total weight including plug-in units is 44 pounds. Slide mechanisms can be attached to the main frame to permit rack mounting.

Two equipment combinations of Type 3410 are presently available: Type PM 3410S, sampling unit for DC to 1 gHz, total price $3330; and Type PM3410RT, real-time unit for DC to 15 MHz, total price $2650.

The Type PM3221 oscilloscope is a general-purpose unit with a 5" single-beam cathode-ray tube. Listed features and specifications include: DC-to-10 MHz range at 10 mvolt sensitivity; vertical-signal delay of 100 nanoseconds, obtained by means of built-in delay lines; power consumption, 70 watts; and weight, 18-¾ pounds. Price, including attenuator probe is $670.

The Type PM3230 oscilloscope has a dual-beam, 4" cathode-ray tube. Specifications for this DC-to-10 MHz unit include sensitivity of 20 mvolts/cm, power consumption of 70 watts, and weight of 24 pounds. Price, including attenuator probe, is $795.

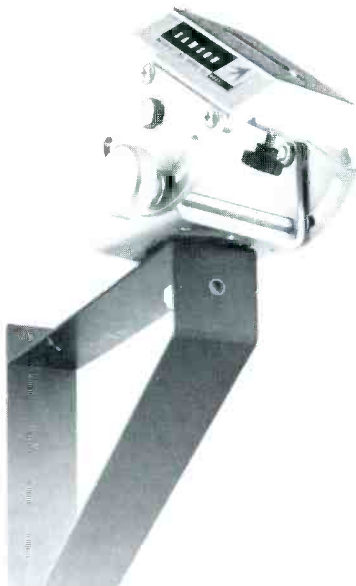


Footcandle Meter
(57)

The Spectra Candela X-100 footcandle meter, manufactured and distributed by the **Photo Research Corp.,** features the use of two different types of photocells for light measurement. A selenium photovoltaic cell is used for "normal" and high light levels, and a Cds photoconductive cell is used to measure low light levels. The change-over from high to low range is accomplished by pressing a switch on the side of the meter. The cells are on separate circuits, and both are color corrected to the standard observer curve.

By the use of multiplier slides and by switching from one cell to the other, six different full-scale readings are possible: 1, 5, 50, 500, 5000, and 50,000 footcandles. Other features listed for the instrument include NBS-traceable calibration, hand-drawn meter scale, and a swivel head. There are accessories for measuring brightness and for integrating incident light, and a light hood to narrow the acceptance angle.

This footcandle meter comes complete with multiplier slides in a belt-type leather case; list price is $139.50.



Mounting Device
(58)

Quick-set, Inc, has announced a new Samson wall and ceiling bracket, designed for permanent mounting of devices which require precise orientation, such as TV surveillance cameras, spotlights, TV monitors, etc. A choice of four different pan heads may be installed on the top or end of the bracket, as required for attachment to wall or ceiling. All heads provide 135° of tilt and 360° of pan. The bracket is of welded steel construction, is 2 inches wide, and is finished in black enamel.

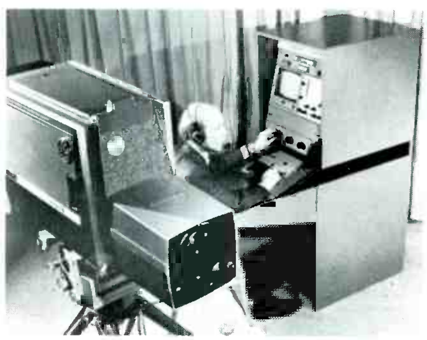
The No. 7532 Samson wall and ceiling bracket is priced at $10; with the No. 7291 head (as illustrated), the price is $33.

Isolation Transformers
(59)

"Ultra-Isolation" transformers — with shielding for electrostatically isolating noisy power lines from noise-sensitive equipment—are now offered in a compact, flat design. The new **Topaz Inc.** "Space Saver" models (in photo) are designed for mounting at the bottom of rack cabinets, between the casters in normally unused space. Units are available with ratings of 1.0 and 5.0 kva.

Some specifications for these units are as follows: Leakage resistance between primary (power line) and secondary or from either winding to ground is kept at greater than 10,000 megohms; effective interwinding capacitance is maintained at 0.0005 pf or less, 0.001 pf or less, or 0.005 pf or less, depending on the customer's choice; transverse (across-winding) noise voltage is 40 dB or more below the value ordinarily attainable by standard box-shielding methods; the attenuation of both transverse and common-mode noise applies in both directions, *i.e.* primary to secondary and secondary to primary. The "Space Saver" transformers are designed to operate at a temperature of 130°C, Class B (Commercial) or Class S (per MIL-T-27B).

In addition to the "Space Saver" units, Topaz now offers its "Ultra-Isolation" transformers in 3-phase models with ratings from 10 kva to 40 kva. The new high-power models operate from any input-output voltage of 120 to 480 volts, 60 Hz. Some specifications are: Leakage resistance between primary (power line) and secondary or from either winding to ground is greater than 10,000 megohms; common-mode rejection is greater than 125 dB; regulation is ±2% no load to full load; effective capacitance between windings is less than 0.005 pf. The high-power transformers weigh approximately 15 pounds per kva, and their size is approximately 1/10 cubic foot per kva, with the largest dimension 36 inches.



New Camera Introduced, Updating Kits Offered
(60)

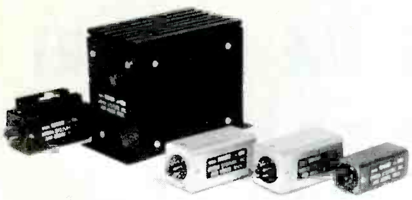
The **General Electric Co.** Visual Communications Products Department has introduced a new separate-luminance live color television camera using chroma enhancement and a new optical system. The PE-350 color TV camera also features new preamplifiers and video processing amplifiers. The camera uses four lead-oxide pickup tubes, but these are now separate mesh types. The unit weighs under 160 pounds, with viewfinder and 10:1 zoom lens.

