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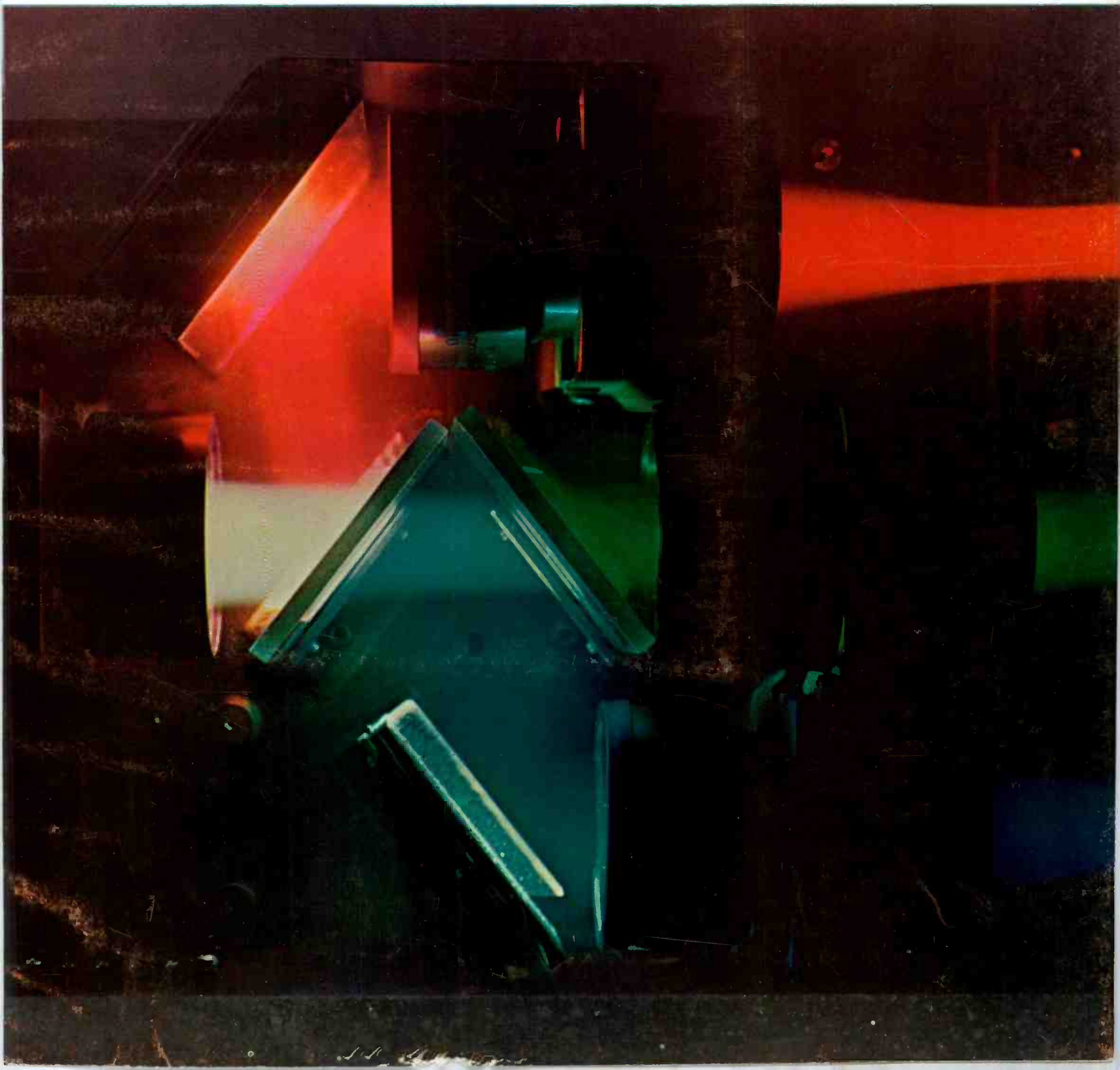

Broadcast Engineering

1968 NAB Convention Preview Supplement

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1968 NAB Annual Convention and

Broadcast Engineering Conference

Conrad Hilton Hotel, Chicago

March 31-April 3

Highlights of the

EQUIPMENT EXHIBITS

Conrad Hilton Hotel

March 31-April 3, 1968

The descriptions in this section are based on information received from the manufacturers up to press time.

A record number of broadcast-equipment manufacturers are scheduled to exhibit their products at the NAB 46th Annual Convention. Prior to the show, 126 manufacturers signed up to display the newest in radio-television equipment in six exhibit halls at the Conrad Hilton Hotel. The display will require approximately 54,000 square feet of exhibit space, 4000 square feet more than was used at last year's convention. The 54,000 square feet of space is the maximum footage available.

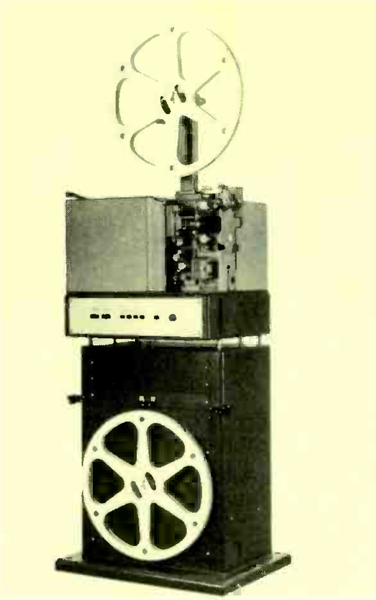
Exhibit space at the Convention will be located in the Continental Room, the East, North, and West exhibit halls, and two new areas—the Normandie Lounge and the Writing Room.

Addressograph Multigraph Corp.
(Booth No. 231)

The Models 85 and 2550 Multilith offset duplicators, the Model 2000 copier, and the Model 2100 book copier will be featured.

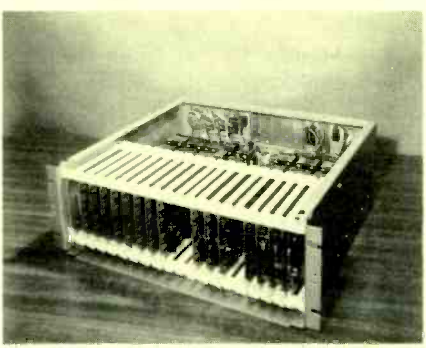
Advance Industries
(Booth No. 319)

A line of preassembled equipment buildings with from 64 to 160 square feet of floor space will be introduced. Available in either steel or aluminum, they are wired and forced-air ventilated; air-conditioning equipment is available. Also to be featured in this display are towers and reflectors.



Allied Impex Corp.
(Booth No. 421)

To be presented for the first time is the Model "Bauer 16/TV" 16-mm automatic telecine projector (pictured). Also to be featured are the Bauer 16-mm heavy-duty double-band projector and the Model "Bauer 16/16" with a xenon light source.



AMP Inc.
(Booth No. 308)

Demonstrations of a new automatic broadcast programmer will be the the highlight of this display. Consisting of a digital computer (Digital Equipment Corp. PDP-8) and an equipment package developed for broadcast programming, the system is capable of programming the following: (1) type and rate of audio and video transition into the scene, (2) scene duration in clock or elapsed time, (3) audio and video source, and (4) disposition of devices after termination of scene.

Also to be introduced, a new vertical-interval switcher uses plug-in relays and PC cards throughout (photo above). All electronics are rack-mounted and may be separated from the console by as much as 500 feet. By combining modules, the following functions are available: preset operation of a 24 x 2 video matrix, 24 x 2 audio matrix, a 6 x 2 video output unit, a "black" unit for inserting black between transitions, and a 24 x 1 mix row.

Equipment which has been introduced before, but is also to be featured, includes an audio output unit, AMP machine controls, and a transition-rate control unit.

Andrew Corp.
(Booth No. 220)

Making its debut is a new 8-inch flexible, air-dielectric coaxial cable. Usable at frequencies up to 600 MHz, its ratings for channel 35 include a loss of .15 dB per hundred feet and a power-handling capability of 70 kw (TV transmitter rating). On channel 4, the corresponding ratings are .042 dB and 223 kw, respectively. This cable is available in continuous lengths up to 1000 feet, and its corrugated conductors are designed to minimize thermal-expansion problems.

High-power coaxial switches, ETV microwave antenna systems, and flexible elliptical waveguides also will be featured.

Belar Electronics Laboratory, Inc.

(Booth No. 204)

The new SCM-1, SCA subcarrier frequency and modulation monitor, when used with the FMM-1 FM frequency and modulation monitor, provides monitoring and test functions for SCA and telemetering applications. Up to three crystal-controlled subcarrier frequencies may be selected by a switch. Two bandwidths (5kHz and 17 kHz) are provided, and a 50-kHz bandwidth is available. The deviation-meter range is ±2 kHz, and modulation-meter accuracy is better than 5%.

Also to be introduced are the AMF-1 AM frequency monitor, AMM-1 companion modulation monitor, RFA-1 and -2 FM and AM RF amplifiers, remote-meter panels for the complete line of monitoring equipment, and a new SCA receiver.

Other models on display will be the FMM-1 frequency and modulation monitor for FM, FMS-1 stereo monitor, FMD-1 broadband FM detector, and the FMD-1TV broad-band FM detector for TV channels.

Monitoring-equipment demonstrations will be conducted in the booth.

Berkey-ColorTran, Inc.

(Booth No. 121)

A complete new line of quartz lighting equipment designed specifically for television-studio use will be featured. Also, the following equipment will be incorporated in a complete overhead-grid lighting display: LQF10-50 Super-Beam 1000, LQV-10 Vari-Beam 1000, LQTB-10 Tru-Broad, LQCS-15 (15-inch) and LQCS-18 (18-inch) fixed-focus scoops, LQCS-15F (15-inch) and LQCS-18F (18-inch) variable focus scoops, LQC10-1/A one-light high-intensity Cyc-Strip, CD12-120B 12-kw dimmer, and the ColorTran portable dimming system with control console.

Broadcast Electronics, Inc.

(Visual Electronics Booth)

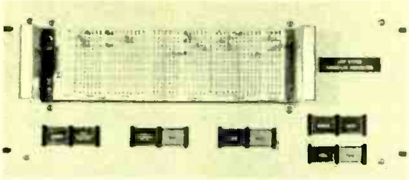
The new 4-channel remote amplifier, Model RA-4CB, will be given a premiere showing by Broadcast Electronics. Operating from 115-volt AC or a self-contained battery, it has automatic switchover in case of power-line failure. The transformer-coupled inputs are 50/150/250 ohms, balanced or unbalanced; output is +4 dBm, switchable to 0 dBm across 600/150 ohms, balanced. Two equalized turntable inputs, a high-level input, and a tone generator for line testing are included. Specifications include gain of 83 dB, and noise 60 dB below +4 dBm.

Other items to be featured include the *Spotmaster* series of tape-cartridge recording and playback equipment, the Model 500B-DL delay unit, TP-1B tape winder, TT-20B turntable preamplifier, the BE-101 and -102 remote-control units, the AD1A audio distribution amplifier, the RA-4CA remote amplifier, and the PortaPak I portable cartridge playback machine.

CBS Laboratories, Div. of CBS, Inc.

(Booth No. 307)

New products to be displayed at the NAB Convention had not been selected at press time; however, a number of previously introduced items of equipment will be shown. Among them are: digital display and control units, Audimax automatic level control, Volumax and FM Volumax automatic peak controllers, loudness controller, Model 600 wide-range program monitor, loudness indicator, image enhancer, and masking amplifier. A mobile color-TV system display will be presented in the exhibit.

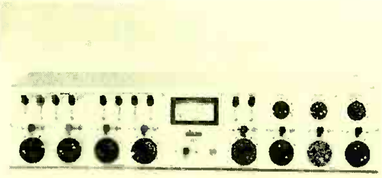


Chrono-Log Corp.
(Booth No. 246)

A new solid-state Step system, using a pin-board memory (see photo), for automated TV station-break switching will be introduced.

Continental Electronics Mfg. Co.
(Booth No. 200)

This display will feature the Type 317C 50-kw AM transmitter. A filmstrip presentation of the proof of performance of this transmitter, showing its overall efficiency, will be a part of the exhibit.



Disan Engineering Corp.
(Booth No. 423)

Making its initial appearance at the Convention, the Disan line includes a cartridge playback and a record/playback machine, Models 600 and 600A (available for rack or table mounting), and a delay programmer cartridge machine, Model 610. The 400 series has eight models of automated programming equipment ranging from the Model 400, with capability for 8 hours of programmed music and 31 spots, to the top-of-the-line Model 440 with two music decks, a 40- to 60-cartridge handler, automatic fader, talking clock, and facilities for demand time and spots.

Also to be introduced are the RFA-8, an RF amplifier (88 to 108 MHz), REM-2 remote amplifier, SSR-12 solid-state regulated power supply, PA2B equalized turntable preamplifier, Model 650 background-music tape-cartridge machine, and the RCM-10-11, a 23-position transmitter remote-control system with twenty metering positions.

Rounding out the display are three models of solid-state audio consoles (two, four, and [in photo] eight channels) which are available for mono or stereo; a monitor amplifier; and a portable, professional studio consisting of a four-channel console, two turntables, and the equipment table.

Fairchild Recording Equipment Co.
(Booth No. 314)

New items to be featured by Fairchild are the FICM integrated control module, SWL fader, multichannel pan pot, Model 1001 gain-shift intercom system, and the Integra II remote-control console. The FICM (illustrated) is a completely packaged, plug-in microphone channel for single-unit or "building-block" applications. Operating from 24 volts at 120 ma, it has input and output amplifiers, input fader, echo feed control, compression control, full-spectrum equalizers, output channel selector, and metering. The integra II console uses plug-in circuit cards to achieve design flexibility, and all audio components are located in the equipment rack. Thus, no audio signals are present in the control console.

Other equipment to be featured, although introduced previously, includes Reverbertron reverberation systems, monitor amplifiers, the 692 series of plug-in remote-control audio cards, and the 600/602 Conax. Live demonstrations of various consoles and reverberation systems are planned.

Gates Radio Co.
(Booth No. 221)

New equipment to be introduced at the show includes the TV-15 audio control console and the TVS-6 add-on submixer. The TV-15 is capable of mixing 15 signals from as many as 60 sources and provides completely independent audition-line and program outputs. Each TVS-6 adds six mixing channels to the TV-15. Another new item, the M-6543 solid-state limiter, also will be introduced.

A highlight of this display will be a completely automated 1-kw AM radio station demonstrating four program formats in addition to automatic programming and transmitter logging. Transmitting equipment to be featured will be the VP-50, 50-kw vapor-cooled AM transmitter; BC-5H, 5-kw AM transmitter; BC-1G and Vanguard II 1-kw AM transmitters; TE-1, FM exciter; and the FM-1H, -5H, -10H, and -20H FM transmitters. Audio consoles to be displayed are the Dualux II, Gatesway II, Stereo Statesman, Executive, Diplomat, President, Ambassador, and Producer. In addition, three automation systems will be shown.

Gotham Audio Corp.
(Booth No. 226)

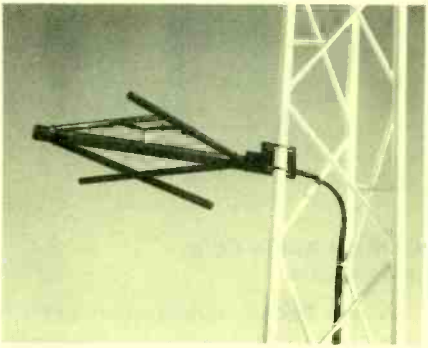
A new line of transistorized (FET) condenser microphones by Neumann is to be introduced. Labeled the "FET 80" Series, the line includes the KM-83 omnidirectional, KM-84 and -85 cardioids, KM-86 with three switchable patterns, and the U-87 (pictured here) which is the FET-80 Series counterpart of the U-67.

The Studer A-62 solid-state tape recorder, featuring modular construction with plug-in equalizer and heads, is another new product to be displayed. Using ¼" tape, this machine is available in mono and two-track models.

Among the previously introduced products to be featured are a stereo microphone system, a studio turntable system, monitor speakers, an FM tuner, an FM-multiplex stereo fault alarm, a polarity tester, a tape splicer, a tape timer, a pitch and tempo regulator, stereo headphones, input transformers, and linear-motion attenuators.

Gray Research and Development Div.
(Booth No. 414A)

The new Models 303 and 306 Micro-Trak stereo tone arms will make their debut at the show. In connection with demonstrations of the Model 303, Gray Research will distribute game calls with the theme "Micro-Trak can fool even the original." The Models 206 and 208 tone arms and the 602C equalizer also will be featured.



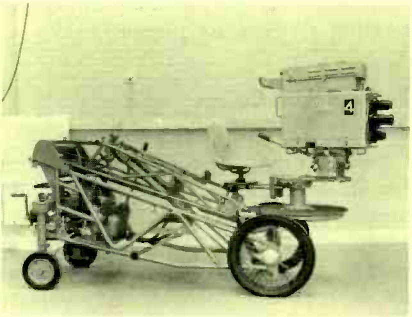
Jampro Antenna Co.
(Booth No. 305)

Featured as a new concept in circularly polarized FM antennas, a new Jampro antenna (above) features digital tuning caps for trimming VSWR to 1.08:1. The antenna is available for shunt feeding from a single 3⅛-inch line, or it may be fed through a divider and individual element cables. The ratio of horizontally polarized energy to vertically polarized energy may be factory adjusted from 100% horizontal polarization to a 50/50 ratio.

Other items to be featured are batwing TV antennas, UHF and high-channel VHF zig-zag antennas, and the complete Jampro FM-antenna line. The availability of complete outdoor packages (antenna, tower, transmission line, and installation service) is to be announced.

Lenkurt Electric Co., Inc.
(Booth No. 402)

Two microwave-radio systems designed for long-haul video networks are to be shown. The Type 75A heterodyne-repeater system operates in the 5925- to 6425-MHz range, is of all-solid-state construction except for the traveling-wave amplifier tube, and accommodates 960 voice channels or color TV. Using solid-state circuitry and klystrons, the Type 76 is designed for service on the broadcast, common carrier, industrial, and government bands. This equipment also is designed for color transmission capability.



Listec Television Equipment Corp.
(Booth 427)

A new camera crane, manufactured by W. Vinten, Ltd. and designated the Falcon Type 526 (above), features hydraulic elevation control and counterbalancing without the use of added weights. It is demountable into four components, is self-powered, and has compensated steering for close maneuvering. Camera-platform height is 2'11" to 8'4" with the standard platform. An alternate platform is available to reduce the height to 1'3". The

Type 556 gas pedestal and the Mark III camera head will also be featured products from Vinten.

Also to be premiered is the Hokushin Type TC-510D 16-mm TV projector. Designed for automatic operation, it has the following features and specifications: reverse run at full speed, predetermined stop, automatic restoration of film loop, automatic replacement of exciter lamps, remote control, level matching for optical and magnetic sound reproduction, quiet operation, built-in tone test for sound system, application time of approximately 50%, film pull-down time of less than .01 second, and a starting time of less than 1 second for picture and sound.

BICC TV-camera cable will be included in the exhibit.

Marconi Instruments
(Booth No. 228)

Three new test instruments which have been added to the line will be introduced at the NAB show. Model T2905/1 generates a sine^2 pulse, a bar waveform with adjustable duration from 12 to 43 usec, and a staircase waveform. From 5 to 10 stairsteps having adjustable durations of 2.3 to 5 usec are available, or the instrument may be modified to generate a sawtooth waveform. The unit generates an internal trigger, or it may be triggered from an external source through the use of the TR2908 blanking and sync mixer, which also is being premiered.

The Model TF2904/1 is used to measure inequalities in gain and delay between the chrominance and luminance channels. Gain measurements within the range of +3 dB to −3 dB and delay measurements up to 110 nsec leading or lagging are possible. 525-line NTSC or PAL systems may be tested with this unit.

The TF2360 TV sideband analyzer, TF1099 video sweep generator, and TM6936 UHF adapter, also to be featured, have been introduced previously.

Marti Electronics
(Booth No. 237)

New additions to the line which will be introduced at the show are the RMC-2AX remote-control and telemetry system for AM and FM transmitters; solid-state RPU and STL receivers; the Model MR-50/150-450 solid-state, mobile communications receiver; and a solid-state RPU transmitter for 150- or 450-MHz operation. Also to be featured at the show are RPU and STL transmitters, an SCA-subcarrier generator, and audio amplifiers and preamplifiers.

McCurdy Radio Industries, Inc.
(Booth No. 309)

McCurdy will present the new Model SS4724A television audio-production console, the new Model SS4475 television audio console, and a new TV intercom system using modular construction. Also to be featured are their monitor amplifiers, preamplifiers, equalizers, and power supplies.

Memorex Corp.
(Booth No. 312)

Available in standard configurations for all helical-scan recorders, the 79 Series of video tape is to be introduced at the Memorex booth. Three different demonstrations of Memorex products are slated for the show: (1). A "live" feed from a video recorder in a second booth is designed to show the quality of Series 78V tape. (2). At announced times each day, the heads of the video recorder being used will be measured for wear. (3). A short technical presentation on tape-testing procedures will be presented by a Memorex engineer.

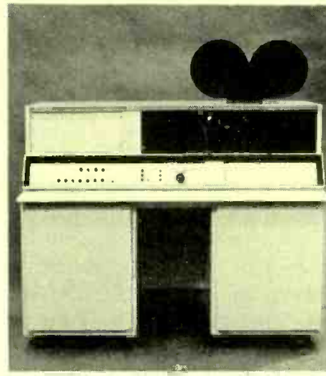
Microwave Associates, Inc.
(Booth No. 115)

A live demonstration of microwave STL and TV pickup of color and monochrome TV and sound channels will be a highlight of the display. Three new models of microwave equipment for auxiliary broadcast, STL, intercity, and TV pickup are the Models MA2B, MA7B, and MA13B, operating at 2, 7, and 13 GHz, respectively (typical unit illustrated above). Hot-standby switchers for dual, solid-state STL equipment complete this category of equipment.

Two other new items to be shown are an 18-pound TV relay transmitter for use in helicopters, and a color-TV back-pack link to be used at the forthcoming political conventions.

D. B. Milliken Co., A Teledyne Co.
(Booth No. 405)

Incorporating the Model DBM-6A video film-recording camera which has been introduced previously, the new Model DBM-R1 video film-recording system will be displayed. It uses an optically flat-faced, high-resolution CRT to minimize edge-resolution problems and pincushion distortion. The film transport is air driven, and the film is positioned during the vertical-blanking interval.



3M Co., Magnetic Products and Mincom Divisions
(Booth Nos. 247, 248)

Featured SCOTCH Brand products from the Magnetic Products Div. are No. 399 video tape and professional audio-range tapes, plus an improved shipping case for video tape.

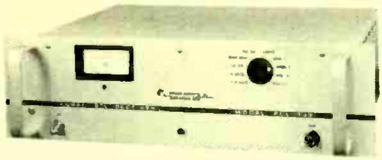
In the same booth, the Mincom Div. will show several products. Three new items to be displayed carry the 3M Brand name. These are the EBR-100 electron-beam television film recorder, a color encoder, and a dropout counter. Two other 3M Brand products to be featured are a dropout compensator and a professional audio recorder.

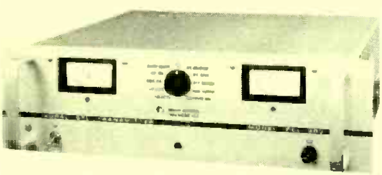
Moseley Associates, Inc.
(Booth No. 223)

The fully solid-state PCL-303B/C composite aural STL (photo), capable of transmitting stereo over a single link, will make its debut. Using direct FM, the system also accepts subcarrier remote-control systems.

The new all-solid-state PCL-202 aural STL for foreign use (300 to 470 MHz) also will be introduced.

Also being featured are the ADP-101 digital automatic transmitter log-

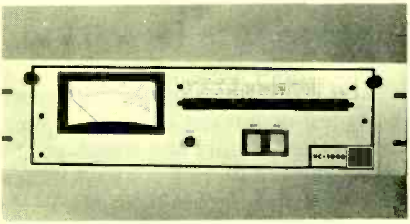




ger, the PCL-303 aural STL, and the PBR-21 and WRC-10T solid-state remote control systems.

Q-Tv Sales and Distributing Corp.
(Booth No. 118)

To be displayed are the "Q" prompter systems (standard and cartridge models), "Q" dispatcher system for horizontal or vertical operation, and ⅝" and ¾" "Q" Videotypers.



Rust Corp. of America
(Booth No. 251)

The Model RC-1000 remote-control system (in photo), a new, 10-position, push-button system using a single DC pair, will be demonstrated. Features include solid-state circuitry, "automatic synchronization," push-button position selection, isolation of metering samplers from telephone lines, and a frequency-shift-carrier control system.

Another new product, the AL-400 Autolog, is a solid-state continuous-line charting system designed to log transmitter parameters automatically for over two months without adjustment.

Also being shown will be the Model RC-2400 remote-control system, the AL-100 and AL-100R automatic transmitter logging systems, a new 14C-3 AM RF preamplifier, and new versions of the 15C-3 FM RF preamplifier and the "RMS" video/audio random switcher. The latter item of equipment is scheduled to be in operation in both the Rust and Visual Electronics booths.

Seeburg Music Library, Inc.
(Booth No. 215)

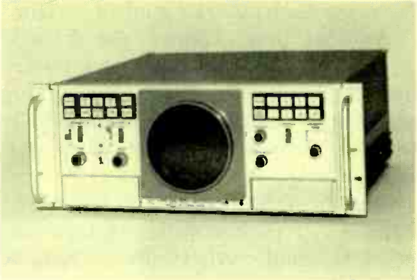
Featured equipment will be the Model SABMC-1 automatic background-music center and the BMC-1 and BMS-2 on-premises record players.

Tape-Athon Corp.
(Booth No. 239)

The Model 900 logger is to be introduced. Also, the Model 5000 dual automated-broadcast system, the Model 900 professional recorder/reproducer, and the Programmer III background-music studio system will be shown.

Tektronix, Inc.
(Booth No. 111)

The Type 520 NTSC vectorscope (in illustration) will be shown for the first time at the NAB show. Designed to measure luminance, hue, and saturation of the NTSC color signal, it



has push-button controls for operating convenience and rapid selection of displays. 0 to 360° phase shifters provide independent phase control of channels A and B, allowing phase shifts caused by unequal signal paths to be cancelled. The phase shifter has a dial resolution of 1° per inch with a range of 30°, and the instrument is designed to permit differential gain and phase measurements accurate within 1% and 0.2°, respectively. A Type 520 PAL vectorscope will be shown as well.

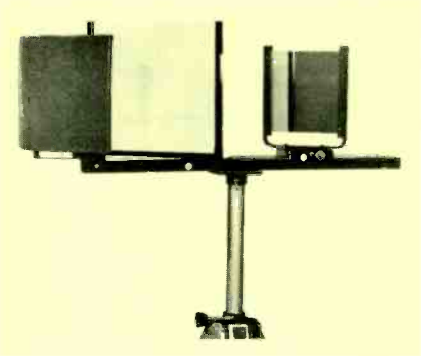
Also to be featured is the Type 529 television monitor designed for observation of sine² pulses, bars, stair-step, and other waveforms. The Type 453 MOD 127C 50-MHz, dual-trace portable oscilloscope will be included in the display.

Telequip Corp.
(Booth No. 244)

New studio lighting equipment and color test-pattern equipment are to be unveiled at the NAB show. Television mounting equipment, video switchers, and special-effects equipment also will be featured.

Telesync Corp.
(Booth No. 218)

Two models of front-projection systems will be shown. The Basic Studio I (mirrors shown below) has a fully adjustable, lightweight aluminum tri-



pod, 18-inch beam-splitter mirror, light-absorbing box, and 16-mm conversion mirrors.

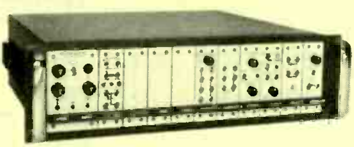
The Studio 90 uses a pneumatically supported, adjustable pedestal, and the projector has capacity for 15 slides. With the front-projection assembly attached, pan and tilt capabilities of 40° and 15°, respectively, are available. With the assembly removed, these angles are increased to 180° and 40°. Total power consumption is 1200 watts (2 projectors).

Prompting equipment and the horizontal-vertical color-effects crawl also will be shown.

Television Zoomar Co.
(Booth No. 105)

Several new items will be introduced. In the test-equipment category, a modulation-transfer-function machine for testing resolution and contrast of lenses, and a manufacturer's model of the *TV Colorgard* Mark II for monitor color-temperature adjustments are to be announced. Studio equipment includes a pan and tilt head with velocity control and joy-stick operation. TVP pneumatic pedestals, H.T.S. HOB pedestal, H.T.S. caption scanner, and the H.T.S. mark II cam head for RCA Model TK-40, -41, -42, and 43 color cameras.

The caption scanner consists of four stages, or frames, each providing a 10" x 12" display area. These are mounted on a ball-bearing pivot and have supporting rollers running on a circular track. A flip-card attachment and a crawl-title unit are available as optional equipment.



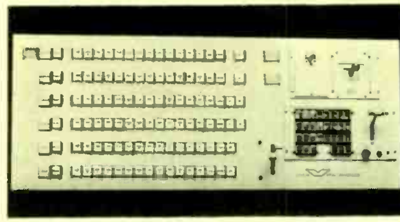
Videometrics, Inc.
(Booth No. 415)

A new line of video test-signal generating equipment is available in two packaging configurations: a modular package accommodates all of the generators, or each generator is available in a separate package. The complete package (in photo) with space for expansion, requires 5¼" of rack space. The individually packaged units are 1¾" by 19".