Two available PE-350 accessories are a cable adapter box and a remote video control panel. The adapter box permits the PE-350 to be used with existing cable for older three-image-orthicon cameras. The remote video-control panel is designed for use by directors to assure that all cameras are color-matched during a performance. The iris and pedestal can be adjusted and color balance is controlled remotely.

The PE-350 camera will accept a wider selection of zoom lenses than its predecessor; it also includes a new quick-disconnect lens mount. A weatherproof rectangular cover has been installed on top of the camera to provide easy accessibility to the viewfinder yoke and the high-voltage power supply.

While the PE-350 camera was being developed, a parallel program was underway to design retrofit kits so that owners of PE-250 cameras could protect their investment. There are three separate kits, one for converting PE-250 cameras to the performance level of the PE-350 camera, and two remote kits.

The improved-performance kit, PK-250-A, is designed to update both electronics and optics in the camera. The remote kit, PK-250-B, is designed to make adjustments for varying color-temperature conditions, improve camera control, and facilitate transportation for remote applications. It includes a new color-temperature-correction filter wheel with eight positions for correcting color temperatures from 8000°K to 3200°K, or from noon to sunset. The optical system kit, PK-250-C, is designed to improve performance under adverse light conditions, such as those encountered during indoor remotes and night sports events.



Audio Components

(61)

Arbor Systems, Inc. has announced several items in a line of audio equipment. Model MX101 is a mixing amplifier with multiple bridging inputs. It is designed to permit mixing of up to 10 inputs with a level increase of up to 40 dB. The output rating is +10 dBm into 600 ohms with less than 0.5% distortion.

Model PA201-10W is a universal power amplifier intended to deliver up to 10 watts into loads of 4 to 50 ohms, with distortion levels down to 0.1% THD typical. The modified class-B solid-state circuit features overload protection; rated input impedance of the amplifier is 1 megohm.

Model TO101A is a solid-state, fixed-frequency Wien-bridge oscillator featuring an AGC circuit for automatic control of the output amplitude. The oscillator, of printed-circuit construction, is contained in an aluminum plug-in housing with an octal base plug. The module may be supplied for any frequency from 20 to 20,000 Hz.

Model UA101C is a silicon-transistor amplifier designed for applications ranging from low-noise preamplifier to moderate-power line driver. Specifications include: gain, 40 dB nominal (adjustable externally); frequency response, ±0.5 dB from 20 to 20,000 Hz; distortion, less than 0.5% THD at any frequency from 20 to 20,000 Hz at +10 dBm output.

The PS301 series power supplies are silicon-solid-state, regulated, modular power supplies designed to provide the peak current requirements of class-B audio amplifiers. Ratings include output voltage of 28 volts DC, factory set (adjustable by internal control from 24 to 30 volts), and output current of 0 to 2 amperes, continuous rating.

Model PS201 is a silicon-solid-state, plug-in power-supply regulator designed to furnish the necessary voltage and current for the Model UA101C and other Arbor Systems models. The PS201 accepts AC from an external transformer and delivers regulated DC. The output voltage is 24 volts DC, factory set (adjustable by internal control from 18 to 26 volts), and the output current range is 0 to 300 ma. ▲

PERSONALITIES IN THE INDUSTRY

Andrew Corp. recently opened a district office in Seattle. The new sales engineering office will serve customers in Washington, Oregon, and Alaska. **John Van** has been appointed district manager in charge of the new office, located at 11520 Lake City Way, N.E., Seattle, Washington 98125.

Walter S. Brewer has been appointed Southwestern Marketing Manager for Berkey-ColorTran, Inc. (A Division of Berkey Photo Inc.). Mr. Brewer formerly headed Graphics Unlimited. He will service ColorTran dealers and cover the motion-picture, television, and still-photography markets in the southwest. He will make his headquarters at 1425 South Main, Suite 9, Tulsa, Oklahoma. The Tulsa office includes a display room which features the full line of ColorTran products.

A series of appointments has been made in the Tape Division of the Photo Products Group of Bell & Howell Co. **Bruce MacFarlane** was appointed national sales manager for audio products. Named audio district managers were: **James Truelsen,** metropolitan Chicago; **Sheldon Pines,** Los Angeles and Southern California; **Anthony Blazakis,** metropolitan Philadelphia; and **Ed O'Rourke,** New York City Area.

Mr. MacFarlane joined Bell & Howell in 1959 as a marketing trainee; most recently, he served as regional sales manager-Atlantic region.

Mr. Truelsen started with the company in 1964 as a management trainee; since then he has served as a district manager for consumer photo products.

Mr. Pines also has served as a district manager of consumer photo products and has been with the company since 1963.

Mr. O'Rourke joined Bell & Howell in 1960; his experience at the company includes a variety of sales-related positions, including several years as a district manager for consumer photo products.

Mr. Blazakis, a newcomer to the company, has 7 years' experience in tape sales, both as a manufacturer's representative, and as the owner of his own retail appliance store.

Appointment of **Richard R. Peterson** as marketing manager for videotape systems also has been announced by the Bell & Howell Tape Division.

Robert E. Lynch has been appointed by Gravco Sales, Inc., to set up a sales office in the Northeastern region. As Northeastern regional sales manager, Mr. Lynch will be responsible for sales in New York, New Jersey, Pennsylvania, Delaware, the District of Columbia, and the New England states. Mr. Lynch formerly was New York regional sales manager for Riker Video Industries.

Gravco Sales is the marketing subsidiary of **The Grass Valley Group, Inc.**

Oral Evans, Harold Blakeslee, and **George Foster** have been named to top posts on the newly formed industrial and educational products marketing staff of the Ampex Corp. consumer and educational products division.

Mr. Evans will be national distribution manager with responsibility for nationwide distributor sales of the division's closed-circuit video-tape recorders, television cameras, and associated equipment. He has been Midwest regional sales manager for Raytheon Learning Systems Co.

Mr. Blakeslee will be field sales manager for closed-circuit video-tape recorders, television cameras, and associated equipment. He joined Ampex in 1963 and most recently was central regional sales manager for video products.

Mr. Foster was named national accounts manager and will be responsible for sales of closed-circuit videotape recorders, television cameras, and associated equipment to original equipment manufacturers and other national accounts. He joins Ampex from Raytheon Learning Systems Co.

The new appointees will be located at the division marketing headquarters in Park Ridge, Illinois.

Robert N. Vendeland has become general manager of **Conrac Division** of **Conrac Corp.** Mr. Vendeland previously was assistant general manager, and prior to that was Conrac's general sales manager for four years.

At the annual stockholder's meeting of **Entron, Inc.,** the following directors were re-elected: **George E. Akerson,** president and publisher of the Boston Herald-Traveler Corp.; **Harold E. Clancy,** first vice-president of the Boston Herald-Traveler Corp.; **Stephen Hartwell,** executive vice-president of Steadman Security Corp., Washington, D. C.: **John D. Hawke, Jr.,** partner, Arnold & Porter, Attorneys, Washington, D.C.; **William C. Koplovitz,** partner in Dempsey & Koplovitz, attorneys, Washington, D. C.; **Vincent Manno,** newspaper consultant and broker, New York, New York; **Roger P. Talmadge,** treasurer of the Boston Herald-Traveler Corp.; and **Edward P. Whitney,** Entron president. **William S. Broderick,** assistant to the publisher, Boston Herald-Traveler Corp., was newly elected to serve on the Board of Directors.

In the subsequent meeting of the Board of Directors, the following officers were re-elected: **George E. Akerson,** chairman of the board; **Harold E. Clancy,** chairman of the executive committee; **Edward P. Whitney,** president; **Heinz E. Blum,** senior vice-president–advanced engineering; **O. D. Page,** vice-president–product engineering; **Anthony J. Vendemia,** vice-president–manufacturing; **John G. Russell,** vice-president–marketing; **Kevin R. Doyle,** secretary; **Michael J. Weinstock,** assistant secretary; and **John D. Hawke, Jr.,** assistant secretary. In addition, **Joseph T. Healy** was elected to the position of treasurer; he has been acting treasurer since February.

W. Frederick Corkran has been elected vice-president–foreign operations by the directors of **Preformed Line Products Co.** Mr. Corkran will be responsible for foreign market development, licensee programs, and export sales. Formerly director of foreign operations, he joined Preformed in November 1966 from the firm's licensee company in Canada.

Abram E. Patlove is the new vice-president in charge of systems operations of **Continental CATV, Inc.,** a wholly owned subsidiary of **Vikoa, Inc.** Mr. Patlove has served as systems development director since joining Continental in 1967. He will assume full responsibility for all Continental cable television systems which are now located in Pennsylvania, New Jersey, and Ohio.

Charles T. Snyder has joined **KTVA** television, Anchorage, as producer-director. He leaves an engineering post at Bell Telephone in Seattle. Mr. Snyder directs KTVA's news programming and other live broadcasts, and also serves as a station engineer.

Robert H. Jones has been appointed chief engineer of **WBLG-TV,** Lexington, Kentucky. Mr. Jones previously had been director of engineering of the Bluegrass Broadcasting Group. He entered broadcasting in 1939 with radio station WLAP in Lexington, and after World War II, he helped construct radio station WBLG (then WKLX), Lexington. An air date of June 2, 1968, has been announced for WBLG-TV (channel 62).

Mr. Bentley

Appointment of **J. R. Bentley** as a new vice-president of **LTV Ling Altec, Inc.,** subsidiary of **Ling-Temco-Vought, Inc.,** has been announced. Mr. Bentley, who has been with the company since 1962, will remain in Anaheim, Calif., where two of the company's major divisions — Ling Electronics and Altec Lansing—share facilities. Mr. Bentley has been secretary and controller of LTV Ling Altec since 1965.

Mr. **Emil P. Vincent,** 48, product manager-audio systems for Visual Electronics Corp., died suddenly at Pasadena, Calif., on April 25, 1968. A former governor and 1967 convention chairman of the Audio Engineering Society, he joined Visual earlier this year and had just relocated to Pasadena. Prior to his association with Visual, Mr. Vincent had been with the CBS and ABC television networks.

Mr. Ratigan

Frank D. Ratigan has been named manager of the Washington, D. C. office of **Philips Broadcast Equipment Corp.** As manager of the Washington office, Mr. Ratigan provides the company's interface with the Department of Transportation, Department of Defense, Federal Communications Commission, and other governmental branches in the areas of electronics and communications.

Robert B. Baker and **James F. Somers** have been elected vice-presidents of **ITT Cannon Electric,** a division of **International Telephone and Telegraph Corp.** Mr. Baker was appointed comptroller in February 1967 and will continue in this position. Mr. Somers will continue as director-administration, a position he has held since early 1967.

Several appointments have been announced by **Superior Continental Corp. Warner T. Smith** has been named to the position of executive vice-president. In his new position, Mr. Smith will assume additional responsibilities in general corporate administration and for a period of time will continue his duties as vice-president in charge of research and engineering.

J. D. Sherrill has been named technical manager of the Superior Cable Division Sherrill's Ford coaxial cable plant. In his new position, Mr. Sherrill will be responsible for all production engineering functions at the Sherrill's

Ford plant and for project coordination with the research and engineering center in Hickory.

Joseph P. Walters has been named product design and applications engineer. In his new position with Superior Continental, Mr. Walters will assume engineering responsibilities for the design, development, and application of cable pressurization equipment and products in support of the Systems Equipment Division.

Chester A. Hale, a native of the Tennessee Tri-Cities area, is a new project supervisor for **Comm/Scope Corp.** In his new position, Mr. Hale will be one of several project supervisors, each of whom is responsible for the successful completion of assigned field construction operations.