Generators in the line include the Polyburst, which generates a total of 12 bursts from .5 to 10 MHz over two horizontal lines. A modulated 20T pulse is used for measurement of luminance/chrominance gain ratios and delay in color circuits. The linearity generator produces stair-step and ramp signals, and there is a sine^2-pulse and window generator.

Vital Industries
(Booth No. 202)

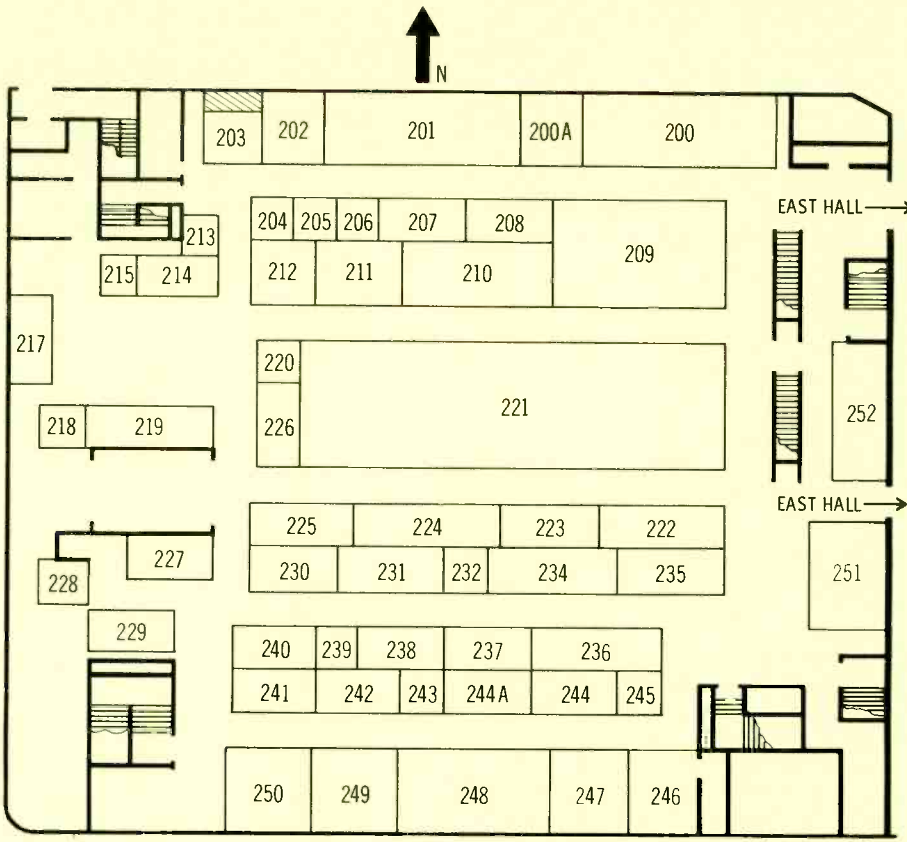
Silicon solid-state devices and IC's are used extensively in the Model VIX-108 vertical-interval video switcher (illustrated here) which is being introduced. The unit has capacity for 18 inputs and 6 outputs in 5¼" of rack space. Switching is accomplished in



0.1 usec during the vertical interval (adjustable from line 6 to line 20), although random switching (also in 0.1 usec) is possible. Some specifications are: crosstalk, −60 dB; differential gain, less than 0.1 dB; differential phase, below 0.2°; signal-to-noise ratio, 65 dB; gain adjustment range ±3 dB; and gain stability, better than 1% per month.

The Model VI-1000 video processing amplifier, also to be premiered, uses IC's extensively. Requiring 3½" of rack space, it has the following listed functions and features: complete blanking and sync regeneration, including all vertical-interval pulses, or gated sync; internally generated sync is provided; accepts original color burst, reinserted color burst, or burst from internal phase-locked oscillator; automatic color/mono switching; VIT signals are allowed to be passed or deleted. Auto/manual chroma-level correction and video-level control is provided; regenerated pulses have adjustable width; white and black clip and sync level are adjustable; and white and black stretch are independently adjustable. Composite sync, composite blanking, vertical drive, horizontal drive, and front-porch switching pulses are available as outputs.

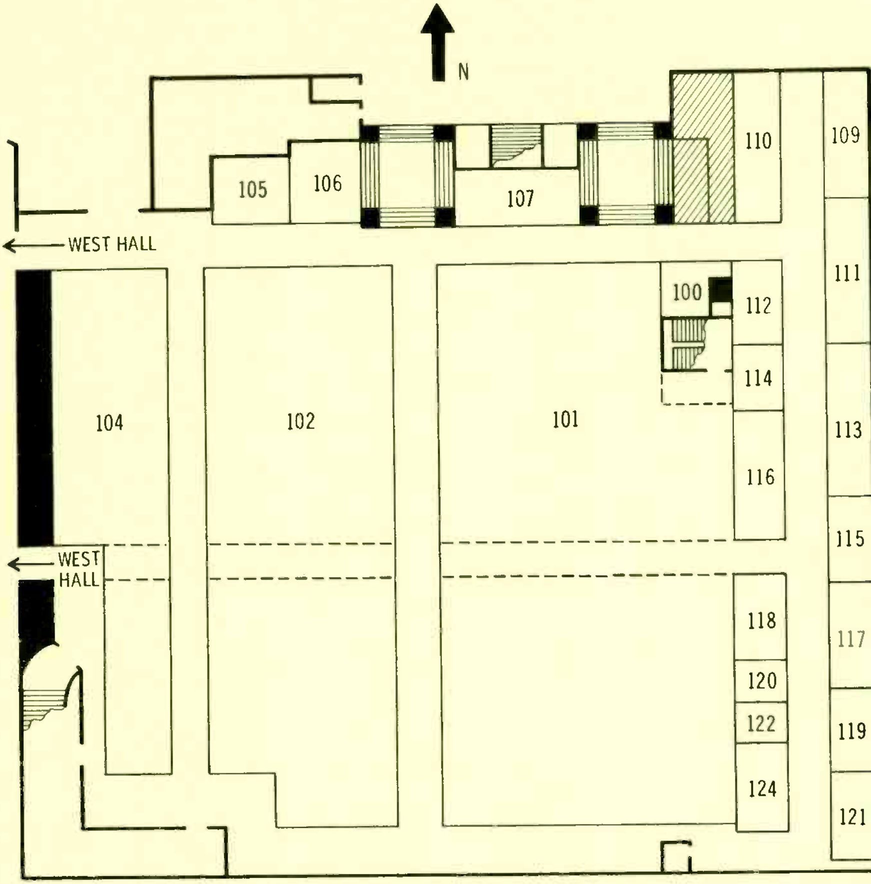
Switching equipment and the color-processing amplifier will be the subject of special demonstrations. The VI-500 video-stabilizing amplifier and VI-10 and -20 video and pulse-distribution amplifiers also will be on display. ▲



WEST HALL

Conrad Hilton

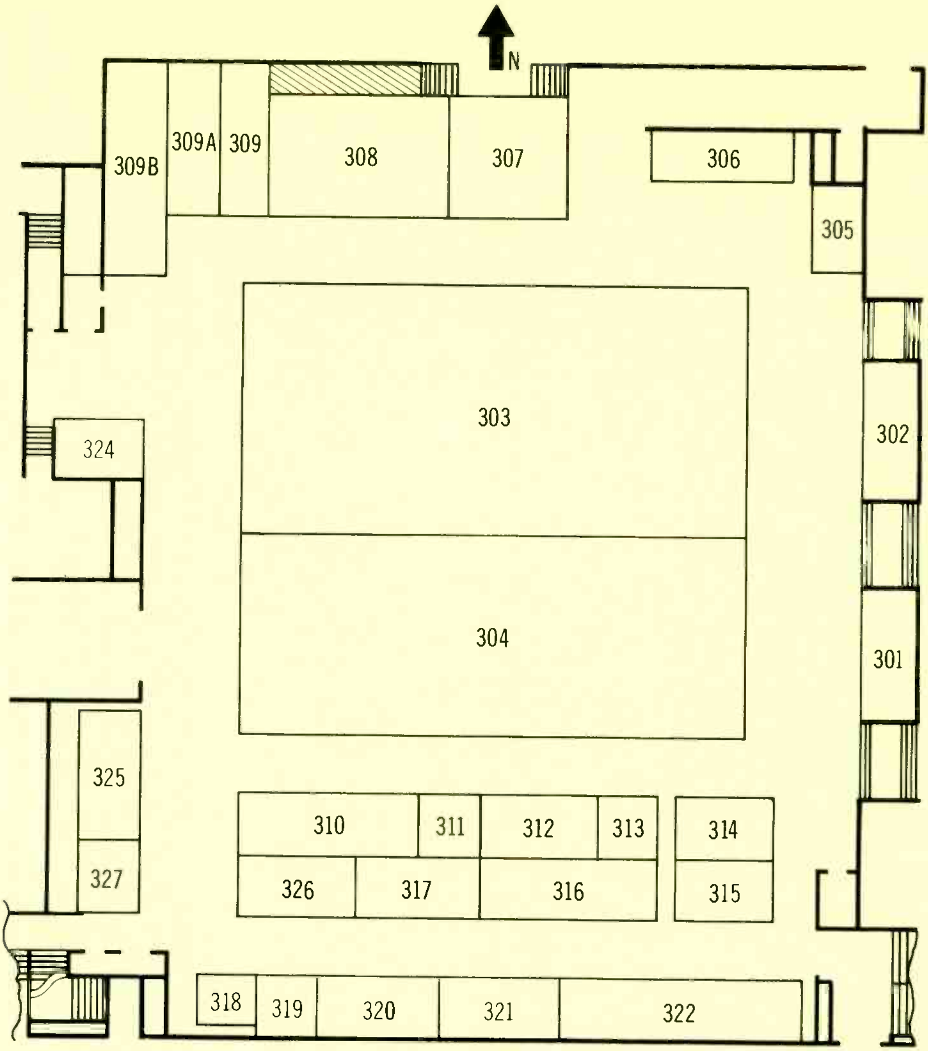
(Booths 200 through 252)



EAST HALL

Conrad Hilton

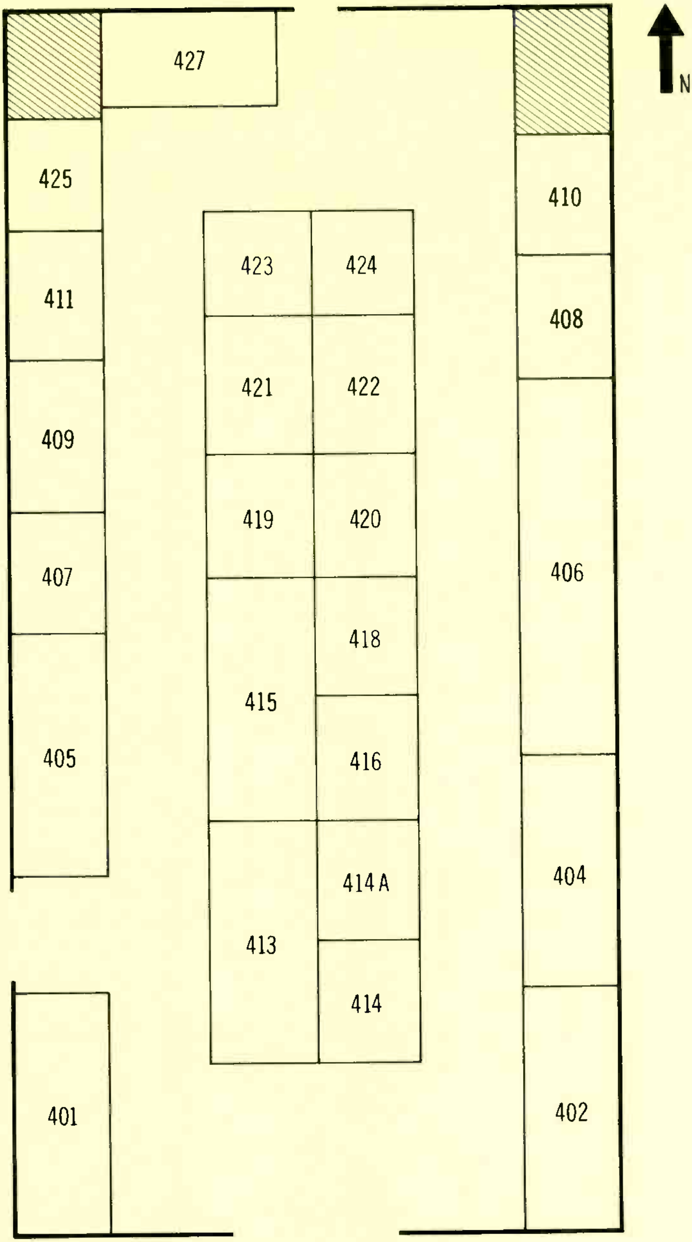
(Booths 100 through 124)



CONTINENTAL ROOM

Conrad Hilton

(Booths 301 through 327)



NORTH HALL

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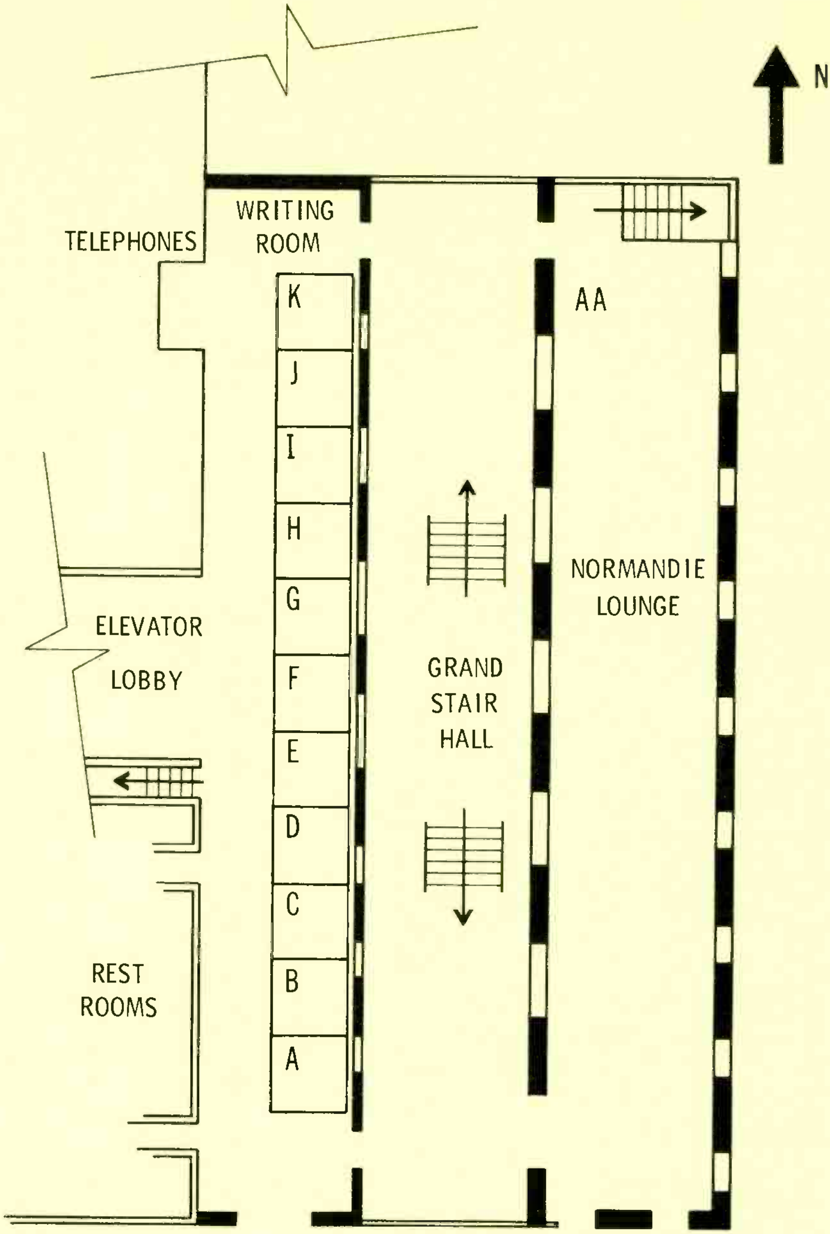

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NAB Convention

Conrad Hilton Hotel, Chicago
March 31-April 3, 1968

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Boulder, Colorado 80302
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Broadcast Electronics, Inc.
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Silver Spring, Maryland 20910
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(Booth No. 307)

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(Booth No. 236)

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(Booth No. 413)

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Twinsburg, Ohio 44087
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(Booth No. 200)

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Dallas, Texas 75220
(Booth No. 419)

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(Booth No. 314)

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Milford, Connecticut 06460
(Booth No. 124)

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P. O. Box 8597—5201 Bridge Street
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(Booth No. 315)

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Santa Monica, California 90404
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New York, New York 10036
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Grass Valley Group, Inc.
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Gray Research & Development Co. Div.
150 Park Avenue
East Hartford, Connecticut 06108
(Booth No. 414A)

Harwald Co.
1245 Chicago Avenue
Evanston, Illinois 60202
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Hewlett-Packard Co.
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Los Angeles, California 90064
(Booth No. 116)

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(Booth No. 217)

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Bellingham, Washington 98225
(Booth No. 224)

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6939 Power Inn Road
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Philadelphia, Pennsylvania 19105
(Booth No. 322)

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(Booth No. 321)

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(Booth No. 416)

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(Booth No. 100)

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1105 County Road
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(Booth No. 402)

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Plainview, New York 11803
(Booth No. 427)

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709 Railroad Avenue
West Des Moines, Iowa 50265
(Booth No. 212)

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111 Cedar Lane
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(Booth No. 228)

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Cleburne, Texas 76031
(Booth No. 237)

McCurdy Radio Industries, Inc.
57 North Putnam Street
Danvers, Massachusetts 01923
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Omaha, Nebraska 68131
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1180 Shulman Avenue
Santa Clara, California 95052
(Booth No. 312)

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Arcadia, California 91006
(Booth No. 405)

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(Booth No. 223)

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New York, New York 10017
(Booth No. 325)

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8101 Tenth Avenue North
Minneapolis, Minnesota 55427
(Booth No. 238)

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Oceanside, New Yòrk 11572
(Booth No. 203)

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649 Lawrence Drive
Newbury Park, California 91320
(Booth No. 240)

Philips Broadcast Equipment Corp.
299 Route 17
Paramus, New Jersey 07652
(Booth No. 304)

Power Optics, Inc.
Township Line and Jolly Roads
Plymouth Meeting, Pennsylvania 19462
(Booth No. 114)

Q-Tv Sales & Distributing Corp.
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New York, New York 10018
(Booth No. 118)

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8121 Central Park Avenue
Skokie, Illinois 60078
(Booth No. 242)

Radio Corp. of America, Broadcast & Communications Products Div.
Building 15-5
Camden, New Jersey 08102
(Booth No. 101)

Radio Corp. of America, Electronic Components & Devices
Harrison, New Jersey 07029
(Booth No. 117)

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1415 Boston-Prov. Turnpike
Norwood, Massachusetts 02062
(Booth No. 106)

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Bloomington, Indiana 47401
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2231 Barrington Avenue
Los Angeles, California 90064
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(Booth No. 210)

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(Booth No. 215)

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Woodside, New York 11377
(Booth No. 244A)

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222 Hartrey Avenue
Evanston, Illinois 60204
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Industrial Products Div.
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Sparta Electronic Corp.
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Sacramento, California 95828
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Glendale, California 91201
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Freehold, New Jersey 07728
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Salt Lake City, Utah 84115
(Booths D, E)

Telemet Co.
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(Booth No. 249)

TelePro Industries, Inc.
Cherry Hill Industrial Center
Cherry Hill, New Jersey 08034
(Booth No. 414)

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Glen Cove, L.I., New York 11542
(Booth No. 244)

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20 Insley Street
Demarest, New Jersey 07627
(Booth No. 218)

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5529 Redfield Street
Dallas, Texas 75235
(Booth No. 407)

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P. O. Box 215
Feeding Hills, Massachusetts 01030
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New York, New York 10013
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Palo Alto, California 94303
(Booth No. 406)

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33 Cain Drive
Plainview, New York 11803
(Booth No. 415)

Vikoa, Inc
400 9th Street
Hoboken, New Jersey 07030
(Booth No. 316)

Visual Electronics Corp.
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New York, New York 10018
(Booth Nos. 301, 302, 303)

Vital Industries, Inc.
3614 S. W. Archer Road
Gainesville, Florida 32601
(Booth No. 202)

Ward Electronic Industries
142 Central Avenue
Clark, New Jersey 07066
(Booth No. 201)

Westbury CATV Corp.
212 South Fulton Avenue
Mount Vernon, New York 10550
(Booth No. 309A)

Wilkinson Electronics, Inc.
1937 West MacDade Boulevard
Woodlyn, Pennsylvania 19094
(Booth No. 200A)

News About the NAB

FCC Chairman To Address Convention

Chairman Rosel H. Hyde of the Federal Communications Commission will address the NAB Convention at the management luncheon on Tuesday, April 2. Mr. Hyde's acceptance of the invitation to address the meeting was announced by NAB President Vincent T. Wasilewski. Mr. Wasilewski will make his traditional Convention keynote address at the opening management luncheon on Monday, April 1.

Recipient of Distinguished Service Award Named

Lowell Thomas, internationally known news commentator, has been chosen to receive the 1968 NAB Distinguished Service Award. The Award, in recognition of Mr. Thomas' contributions to the broadcasting industry, will be presented at the opening General Assembly of the NAB 46th Annual Convention on Monday, April 1. Past recipients include the late President Herbert Hoover, comedian Bob Hope, and top station, network, and industry leaders.

Mr. Thomas has reached many millions through radio, television, motion pictures, newspapers, and lectures. He broadcast his first radio news commentary in 1930. For more than seventeen years, his was the voice of Movietone News and of thousands of single-reel films. In addition to his early success in radio, Mr. Thomas also was a pioneer television news commentator. When television films came into use, he produced his "High Adventure" series, which has been seen in several countries.

He began his journalism career in a Colorado mining camp, where he was editor of two daily papers. Later, while studying and lecturing at three colleges, he continued as a full-time reporter. Mr. Thomas has traveled extensively during his years as a correspondent in both World Wars and while gathering material for his many adventure films.

A native of Woodington, Ohio, he has received degrees from the University of Northern Indiana, the University of Denver, and Princeton, where he also was a faculty member.

Established in 1953, the NAB Distinguished Service Award is presented to individuals who make "a significant and lasting contribution to the American system of broadcasting by virtue of singular achievement or continuing service for or in behalf of the industry in any or all phases."

Previous recipients are: Chet Huntley and David Brinkley (1967); Sol Taishoff (1966); Leonard H. Goldenson (1965); Donald

H. McGannon (1964); Bob Hope (1963); Edward R. Murrow (1962); Justin Miller (1961); Clair R. McCollough (1960); Robert W. Sarnoff (1959); Frank Stanton (1958); Herbert Hoover (1957); Robert E. Kintner (1956); Mark Ethridge (1955); William S. Paley (1954); and David Sarnoff (1953).

To Receive Engineering Achievement Award

Howard A. Chinn, director of general engineering for the CBS Television Network Engineering and Development Department, has been chosen to receive the annual NAB Engineering Achievement Award.

Mr. Chinn, a 36-year broadcast veteran, was selected for his leadership in helping to develop the new NAB Standard Loudness Reference Recording. An expert on audio volume levels, Mr. Chinn is a co-inventor of the standard volume indicator and has co-pioneered psychoacoustic studies to determine broadcast listeners' frequency-range and volume-level preference.

Mr. Chinn joined CBS in 1932, and, except for his World War II association with the Radio Research Laboratory and the U.S. Office of Scientific Research and Development, he has been employed by the network in an engineering capacity. When CBS decided to enter commercial television, its studios were designed and installed under Mr. Chinn's direction.

He received BS and MS degrees from the Massachusetts Institute of Technology and has lectured in electrical engineering at the New York University graduate school.

For his wartime activities, Mr. Chinn received the Presidential Certificate of Merit, the second highest award available to civilians.

The NAB award will be presented by George W. Bartlett, NAB vice-president for engineering, on Wednesday, April 3, at the final luncheon of the 1968 Broadcast Engineering Conference in Chicago.

Association Secretary-Treasurer Re-Elected

The NAB Board of Directors has unanimously re-elected Everett E. Revercomb to his 13th consecutive one-year term as the Association's secretary-treasurer. The election is required annually by the NAB by-laws.

Advanced Seminar Slated

The NAB Board of Directors has approved the holding of an Advanced Engineering/Management Development Seminar at Purdue University, West Lafayette, Ind., next fall. NAB previously has held three Engineering/Management Development Seminars designed to encourage and aid individual broadcast engineers in developing further their working philosophy of management. The advanced seminar next fall will be limited to those who participated in one of the last three seminars, and would continue the basic program at an advanced level.

Future Convention Dates and Sites

The NAB Board of Directors has approved the holding of the 1972 Annual Convention April 9-12 in

Chicago, and the 1973 Convention March 25-28 in Washington, D.C. Dates and sites of earlier Conventions previously approved by the Board are: 1968, March 31-April 3, Chicago; 1969, March 23-26, Washington; 1970, April 5-8, Chicago; and 1971, March 28-31, Chicago.

"New FM Horizons" Theme for FM Day

The FM Radio Committee of the NAB has set "New FM Horizons" as the theme for the special FM session at the NAB Annual Convention. The sessions will be part of the Convention FM Day on Sunday, March 31, with NAB programming the afternoon meeting and the National Association of FM Broadcasters in charge of the morning session.

Among the new horizons to be discussed will be the growing use of FM car radios, operations in both small and large markets by newer stations, and new technical developments including translators, on-channel boosters, and dual polarization.

Reports will be delivered by FM Radio Committee Chairman Harold I. Tanner, WLDM, Detroit, and by Charles M. Stone, NAB vice-president for radio.

Research Budget Approved

The Board of Directors of the NAB has approved an expenditure of $124,000 for financing industry research during the next year. Projects will include studies of public attitudes, methodological research of audience measurements, and the gathering of information needed to counter attempts to reallocate some of the present broadcast spectrum to business uses.

Headquarters Building Progresses

Clair R. McCollough, Chairman of the NAB Building Committee, has reported that construction on the Association's $2,320,000 headquarters building in Washington is a week to ten days ahead of schedule. Construction is scheduled for completion on Feb. 1, 1969, with the structure ready for display to members attending the Washington Convention March 23-26 of that year.

Warns of Dangers to Broadcasting

Vincent T. Wasilewski, president of the National Association of Broadcasters, warned recently that the basic structure of communications in this country is in danger of being "torn apart" and reshaped "in an entirely different form."

Speaking before the International Radio and Television Society, Mr. Wasilewski told his fellow broadcasters that they must: "actively remind our fellow Americans of the values and contributions of the present system," "concentrate on preserving the basic structure of broadcasting," and, "accept constructive change."

An increasing pressure on spectrum space, the NAB president said, has resulted in "an alliance of interests whose power is formidable." One common issue ties this group together, Mr. Wasilewski said. "They all are strong forces for change." Many of them, as advertisers, are "our friends," he noted. "But they are powerful, they are influential, and they cannot be underrated nor ignored," he stated.

Another pressure point, the industry spokesman noted, is the Office of Telecommunications Management—the agency in charge of the Government's use of its portion of the spectrum. This agency is sympathetic toward Government, he said, and its members have no commercial broadcasting background.

Mr. Wasilewski also called attention to efforts in Washington to establish a Department of Communications with cabinet status. Those backing this move, he said, seem to want to place the power to allocate spectrum space in the hands of the Executive Department.

Another development, which Mr. Wasilewski said in the long run would be "the most important," is the appointment by President Johnson of his Task Force on Communications. The Task Force must examine and make recommendations on: satellites, including the question of satellite-to-home broadcasting; the feasibility of a wired system of communications; the use of the spectrum and what changes might be made in that area; and the Communications Act, to determine whether that law needs basic revision and reorientation.

Mr. Wasilewski said the broadcasting industry hopes to assist the Task Force, whose report is due by next August. In turn, he said, broadcasters want the Task Force to examine the reasons why in less than 20 years "Americans have spent $20 billion for 120 million sets to receive free over-the-air service."

"Before broadcasting is deprived of any frequencies," the industry spokesman said, "it should be established by valid research that space presently allocated to land mobile is efficiently used" and "that the diversion will be for essential and superior purposes."

"It should also be borne in mind," he continued, "that broadcasting's future depends on spectrum space. If commercial television is to provide the specialized programming for minority tastes, if educational television is to flourish, they must have time and space in which to exist and grow."

And if the nation is wired, " . . . and that wire is controlled by an enormous common carrier . . . what will become of local-interest programming and local public service?" he asked.

"While it is obvious that we do not intend idly to be a witness to the destruction of the present free broadcasting system," he said, "we should not always be defenders of the status quo."

"We should recognize that this industry is going to change," he said. "We should participate constructively in that change."

"The free broadcaster's effort is . . . to make certain that policies are soundly based before they are adopted," Mr. Wasilewski emphasized. "Change must mold, improve, but not destroy . . . free broadcasting." ▲

Guide to Downtown Chicago

Hotels and Motels

37. Ascot Inn
38. Avenue Motel
11. Bismarck
35. Conrad Hilton
36. Essex Inn
5. Executive House
13. LaSalle
18. Palmer House
30. Pick-Congress
33. Sheraton-Blackstone
7. Sherman House

Theaters

32. Blackstone
20. Goodman Memorial
22. Orchestra Hall
17. Schubert
26. Studebaker

Transportation

Bus Stations:

9. Continental Trailways
8. Greyhound

Railroad Stations:

34. Dearborn Station
31. Grand Central Station
39. Illinois Central Station
25. LaSalle Street Station

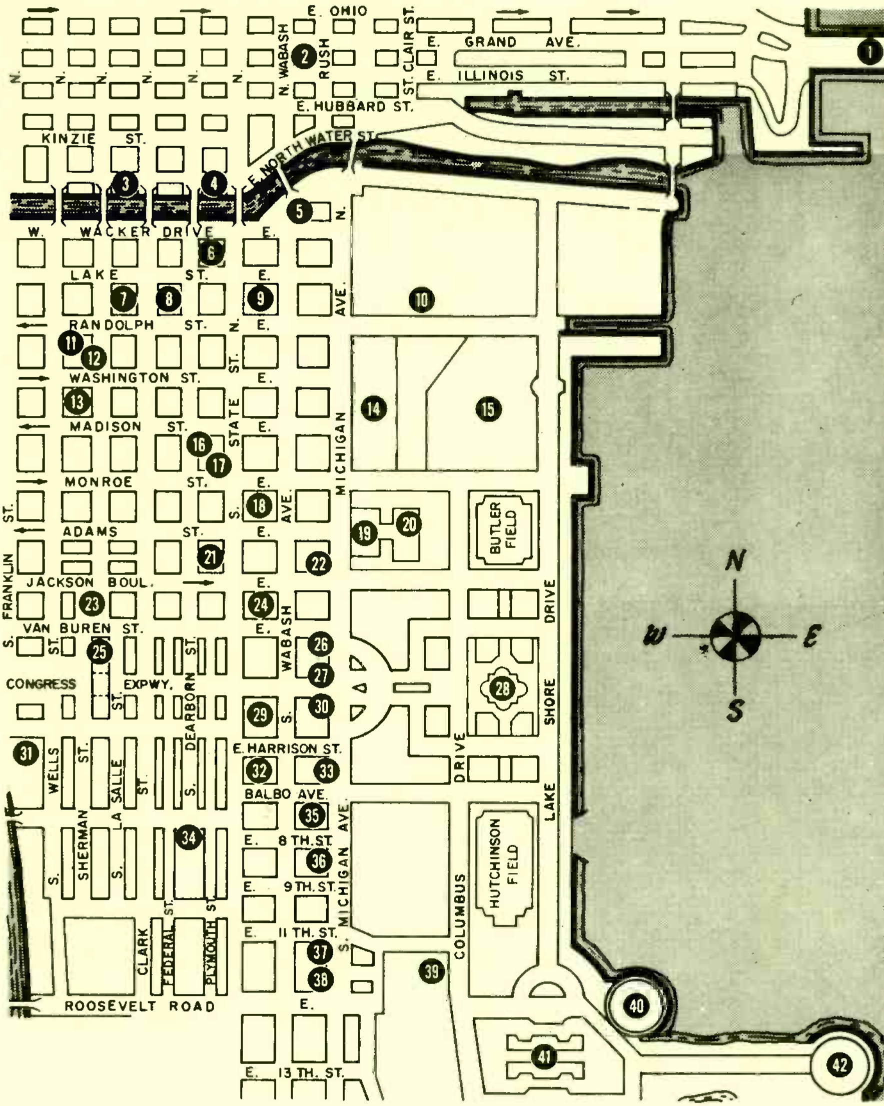
City Parking Garages:

2, 3, 6, 12, 14, 15, 29

Other Points of Interest

42. Adler Planetarium and Astronomical Museum
19. Art Institute
23. Board of Trade (Observation Tower)
28. Buckingham Fountain
41. Chicago Natural History Museum
24. DePaul University
4. Marina City
1. Navy Pier
10. Prudential Building (Observation Tower)
27. Roosevelt University
40. Shedd Aquarium
16. Visitors Bureau
21. United States Courthouse

The Museum of Science & Industry is at 57th Street and South Shore Drive (not shown on the map).


E. OHIO
E. GRAND AVE.
E. ILLINOIS ST.
E. HUBBARD ST.
N. WABASH
RUSH
ST. CLAIR ST.
KINZIE ST.
E. NORTH WATER ST.
W. WACKER DRIVE E.
LAKE ST. E.
RANDOLPH ST. E.
WASHINGTON ST. E.
MADISON ST. E.
MONROE ST. E.
ADAMS ST. E.
JACKSON BOUL. E.
VAN BUREN ST. E.
CONGRESS EXPWY.
E. HARRISON ST.
BALBO AVE.
E. 8 TH. ST.
E. 9 TH. ST.
E. 11 TH. ST.
E. 13 TH. ST.
ROOSEVELT ROAD
N. STATE ST.
S. FRANKLIN ST.
WELLS ST.
S. LA SALLE ST.
S. SHERMAN
DEARBORN ST.
S. CLARK
FEDERAL ST.
PLYMOUTH ST.
N. MICHIGAN AVE.
S. MICHIGAN AVE.
S. WABASH AVE.
COLUMBUS DRIVE
LAKE SHORE DRIVE
BUTLER FIELD
HUTCHINSON FIELD
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1968 NAB

Convention

Report

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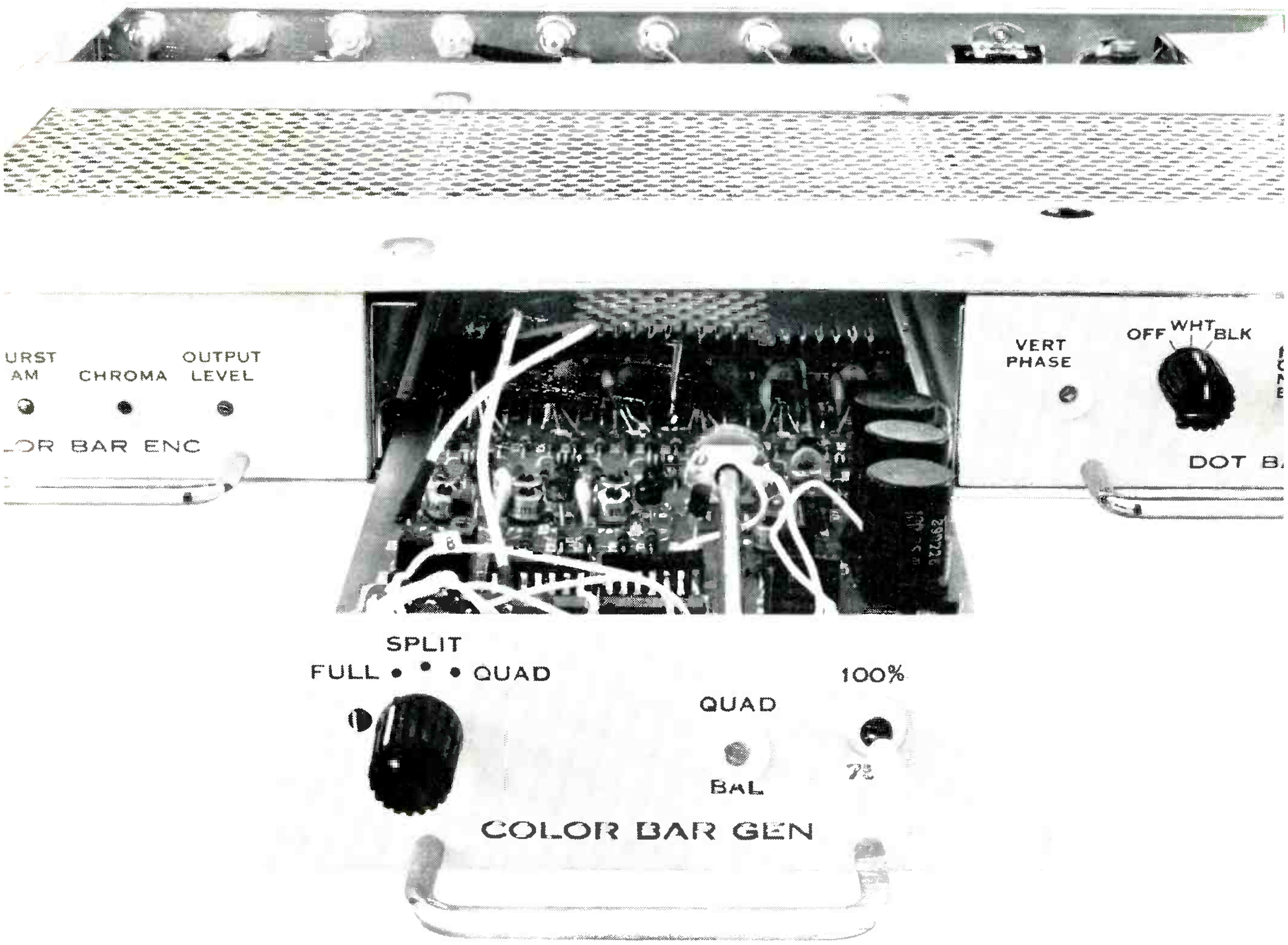

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the technical journal of the broadcast-communications industry

Broadcast Engineering

Volume 10, No. 3 March, 1968

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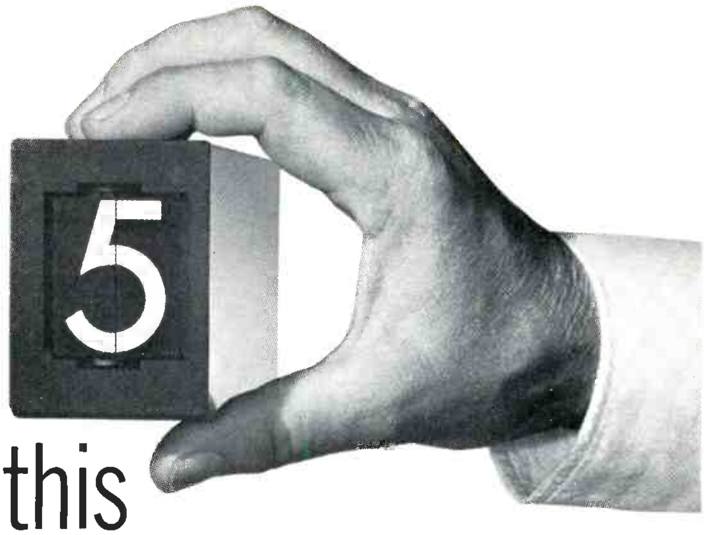
Features

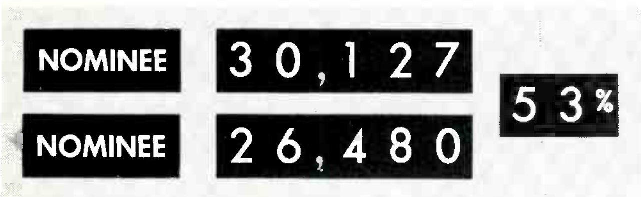
Departments

The colorful pattern on our cover shows the optics of a color TV camera in action. Color cameras will play a prominent role in the NAB Convention this month, but there will be hundreds of other things to see and hear as well. For a sample, see the preview starting on page 61. (Cover photo courtesy of General Electric Co.)

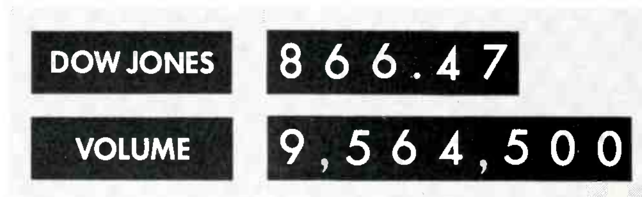


Look what your cameras can do with display units like this

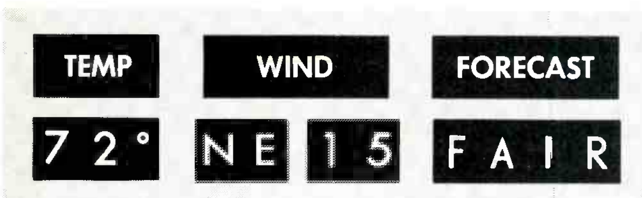
CBS Laboratories' Digital Display Units are part of a low cost, compact system that works daily wonders in any size TV studio!



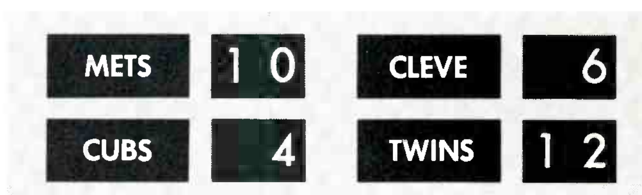
ELECTIONS–No contest.
These modular units were designed specifically for TV use to give optimum clarity up to 70 feet — from any camera angle up to 145 degrees.



STOCK REPORTS–Excellent for the long pull.
Rugged electro-mechanical operation is fool-proof and built to last. No bulb burn-out or the other problems of rear-illuminated displays.



WEATHER–Cool operation.
Only 2.7 watts required per unit, with no power between postings. Glare-free even under the strongest lighting conditions.



SPORTS–An easy set-up.
Just stack these units in a flat to suit any requirement. Custom designed matrix wiring also available for complete flexibility.

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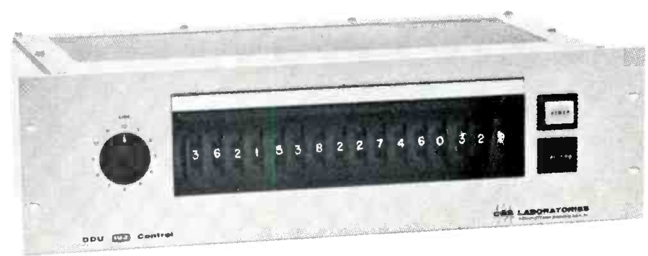

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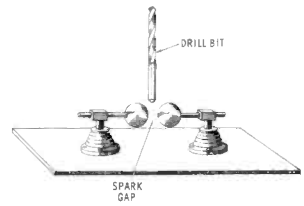
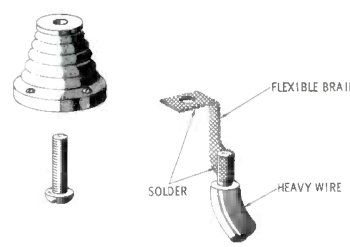
ENGINEERS' EXCHANGE

Gauge for Spark-Gap Settings



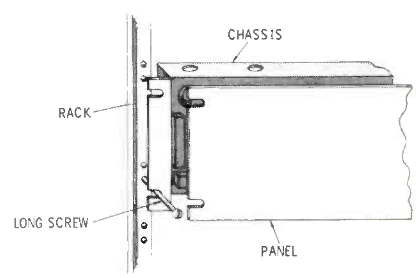
To meet the manufacturer's recommendation for initially setting spark gaps, use the shank of a drill bit of appropriate size. When the proper setting has been established for certain transformers, chokes, or lightning gaps, it is a good idea to make a record of the spacing so that it can be reset quickly after repairs or replacements have been made.

Terminals for Tight Places



In cramped spots where ordinary terminals for heavy wires won't fit, shape a hole of the proper size in a strap of flexible braid. Tin the surfaces so they will hold the desired shape.

Mounting Heavy Chassis in Racks



In some installations, a heavy chassis and its panel may be held in a rack by the same screws—and it's an exasperating job to get all the holes lined up. The work may be simplified by first inserting one long screw to keep the parts aligned until the regular screws are put in place.

—Items contributed by Hugh Lineback

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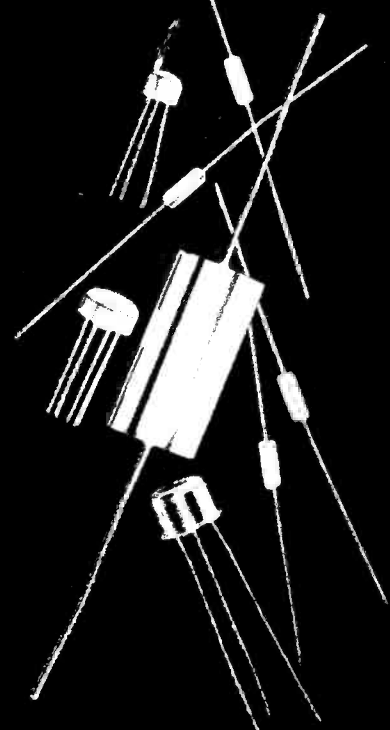

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Video Recorder Head-Tip Wear

by Dan Esterly and Peter Skalon*

The causes of head-tip wear, how to detect it, and how to minimize it are discussed.

All magnetic recording tapes present an abrasive (oxide-coated) surface to the video head tips in the recorder or playback machine. Thus head wear begins the moment the first tape is recorded or reproduced. The rate of wear produced by undamaged tape of good quality is relatively low, but it has a finite value. Tape that has been mechanically damaged in a way that distorts its oxide-coated surface is quite another matter.

In the case of video head tips which traverse the tape at high writing speeds (*e.g.*, 1500 inches per second), undamaged tape allows a useful head life of 100 hours or more. On the other hand, damaged tape may cause rates of wear ranging up to 400 microinches per hour, thereby reducing useful head life to only a few hours.

Evaluation of Tape Abrasion by Head Tip Coloration

Normal wear of polished head tips results in the appearance of tip coloration, which is characteristic of the brand of tape in use. The density of the color and the area of the tip surface covered with color varies with the abrasive properties of the tape and with the time in operation. In general, when a tape produces a color on the head tips, it is safe to use. It is to be expected that one brand of tape may wipe off the color produced by another brand, before producing its own characteristic coloration on the tips.

The normal rate of head-tip wear ranges from less than six microinches per hour to 15 microinches per hour. When the wear rate is less than six microinches per hour, the color produced is most dense and covers the largest area on the tip surfaces. When the rate is between six and 15 microinches per hour, the color density will decrease or the colored area will become smaller. When the wear rate exceeds 15 microinches per hour, any color initially present on the head tips will disappear. Thus, if no coloration appears on the head tips, it may be assumed that the wear rate exceeds 15 microinches per hour.

Figs. 1 through 4 illustrate the variations in the color produced by different brands of tape at wear rates of less than six microinches per hour. Fig. 5 illustrates the absence of head-tip coloration when the wear rate exceeds 15 microinches per hour.

Damaged Tape

Tape that has been physically damaged by creasing, crumpling, or scratching is the prime cause of the high wear rates approaching 400 microinches per hour mentioned earlier. Any sharp deformation or scratching of the oxide coating interrupts its continuity and uniformity, resulting in a cutting action somewhat akin to that of a file. (It also loosens individual particles of oxide, which may be picked up and retained by the head tips or the head drum; but more on this in a moment.) When physically damaged tape passes the head tips, the tips are scratched by this cutting action (see Fig. 6). Then, as more tape passes the scratched tips, it is damaged in turn by the milling action of the tips. For this reason, severely scratched head tips must be polished before further use.

*Engineers, Research and Advanced Technology Div., Ampex Corp.

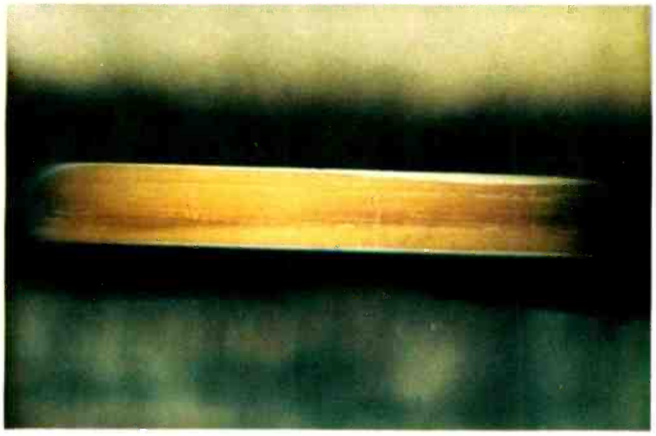

Fig. 1. Head tips exhibit a dense light-brown coloration which appears rapidly, reaches maximum density in less than 30 minutes, and covers 80 to 95% of tip surfaces.

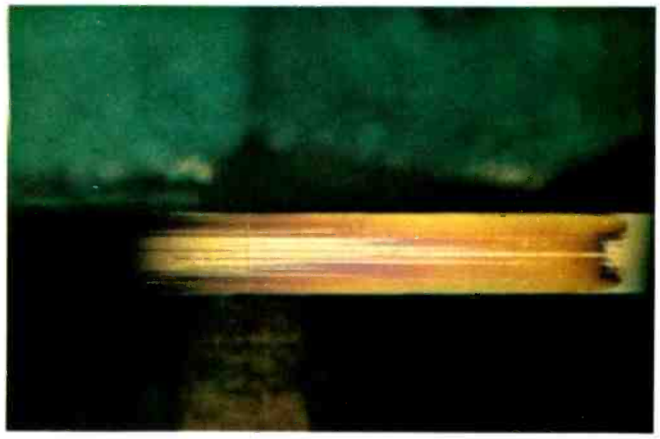

Fig. 2. Brown fringed with violet appears slowly, reaches maximum density and coverage in about 30 minutes, covers 60-90% of tip surfaces. Base-metal streaks are common.

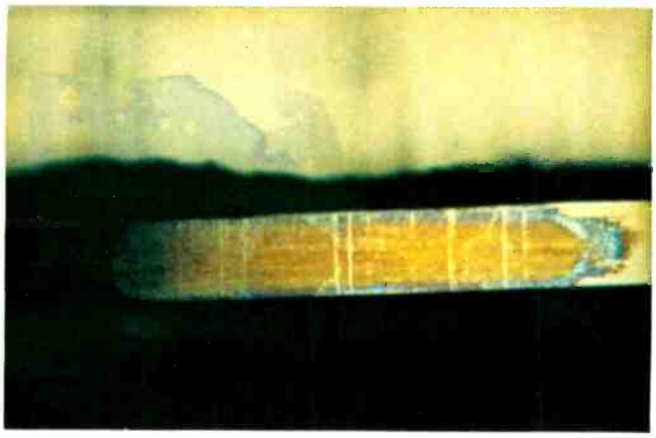

Fig. 3. Head tips exhibit golden-brown area fringed with blue. This coloration appears at the same rate and over the same percentage of the area as that shown in Fig. 2.

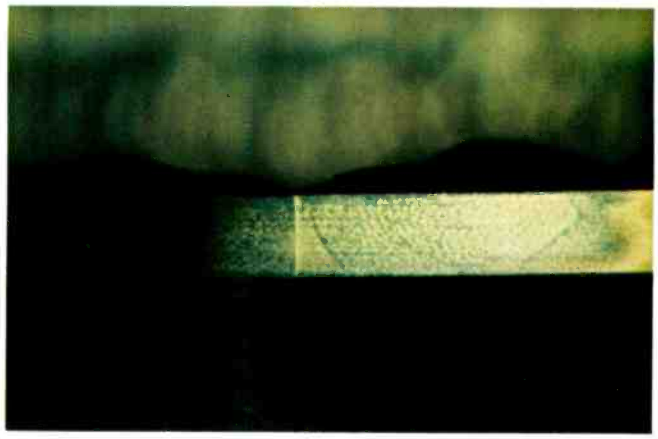

Fig. 4. Head tips exhibit blue-green and brown color. Coloration increases in density over 80 to 95% of the tip area. (Note appearance of Alfesil grain structure.)

Fig. 5. Wear rate high, head tips devoid of coloration.

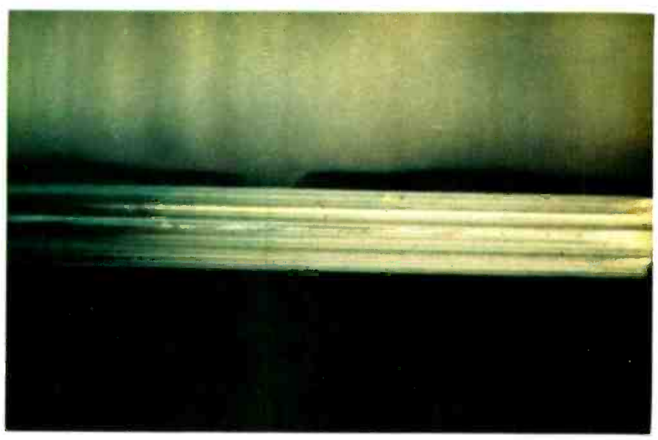

Fig. 6. Scratched head tips must be polished before use.

Fig. 7. Creases cause oxide buildup, high tip-wear rates.

Fig. 8. Oxide redeposits signal end of useful tape life.

Fig. 7 illustrates typical damage to tape caused by creasing or folding. When creased sections of tape pass the head tips, the rate of wear increases drastically, and loosened particles of oxide are picked up and retained by the head tips and the drum.

Fig. 8 shows the random redeposit of oxide particles near the edge of the tape. The appearance of these streaks signals the end of useful tape life, because it indicates a general breakdown of the oxide binder.

Fig. 9 illustrates a typical random crumpling of the tape from edge to edge. Crumpled tape represents the greatest danger that the head tips may encounter. There is a virtual certainty of tip damage in the form of long, deep scratches, and the subsequent damage of good tape by the damaged tips. Also, a rapid buildup of loose oxide may accumulate on the drum surfaces to aid in the destruction of the tape.

Fig. 10 shows the repeated transverse burns or scratches across the width of the tape caused by damaged head tips or by an oxide-loaded head drum. The deformation of the *Mylar* backing over the same tape section is illustrated in Fig. 11.

Measurement of Wear Rates

The wear rate per hour equals the difference between the initial tip projection and the remaining tip projection, divided by the operating time in hours. If .000050 inch is worn from each tip over an operating time of two hours and 30 minutes, the wear rate is 20 microinches per hour.

Rules for Operation and Preventive Maintenance

1. Before each day of use, closely inspect all metal surfaces (including tape guides, idlers, compliance arms, head tips, and drum) that touch the oxide-coated surface of the tape for an accumulation of oxide. If any is present, remove it immediately, using a cotton-tipped swab moistened with head cleaner.

2. Be alert for sections of tape that are crumpled, creased, or scratched. These sections appear most often near the beginning of the tape, but wherever they appear, they must be removed before the tape is used, to avoid needless head-tip damage.

3. Examine the head tips regularly by means of a tool-post-mounted microscope equipped with a diffused light source. The condition of the tapes being used may be determined by the appearance of the head tips. If severe scratches are detected, polish the tips by running the head for a short period with tape that produces a polished condition like that in Fig. 5. If any head tips are found to be broken, do not use the video-head assembly until it has been repaired or exchanged.

4. While tape is being manipulated by hand, use care to avoid situations that may lead to creasing or crumpling.

5. Remember that degradation of the reproduced picture, caused by a buildup of oxide on the head tips, is usually accompanied by a buildup of oxide on the drum surfaces as well. Make it a practice to clean the head tips and the head drum as soon as possible after such degradation first appears. ▲

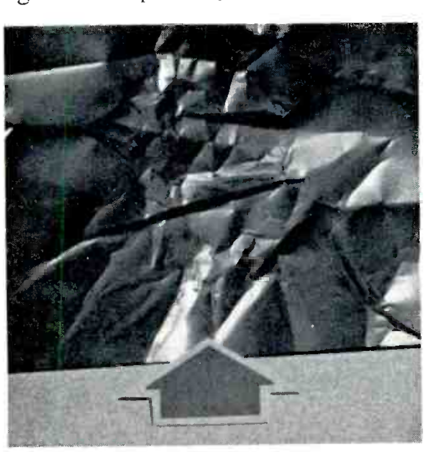

Fig. 9. Crumpled tape scratches tips, causes oxide buildup and rapid wear.

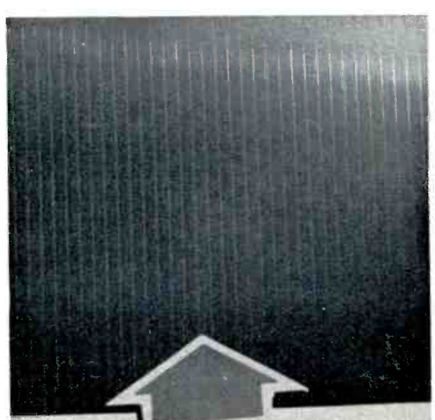

Fig. 10. Transverse burns from passing over a damaged tape cause wear.

Fig. 11. Opposite side of tape in Fig. 10; backing is permanently deformed.