Roy A. Tester has joined Comm/Scope as a field technician. At Comm/Scope Mr. Tester will specialize in electronic equipment applications and operations and will carry out field assignments as an assistant to the project supervisor. Comm/Scope is a subsidiary of Superior Continental.

Peter W. Smith has been appointed chief engineer of **Central Dynamics** Ltd. Mr. Smith is Australian and came to Canada in 1967 to join the company. He was formerly chief engineer of South Australian Telecasters Ltd. in Adelaide, and before that he was chief engineer for telephony and telegraphy with the Telecommunications Co. of Australia.

Ronald N. Kahill has been appointed Product Manager, Wire and Cable, for **Superior Continental Corp.** In his new position, Mr. Kahill will be responsible for the development of marketing and sales plans for all wire and cable products manufactured by Superior Cable Division of Superior Continental.

Tom Moss has been named vice-president, general manager, of **The Turner Co.** Mr. Moss, who joined Turner in 1952, was formerly vice-president of operations and marketing. In the newly created general-manager position, he will have complete responsibility for all phases of Turner's operations.

General Electric Co. has named **Robert L. Casselberry** manager of marketing for its Communication Products Department with management responsibility for widening marketing programs for point-to-point communications equipment. In his new position, Mr. Casselberry will head all functions involved in the development of both new and existing markets for Information Network Systems, Data Communications, and Power Line Carrier Current equipment.

Mr. Palius

Mr. Baruch

Berkey-ColorTran, Inc., has announced the appointment of **Kenneth M. Palius** as vice-president. Mr. Palius will direct the marketing and development program for the company. Before joining Berkey-ColorTran, Mr. Palius had been with ABC Television (New York) for 19 years in various capacities. He also was a member of the ABC/CBS/NBC Committee that determined the networks' color television lighting specifications for athletic stadiums and arenas.

In another announcement, **Gerald R. Baruch** has been appointed advertising and sales promotion manager. Before joining Berkey-ColorTran in November of 1966, Mr. Baruch was advertising production manager for the Jewish Federation Council of Greater Los Angeles for 8 years.

Mr. Weber

Mr. Marshall

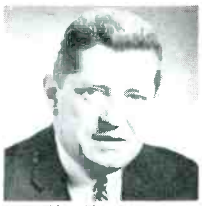
Ampex Corp. has announced three administrative appointments for the Magnetic Tape Division. **Paul J. Weber,** formerly the corporate marketing services manager, has been named marketing manager. Mr. Weber joined Ampex in 1955 and has held various executive marketing positions prior to his current assignment.

Mr. Weber succeeds **John A. Buchanan,** who has been appointed to the newly created post of division planning manager. Mr. Buchanan will direct long- and short-range product, market, and facilities planning. He has held various product marketing positions in the division since joining Ampex in 1959.

Named to succeed Mr. Weber as corporate marketing manager was **Ronald A. Polster.** He has served Ampex in marketing positions since 1959.

Nathaniel M. Marshall has been named vice-president of marketing, industrial, and educational products for the consumer and educational products division of **Ampex Corp.** Mr. Marshall is responsible for marketing closed-circuit video-tape recorders; television cameras; and associated equipment for educational, industrial, medical, military, and other uses. His office is at 205 West Touhy Avenue, Park Ridge, Illinois.


Mr. Wickliffe


Mr. Marten

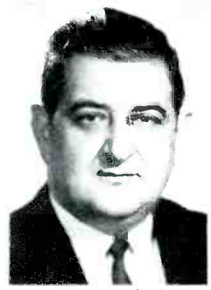
Stanley W. Wickliffe has been named to the newly established position of Marketing Supervisor for the Western Region of the **General Electric Co.,** Closed Circuit Television Business Section. In his new position, Mr. Wickliffe will be responsible for sales and service of closed-circuit television and video-tape-recording systems throughout 14 western states, Alaska, and Hawaii. He will be headquartered at 116 North Robertson Boulevard, Los Angeles, California.

In another announcement, **George B. Marten** was named advertising and sales promotion technical communications specialist for the Communications Products Department. In the newly established position, Mr. Marten will supervise the production of technical manuals, sales-promotion material, and broadcast-equipment catalogs. Mr. Marten previously was senior technical editor for the Advertising and Sales Promotion Department.


Dr. Zaffaroni


Mr. Hale

Dr. Alejandro Zaffaroni and **Prentiss C. Hale** have been elected to the **Memorex Corp.** Board of Directors. Dr. Zaffaroni is executive vice-president and a member of the Board of Directors of Syntex Corp., Palo Alto, California, maker of pharmaceuticals. He also serves as president of Syntex Research. Mr. Hale is chairman of the board for Broadway-Hale Stores, Inc., and Hale Bros. Associates, Inc. He also serves as director of Union Oil Company, Bank of America, Foremost-McKesson, Inc., Santa Fe Railway, and a number of other prominent companies.


Mr. Garshick


Mr. Manchester

Eli Manchester, Jr. has been named vice-president and general manager of **Boston Insulated Wire and Cable Co.** Mr. Manchester first joined the company in October 1963; he has served as vice-president in charge of manufacturing since September 1966.

Also at Boston Insulated Wire and Cable, **Alfred Garshick** has been made chief engineer. Prior to joining the company, Mr. Garshick served with the Signal Corps Supply Agency of Philadelphia and Dictograph Products of New York. ▲

ENGINEERS' TECH DATA

100. **ALTEC LANSING**—Bulletin AL1374 is a technical treatise on the use of microphones in sound-reinforcement systems.

101. **AMERICAN NUCLEONICS**—Model 614A plug-in amplifier is the subject of a product data sheet.

102. **AMPEX CORP.**—Bulletin G276 describes program automation at KTBT-FM. Other products and the bulletins describing them are: VR-120CA VTR, Bulletin V158; AG-600 mono/stereo recorder, Bulletin A199; AA-620 portable amplifier/speaker, Bulletin A200; AM-10 mono/stereo mixer, Bulletin A208; AA-80 80-watt amplifier and accessories, Bulletins A171 and A183.