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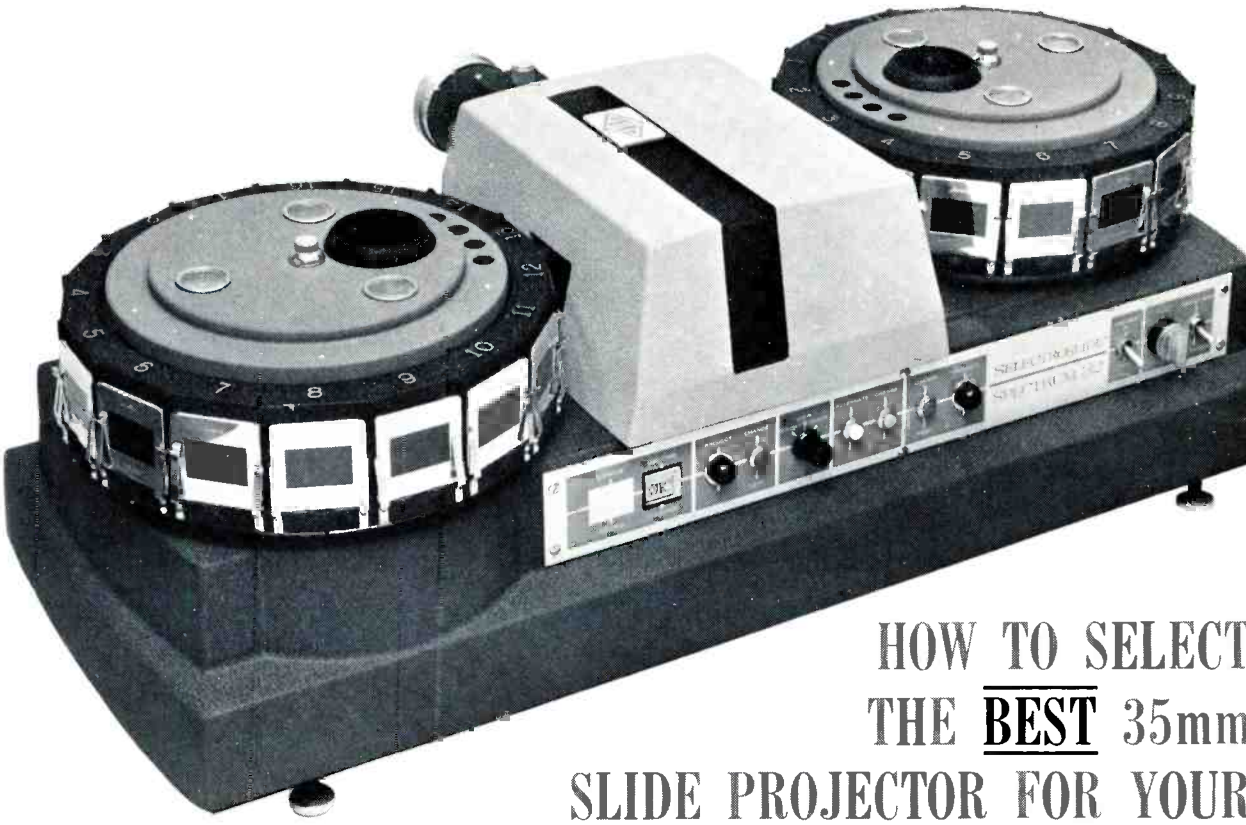

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Broadcast Towers and the FAA

*by Robert A. Jones**

*and Donald L. Markley***

What do airplanes have to do with broadcast stations? Plenty, as this article shows.

When a broadcast tower of any type is planned, a study must be made to determine if navigable air space will be affected. Of course, this study must be made prior to the preparation of any necessary FCC applications, since it may reveal that the proposed tower site is unusable. While we all are aware of the necessity of such studies for the "monster" towers of 1000 feet and higher, it must be realized that under certain conditions even a 50-foot tower may be considered a hazard to air navigation. The following article is intended to explain some of these considerations and, hopefully, to show the need for cooperation between broadcasters and those engaged in aviation.

Airway Requirements

The Federal Aviation Agency (FAA) has the responsibility, among other things, of preserving as much as possible of the usable air space. This agency is justly concerned when a tower is proposed that will result in increasing the minimum en-route altitude (MEA) along any of the standard federal airways. When this minimum altitude has to be increased, more than a few feet of airspace at the tower location is lost; the airspace for the entire length of the airway is affected. For example, a typical airway extends between Chicago and Indianapolis. Assume the minimum obstruction clearance altitude (MOCA) for this airway is shown on the charts as 2100 feet above mean sea level (AMSL). The MEA would be 2500 feet, and, under the present rules, the lowest allowable altitude for instrument flight is at the next thousand-foot level, or 3000 feet. Assume also that the present MOCA is the result of a 400-foot tower. Then a new 1600-foot tower along this airway is proposed. This means the MOCA will have to be increased by 1200 feet to 3300 feet (AMSL). The MEA would increase to at least 3700 feet, and the lowest altitude then available for instrument flight on this section of the airway would be 4000 feet. While this may not appear to be a significant loss, in areas of high traffic density, such as surrounds Chicago and Indianapolis, the loss of this much usable flying room could be cause for concern. In areas having low traffic density, the FAA probably would make the change requested.

To conduct a feasibility study for a new tower structure, it is first necessary to acquaint yourself fully with Part 17 of the FCC Rules and Regulations. This part contains information regarding the various zones and requirements that must be considered, and it points out which tower proposals require an aeronautical-hazard study by the FAA. The next step should be to refer to a *current* aeronautical Sectional Chart of the area concerned. (See Fig. 1.) These charts can be obtained at most local airports, or they may be ordered from the U.S. Coast and Geodetic Survey, Department of Commerce, Washington, D. C. The Sectional Chart shows the location of all airports and airways in the area which might be affected by the proposed tower. Airways are shown as shaded lines and are identified by number in much the same way that highways are numbered on a road map. For most airways, a letter "V" precedes the number, as for example V-161. The letter signifies that this is a VHF airway; that is, its

*Consulting Engineer, LaGrange, Ill. and BE Midwest Regional Editor.
**Consulting Engineer, Mapleton, Ill.

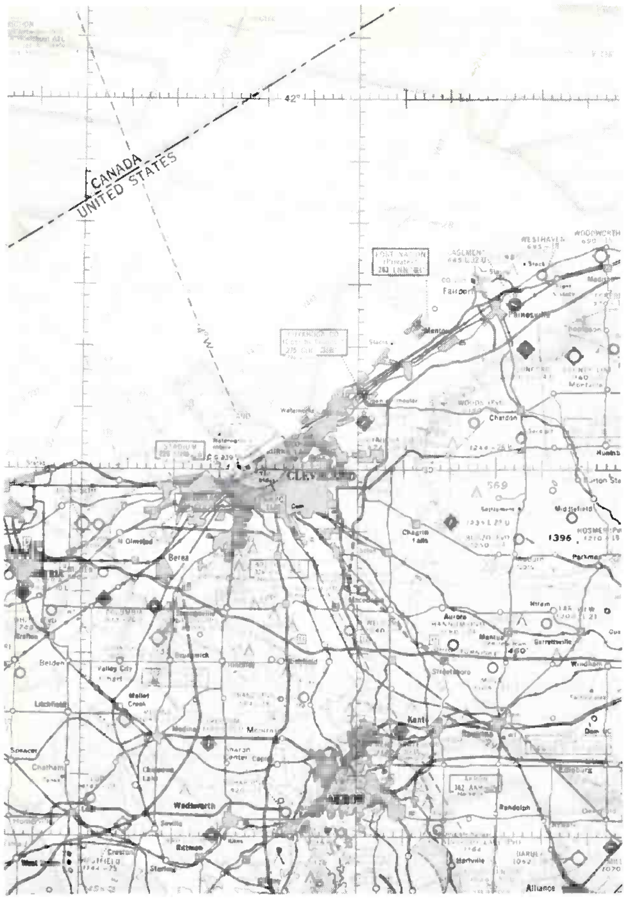

Fig. 1. Part of an aeronautical Sectional Chart is shown.

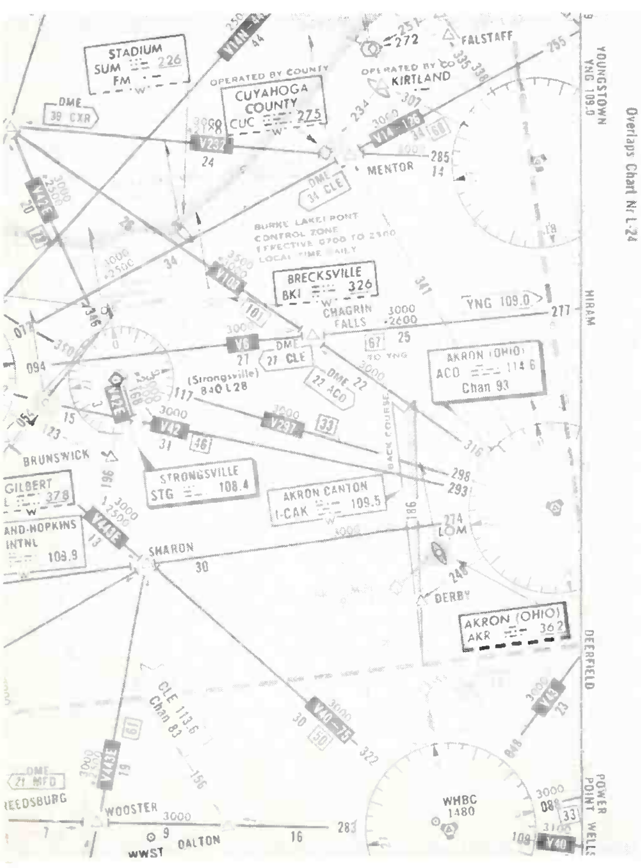

Fig. 2. Sample portion of a Low Altitude en Route Chart.

location is based on a VHF navigation facility. Some airways based on the old LF/MF radio ranges still exist, but these are becoming rare. On the charts, such airways are shaded a different color than are Victor (V) airways; standard practice at present is for the Victor airways to be shown in blue and the older LF/MF radio-range type to be shown in red.

Additional information about local airways can be found on the Low Altitude en Route Charts. The chart for a given area usually can be examined at the local airport, or it can be purchased from the U. S. Coast and Geodetic Survey. An example of this type of chart is shown in Fig. 2. These charts contain information about the MOCA and MEA for each airway. One point to keep in mind is that airways are not narrow highways through the sky. VHF airways extend four nautical miles each side of the center line, which is shown on the chart as a blue line. Thus the airway is the equivalent of about ten statute miles wide.

Airport Requirements

Broadcast towers normally are located outside, but near, the principal city to be served by the station. Unfortunately, airports for the same city are similarly located. This fact sometimes leads to conflict between airport planners and broadcasters, because the loss of usable air space in the region surrounding an airport, where aircraft are landing or departing, is a matter of great concern.

If it is proposed to construct a broadcast tower in the vicinity of an airport, more factors have to be considered. Again, the reader is urged to read FCC Part 17 and, in addition, to study Part 77 of the FAA Regulations. In these publications, several zones extending outward and upward from the end of the runway are identified. The width, slope rate, etc., of the zones depend largely on the type of airport and its radio and instrument approach facilities. These zones can be plotted on a topographic map of the area to help determine their relationship to the proposed tower site. In addition, if your local airport has instrument approach facilities (and most metropolitan airports do), you can obtain the following charts there:

1. Low Altitude Area Chart
2. Standard Instrument Departure Chart
3. Approach and Landing Chart

You can purchase these charts from the U.S. Coast and Geodetic Survey, but experience shows that it is much quicker to borrow a copy from a local source. For example, each of the pilots at a charter service will usually have a complete current set of these charts.

The local charts show the locations of the approach and departure routes and areas. They also contain information relative to the altitudes involved. You should locate the proposed broadcast tower on one of these charts and determine if any violations of navigable air space exist. If violations do exist, it may be necessary to relocate the tower or reduce its height.

VFR Requirements

In addition to the numbered federal flyways mentioned above, there are what may be called local or area VFR flyways. Most private pilots follow Visual Flight Rules (VFR), flying without the requirement of

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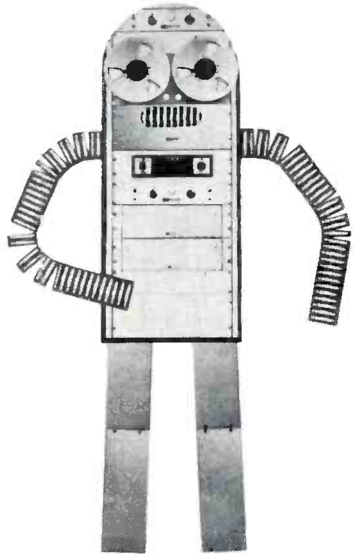

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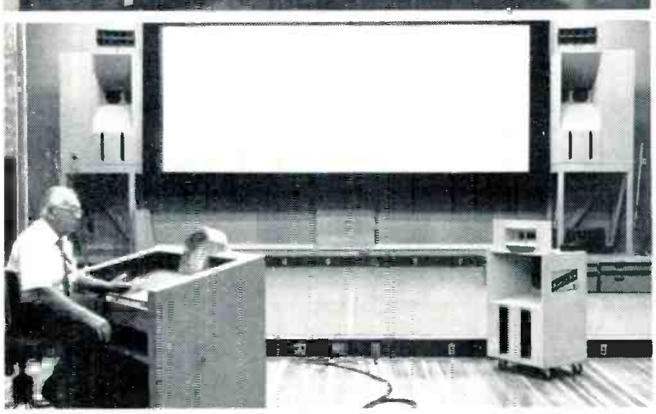

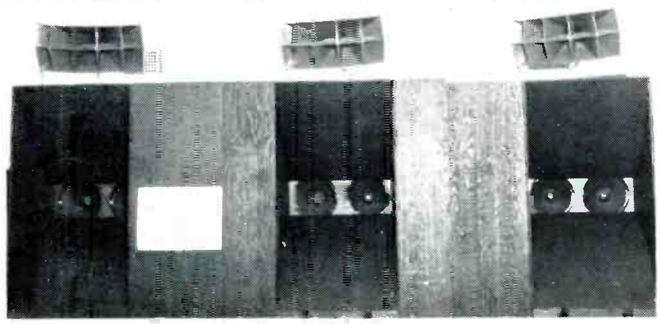

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adhering to strict instrument or radio-range procedures. In VFR flying, pilots normally follow obvious landmarks, such as rivers, major highways, shorelines, and railroads. Because of this, the FAA and some state aeronautics commissions (for instance, the Wisconsin Aeronautics Commission) often object to any tall structures in or near these natural VFR flyways. This situation is especially true with respect to the new Interstate highways; experience indicates that one should stay at least four nautical miles either side of such routes, although other factors are involved as well.

Making Application

After the entire study has been completed and it appears that the tower will not be a serious hazard to air navigation, it is necessary to file FAA Form 117 with the regional FAA office. (The addresses of these offices are shown in Table 1.) The FAA then conducts a study of the structure and, if it deems it necessary, issues and circularizes a public notice of the investigation. All interested parties are requested to file comments and/or objections, setting forth all the reasons why approval of the application is opposed.

As the applicant, you should of course file comments, too. Do not go into the area of the wonderful public service you feel the station will furnish. The FAA ignores public service if there is a possibility that a multijet behemoth might wrap itself around a tower. Instead, explain why you feel the tower will cause no appreciable hazard to air navigation. Also, be quick to point out any existing buildings, other towers, or natural formations, such as hills or mountains, that may tend to shield the proposed tower.

If it appears that a proposed tower may cause some hazard to air navigation, a visit to the local FAA office may answer many questions before you go to the trouble of filing any applications. Remember that the FAA is simply trying to do its job and will cooperate with you to the highest degree possible.

Example Cases

In the foregoing sections, some of the FAA Regulations and their normal interpretations, as applied to broadcast-station towers, have been outlined. Now two recent cases, one an AM tower and the other a television tower, will be described to show the kind of studies normally made. It is hoped that these examples will help guide the reader in making his own tower-hazard studies. Again, the reader's attention is called to the need to become familiar with Part 17 of the FCC Regulations and Part 77 of the FAA Rules.

Radio Tower

The first case is that of an AM station. WGLC at Mendota, Illinois. Like many radio stations, WGLC operates with a nondirectional antenna. For the operating frequency of this station (1090 kHz), the desired tower height would be 199 feet. This height yields a good radiation efficiency, yet it is less than the height for which tower lights are required.

We first made a study of flyways, both IFR and VFR, from the most recent aeronautical charts of the general area around Mendota. No problems from this source were indicated in the ideal area for the transmitter site.

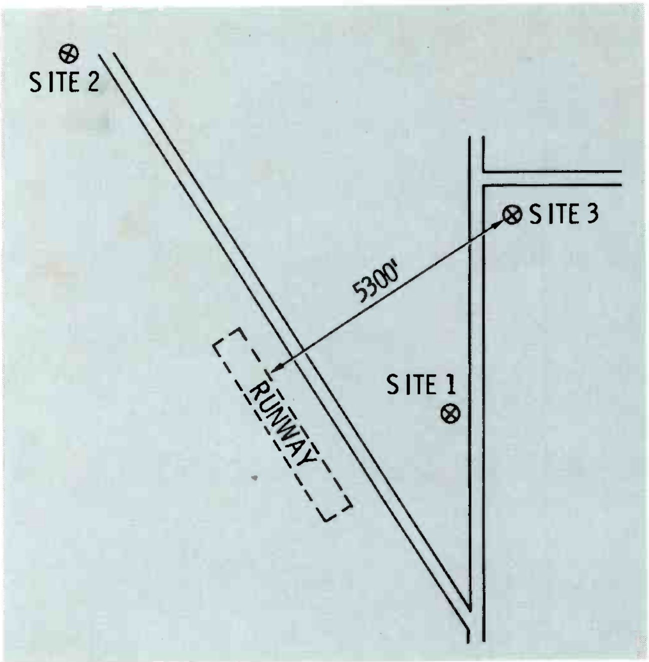
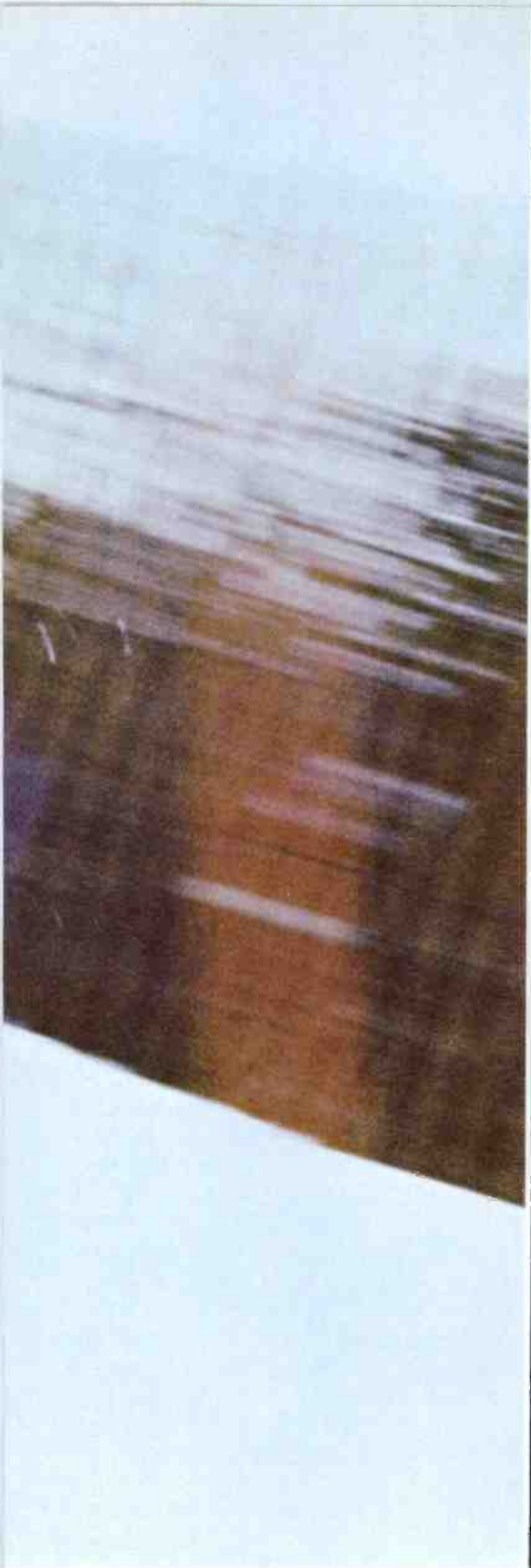


Fig. 3. Three possible sites considered for WGLC tower.

We did discover, however, that a local airport, Fitzgerald Airport, was close by. A United States Geological Survey map of Mendota and vicinity was then used for a more detailed study of the proposed site. Experience shows this kind of map is the most accurate to use for locating towers, boundries of local airports, geographical coordinates, elevations, and other heights in the vicinity. On this work map, we marked three available sites (Fig. 3). These were based on conversations with local realtors and farmers concerning what land could be purchased. We were highly restricted in potential

Table 1. Federal Aviation Agency Regional Offices

Region	Address
Eastern Region	
Maine, N.H., Vt., Mass., R.I., Conn., N. Y., Del., N.J., Penn., Ohio, Md., Va., W.Va., Ky., D.C.	New York International Airport, Jamaica, Long Island, New York 11400
Southern Region	
Tenn., N.C., S.C., Ga., Fla., Ala., Miss., Puerto Rico, Canal Zone, Swan Island, Virgin Islands	P.O. Box 20636, Atlanta, Georgia 30320
Southwest Region	
Ark., La., Tex., Okla., N. M.	P.O. Box 1689, Fort Worth, Texas 76101
Central Region	
Mich., Ind., Wis., Ill., Minn., Mont., Iowa, Mo., N.D., S.D., Nebr., Kans.	4825 Troost Avenue, Kansas City, Missouri 64110
Western Region	
Wyo., Colo., Ariz., Utah, Idaho, Wash., Ore., Nev., Calif.	P.O. Box 90007, Airport Station, Los Angeles, California 90009
Pacific Region	
Areas contained within the Honolulu, Wake and Guam Flight Information Regions established by the International Civil Aviation Organization, and American Samoa.	P.O. Box 4009, Honolulu, Hawaii 96812
Alaskan Region	
Alaska	P.O. Box 440, Anchorage, Alaska 99501



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sites in this general area of very productive farm land; most farmers were just not interested in parting with any acreage.

Prospective site No. 1 had to be dismissed because it was within a half mile of the airport, and definitely too close. Site No. 2, while over a mile from the closest point on the airport, would be in line with the single runway. This site obviously would be in the approach path and had to be ruled out. This left only site No. 3, also located about a mile from the airport, but in a direction at right angles to the single runway. A quick study of the topographic map indicated there was a ten-foot difference in elevation between the airport and this prospective site. This minor difference would have to be taken into consideration in making a final tower-height determination.

From the Mendota Topographic Map, the exact distance (5300 feet) and direction (25°) between the airport and the site were scaled. (These quantities were measured from the closest point on the airport boundary.) In accordance with Part 77 of the FAA Rules, the slope ratio for this distance was calculated to be 20:1. This is the ratio beyond the first 5000 feet from the airport reference point (Fig. 4). By simple mathematics it was easy to calculate that for a slope of 20:1 and a distance of 5300 feet, one could extend a tower upward to a height of 165 feet above the ground elevation of the airport. As noted above, this figure was corrected for the ten-foot difference in elevation between the site and the airport.

Thus the greatest height we could use was 155 feet, which is considerably less than the desired height. For a 199-foot tower at a right-angle direction from the runway, the site would have had to be at least 6180 feet from the airport. No land could be obtained at that distance. One or two sites farther out were available, but they were too far from the business district of Mendota. Section 73.30 must be kept in mind; after all, it would do no good to find a site acceptable to the FAA for tower heights, if it would be impossible to serve the principal city with the minimum signal required by the FCC.

After finding the maximum tower height at the No. 3 location to be 155 feet, we then checked this height for compliance with the FCC requirement for minimum radiation efficiency. For a class-II station, the required minimum effective field strength at one mile is 175 mv/m for one kilowatt (or 87.5 mv/m for 250 watts in the case of WGLC). This efficiency can be expected for an electrical height of 0.15 wavelength, or 134.6 feet at 1090 kHz. Thus our allowable height gives enough leeway for the tower pier and base insulator. Because of this height restriction, however, some top loading was added to increase the efficiency enough to be certain of compliance with the minimum FCC requirements.

As this example points out, one often has to compromise between heights desired for coverage and those that meet FAA limits for air safety.

Television Tower

The second example deals with a 917-foot television tower. Obviously, the FAA is greatly concerned with towers of such height, or greater, and their placement is very important. The best solution when locating a tower this high is to try to place it in an existing "antenna farm." Antenna farms are recognized as groups of tall towers in the same vicinity which, in effect, present just one hazard due to their proximity to each other. The addition of one new tower to an already existing group will not significantly add to the hazard, and probably would be approved. In this example, a new television tower near Evansville, Indiana was proposed. It was not possible to locate this structure near any existing towers because the FCC minimum-mileage Rules for cochannel and adjacent-channel separation prevented it.

First, it is easily recognized that no tower of this magnitude can be constructed anywhere near an airport. In general, it is best to try to maintain a distance of at least ten miles. Second, and usually more important, is the location of the tower with respect to flyways, both VFR and IFR. The proposed site is shown on the aeronautical map of Evansville and vicinity in Fig. 5. At the closest, this location is over 14 miles from the Evansville airport and over 16 miles from the Owensboro (Kentucky) airport. Also, the selected site is sufficiently far from the Ohio River, a natural VFR flyway, and as far south of Federal IFR flyway V-4 as possible. (This flyway is shown as a shaded line north of the proposed site.)

Because the tower exceeds 500 feet above ground level (AGL), the proposal is in conflict with Section 77.23(a)(1) of the FAA Standards of Part 77, Subpart C. Our initial study also indicated that it might be in conflict with Section 77.23(a)(5), which does not permit a tower to protrude within 1451 feet of an established minimum flight altitude. This requirement was not met with respect to V-4. But, there is another factor involved in this particular situation: Our study revealed

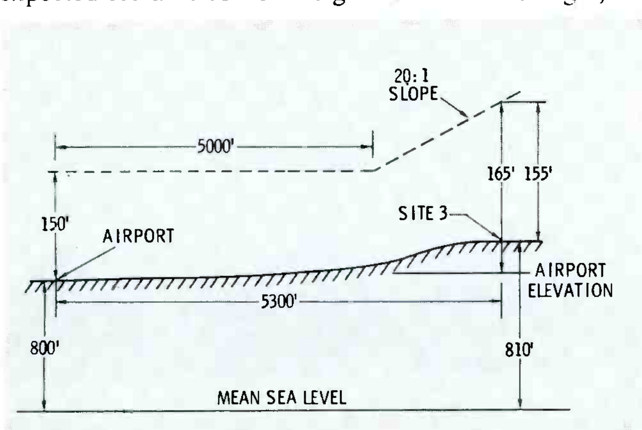

Fig. 4. Maximum height of the WGLC antenna structure was determined as shown.

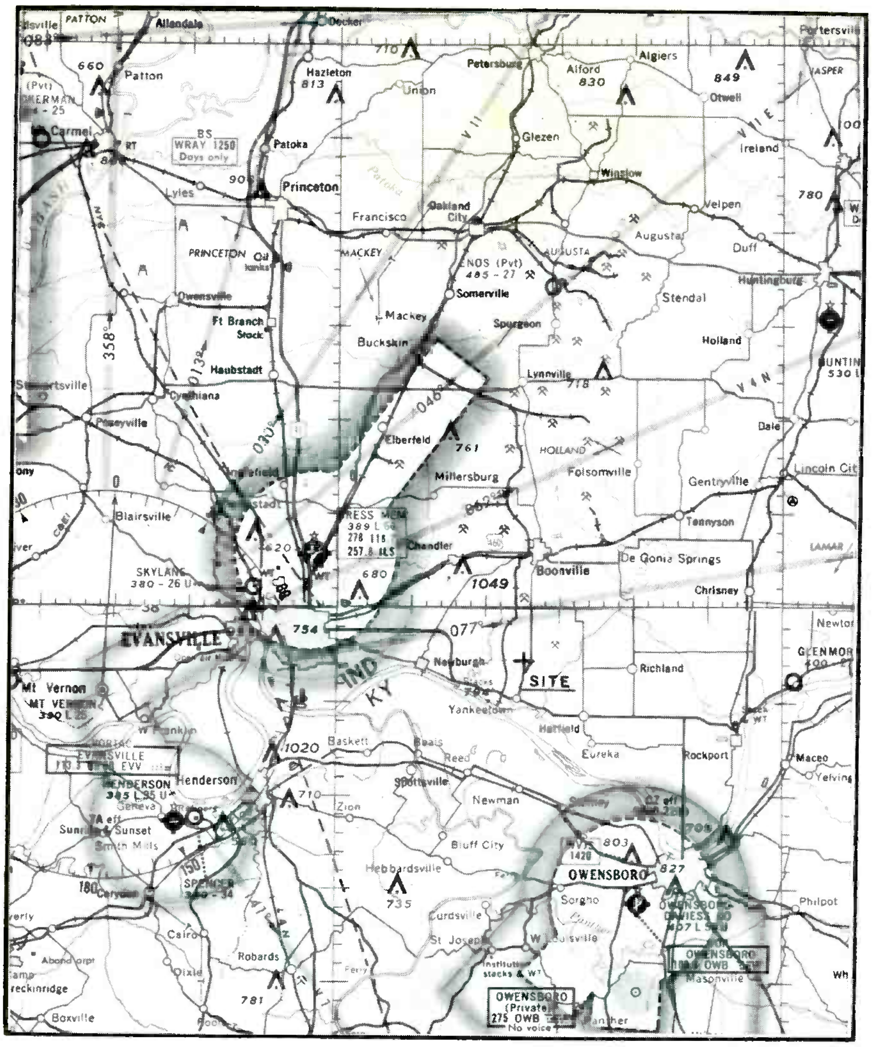

Fig. 5. Aeronautical map of Evansville area shows factors in choice of site for television tower in text example.

that another tall tower already existed a few miles to the northwest, near Chandler, also within the normal five-mile boundry of V-4. The map shows this tower to have a height of 1049 feet AMSL. This height is 380 feet less than our proposal of 1429 feet AMSL. Further study brought forth the fact that the existing tower had recently been approved for a height of 1449 feet AMSL. This height establishes the minimum flight altitude on V-4 as 2900 feet. It can be seen that our proposed tower height of just 1429 feet would not exceed the FAA requirements of Section 77.23(a)(5); in fact, we could have proposed an additional twenty feet of tower. Or, in other words, our tower height would not raise the MEA for flyway V-4.

In the example case, the FAA did circularize the proposed application, because of the above two FAA Rules. Two objections were received, and a hearing was held at the FAA office at Des Plaines, Illinois. (This is the Regional office that handles all Indiana matters.) Such proceedings are semiformal and provide the applicant and objectors with an opportunity to participate in discussing the proposal. In our case, most of the objections were directed toward the assumption that the new tower would raise the altitude of V-4 east of the Evansville VORTAC. Also, it was thought that the proposal would cause the loss of the "capital" altitude of 2000 feet AMSL. (A capital altitude is any altitude which is a multiple of one thousand feet, *e.g.*, 2000 feet, 3000 feet, etc.) After it was brought out that the MEA on flyway V-4 was already established at 2900 feet, all objections were withdrawn. The result of the hearing was the approval of the proposed tower.

Conclusion

While all this may sound easy, it is not necessarily so. It is very important to study the heights of all existing towers and/or other obstructions along the nearest flyway. It is also iportant to determine, if possible, the MEA for these nearby flyways. This will not relieve the applicant of the responsibility of filing FAA Form 117, nor the FAA from making the required study. But, it will provide a good idea of whether the proposal will be approved. It should be pointed out that MEA's are not completely rigid limits or sacred boundries and can be changed if good cause can be shown. In and near airports, where the proposed tower would cause instrument-approach minimum altitudes to be affected, the FAA seldom yields. In general, any tower that will affect instrument approaches or other airport criteria can seldom be approved.

It is hoped that the foregoing article has served to show some of the more important criteria, and how to deal with them, in seeking FAA approval for your next tower. ▲

at NAB

Harmonic-Distortion Meters and Their Use

by Thomas R. Haskett—Every technician who does audio maintenance must understand this instrument.

A radio broadcast transmitter is part of a chain of equipment which reproduces sound; the accuracy of reproduction depends on how well designed, constructed, and adjusted the links in this chain are. When the output differs from the input in any respect other than amplitude, distortion or noise (or both) has been introduced.

Distortion is more apparent with music than with speech, and more noticeable with a wide bandwidth than with a narrow bandwidth. In a 50-15,000 Hz system, for example, a critical listener may notice as little as 1% distortion, whereas many people only become aware of distortion at 2% or more. If the upper frequency limit is reduced to 7500 Hz, more distortion can be tolerated. When music distortion in a 50-15,000 Hz system exceeds about 3 or 4%, listener fatigue eventually sets in.

Setting up broadcast equipment for least distortion by ear is out of the question today. FCC Rules require annual proof-of-performance measurements of audio transmitting equipment. When distortion or noise exceeds certain specified values, the station engineer must troubleshoot the equipment until the required performance is restored.

Harmonic Distortion

When FCC Rules were originally formulated, little was known about audio distortion. Today, two types of distortion are recognized—harmonic and intermodulation. When a single-frequency signal is put through an amplifier, any spurious output is harmonic distortion (or noise). But single frequencies seldom occur in normal program material, and with two or more frequencies in a signal, other effects can be observed. Like the mixer tube in a radio or TV receiver, which produces a beat, the usual audio stage produces a certain amount of beating between different frequencies. This beating is known as intermodulation distortion, or IM. Since only harmonic distortion is covered in the FCC proof-of-performance rules, the remaining discussion will be confined to such distortion only.

There are two ways of measuring harmonic distortion. One method—used in laboratories and certain other specialized applications—is to measure the level of each harmonic by means of a wave analyzer. By far the most common method is the measurement of THD (total harmonic distortion), and this is the method usually used for broadcast purposes. The subject has been covered extensively elsewhere (1, 2).

Pertinent FCC Regulations

The Commission has established limits for harmonic distortion in studio and transmitting equipment (3). Sec. 73.40 applies to AM stations and limits distortion to 5% from 0 to 84% modulation, and to 7.5% from 85 to 95% modulation. Sections 73.317 and 73.554 apply to commercial and noncommercial FM stations, respectively, and limit distortion to 3.5% from 50 to 100 Hz, to 2.5% from 100 to 7500 Hz, and to 3.0% from

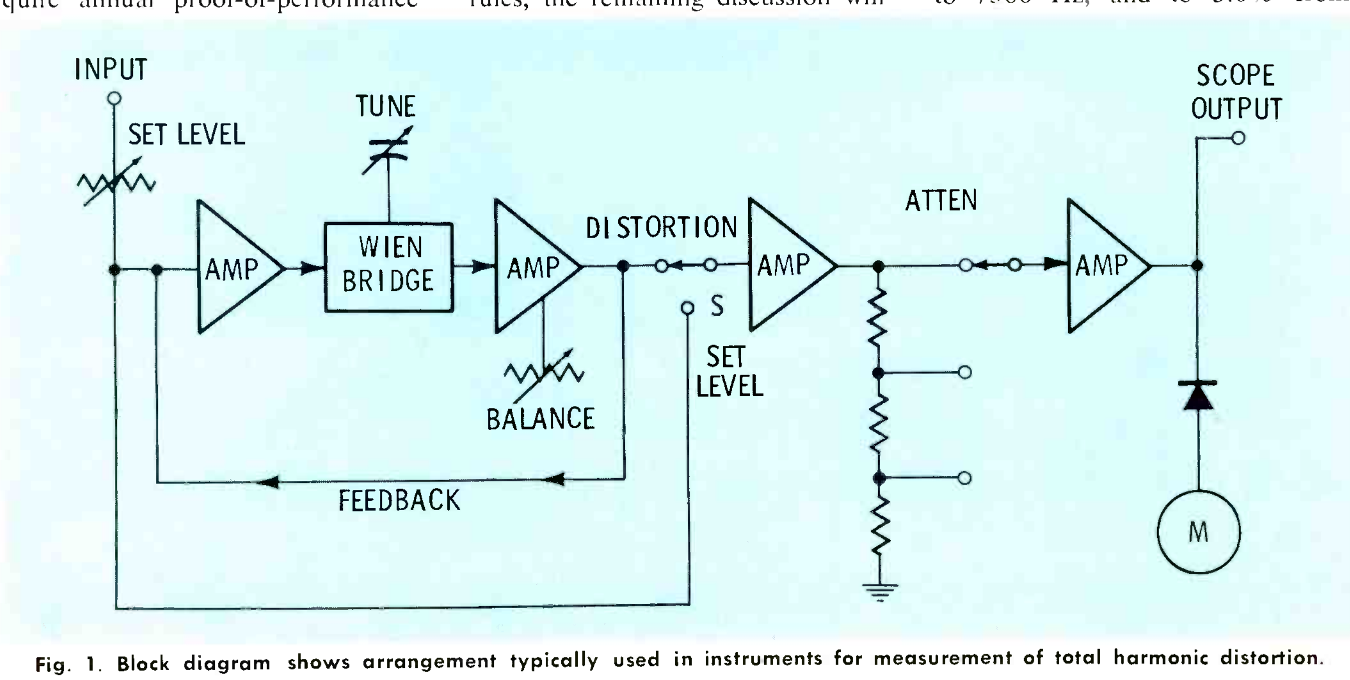

Fig. 1. Block diagram shows arrangement typically used in instruments for measurement of total harmonic distortion.

7500 to 15,000 Hz. Sec. 73.687 applies to TV stations, with the same requirements as for FM.

Sec. 73.47 (for AM stations) requires measurements to be made annually at 50, 100, 400, 1000, 5000, and 7500 Hz at 25, 50, 85, and 100% modulation. Harmonic measurements must be made up to the tenth harmonic or 16,000 Hz. Sec. 73.254 (for FM stations) requires annual measurements, including harmonics up to 30,000 Hz, at 50, 100, 400, 1000 and 5000 Hz at 25, 50, and 100% modulation, and at 10,000 and 15,000 Hz at 100% modulation.

There is no comparable requirement for annual proofing of the TV aural transmitter, but most engineers perform the measurements anyway to make sure the equipment is operating properly.

The Rules also provide for measurements of hum and noise. Limits are as follows: At AM stations, residual noise must be at least 45 dB below 100% modulation in the band 30-20,000 Hz. At FM stations, FM noise must be 60 dB below 100% modulation in the band 50-15,000 Hz. At TV stations, FM noise in the aural chain must be 55 dB below 100% modulation in the band 50-15,000 Hz. These hum and noise measurements are usually read on the HD meter. (Limits also are set for AM noise in FM and TV aural transmitters; for measurement techniques, see Reference 5, 6, 7, or 8.)

How the HD Meter Works

Total harmonic distortion is measured today by a system that has become standardized through practice. Fig. 1 is a block diagram of a hypothetical average HD meter. It is a typical circuit; some specific instruments may contain additional elements. In practice, the signal under test is fed to the input with switch S in the SET LEVEL position. The ATTEN switch is set to 100%, and the SET LEVEL control (at the input) is adjusted until the meter reads 100%. At this point, the total input to the instrument (fundamental plus any harmonics which may be present) is indicated on the meter as a reference level.

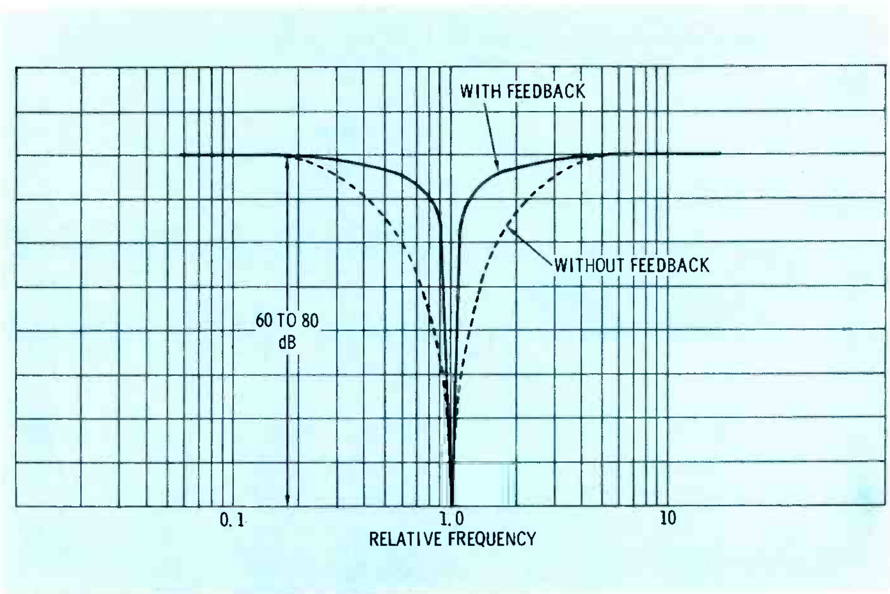

Fig. 2. Null-producing portion of HD meter produces rejection such as this.

Next S is thrown to the HD position, switching in the Wien bridge. The operator manipulates the TUNE control (a part of the bridge) and the BALANCE control (usually a part of a following amplifier) to null out the fundamental signal. With feedback, this null is quite sharp (Fig. 2). Once the fundamental has been removed, what is left is harmonic distortion and noise. The ATTEN switch is moved downrange until a meter deflection is obtained. This reading is the total harmonic distortion and noise in percentage.

To measure residual hum and noise in station equipment, the HD meter is used in the SET LEVEL position. First a reference 1000-Hz tone is fed through the ssytem, and the meter is adjusted to this signal so that it reads 0 dB. (The meter scale is marked in % distortion, dB noise or dBm, and possibly volts and millivolts.) Then the generator feding the 1000-Hz tone is disconnected from its power source. The HD meter is switched downrange until a reading is obtained. This reading is total hum and residual noise.

The oscilloscope output on the HD meter is usually a take-off point just before the meter rectifier. It is useful because it permits observation of the waveform being measured. The oscilloscope must have a high-impedance input (above 10K) to avoid loading the HD-meter circuit.

Some HD meters are furnished with a three-wire AC cord and a grounding plug. When this AC ground is used, the instrument must not be grounded at the case. Alternatively, the AC ground may be eliminated and a ground at the meter input used instead. The rule is: only one ground per instrument, to avoid ground loops and spurious pickup.

Meters in Use Today

Several models of HD meters are available for broadcast-station use today. Typical specifications might include: frequency range, 20-20,000 Hz; HD accuracy, ± 5% of full scale; lowest full-scale range, 1% (HD) and −50 dB (noise); residual HD and noise, 0.1%. Prices vary considerably, and generally the more expensive models have greater accuracy (usually far exceeding that needed for an audio proof) and permit measurements to be made more conveniently. Provided the operator knows what he is doing and knows the limitations of his equipment, most commercially available units can be used to perform satisfactory broadcast distortion measurements.

Operating Tips

Before accurate distortion measurements can be made, it is necessary to have an audio generator with low residual distortion. Generators are available—in the same price range as the HD meters—with

• *Please turn to page 137.*

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DIGITAL CIRCUITS FOR BROADCASTERS

by J. L. Smith*

Logic circuits are comprised of basic elements; these building blocks are described in this article.

Part 2 of four parts.

This is the second of a series of four articles being presented to provide a cursory look into the principles of digital circuits and how they may be applied to broadcast equipment. The first article provided an introduction to the subject by discussing binary states, binary numbers, and the general concept of logic circuits. This article will examine briefly the basic logic elements, *i.e.*, AND, OR, NOT, and Exclusive OR.

AND Circuit

The AND circuit, or AND gate as it is sometimes called, is in effect a special form of switch which has multiple inputs and a single output. The output is at logic 1 when, and only when, *all* the inputs are at logic 1. Several ordinary switches connected in series constitute an AND gate if a closed switch is defined as logic 1. The string of switches is a closed circuit when, and only when, all the switches are closed.

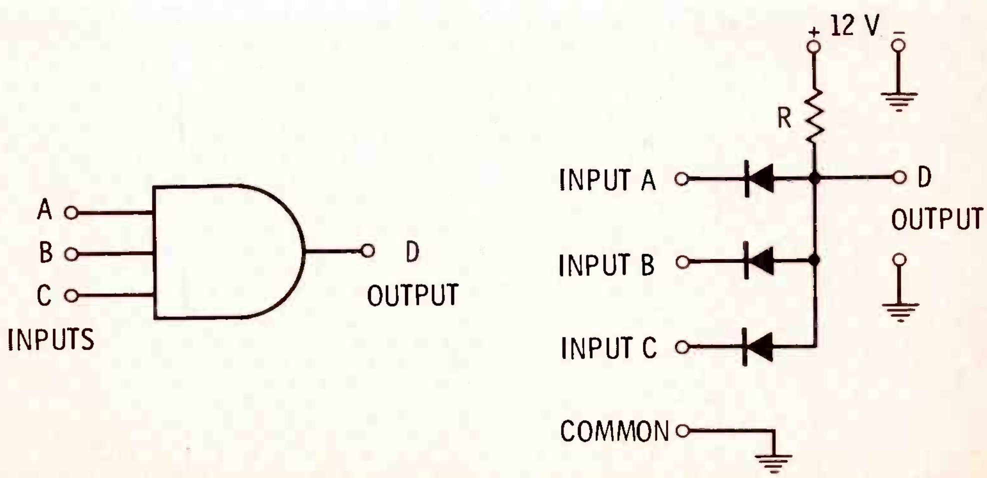
A truth table is a tabular representation of the output of a logic circuit for all possible combinations of the inputs. The truth table for a three-input AND gate is shown in Fig. 1, along with schematic representations of the same circuit. Fig. 1A shows that there are eight separate combinations of the three variables, A, B, and C, possible with a three-input gate. The number of combinations is 2^n, where n is the number of inputs. Also notice that the table starts with the binary number zero (000) and increases by adding one each time until the number seven (111) is reached. This method of generating the table insures that no combination is omitted. The output, D, is logic 1 only when all inputs are at logic 1.

Since digital equipment might employ a large number of identical AND gates, schematic diagrams are simplified by use of the symbol shown in Fig. 1B. The number of inputs may vary within limits, but there is always only one output.

*Manager, Broadcast Systems Engineering, Collins Radio Co.

AND			
A	B	C	D
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(A) Truth table



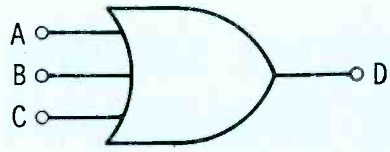
(B) AND symbol

(C) Schematic

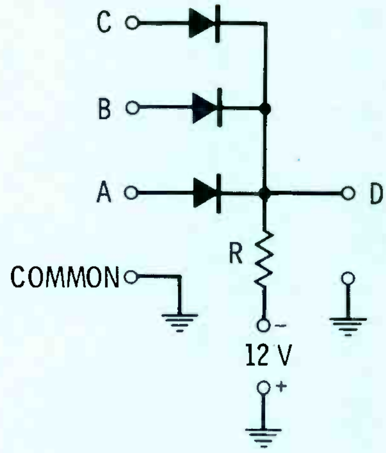
Fig. 1. Elements of AND gate are shown; circuit action is analogous to the action of switches connected in series.

OR			
A	B	C	D
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(A) Truth table



(B) OR symbol



(C) Circuit

Fig. 2. Diagrams and table show elements of the OR gate; circuit behavior is similar to that of switches in parallel.

Electrically, the AND gate may be implemented by the circuit in Fig. 1C. When inputs A, B, and C are at a logic 0, they are at ground potential. Current is from the +12-volt terminal, through resistor R and the diodes, to ground. *(Editor's note: Observe the distinction here between current, which is from positive to negative, and electron flow, which is from negative to positive.)* The output is at ground potential except for the forward voltage drop across the diodes, which is perhaps on the order of ½ volt. If only one or two inputs are raised to logic 1 (6 volts, for example), the output cannot rise to logic 1 because the third diode is still conducting and shunts the output, thus holding it at logic 0. When all three inputs are at logic 1, the output rises to logic 1 because there is no shunting path.

Logic circuits are simplified by use of a mathematical analysis called Boolean algebra, the algebra of the two-state variable. Boolean algebra will be discussed only briefly in this series. Algebraically, the three-input AND gate is represented by

$$ABC = D$$

This representation should not be confused with algebraic multiplication, for it is not. The expression should be read as "A *and* B *and* C equals D."

The AND gate is used to perform the logic needed when it is desired to have an indication that two or more occurrences are present simultaneously. For example, the three-input AND gate shown may be put to work by using D as the controlling signal to apply high voltage to a transmitter when: (A) the filaments are on, *and* (B) the blowers are running, *and* (C) the door interlocks are closed. If any one of these three input conditions is missing, the high voltage will not be activated.

Also, when A and B are inputs of serial binary data, then a level applied to C will serve to switch on and off the data A *and* B at the output. In this application, the AND circuit is used as a gate to control the function A *and* B, thus the name, AND gate.

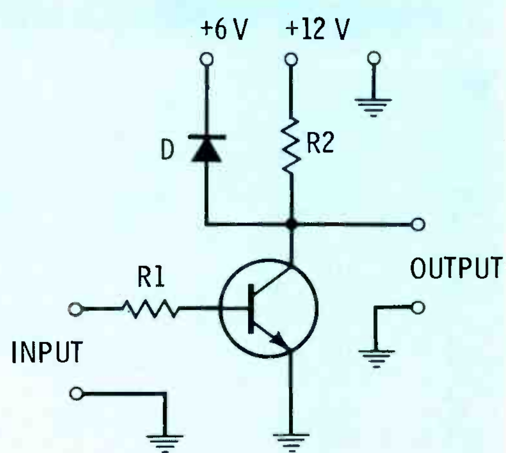
OR Circuit

The OR circuit, sometimes called an OR gate, is another form of special switch which has multiple

NOT	
INPUT	OUTPUT
1	0
0	1

(A) Truth table

(B) NOT symbol



(C) Schematic

Fig. 3. Elements of the NOT circuit; circuit action produces output that is the complement of the input logic level.

inputs and a single output. The output of the OR gate is logic 1 when *any* of the multiple inputs is at logic 1. The OR gate can be visualized by considering a number of ordinary switches in parallel and defining logic 1 as a switch closure. It matters little if one or many switches are closed, the result is still a closed circuit.

The truth table describing a three-input OR gate is shown in Fig. 2A. The schematic representation is shown in Fig. 2B, and the diode logic implementing the OR is shown in Fig. 2C.

By comparing the truth tables of the AND gate and the OR gate, it is noticed that one truth table can be made identical to the other if the 1's and 0's are interchanged. (When this substitution is made in, say, the truth table in Fig. 2A, the resulting table is inverted with respect to the truth table in Fig. 1A, but otherwise identical to it.) Consequently, it is said that the OR gate is the complement of the AND gate, and a logic 1 is the complement of logic 0.

Electrically, implementation of the OR gate is similar to that of the AND gate, but it is important to note some of the complementary features in the electrical circuit. The supply voltage is negative in the OR gate, whereas it was positive in the AND gate. Also, the diode polarity is reversed. When all inputs are at logic 0 (ground potential), current is through the diodes and resistor R to the −12-volt terminal. Under this condition, output D is at logic 0. (The output is below ground potential by the forward drop across the diodes. This is part of the logic noise and is negative in this particular configuration, whereas it is positive in the AND gate.)

When any *one* of the inputs is raised above ground by applying a logic 1 (+6 volts, for example), all the other diodes are back-biased by this amount, and the output is allowed to go to logic 1.

The Boolean-algebra expression for the OR gate is written as

$$A+B+C=D$$

An additional word of caution is worthwhile here. The above expression *does not* represent the algebraic sum of the terms, but is read as "A *or* B *or* C equals D."

The OR gate is used when it is desired to have an indication when any one of several occurrences takes place. The three-input OR gate may be used to let D *remove* high voltage from the transmitter when: (A) the cabinet temperature exceeds a high limit, or (B) the VSWR exceeds a high limit, or (C) the plate current exceeds a high limit.

NOT Circuit

A NOT circuit is a device with one input and one output. The output is always the complement (opposite state) of the input; that is, if the input is logic 1, the output is logic 0, and vice versa. The NOT circuit is best visualized as a phase-inverting transistor stage operating in the saturated mode. Fig. 3 presents the elements of the NOT circuit.

When a logic signal is passed through a NOT circuit, the complement of the signal appears at the output. Fig. 3C shows how this is accomplished. If logic 1 (+6 volts, for example) is applied to the input, the transistor is turned on to saturation. The collector-to-emitter resistance becomes very low, and the output is at zero potential except for the saturation voltage across the transistor. Resistor R1 serves to limit the base current of the transistor, and R2 serves to limit the collector current. When the input is logic 0 (0 volts), the transistor does not conduct, the collector-to-emitter resistance is high, and the output rises. Clamp diode D prevents the output from rising above +6 volts; when the transistor is off, current flows througfh R2 and D to the +6-volt terminal and, in effect, the output is connected to the +6-volt supply. When the transistor is conducting, the diode is back-biased and is effectively out of the circuit. Therefore, the logic levels at the output of the NOT are the same as the levels at the input.

The Boolean-algebra expression for the output of the NOT circuit with a signal applied to the input is $\bar{A}$. This is read as "A complement," or simply "A bar."

The NOT is used when it is desired to perform a function with the *absence* of an occurrence. For example, generally speaking, a voltage level (logic 1) is required to operate a relay, turn on a light, etc. If it is desired to perform one of these operations when the control function is at ground potential (logic 0), then the control function is run through a NOT to obtain the complement level. $\bar{A}$ is logic 1 when A is *not* logic 1.

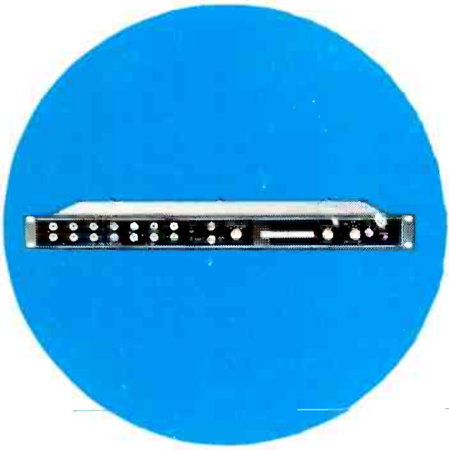
The output of the NOT may be used to operate a shorting switch across the high-voltage filter capacitor when the high voltage is not turned on. If one side of an SPDT switch is designated A, then the other side is automatically $\bar{A}$ because when one side is open, the other is closed and vice versa.

Exclusive OR Circuit

The Exclusive OR circuit is a special form of the OR gate and is made up of a combination of OR gates and NOT circuits. The Exclusive OR has two inputs and one output. The output is logic 1 when either (but not both) of the inputs is logic 1; it is logic 0 when both of the inputs are logic 1 or logic 0. Fig. 4A demonstrates the usefulness of the truth table by clearly showing the logic of the Exclusive OR.

The implementation of the Ex-

• *Please turn to page 115.*



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TV SYSTEMS, CLOSED CIRCUIT

2500-MHz Reception and Distribution

by Allen Pawlowski*—

Consideration is given to the requirements for getting the signal from the receiving antenna to the set.

Assignments in the 2500-MHz ITFS band are made according to a frequency plan which specifies channel groupings (Table 1). Each group consists of four 6-MHz channels spaced 6-MHz apart. This is the typical semi-adjacent channel spacing used in TV broadcasting, so a single unit can be used to receive ITFS channels and convert them to semi-adjacent VHF channels, typically 7, 9, 11, and 13. The converted channels are then amplified and distributed through cable to standard classroom receivers. The converter and distribution system must handle these signals together.

Computations of signal level and fade margin for the 2500-MHz converter must include distribution-system considerations. The first involves signal-to-noise ratio. This is a measure of how much snow is in the picture. The second comes about because the converter and distribution system must handle more than one channel at the same time. The basic system parameter in question here is multichannel intermodulation. This is a measure of how much the signal of one channel interferes with another.

The job of the systems designer is to understand the principles of noise and intermodulation and to apply this understanding carefully to each system. On the one hand, he must maintain signal levels sufficiently high to prevent snowy pictures. On the other hand, he must carefully maintain operating levels below the intermodulation point of the equipment used. This means that any system performs best if it operates at levels between these two areas of degradation. How these degrading parameters are defined and behave in a system is the basis of this article. Also discussed is the interaction between the 2500-MHz receiver and the school distribution system.

Signal-to-Noise Ratio

Table 2 lists picture-quality definitions for different values of signal-to-noise ratio. These definitions are based on reports by the Television Allocations Study Organization (TASO). The levels given have been adjusted to represent RF measurements as opposed to video measurements.

The list of picture definitions in Table 2 gives the system designer some basis upon which to make recommendations. It must be his objective to provide high-quality viewing in the classroom while not over-engineering the system.

Intermodulation

Multichannel intermodulation is, as stated earlier, a measure of how much a signal on one channel is interfering with that on any other channel. Just as there is a list of definitions for signal-to-noise ratio, there is one for intermodulation also. This list, Table 3, has grown out of the CATV industry and has become that industry's standard. Intermodulation is more commonly stated in percent or dB below the desired signal, as shown in the table, rather than as a ratio.

Here again are some basic considerations which will assist the systems design engineer in providing high-quality viewing in the classroom.

Application

Application of the factors just discussed involves the operating parameters of the equipment used in a system. Since the amount of equipment used depends on the size of the system, it is better for purposes of discussion to consider one that is moderately large. Assume that four amplifiers in cascade are required to distribute signals to all classroom outlets. Also assume that it is desired to distribute local TV and ETV broadcast signals in addition to the ITFS signals. This can easily require a distribution system designed for 7 to 12 channels, so assume that 12

Table 1. ITFS Channels

Group A		Group B		Group C		Group D	
Channel No.	Band limits MHz	Channel No.	Band limits MHz	Channel No.	Band limits MHz	Channel No.	Band limits MHz
A-1	2500-2506	B-1	2506-2512	C-1	2548-2554	D-1	2554-2560
A-2	2512-2518	B-2	2518-2524	C-2	2560-2566	D-2	2566-2572
A-3	2524-2530	B-3	2530-2536	C-3	2572-2578	D-3	2578-2584
A-4	2536-2542	B-4	2542-2548	C-4	2584-2590	D-4	2590-2596
Group E		**Group F**		**Group G**		**Group H**	
Channel No.	Band limits MHz	Channel No.	Band limits MHz	Channel No.	Band limits MHz	Channel No.	Band limits MHz
E-1	2596-2602	F-1	2602-2608	G-1	2644-2650	H-1	2650-2656
E-2	2608-2614	F-2	2614-2620	G-2	2656-2662	H-2	2662-2668
E-3	2620-2626	F-3	2626-2632	G-3	2668-2674	H-3	2674-2680
E-4	2632-2638	F-4	2638-2644	G-4	2680-2686		

*Senior Systems Engineer, Educational and Communications Systems Div., Jerrold Electronics Corp.