103. **ANDREW CORP.**—ITFS antennas [2.5 to 2.7 gHz] in offset and omnidirectional patterns are the subject of Technical Bulletin 182.

104. **ANTENNA PRODUCTS CO.**—Literature describing rotatable and fixed log-periodic antennas, broadcast towers, and VHF dipoles and corner reflectors is available.

105. **APPLIED ELECTRO MECHANICS**—Model BUDR-1 balun amplifier for video distribution is described in a technical bulletin.

106. **ATLAS SOUND**—Form PP-1840 describes microphone stands, microphone booms, and studio accessories.

107. **AUDIO DEVICES**—A new technical data sheet for the **Audio-pak** Model A tape cartridge is offered.

108. **AUDIOSEARS CORP.**—The 1968 catalog of headsets, handsets, microphones, components, and accessories is offered.

109. **BALL BROTHERS**—Mark 81 video-signal multiplexer is described in a technical bulletin.

110. **B & K**—A product-data sheet gives applications and specifications for Model 123 ⅓-octave spectrum shaper and Model 1612/S2L ⅓-octave spectrum shaper and analyzer.

111. **BARKER & WILLIAMSON**—Specifications and descriptions of test equipment, coaxial switchers, dummy loads, RF filters, and RF components are included in an 8-page catalog.

112. **BECKMAN INSTRUMENTS**—Insulation test equipment, impedance bridges, high-voltage power supplies, and automatic testers are covered in a 40-page catalog.

113. **BENRUS TECHNICAL PRODUCTS**—Catalog No. 802 gives descriptions and specifications for CRT-display units and interchangeable deflection amplifiers.

114. **BERKEY-COLORTRAN**—Information sheet concerns nonjacketed 2000-watt and 5000-watt single-ended tungsten-halogen lamps.

115. **CCA**—Information concerning the FMA-6811 medium-power circularly polarized FM antenna is offered.

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

117. **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.

118. **CLEVITE CORP., PIEZOELECTRIC DIV.**—Brochure includes specifications on line of mono and stereo headphones.

119. **COHU**—"The ABC's of ETV" is the title of Brochure 8-91.

120. **COLORADO VIDEO**—SMPTE reprint "A New Method of Television Waveform Display" is offered.

121. **CONCORD ELECTRONICS**—The VTR-700 remote-controlled VTR designed for continuous recording or playback is described in a 4-page brochure.

122. **CROWN INTERNATIONAL**—The CX700 series of full-track to eight-track reel-to-reel recorders is the subject of a specification and price sheet.

123. **DATAPULSE**—Applications bulletin for Model 110B pulse generator is entitled "A Sophisticated Pulse Generator to Simplify Your Testing Problems."

124. **DELHI**—Twelve-page catalog concerns towers and masts for Citizens-band and similar applications.

125. **DELTA ELECTRONICS**—Specification sheets and application bulletins give information about the OIB-1 operating-impedance bridge and CPB-1 and -1A common-point impedance bridges.

126. **DIALIGHT CORP.**—Catalog L-208 provides data, drawings, and ordering information for 513 Series switches.

127. **DYNAIR ELECTRONICS**—Bulletins M15A and M14A describe the Mini-Mop video-cable equalizer and the Mini-Sync TV-sync generator, respectively.

128. **EUPHONICS**—Color brochure discusses disc recording and the Miniconic semiconductor playback cartridge.

129. **FAIRCHILD RECORDING**—Model 1001 gain-shifter intercom system is the subject of preliminary-data release.

130. **FILTRON CO.**—24-page Catalog No. P-68 lists complete line of RFI/EMC filters.

131. **FT. WORTH TOWER**—Literature dealing with towers, passive reflectors, and equipment buildings is offered.

132. **GATES**—Solid Statesman peak-limiting amplifier is subject of brochure.

133. **GAUSS ELECTROPHYSICS**—Brochure describes Series 1200 high-speed tape-duplication system and Series 1260 endless-loop tape bin.

134. **HUGHEY & PHILLIPS**—Bulletin HPS 168 describes line of ring-type tower-lighting isolation transformers.

135. **INTERNATIONAL ELECTRONIC RESEARCH CORP.**—Bulletin 151 gives information about IERC heat-dissipating devices for micro-circuit packages.

136. **INTERNATIONAL NUCLEAR**—Model TPC2 burst-phase corrector is subject of literature.

137. **JOA**—Prices and data are given for new cartridges and cartridge-reconditioning service.

138. **KALART/VICTOR**—Victor Models STV-18 and STV-TB 16-mm projectors and Tele-Beam Model A912 large-screen television projection system are covered in three brochures.

139. **3M CO.**—Series of quarterly bulletins about video-tape recording is initiated. Called "Video Talk," the first bulletin has as its subject "Video Tape Speed."

140. **D. B. MILLIKEN**—Model DBM-R1 video-film recording system is described in data sheets.

141. **MICRO COMMUNICATIONS** — Catalog includes performance curves and engineering data on filters, diplexers, sideband filters, power combiners, and transmission lines.

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

143. **MOSELEY ASSOCIATES**—Bulletin 221A describes Model ADP-101 digital, automatic transmitter logger.

144. **MOTOROLA**—New two-way-radio control stations are described in brochure.

145. **OAK MANUFACTURING**—Literature describing switches, TV and FM tuners, and rotary solenoids is available.

146. **POMONA ELECTRONICS**—1968 general catalog of electronic test accessories has 44 pages and lists 300 products.

147. **PREFORMED LINE PRODUCTS**—26-page brochure describes testing services; two-page brochure describes reducing splices; and a second two-page brochure describes dead ends for use on glass-fiber strand.