Table 2. Picture Quality vs S/N Ratio

S/N Ratio (dB)	Picture Quality	Picture Quality Definition
49	Excellent	Snow-free pictures as judged by all viewers
39	Fine	Just perceptible background snow
33	Good	Snow in picture but not yet objectionable
29	Marginal	Somewhat objectionable snow

Table 3. Intermodulation Criteria

Level	Definition
—46 dB or 0.5%	Level at which the interference is not visible when viewing an average picture
—52 dB or 0.25%	Level at which the interference is not visible when viewing a blank (white) screen

channels are required. It is now possible to look at the distribution system to see what considerations will reflect back to the 2500-MHz system design.

Amplifier Levels

One typical amplifier for multichannel cascaded systems is of the split-band type, with separate low- and high-band sections. Only the high-band section will be considered here, since that is the portion which will handle the converted ITFS signals. The pertinent specifications for this amplifier are as follows:

Gain: 40 dB maximum, can be reduced with the gain control to 30 dB
Noise Figure: 9 dB maximum
Output Capacity: +46 dBmv per channel for 12 channels at 0.5% cross modulation

With this information given, it is possible to determine the best operating conditions for the distribution system. This will result in the important operating parameters of signal-to-noise ratio and overload limits.

First, it is necessary to determine the noise level at the output of the last amplifier. This is expressed as:

$$\text{Noise dBmv} = -59 + F + G + 10\log_{10} N$$

where,
F is the individual amplifier noise figure in dB,
G is the operating gain of the amplifier, and
N is the number of amplifiers in cascade.

In the example:

$$\text{Noise dBmv} = -59 + 9 + 37 + 10\log_{10} 4 = -7 \text{ dBmv}$$

(Operating gain of 37 dB selected to provide 3-dB maintenance margin).

With the level of noise at the last amplifier found, it is now necessary to determine the maximum permissible signal level to assure operation below visible cross modulation. This can be done by calculating the derating figure for the number of amplifiers in cascade and subtracting this result from the maximum permissible output for one amplifier. The derating calculation is the same as used for the noise computation above, $10 \log_{10} N$. For four amplifiers in cascade, this is 6 dB.

At this point, it becomes necessary to look into the meaning of the term "maximum output." The specification for the amplifier says that the output will contain not more than 0.5% cross modulation when operation is with 12 channels at a level of + 46 dBmv. Considering the system as a whole, the cross modulation cannot be allowed to exceed the 0.5% level. The engineer must, therefore, derate the amplifier so that the entire cross-modulation latitude is not consumed by this portion of the system. A minimum of 3-dB derating is desirable. This means that half the permissible cross modulation is generated by the distribution amplifiers and the remainder is reserved for other system equipment. The total derating is, therefore, 9 dB from catalog rated output, or +46 dBmv −9 dB derating = +37 dBmv maximum output per channel.

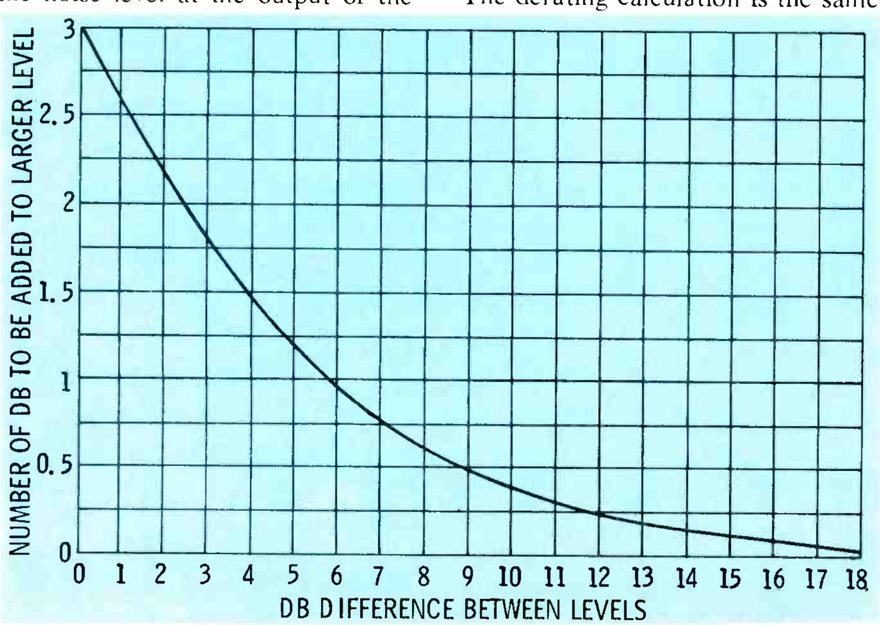


Fig. 1. Graph shows the result when two different noise levels are combined.

S/N Ratio

By comparing the maximum output of the system amplifiers, +37 dBmv, with the noise output computed earlier, −7 dBmv, it can be seen that the quality of signal delivered to the last outlet on the system is limited by the system to a 44-dB signal-to-noise ratio. Table 2 shows that the system qualifies as "extra fine," in that performance is located between the "fine" and "excellent" ratings. This rating, however, holds true only if the input signal is noise free. Thus, two important points are indicated: (1.) The picture quality at the last outlet can be no better than 44 dB S/N as controlled by the system. (2.) If the input signal contains noise, this noise will add to that generated by the system and result in an overall degradation of pictures.

At first glance, it would seem that nothing but the best-quality input signal can be tolerated. At second glance, it can be seen that this is not really true. Fig. 1 shows how two noise levels add. For example, this graph shows that when two noise levels are equal (0-dB difference) the combined level is 3-dB higher than the individual levels. When the difference between two noise levels is 6 dB, the combined level is only 1-dB higher than the highest level.

To illustrate: If the signals delivered by the converter have a 50-dB signal-to-noise ratio, they will combine with the 44-dB signal-to-noise ratio of the system to deliver signals of 43-dB signal-to-noise ratio at the system extremities. These are the desirable operating conditions for the system, and performance still qualifies as "extra fine" in picture rating.

Fading

One last consideration must now be brought into play; this is the fading of the 2500-MHz air signals. The calculations must include a fade margin to some minimum permissible received level. Fade-margin allowances (Fig. 2) are based on 99.99% reliability for this range of frequencies. The minimum signal quality at the maximum fade condition can be selected from Table 2. Here it is desirable to use the 33-dB point. This is known to be a snowy picture and not objectionable, especially since the duration of fading this deep will be very short, usually in the range of a few seconds.

By now, there are enough things under consideration to require a graphic representation to keep them all in order. Fig. 3 is a plot of these items. Note first the consideration of the school distribution system. Regardless of where the school is, the system will be designed for a minimum operating signal-to-noise ratio of 44 dB (line 1 on the graph). So as not to degrade this operation by more than 1 dB, the unfaded signal quality from the ITFS converter is designed to have a minimum signal-to-noise ratio of 50 dB (line 2 on the graph). Under a maximum faded condition, the quality of converted signal would follow the dash line (line 3) on the graph. Note that maximum expected fading does not cause degradation to the

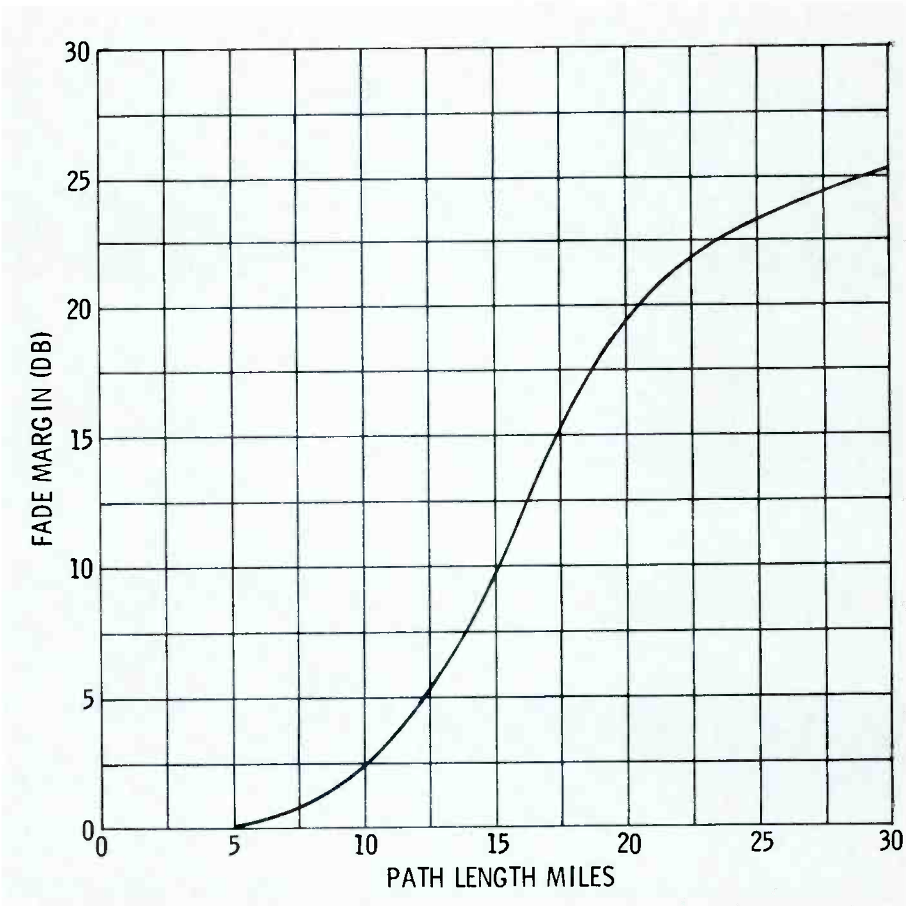


Fig. 2. Fade margin for 2500-MHz band is shown as a function of path length.

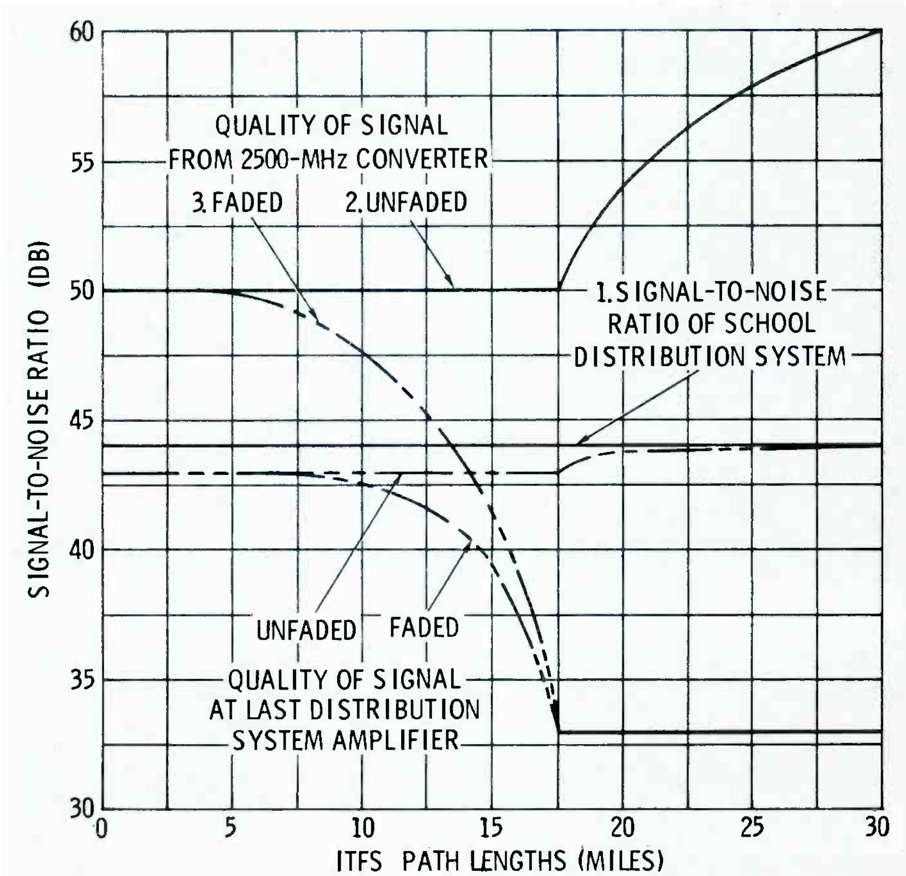
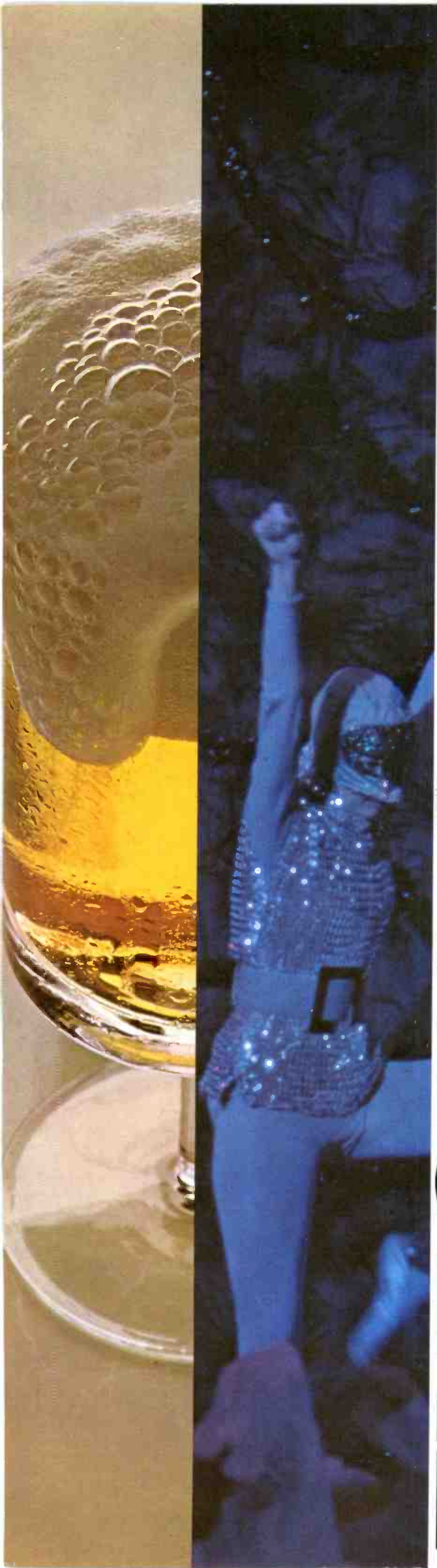


Fig. 3. Graphical plot shows factors being considered in design of the system.



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selected 33-dB minimum S/N until the path length has reached 17.5 miles. For paths that exceed 17.5 miles, it is necessary to design for higher receiver signal input to prevent fading below the selected minimum.

Received Signal

Until now, signal quality has been discussed in terms of signal-to-noise ratio. It is now necessary to relate this to actual operating levels for a typical 2500-MHz converter. This involves application of the formula for determining the noise threshold of a given unit:

$$\text{Noise dBw} = -204 + F + 10 \log_{10} B$$

where,

F is the converter noise figure in dB, and

B is the bandwidth consideration in Hz.

One typical ITFS converter has a specified noise figure of 13 dB. The formula also requires a bandwidth consideration. Since a standard video signal is involved, a bandwidth of only 4 MHz need be considered. Substituting these values in the formula:

$$\begin{aligned}\text{Noise dBw} &= -204 + 13 \\ &\quad + 10 \log_{10} (4 \times 10^6) \\ &= -204 + 13 + 60 \\ &\quad + 10 \log_{10} 4 \\ &= -125 \text{ dBw}\end{aligned}$$

The calculated noise threshold is −125 dBw for this particular converter. For a 50-dB signal-to-noise ratio, 50 dB is added to the −125 dBw level, resulting in a desired level of −75 dBw. This is the minimum design signal level for paths up to 17.5 miles long. Beyond that distance, the input signal level required increases as indicated by Fig. 3. The input requirement shown in Fig. 4 represents a compromise between high cost and substandard performance. This graph is provided on a universal basis in that it can be used with any receiver/converter having a noise figure between 5 and 15 dB.

Application of Fig. 4 is illustrated by the following example. A receiver/converter is quoted as having a noise figure of 9 dB maximum. Assume that a school is located 20 miles from the transmitter. The intersection of 20 miles with the design curve is extended to an intersection with the 9-dB receiver noise-figure line. The required input signal is determined by extending this intersection diagonally downward to the scale and reading −74.5 dBw, for this example.

Conclusion

A rather long series of conditions has been taken into account here. The example used is not unreal, yet it carries all considerations to their extremes which, in practice, will be the exception rather than the rule. The objective was to set some standards of operation that would allow for future expansion that could easily reach the conditions of the example. In either smaller systems or ones carrying fewer channels, utilizing the graphs and other parameters recommended will provide the margin for expansion which, in education, is the rule rather than the exception. ▲

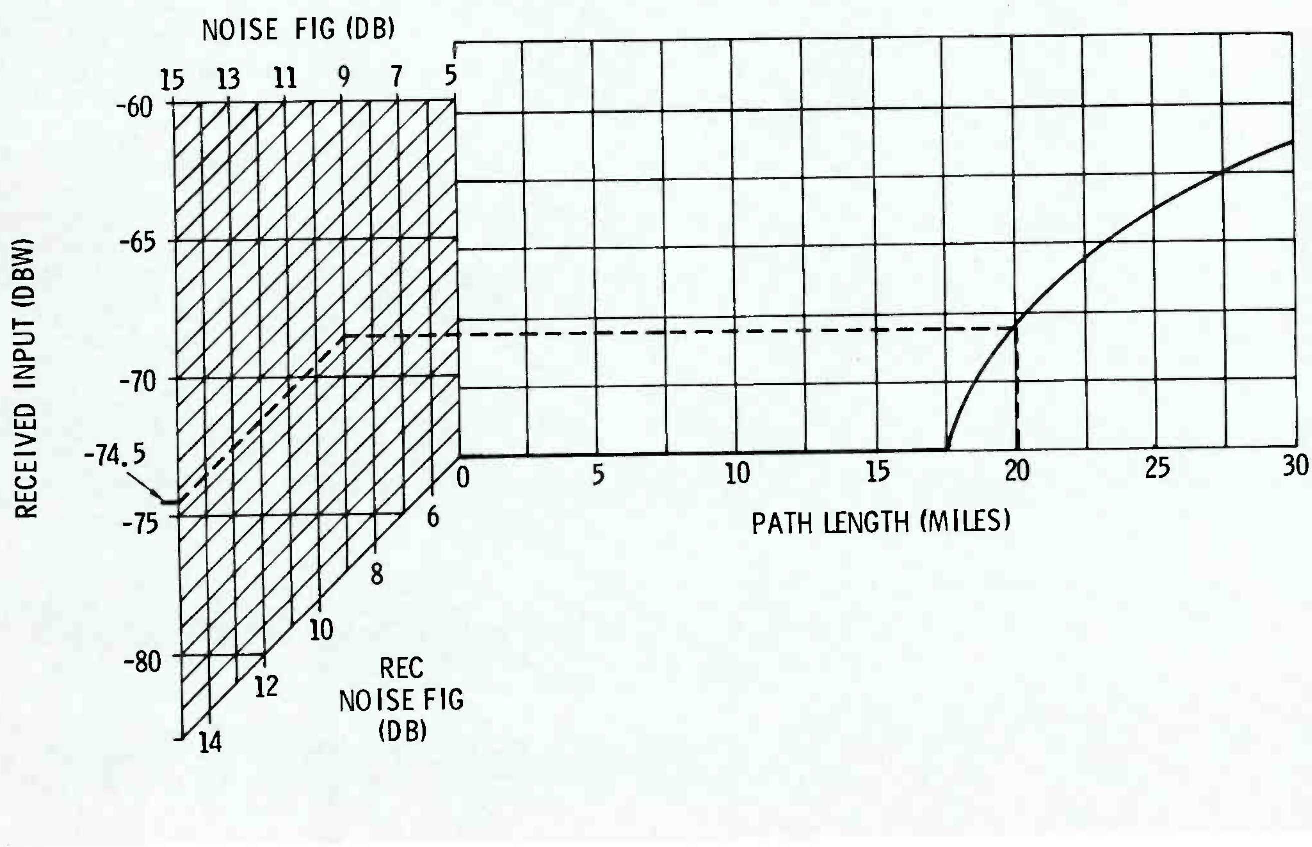


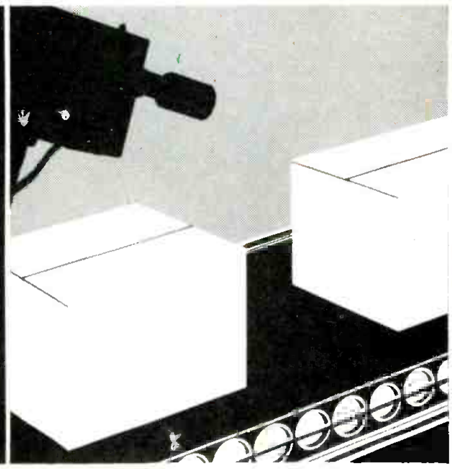
Fig. 4. 2500-MHz received-signal design curve relates the required signal to the path length and receiver noise figure.

For Whatever Is Worth Watching...

BROADCASTING

TYPES	COLOR FILM CAMERAS
7038V, 8572V, 8134V	PE 24, PE 240, TK 27
	LIVE COLOR CAMERAS
Z-7929R, Z-7929G, Z-7929B	TK 42, TK 43

INDUSTRIAL AND ETV



TYPES	FEATURES
7735B	EXTREMELY LOW LAG *excels in live pickup*
8484	HIGH SENSITIVITY *industrial remote use*
7262A	LOW HEATER POWER *for remote surveillance*
8507A	HIGH RESOLUTION *separate mesh 7735B*
8572	HIGH RESOLUTION *separate mesh 8484*

OR WHATEVER

APPLICATION REQUIRING EMPHASIS ON:

Sensitivity
Very High Resolution
Spectral Response
Ruggedness
Reticule Face Plate
Radiation Resistance
Minimum Lag
Extended Persistence

Do It Better with General Electric Vidicons!

Whatever TV camera you use or whatever your application... General Electric vidicons provide better pictures, performance and reliability. Significant advances in vidicon chemistry give the *lowest lag* of any vidicon available for demanding television applications. Similar advances now allow a selection of vidicons with a notable combination of long life and high sensitivity.

For Top-Notch Broadcasting—GE vidicons give the best picture your live and color film cameras were designed to produce, to an audience where only the best is good enough!

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GENERAL ELECTRIC

288-15

March 1968

We interrupt this magazine to bring you. . .

Late Bulletin from Washington

by Howard T. Head

New Nighttime Interference Calculations Studied

Comments are due soon on a Commission proposal for the adoption of new rules governing the calculation of AM directional-antenna patterns and mutual interference among stations employing such antennas. The purpose of the proposal is to establish uniform tolerances on directional-antenna patterns. This would have the dual advantages of ruling out the filing of impractical proposals, and of permitting the calculation of patterns and skywave interference using high-speed digital computers. Extensive studies of the Commission proposal have been made on an informal basis by the Association of Federal Communications Consulting Engineers (AFCCE).

The new proposal would replace all existing directional-antenna patterns with those calculated using the new standardized method. The method presently under study would establish calculated patterns based on the assumptions of sinusoidal thin-wire current distribution, an infinite ground plane, and an assumed 1-ohm loss resistance in series with each element of the antenna system. Tolerances would be established by augmenting the calculated pattern with a 5% tolerance, to which would be added a quadrature term consisting of 3.5% of the rms value of the horizontal-plane pattern. In no event would an inverse field less than 6 mv/m be permitted.

The patterns for licensed directional antennas now in operation have been computed by a variety of methods, and few, if any, correspond to the patterns determined under the new proposal. If this proposal is adopted, the Commission would consider requiring all existing licensees to file new patterns and interference studies in accordance with the new procedure. Readjustment of existing directional antennas might be required of stations whose patterns exceed those computed by the new methods.

Presunrise Activity for AM Stations

The United States has held informal discussions in Ottawa with engineers of the Canadian Department of Transport (DOT), looking toward further extension of hours under Presunrise Service Authority (PSA). The present agreement with Canada provides relaxed requirements for determining presunrise interference requirements where Canadian stations are affected; however, presunrise operation may not begin until 6:00 a.m. local standard time. Canadian consent is being sought to permit presunrise operation to begin at 6:00 a.m. daylight time. Both daytime-only and unlimited-time stations would be affected.

A number of unlimited-time stations have taken advantage of the provisions for operation with daytime facilities between 6:00 a.m. and local sunrise with power in excess of 500 watts (see January 1968 Bulletin). In some instances, presunrise power must be reduced below the regularly licensed daytime power, and three modes of operation -- daytime, nighttime, and presunrise with reduced power -- result. One particularly burdensome effect involves stations operating directional antennas by remote control; inspections at the transmitter are required within two hours after commencing any directional mode of operation, and as many as three modes may be involved for some stations. In some cases, the Commission has relaxed this requirement to the extent of permitting omission of inspections where operation in a given mode lasts for less than one hour. Specific permission must be sought for such relaxation in each individual case.

Noncommercial Educational FM Agreement With Canada Sought

The Commission delegation discussing AM presunrise operation with the Canadian officials also discussed international agreement on a table of FM channel assignments covering the noncommercial band (Channels 201-220, inclusive). Agreement with Canada is essential before the Commission can implement its proposals to adopt a Table of Assignments and new Technical Standards for noncommercial educational FM stations (see January 1967 Bulletin).

Meanwhile, television stations on Channel 6 are apprehensive about possible interference caused to channel-6 (82-88 MHz) reception by operations in the noncommercial FM band (88-92 MHz). The Commission is proposing to limit this interference by confining the higher-power FM stations to channels near the upper end of the noncommercial band. However, available reports, including one published by the Commission Chief Engineer's office, indicate that it may not be possible to eliminate completely all interference caused by noncommercial educational FM stations to channel-6 television reception.

Land Mobile/Television Frequency Struggle Intensifies

A special all-industry Committee has been formed jointly by several leading television trade associations to combat the threat to television channel assignments imposed by the increasing demands of the land mobile radio services (see February 1968 Bulletin). The Advisory Committee for the Land Mobile Radio Services, composed solely of land-mobile radio manufacturers and users, has submitted a detailed report to the Commission. The report concludes that existing frequency space cannot accommodate expected land-mobile expansion, and it proposes that television channels be reallocated to land mobile services. Included in the proposals is a suggestion that the Commission look toward the ultimate shift of all home television reception from broadcasting to wire distribution, such as that provided by CATV.

Short Circuits

Effective March 15, the Commission will issue provisional third-class radiotelephone permits, good for a twelve-month period, by mail (see November 1967 Bulletin). . . The U.S. and Mexico have extended the existing AM treaty through 1968, pending the negotiation of a new treaty. . .Proposed rules to require the display of call signs of television auxiliary stations on the antenna supporting structure have been made final. . .An ETV station has been granted a waiver of the rule requiring a first- or second-class operator on duty in control of the television STL station. . . NAB has asked the Commission to simplify the AM and FM program logging rules.

Howard T. Head. . .in Washington

ANDREW

lower attenuation

higher power

8″ diameter flexible HELIAX® coaxial cable

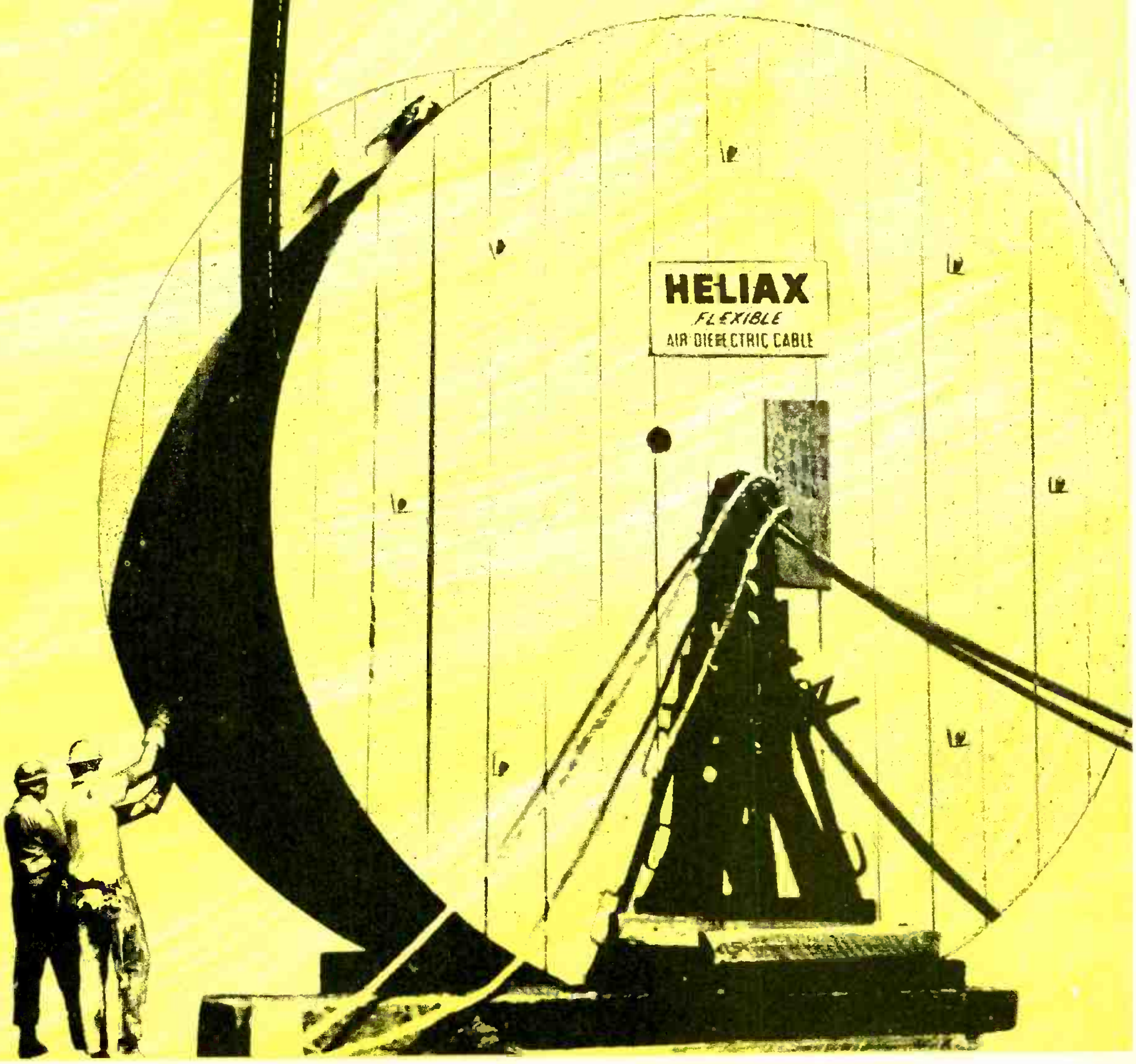
8″ Air dielectric HELIAX coax extends the advantages of flexible cable to very low attenuation or very high power applications that formerly required rigid transmission line.

Corrugated inner and outer copper conductors accommodate thermal expansion without the need for sliding contacts. End connectors mate with 6⅛″ EIA flanges and lock inner and outer conductors together to eliminate differential expansion.

The continuous, connector free cable assures freedom from the VSWR "spikes" associated with the periodic inner connectors of rigid line in a long feeder. Cable assemblies can easily be electrically tested on the reel to assure your exact system performance. For complete details write Andrew Corporation, 10500 West 153rd Street, Orland Park, Illinois 60462.

HJ 10-50 HELIAX COAXIAL CABLE

	At 30 MHz	At 600 MHz
Attenuation	.027 dB/100 ft	.15 dB/100 ft
Average Power	300 kW	58 kW
Other Power Ratings	For SSB, 200 kW PEP with antenna VSWR of 3:1 2 Megawatts Peak	TV transmitter power ratings, 223 kW at Channel 4 and 70 kW at Channel 35



2-68

Circle Item 20 on Tech Data Card

FOR ANY *FM* POWER

The CCA FMA-6601 is a medium power, (1KW per bay) horizontally polarized element, constructed of stainless steel with basic broad band characteristics. Minimum windloading weight per bay is only five pounds. Available up to 16 bays. Cost approximately $350.00/bay. Basic cost includes matching transformer with guaranteed VSWR of 1.1:1. Can be used in following suggested popular combinations:—

1KW Trans. + 4 Bay Ant. = 3KW ERP
5KW Trans. + 6 Bay Ant. = 25KW ERP
5KW Trans. + 12 Bay Ant. = 50KW ERP
10KW Trans. + 12 Bay Ant. = 100KW ERP

FOR CLASS "A" FM CHANNELS

***3KW ERP HORIZONTAL + *3KW ERP VERTICAL**

CCA FM-3000D (3KW Trans.) + CCA FMA-6811-3 (3 Bay Circular Antenna = 3KW-H 3KW-V

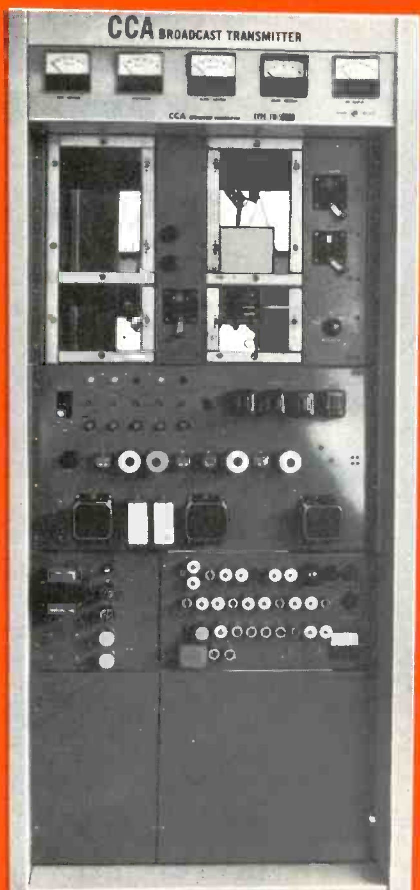
$8,995.00 + $1,350.00 = $10,345.00

***3KW ERP HORIZONTAL**

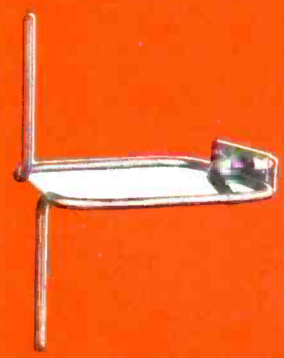
CCA FM-1000D (1KW Trans.) + CCA FMA-6601-4 (4 Bay Horizontal) = 3KW-H

$5,795.00 + $1,400.00 = $7,195.00

The popular CCA FM-3000D, 3KW FM Broadcast Transmitter uses the famous CCA grounded grid circuitry and an Eimac, zero bias tetrode—3CX3000A7. This tube only costs $265.00 and tube life of 15,000—to 20,000 hours are not unusual when used in the super cooled, conservatively rated CCA FM-3000D. Other features including 20KW RF tuning components, complete accessibility, calibrated controls, sealed control relays, 3 cycle automatic recycling, no requirement for neutralization. These are but a few of the many features that have made the CCA FM-3000D, the broadcasters most popular choice in their Class "A" 3KW circularly polarized stations.



FRONT VIEW CCA FM-3000D



The CCA FMA-6811 is a medium powered (1KW per bay) circularly polarized antenna. Rugged stainless steel construction, but with minimum windloading. Weight per bay is only seven pounds. Available to 16 bays. Cost approximately $450.00/bay. Basic patterns are comparable to higher power units. Excellent for medium and low power applications. Suggested popular combinations:—

1KW Trans. + 7 Bay Horiz. = 3KWH + 3KWV
3KW Trans. + 3 Bay Ant. = 3KWH + 3KWV
5KW Trans. + 12 Bay Ant. = 25KWH + 25KWV
10KW Trans. + 12 Bay Ant. = 50KWH + 50KWV

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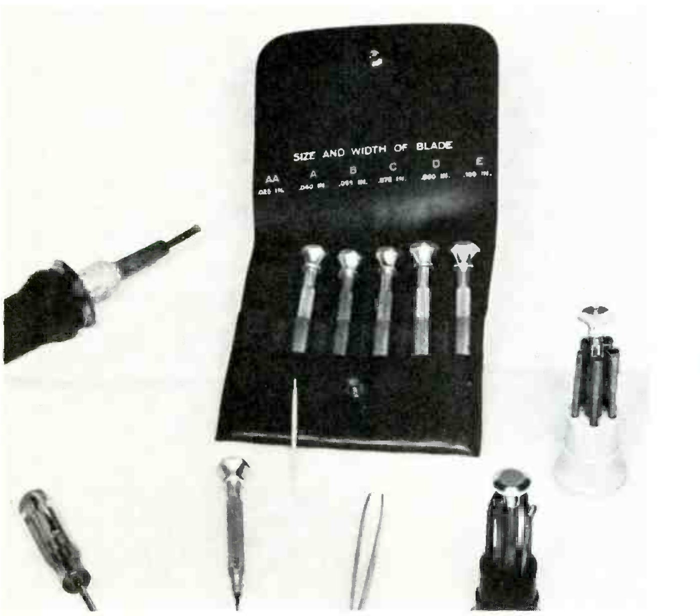
RECENT CCA BROADCAST CUSTOMERS

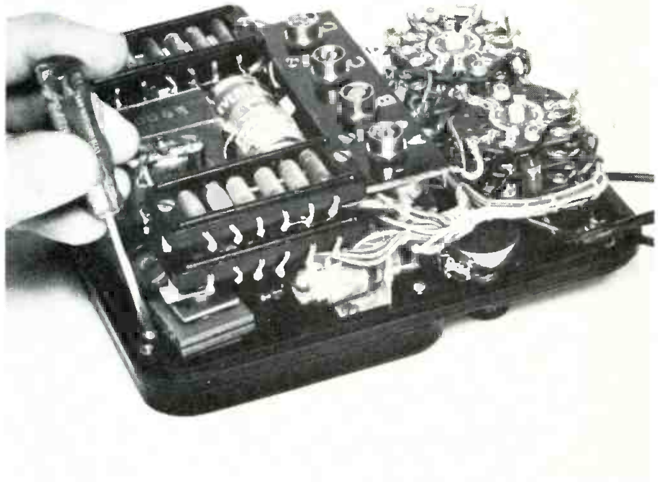
1KW-AM—WAYS, Charlotte, No. Car.; WRBN, Warner Robins, Ga.; WVMG, Cochran, Ga.; WJTS, Jupiter, Fla.; WIXI, Lancaster, Ky.; WKAL, Rome, N. Y.; WSEB, Sebring, Fla.; WBOM, Jacksonville, Fla.; WNES, Central City, Ky.; WEEW, Washington, No. Car.; WAZS, Summerville, So. Car.; KAGT, Anacortes, Wash.; KENT, Prescott, Ariz.; KTCH, Wayne, Nebr. • ***5KW-AM***—WFIF, Devon, Conn.; WCOA, Pensacola, Fla.; KPUG, Bellingham, Wash.; KVOR, Colorado Springs, Colo.; WQIZ, St. George, So. Car.; KOSG, Pawhuska, Okla.; WKOP, Binghamton, N. Y.; WVAM, Altoona, Penna.; KATN, Boise, Idaho; KDOT, Scottsdale, Ariz. • ***10KW-AM***—CHOO, Canada; KTAC, Tacoma, Wash. • ***250W-FM***—Lane Community College, Eugene, Ore.; B & B Broadcasting, Greenville, Penna. • ***1KW-FM***—WYGO, Corbin, Ky.; KOTO, Alamogordo, N. Mex.; WOZK, Ozark, Ala.; WMAS, Springfield, Mass.; WSIP, Paintsville, Ky.; WVMG, Cochran, Ga.; WNGO, Mayfield, Ky. • ***3KW-FM***—WNWC, Arlington Hts., Ill.; WRIO, Rio Grande, N. J.; WLCK, Scottsville, Ky.; KLCO, Pouteau, Okla.; KWHP, Edmond, Okla.; WLBC, Muncie, Ind.; WSEN, Baldwinsville, N. Y.; KSWM, Aurora, Mo.; WRLS, Hayward, Wisc.; WOCO, Oconto, Wisc. • ***5KW-FM***—WAKW, Cincinnati, Ohio; KUAC, College, Alaska; WGUS, North Augusta, So. Car.; WGVM, Greenville, Miss.; KCSC, Edmond, Okla. • ***10KW-FM***—WDAS, Philadelphia, Penna.; WAEF, Cincinnati, Ohio; WWQT, Gainesville, Ga.; WHOS, Decatur, Ala.; KMYR, Denver, Colo.; KCMS, Manitou Springs, Colo.; WIFI, Philadelphia, Penna.; WMAS, Springfield, Mass.; WFMG, Gallatin, Tenn.; WFMF, Chicago, Ill.; WRVM, Madison, Wisc.; WNES, Central City, Ky.; WGNU, Granite City, Ill.; WAMO, Pittsburgh, Penna.; KXLS, Oklahoma City, Okla.; WCOA, Pensacola, Fla. • ***20KW-FM***—WOPA, Oak Park, Ill.; KNDX, Yakima, Wash.; WAGY, Forest City, No. Car.; KALF, Mesa, Ariz.; KGAF, Gainesville, Tex.

Making Meter Repairs

If there are useless meters lying around your station, there needn't be. Minor repairs can be made by anyone with steady hands. This article can't help you in those instances where the FCC Rules and Regulations state specific repair requirements (*e.g.*, Sections 73.39, 73.320, and 73.688); but in the case of meters used in noncritical applications, a broken glass or a sticking pointer usually can be repaired with a minimum of effort.

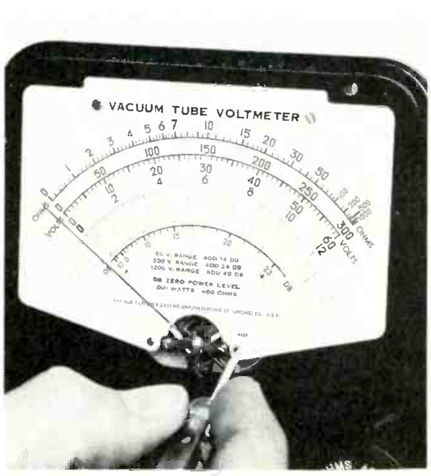


Recommended tools include pencil iron, jeweler's screwdrivers, small socket wrenches, small end wrenches, nonmagnetic tweezers, small pocket-type screwdriver, and clean rubber mat.



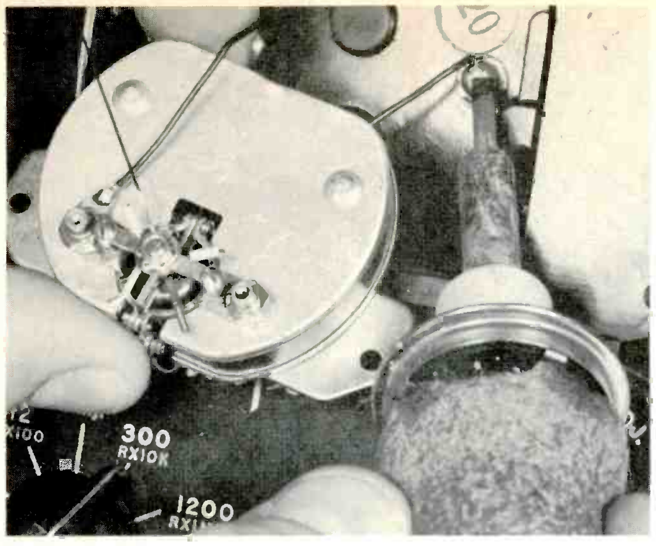
Access to the meter mounting screws is usually gained after the instrument back is removed. The meter is secured by two to four screws entering from the rear. Captive screws with mounting nuts also are used. Removal of the screws shown releases the meter cover in this instrument. In others, entire meter is released, then cover can be removed.

A broken glass can be changed by removing mounting screws or clips. A hardware store usually can provide a replacement cut to size. Order single-weight glass.

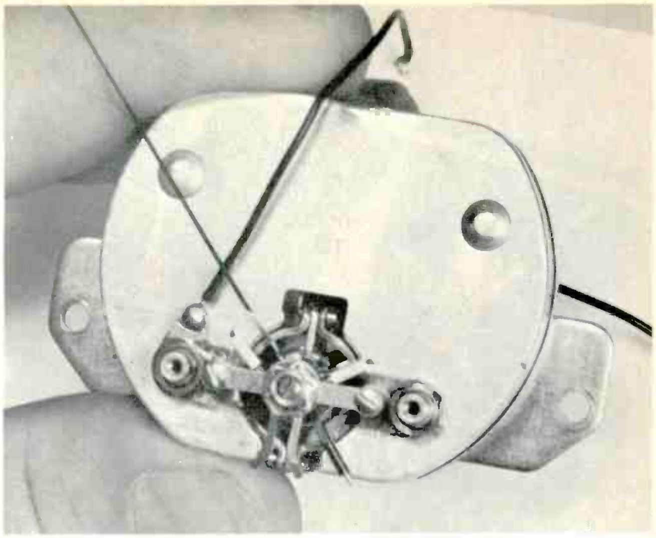


With meter cover removed, scale is exposed. Mounting screws usually number two or four. Use small screwdriver and remove screws carefully. Don't drop screws or lockwashers into meter movement.

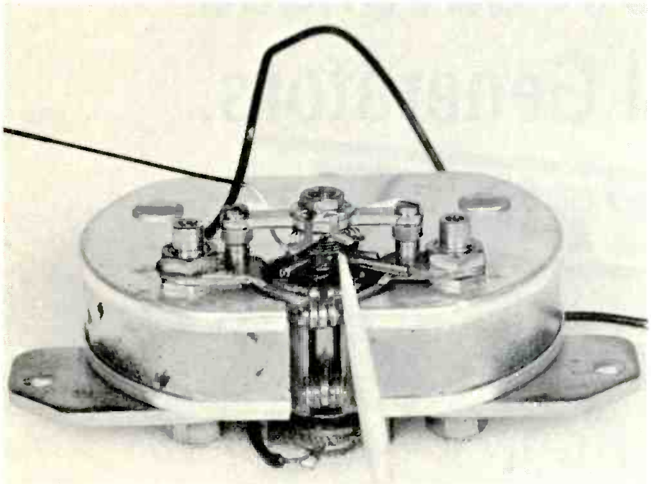
A high-intensity lamp can be used to detect visible dirt or magnetic particles in magnet gap. Often, a slightly moistened toothpick will remove the dirt. Magnetic particles must be removed with tweezers.



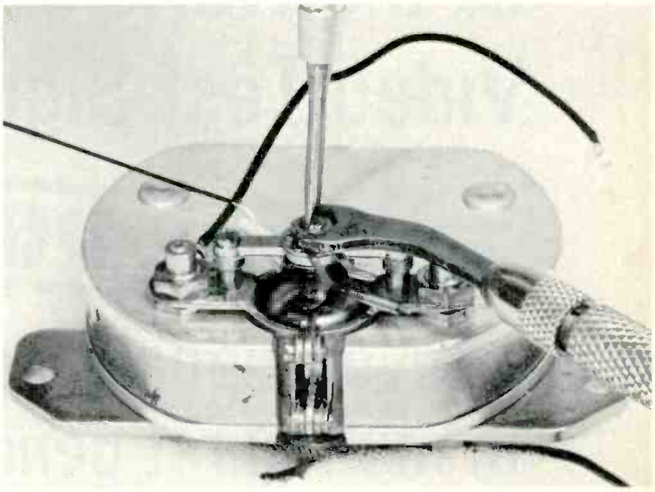
Unsolder meter leads. Avoid use of soldering gun unless mounting studs are large. The magnetic field of a gun can damage the meter. Pencil iron will usually do the job. Meter and pointer are vulnerable—handle carefully.



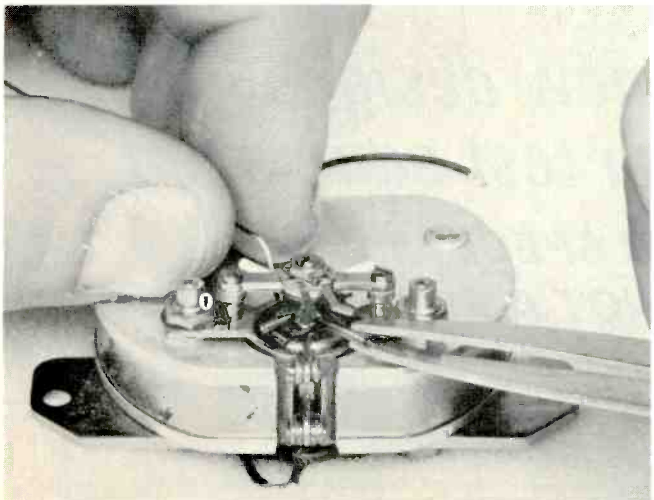
Hold sheet of white paper behind meter and look through magnet gap. Dirt and magnetic particles can be seen easily. Check armature bobbin for burned or frayed wires. If these are visible, meter is beyond your repair.



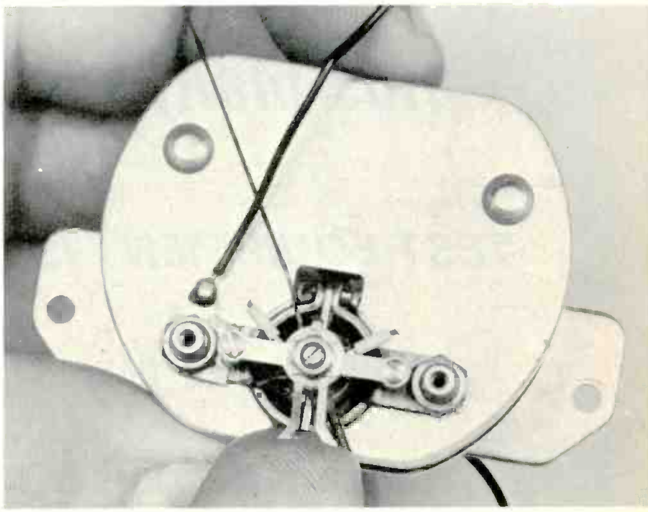
Check hairsprings at top and bottom. Each spring should make a perfect, flat spiral and be soldered at both ends. Overlapped or tangled springs can be released with toothpick. Kinked springs can be straightened gently with tweezers.



Loosen bearing shaft locknut with wrench. Turn screw clockwise very gently until resistance is felt, then back screw off ½ turn. Hold screw stationary and tighten locknut. Grasp pointer and the rear extension gently, and check vertical movement, which should be very slight.

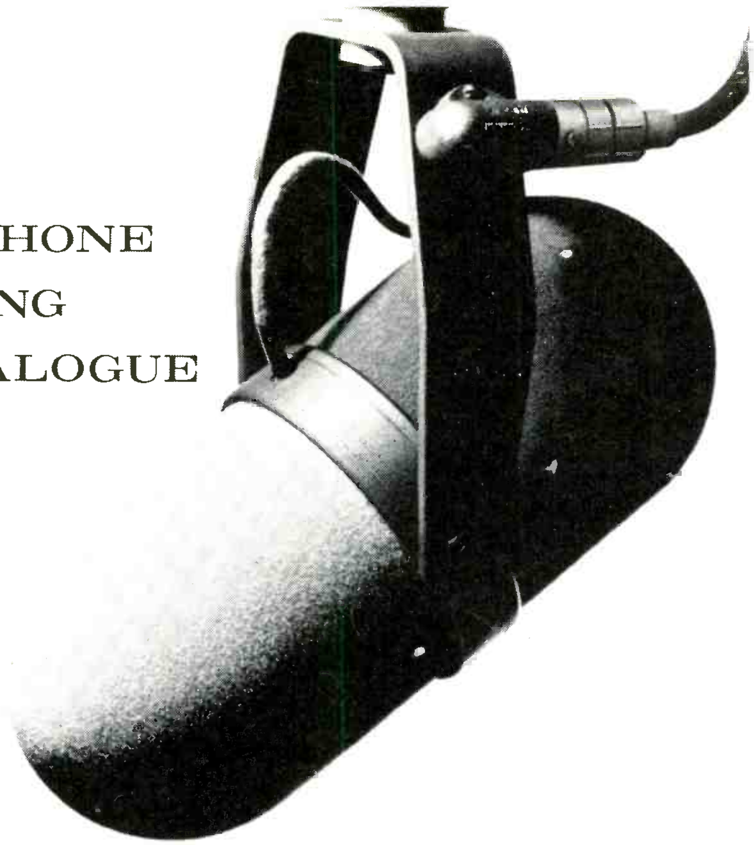


If meter readings change when physical position is changed, counterweights need to be adjusted. Grasp pointer gently whenever weight is moved to prevent bending of meter pivots. Use a trial-and-error method until movement is minimized.



Set zeroing arms at top and bottom to their center positions. Set zero screw on meter front to its zero position so that the pin will engage slot in top arm when cover is replaced. Back arm may have to be moved later to insure correct range of zero screw.

THIS BOOM MICROPHONE IGNORES EVERYTHING ...EXCEPT THE DIALOGUE



Consistency of sound track quality on an endless variety of locations and sets can be dramatically improved with the remarkable Shure SM5 Boom Microphone. It "hears" the dialogue rather than the ever-changing character of the surroundings.

Because its cardioid directional pattern is uniquely uniform with frequency and symmetrical about its axis, the SM5 is singularly independent of the effects of environment. Even in extreme shooting situations (such as with tight sets, low ceilings, hard walls, low microphone angles, traffic or air conditioner noise and rumble, and changing distance) the SM5 minimizes sound coloration and ambient noise pickup. Equalization changes—on the set or in transfer—are seldom, if ever, necessary.

The highly effective attached windscreen completely encloses the two-stage mechanical filter, so that there are no external "rubber bands" for the wind to "strum." The absence of response-correcting inductors or impedance transformers assures freedom from hum.

Call on the Shure SM5 to solve your most annoying boom problems!

For additional information, write directly to Mr. Robert Carr, Manager of Professional Products Division, Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Illinois.

SHURE SM5

UNIDIRECTIONAL DYNAMIC BOOM MICROPHONE

SHURE PROFESSIONAL MICROPHONES . . . FOR BETTER AUDIO

MODEL SM56
CARDIOID
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Extremely versatile in studio, control room, and remote use. Also widely acclaimed for rhythm recording. Bright, clean sound. Exceptionally uniform cardioid pattern gives optimum control of environment.

MODEL SM33
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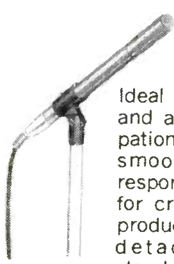
Warm, smooth sound for studio, control room, and scoring stage. Super-cardioid directional pattern. Compact, yet rugged.



MODEL SM76
¾" OMIDIRECTIONAL
DYNAMIC

Ideal for interviews and audience participation, yet unusually smooth wide range response (40-20 KC) for critical music reproduction. Instantly detachable from stand. Steel case with Cannon connector.

MODEL SM50
OMNIDIRECTIONAL
DYNAMIC

Self-windscreened and pop-free for news, sports, remotes, and interviews. Also ideal for many studio and control room applications. Comfortably balanced for hand or stand use. Natural response.

Circle Item 19 on Tech Data Card

PORTABLE CONTINUITY AND PHASING TESTER

*by A. Molchanovsky**

—A simple solid-state test set speeds audio check-out in the field.

Tests for continuity and phasing should be performed after an installation for an outside broadcast is completed. The need for a continuity test is obvious, but an audio signal source rather than an ohmmeter should be used. An ohmmeter check is not only tedious and time consuming, but also incomplete. It checks the cables, but it does not include any mixing amplifiers and transformers, which most certainly are incorporated in the installation.

The phasing test is very important also. Consider two microphones connected to a mixing amplifier and placed before a group of singers. Both microphones receive more or less the same signal, and if the microphone outputs arrive at the mixing amplifier in opposite phase, they tend to cancel each other. This results in the curious effect that the output of the mixer rises as one of the faders is closed. Another effect of improper phasing of two microphones is the loss of low frequencies. This comes about in the following manner: Sound travels at a speed of about 1100 feet per second, so the wavelength at 1 kHz is about one foot. This means that the phase of a 1-kHz signal changes about every six inches. This distance of phase reversal becomes progressively smaller at higher frequencies, and therefore the phase relationship between different high-frequency signals arriving at the faces of the two microphones changes all the time. Thus the actual phasing of the two microphones becomes unimportant when high frequencies are considered. This is not the case, however, for the lower frequencies, where the wavelength is much longer and the phase changes but slightly with distance. In this case, the signals arrive either in phase or out of phase at the two microphones. This is the reason that a whole "slice" of the low-frequency spectrum can be lost by improper phasing of microphones, making the performers sound unnatural.

Phasing can be checked by sending an asymmetrical signal from the microphone ends of the cables and observing the signal at the output of the mixing amplifier on an oscilloscope (Fig. 1). The signal on the oscilloscope should be of the same phase for all the microphone inputs.

Since the continuity and phasing tests are so important, it was decided to develop a small, simple test unit which checks both continuity and phasing of any audio installation. At the same time, this test unit should afford a possibility to check the sensitivity (gain) of each channel. Phasing should be indicated by pilot lamps rather than by means of an oscilloscope.

The testing unit built with these considerations in mind consists of two parts, a generator and a receiver. The generator develops either a sine-wave signal at microphone level and 50-ohms impedance (to check channel gain), or a special phasing signal. The receiving unit has a green and a red pilot lamp to indicate the phase of the arriving signal. Both units are small, as can be seen in Fig. 2, and are operated by internal batteries.

*Development Engineer,
Israel Broadcasting Authority

Generator Unit

Externally, the sending unit consists of a metal tube which has a slide switch at one end and a microphone connector at the other end. The generator consumes only 2 ma and is powered by a small 15-volt battery. A small hole was drilled in the base of the microphone plug, and a pin was inserted through it. A miniature switch was placed behind the base so that the switch is actuated by the pin whenever the plug is inserted into a socket. The switch connects the battery to the generator circuit and thus turns the unit on; consequently the battery cannot be used up inadvertently between tests. This arrangement also obviates a need for an "on" pilot lamp which would shorten drastically the life of the battery.