148. **PROSSER INDUSTRIES**—Model 2511A, 2500-watt, 60-Hz alternator for under-the-hood installation is the subject of specification sheet F-2511-1.

149. **RUSSELL INDUSTRIES**—Availability of a new catalog listing shielding materials and devices is announced.

150. **NAGRA**—Synchronous ¼-inch tape recorders and accessories are subject of leaflet.

151. **SCANTLIN ELECTRONICS**—Brochure describes Videotype electronic titling unit.

152. **SEALECTRO CORP.**—24-page applications handbook describes typical uses for programming devices.

153. **SHURE**—Eight-page professional products catalog lists microphones, circuitry, cartridges, tone arms, and microphone accessories.

154. **SORENSEN**—Short-Form Catalog No. 68A lists power supplies, AC-line regulators, and frequency changers.

155. **SPARTA**—A catalog sheet covering tape-cartridge accessories, including storage racks, tape erasers, and head degaussers, is offered.

156. **STANCIL-HOFFMAN**—Model R75 tape recorder/reproducer for mono or stereo is the subject of a specification sheet.

157. **STARTRONICS**—"Design Notes," a series of engineering-design aids, is inaugurated. No. 1 gives coaxial-line parameters and formulas.

158. **SUPERSCOPE**—31-page catalog, "All the Best From Sony," features Sony/Superscope tape recorders, magnetic tape, microphones, and accessories. Additional catalog gives technical specifications of consumer and professional microphones.

159. **SWITCHCRAFT**—Catalog No. C502a lists latest audio connectors. Bulletin 174 describes multiple-station Series 65000 push-button switches.

160. **TAPECASTER**—Series 700 tape-cartridge machines are subject of a brochure.

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

162. **TELEVISION ZOOMAR**—TVP pneumatic camera pedestals and Mark II Colorgard meter, used to balance color receivers on production lines, are described in product-information sheets.

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

164. **TEXSCAN**—68-page Catalog-68 lists product line of test equipment and accessories.

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

166. **TRIPLETT**—20-page Catalog No. D-68 gives mechanical details and electrical specifications of panel-mounted and portable instruments.

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

168. **UNIVERSITY SOUND**—New 28-page catalog of commercial sound products lists over 100 products and includes sound-system design charts, formulas, and technical data.

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

170. **ZOOMAR, INC.**—Information sheet tells how to attach the new Mark XX remote-control zoom lens and describes the Variospeed control box.

Advertisers' Index

Professional Services

Classified

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

Equipment for Sale

Now you can choose the type of tape wound in your cartridges from **BROADCAST EQUIPMENT REBUILDERS!!** You know what you prefer. If we don't stock it, we'll get it for you . . . and, at our same low prices regardless of the cost per reel to us! The most popular cartridge tape always in stock . . . Scotch . . . Ampex . . . Audiotape. Wanted: Used broadcast consoles for our listings. Broadcast Equipment Rebuilders, Rt 8, Box 718, Fayetteville, N.C. 28304. Phone 919-425-7332. 6-68-1t

Gates stereo Top Level amplifier, Isocoupler for 99.3 MHz, rated at 10 kw, Gates dual polarized FM antenna consisting of 3 horizontal elements and 3 vertical, for 99.3 MHz. 270 ft. Andrews H7-50A, 1-5/8" unjacketed Heliax, and 340 ft. Andrews HJ7-50A, 1-5/8" jacketed Heliax. Two Sparta 600P stereo cartridge playbacks, and one Sparta 600RP record/playback unit. All equipment in use about one year and in very good condition. Contact chief engineer, Radio Station WNAM, P.O. Box 707, Neenah, Wis., 54956, or phone 414-722-6471. 6-68-1t

Four TK-41 color cameras with sync generators, color bar generator in air-conditioned truck less audio and switching. Reasonable. Reply Box 209, Broadcast Engineering 6-68-2t

Equipment Wanted

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

4-channel mixer (Gates Consolette or similar) and 2 Magnecord PT-6 tape recorders. Hogan-Rose & Co., Att: JMR, 105 W 5th Ave., Knoxville, Tennessee 37917. 6-68-2t

"UHF STATION EQUIPMENT, including transmitter, recorders, color and b-w cameras and all other components; within the next six months. Reply Box 210 Broadcast Engineering." 6-68-2t

Employment

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

IMMEDIATE OPENINGS—Qualify for any of the following positions: Technicians for RCA Closed Circuit Television equipment, Camera Technicians Video Tape Technicians Video Technicians—TV Maintenance men Maintenance Supervisors—TV Systems Supervisers Video Engineers—TV Operations Managers—Sales Engineers. RCA Rep., 143-08 94th Ave., Jamaica, New York, or (212) 297-7344. 5-68-tf

THE GRASS VALLEY GROUP

is forming a SALES organization.

BROADCAST TELEVISION ENGINEERS

are needed for all areas.

Sales experience helpful but not essential.

GRAVCO SALES, INC.
6311 Yucca St.,
Los Angeles, California
Call or Write:
(213) 462-6618

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

ENGINEER-TEACHER-WRITER wanted for position in education department of accredited, nationally known, electronics correspondence school. Must be good in electronics theory and mathematics, and be able to write well. Degree required. Send personal letter of application to Mr. Don Grantham, Grantham School of Electronics, 1505 N. Western Ave., Hollywood, California 90027. 5-68-2t

Openings—1st phone engineers experienced in maintenance, audio, video tape. Send resume, Chief Engineer, WGBH-TV, 125 Western Avenue, Boston. 5-68-3t

Tired of the snow and slush? Medium-size CATV company needs technician with at least second class license; experienced in standard CATV equipment; also microwave; cameras, VTR, etc. Excellent location in southwest. Send full resume together with salary requirements and availability to Box 211 Broadcast Engineering. 6-68-1t

CATV DESIGN ENGINEERS

Leading CATV manufacturer has openings for RF circuit designers skilled in designing broadband, solid-state amplifiers, and other CATV active devices. Reply Box 213, Broadcast Engineering. 6-68-1t

ELECTRONICS - AUDIO

San Francisco State College. Repair & Maintenance. Must be familiar with broadcast type TV audio equipment. $676-$821. Ph. 415-469-1871. EQUAL OPPORTUNITY EMPLOYER. 6-68-1t

CCTV CHIEF ENGINEER

CCTV Chief Engineer required for Closed-Circuit Television operations. The successful candidate will be thoroughly grounded in Systems, Studio Design, and Distribution Systems. Duties will include the writing of specifications for equipment purchase and supervision of Technical Staff. Preference will be given to applicants with a degree in Engineering. Interested applicants please apply in person or writing to: Personnel Office, University of Alberta, 89 Avenue and 114 Street, Edmonton, Alberta, CANADA. 6-68-1t

GROUND FLOOR OPPORTUNITY. New system about to start in Southwest New England. Immediate openings for Chief Engineer and System Manager. Excellent growth for men with some experience. Rush resume including salary requirements to Box 212 Broadcast Engineering. 6-68-1t

TELEVISION PRODUCER-DIRECTOR

Exerienced Producer-Director to work with faculty members in production of television programs for broadcast as well as closed circuit. Capable of working with varied temperaments and interests and knowledgeable about educational principles. Capable of teaching course in television production. Masters degree preferred. Interested applicants please apply in person or by writing to: Personnel Office, University of Alberta, 89 Avenue and 114 Street, Edmonton, Alberta, CANADA. 6-68-1t

CATV FIELD ENGINEERS

Challenging opportunities to be the technical representative of of one of the leading CATV manufacturers. Position requires individuals with technical communications background and ability to "get the job done" with minimum supervision. Extensive travel required. Reply Box 214 Broadcast Engineering. 6-68-1t

Training

To advance in electronics, knowledge and ability are required. Grantham offers correspondence and resident instruction, in depth, leading to the degree of Associate in Science in Electronics Engineering. G.I. Bill approved. Credit for previous training and experience allowed. Free Catalog. Write: Dept. E-2, Grantham School of Electronics, 1505 N. Western Ave., Hollywood, California 90027. 6-67-tf

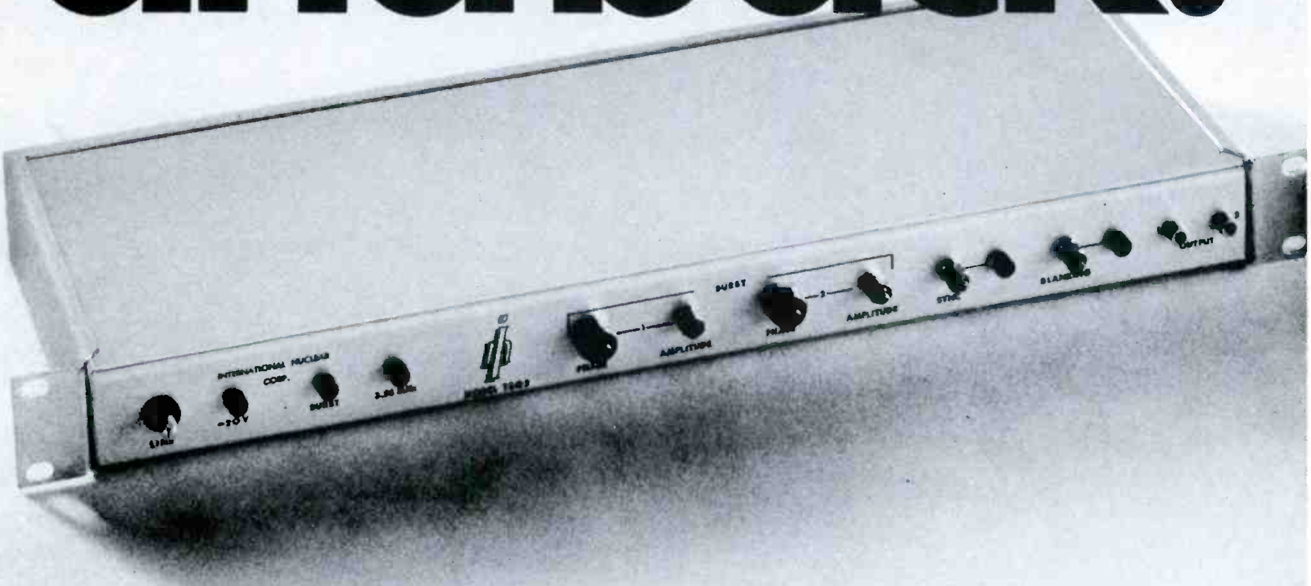
First phone through tape recorded lessons at home then one week personal instruction in Minneapolis, Atlanta, Washington, Detroit, Denver, Seattle, or Los Angeles. Sixteen years FCC license teaching experience. Proven results. 95% passing. Bob Johnson Radio License Preparation, 1060D Duncan, Manhattan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

Position Wanted

Hardworking chief Engineer available. Construction, maintenance, proofs, AM and FM stereo. No junk or dishonest stations need reply. Family man. Will consider maintenance engineering. Box 206, Broadcast Engineering. 5-68-2t

TV Development Engineer. Broadcast, CCTV, CATV and Film Systems, Cameras, Projectors, Color Transmitters and Receivers, Video Test Equipment. 25 years tube and solid-state experience. Wm. P. Kruse, SMPTE, 324 Tyrone, El Cajon, California. 92020. 6-68-1t

To Black and back.



International Nuclear's brand new TBG2 Black Burst Generator allows you to go to black and back with perfection.

The TBG2 has two outputs available for added versatility, and each have burst phase and burst amplitude adjustments so the two feeds can be matched under any condition.

The TBG2 has the industry's only continuously rotatable phase control, and it's accurate to within one degree. All the controls are on the front panel, and can be locked.

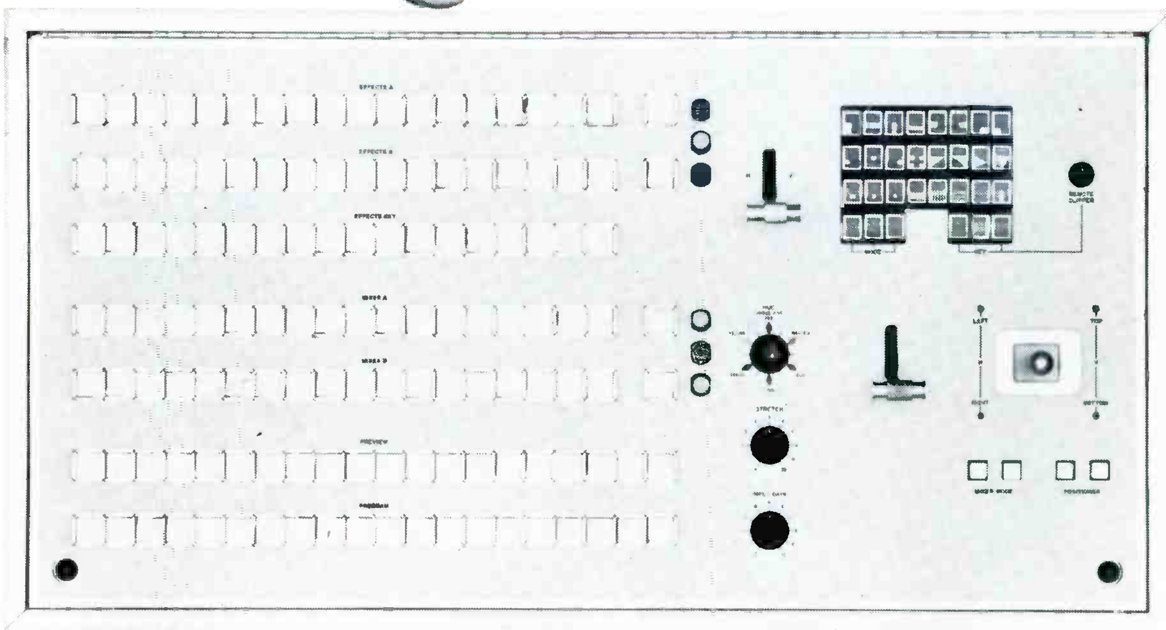
The TBG2 Black Burst Generator is small, compact and lightweight. So is the price, $475.00.

Write or wire or phone collect:
Ray Weiland, President
INTERNATIONAL NUCLEAR CORPORATION
608 Norris Avenue
Nashville, Tennessee
(615) 254-3365
"Transistorizing the Television Industry"

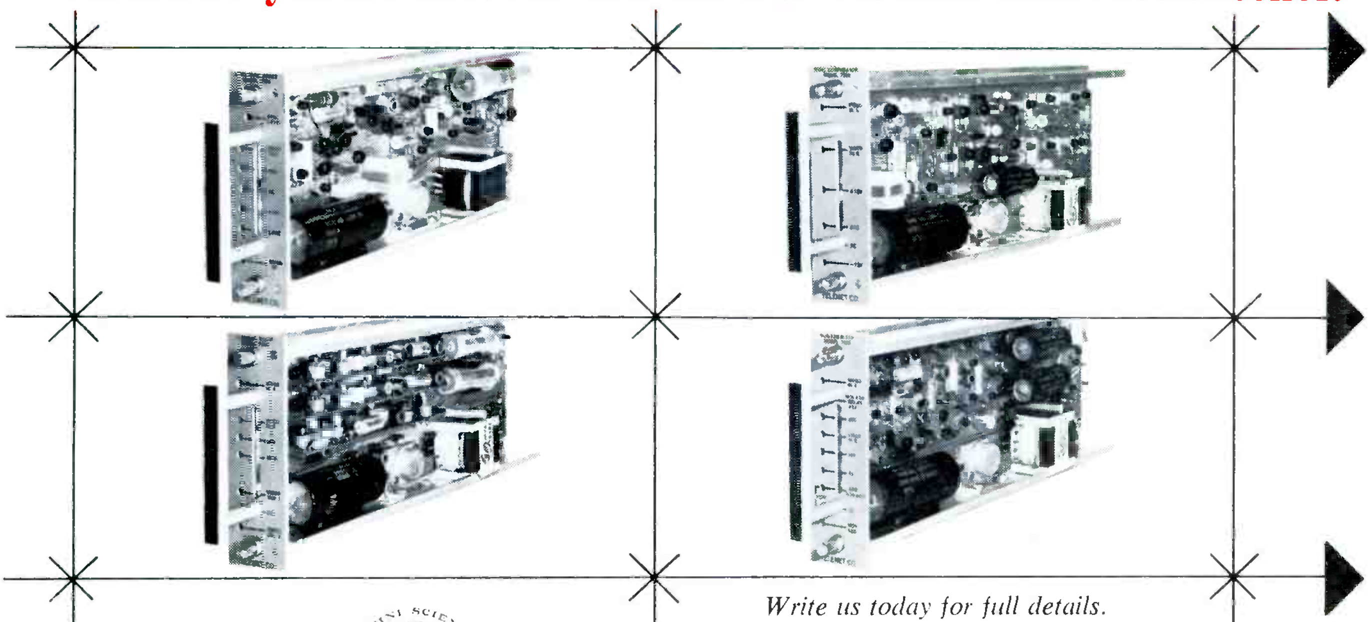
INTERNATIONAL NUCLEAR CORP.

Circle Item 37 on Tech Data Card

You'll want to put the finger on TELEMET.



We'll turn you on with our new SS-140 Vertical Interval Switcher.



Write us today for full details.

TELEMET COMPANY

185 DIXON AVENUE / AMITYVILLE, NEW YORK 11701 / PHONE: (516) 541-3600

Circle Item 38 on Tech Data Card