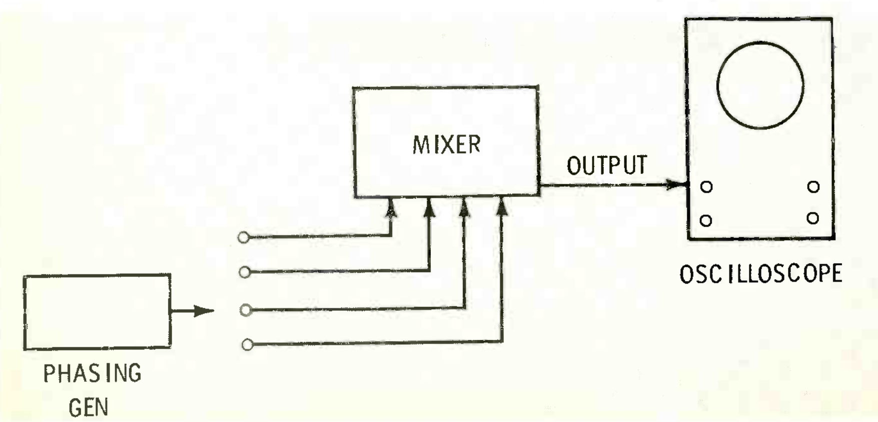
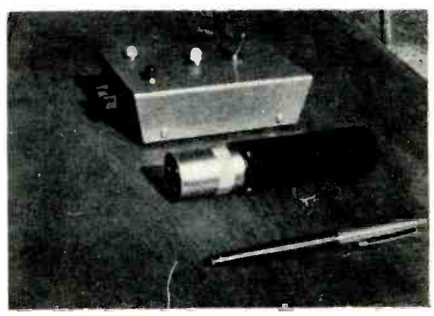
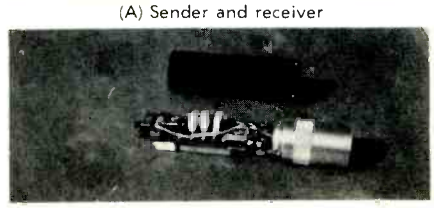


Fig. 1. Phasing is checked by observing output signal for known input phase.



(A) Sender and receiver



(B) Receiver outside case

Fig. 2. Solid-state audio testing set.

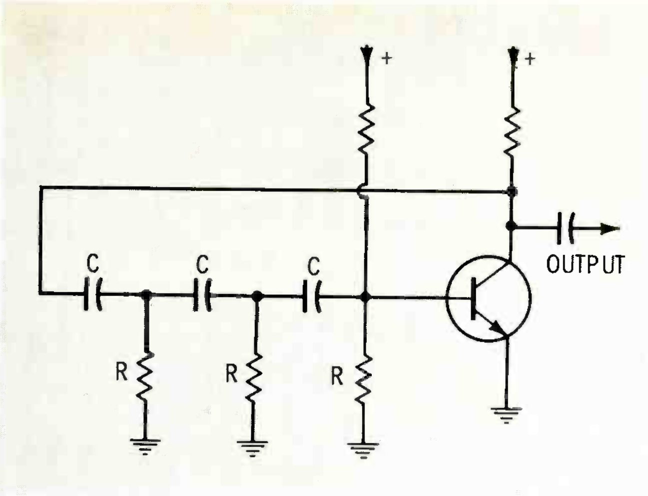


Fig. 3. Diagram of conventional phase-shift oscillator.

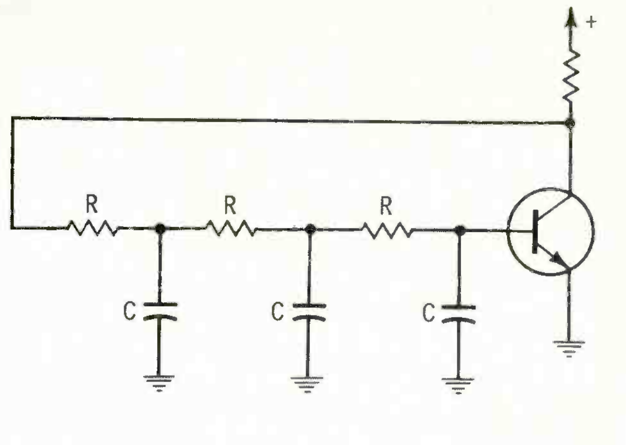


Fig. 4. Phase-shift network also acts as low-pass filter.

Phase-Retard Oscillator

The generator circuit presented a problem, since all standard oscillator circuits contain a level-stabilizing element such as a thermistor or pilot-lamp filament. This was out of the question since battery drain has to be kept very small. It was therefore decided to use a "phase-retard" oscillator, which consumes very little current. In addition, this circuit is inherently self-limiting and thus provides a sine wave of about 2% harmonic distortion and a constant and stable amplitude.

Since the "phase-retard" oscillator is not well known, a short review of the circuit will be given here. Consider first the circuit in Fig. 3. This is the well-known "phase shift" oscillator. The amount of phase shift introduced by the R-C network depends on frequency, so at some frequency it is 180°, making the feedback from collector to base positive. At that frequency, the loss of the network is 29 (gain of 1/29), so if the gain of the transistor is more than 29, the circuit will oscillate. The amplitude of the oscillations is limited only by the transistor gain curve, and the output signal is severely distorted and of badly defined amplitude.

Now consider the circuit of Fig. 4. This is actually the same circuit as in Fig. 3, but with the C and R positions interchanged. The phase-shifting ability of the network remains unchanged, and the circuit oscillates as before. However, the R-C network doubles as a low-pass filter, and, because of attenuation of the harmonic frequencies by the network, a rather distorted sine wave at its input emerges quite pure at its output. It can be shown mathematically that a square wave at the input of such a network (at the frequency of oscillation) emerges as a sine wave having only 2.4% distortion.

The idea of using this circuit is as follows: If the operating point of the oscillator transistor is chosen correctly, the wave shape at the collector will become a square wave (because of overload) of a definite amplitude. After passing through the R-C network, the signal will arrive at the base as a sine wave and thus maintain oscillation. This sine wave will be of an amplitude as constant as that of its parent square wave.

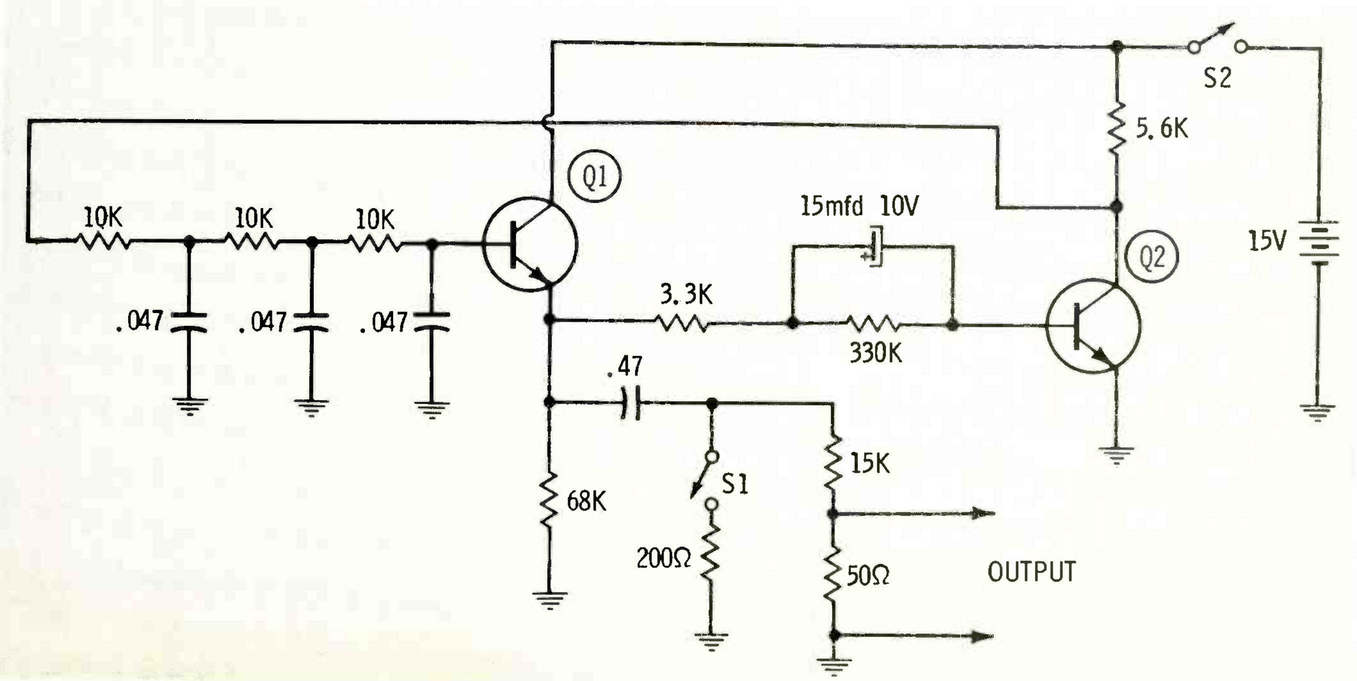


Fig. 5. Complete circuit of the sending unit. Power is applied only when unit is plugged into microphone receptacle.

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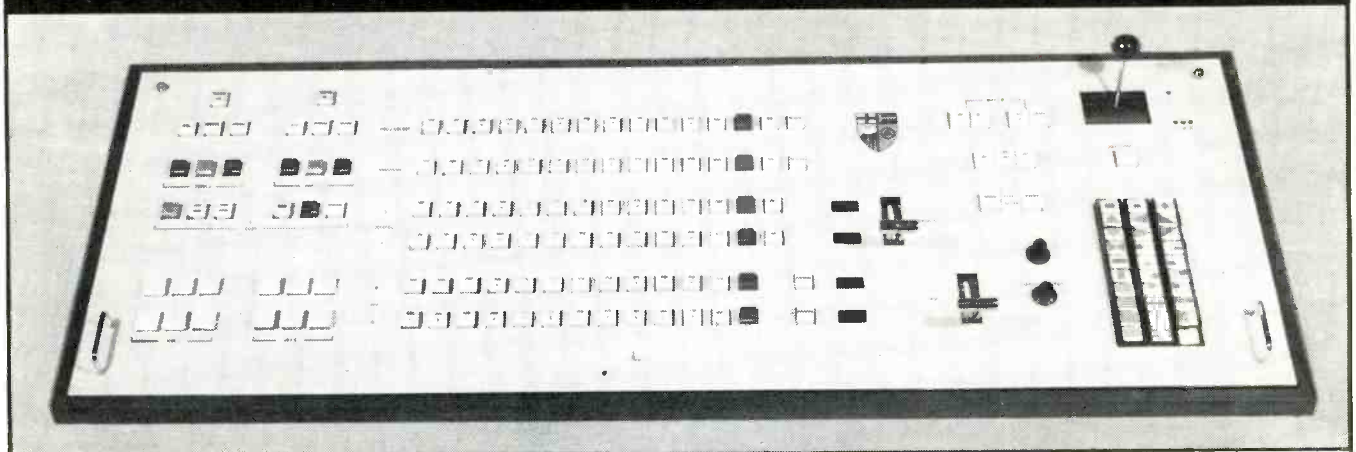

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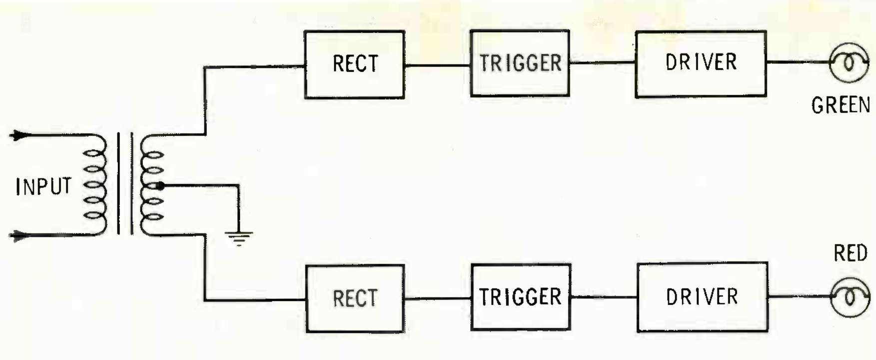

Fig. 6. The receiving unit differentiates between signals of opposite phase.

Complete Circuit

The complete schematic of the sending unit is shown in Fig. 5. The R-C network is connected between the collector and base (through emitter follower Q1) of oscillating transistor Q2. The operating point of Q2 is chosen so that the transistor is symmetrically overloaded and thus supplies a square wave of constant amplitude to the phase-shift network, which changes the signal into a sine wave at the base of Q1. The emitter of Q1 follows its base and is the source of the output signal, thus isolating the phase-shift network from the external load. The amplitude of the output signals depends on that of the square wave at the collector of Q2, which in turn depends only on the DC supply voltage. Thus the output amplitude is stabilized.

There are two more points to note: (1.) The resistor network at the output serves to reduce the oscillator output (which is about 0.2 volt) to microphone level at 50-ohms output resistance, and to change it from a sine wave to sharp positive pulses (by loading the oscillator) when switch S1 is closed. This signal is used to check phasing. (2.) Switch S2 is the power switch mentioned earlier. It connects the battery only when the unit is plugged into a microphone receptacle.

The Receiving Unit

The receiving unit is used to check the phasing of different channels in the installation. This unit is connected to the output of the mixing amplifier, and the signal at its input should be about 0 dBm. Phasing is indicated by the lighting of either a green or a red lamp.

The receiving unit consists of two identical channels (Fig. 6). Each channel starts with a rectifier which operates on positive pulses only. Each rectifier is followed by a Schmitt Trigger, which in turn controls the lamp-driver transistor.

The input is connected through a miniature push-pull driver transformer so that the two channels always receive oppositely phased signals. In this way, only one channel (which receives the positively phased pulse) is operated, depending on the polarity of the incoming signal. The complete schematic of the receiving unit is shown in Fig. 7.

The two units are very small and easy to handle, as can be seen from Fig. 1, and once put into use, they become indispensable on outside broadcasts. ▲

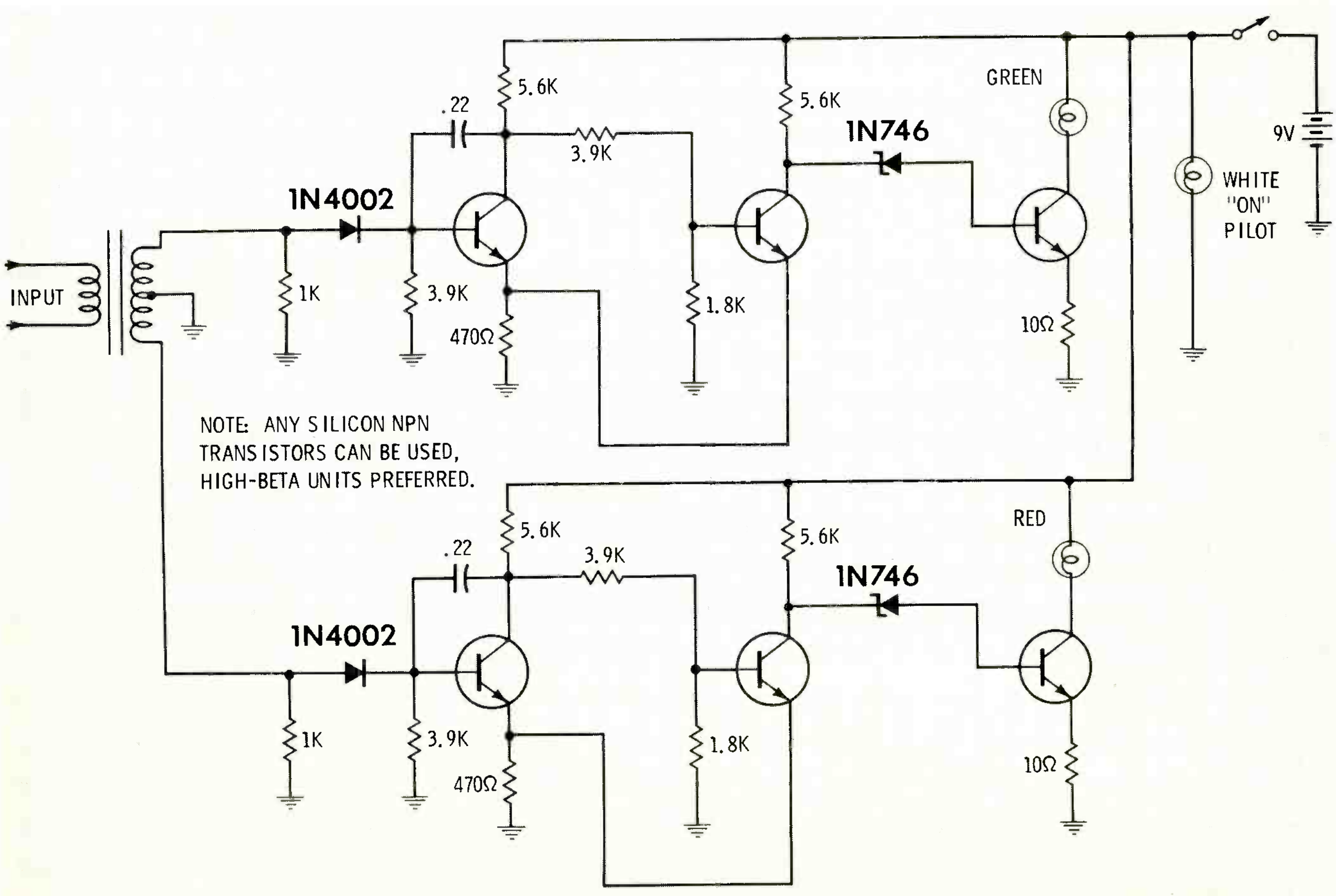

Fig. 7. Receiving unit has push-pull input transformer driving identical channels which control two indicator lamps.

Servicing Mobile Radio With a Scope

If your maintenance responsibility includes mobile equipment, the versatile oscilloscope can help you.

by Leo G. Sands

The oscilloscope is probably the least-used instrument in mobile-radio maintenance, although it is one of the most valuable servicing tools. It can be used wherever AC power is available, or even in the field when a DC-to-AC inverter is used to operate it from a battery. Units operated from self-contained batteries are available, although they are relatively expensive. Modern AC-operated scopes are much smaller and lighter than those available in the past, and many are useful at frequencies up to 12 MHz. Several recently available models are rated for flat response from DC to 4.5 MHz, but are often useful well above 10 MHz.

For mobile-radio servicing, a scope should be capable of being used for measurements at frequencies from DC to 4.5 MHz or higher. When set for DC, such a scope can be used instead of a VOM or VTVM for making DC-voltage measurements, and for monitoring limiter, AVC, and discriminator circuits.

DC Measurements

When the horizontal sweep is set to zero and the scope vertical input is set for DC, a dot appears at the center of the screen when the DC-input voltage is zero. The dot moves an amount and in a direction depending on the polarity and magnitude of the DC-input voltage.

For setting an FM discriminator, the usual procedure is to use a VTVM with center-scale zero, so the discriminator can be tuned for zero output when an unmodulated input test signal is applied. A DC scope can be used for the same purpose; it is probably easier to read at the zero-voltage point, and it is not necessary to keep resetting the zero point. A scope also can be used for monitoring limiter voltage when an FM receiver is being aligned, or AVC voltage when an AM receiver is being aligned.

For FM-discriminator alignment in a tube-type receiver, the vertical input of the scope is connected to Point A as shown in Fig. 1A, and the scope ground lead is connected to the receiver chassis. The same is true in the case of a solid-state receiver, except when Point B (Fig. 1B) is not at DC ground potential. In that case, the scope ground is connected to Point B, but care must be exercised to prevent the scope chassis from making contact with the receiver chassis.

For aligning a tube-type FM receiver, the scope vertical input may be connected across R1 to monitor limiter voltage when the circuit shown in Fig. 2 is used, and when the input is an AM or unmodulated test signal. If the grid resistor is located directly from grid to ground, the scope can be connected to the limiter through an RF probe. For aligning AM receivers, the scope input is usually connected across the AVC bus.

Some scopes are equipped with an internal reference voltage for calibration. This arrangement makes it possible to read DC voltages from the scope screen with approximately the same accuracy as with a VTVM.

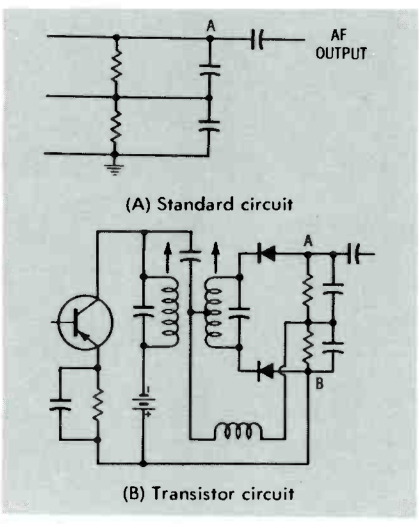

Fig. 1. Discriminator test points for scope during FM alignment procedure.

Sweep Alignment

Although most technicians peak receiver IF and RF circuits with an AM or unmodulated test signal while monitoring limiter or AVC voltage, the correct bandpass characteristics can be preserved more easily by using a sweep generator. In the latter case, a scope is required.

For alignment of an FM receiver, the scope vertical input is connected across the grid resistor (Point A in Fig. 2) or to the limiter grid through a probe. For alignment of an AM receiver, the vertical input of the scope may be connected, through a probe, to the detector side of the last IF transformer. The sweep-signal output of the generator is connected to the scope horizontal input to apply a 60-Hz sine wave for horizontal deflection. The RF output of the generator is fed through a small capacitor to the grid of the stage ahead of the one being aligned; the feed point is moved stage by stage toward the receiver front end as the alignment proceeds.

The sweep generator is set to the applicable IF or RF frequency, and the sweep may be set at 100 kHz initially and then reduced until the

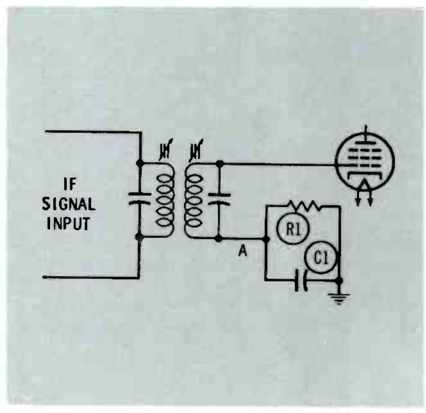

Fig. 2. Monitor limiter voltage at point A when an AM input signal is used.

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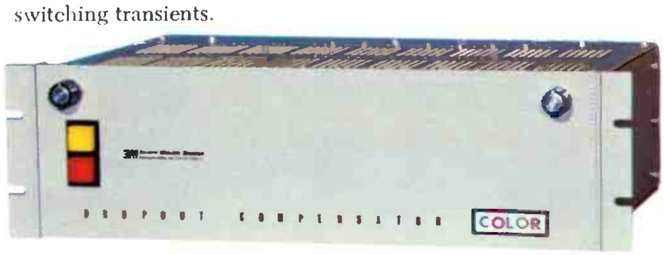

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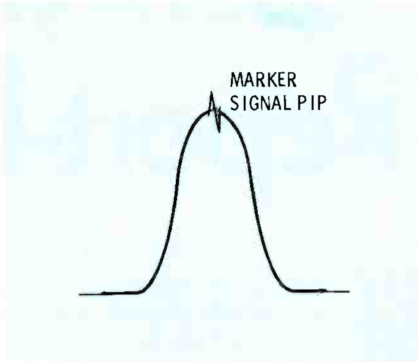

Fig. 3. Bandpass curve showing a marker pip to indicate center of passband.

trace on the scope screen is of suitable width. The bandpass of a receiver, as seen on the CRT, should look approximately as shown in Fig. 3. It is important that the center of the waveform be at exactly the right IF or RF frequency. This can be determined by applying a frequency-marker signal in addition to the sweep. Sweep generators are often equipped with a built-in marker generator, but for best accuracy an external crystal-controlled marker generator, or a frequency meter, should be used.

FM-Detector Adjustment

As discussed earlier, the usual way of adjusting an FM discriminator is to set it for zero output as indicated by a VTVM, with an unmodulated test signal applied. This technique is by no means ideal, since the response can be nonlinear even if the adjustment appears to be correct. A better job can be done with a scope and a sweep generator. The vertical input of the scope is connected to the output of the discriminator as shown in Fig. 4. The RF output of the sweep generator is fed to the grid of the limiter stage immediately preceding the discriminator. Both the primary and secondary of the discriminator IF transformer are tuned until the waveform is balanced, as shown in Fig. 5A. This waveform is obtained with the scope horizontal deflection provided by the sine-wave signal from the sweep generator. By setting the scope sweep to twice the sweep-rate frequency (usually 60 Hz) and using the scope internal sawtooth generator, a double pattern is obtained which looks something like the one shown in Fig. 5C. For some technicians, this pattern may be a better one for checking out discriminator balance, but the choice is a purely personal one.

Many FM receivers now employ a gated-beam FM discriminator, which is much easier to adjust than the conventional discriminator. As shown in Fig. 6A, there is a parallel resonant circuit connected to the quadrature grid of the tube. The slug of coil L is adjusted for maximum audio recovery, as determined by listening to an FM signal. No meters are required. However, a more accurate job can be done by looking at the IF signal at grid 3 with a scope. Use a low-capacitance probe, and adjust L for maximum signal amplitude with an unmodulated signal applied. Also the receiver audio output may be monitored with the scope while a tone-modulated FM signal is fed into the receiver and L is adjusted for maximum amplitude and minimum distortion of the recovered tone signal.

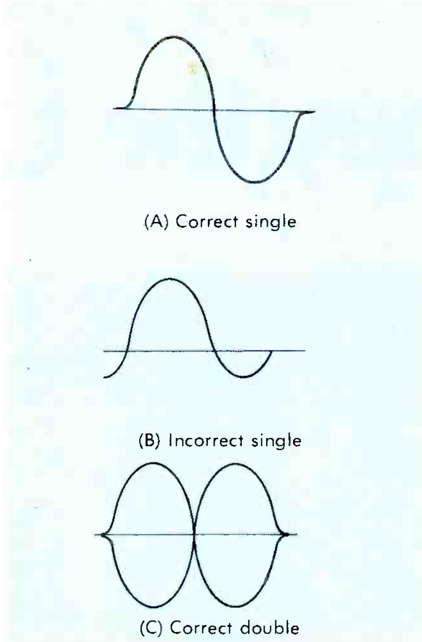

Fig. 5. Output waveforms from FM discriminator using sweep-signal input.

The test point (TP) shown in Fig. 6A is used when the preceding stages are aligned. A VTVM can be connected there, or a scope can be used to monitor the signal at this point when the sweep-generator alignment technique is being used.

Another type of FM detector, which is similar to the gated-beam discriminator, is shown in Fig. 6B. The tube is a 6DT6 or other sharp-cutoff pentode. The quadrature coil (L) is tuned for maximum DC voltage across R1, as monitored by a scope (set for DC); the test signal is unmodulated.

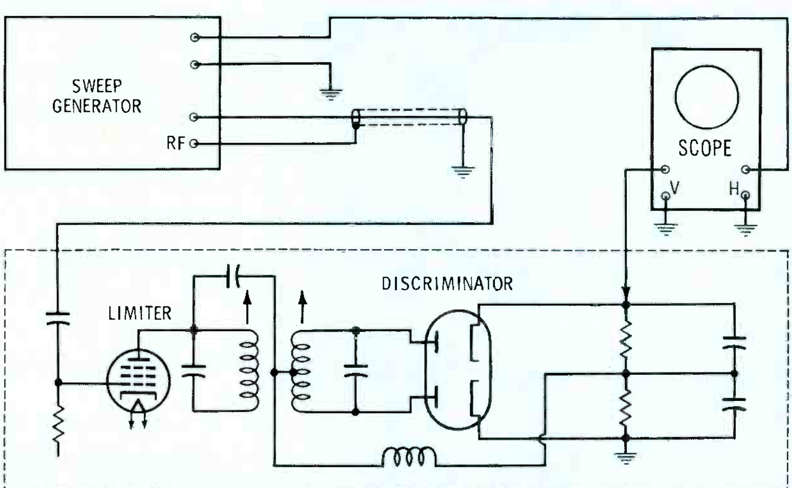

Fig. 4. Equipment properly set up for tube-type FM discriminator alignment.

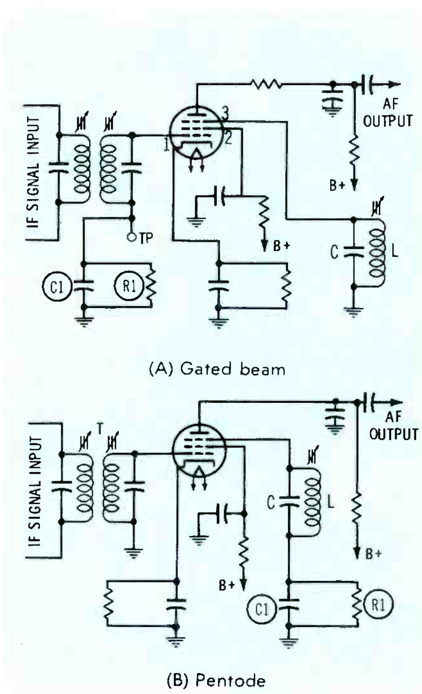

Fig. 6. Three-grid FM discriminators.

The stages preceding the detector may be aligned by connecting a scope to the first grid through an RF probe when an AM test signal is used, or through a low-capacitance probe when an unmodulated signal is used. Adjust the stages for maximum signal indication on the scope. If there is a limiter stage ahead of the detector, however, it is better to monitor the signal at the limiter input.

After the receiver has been aligned, the detector-input transformer (T, Fig. 6B) should be tuned for best signal-to-noise ratio with a very weak FM signal applied. If the FM signal is tone modulated, the audio output of the receiver can be monitored with a scope, and the best signal-to-noise ratio can be noted visually. The final tuning consists of trimming coil L for best audio recovery and signal-to-noise ratio, and minimum audio distortion.

Transmitter Servicing

A wideband scope can be used for direct observation of RF signals in transmitters at stages operating at frequencies below approximately 12 MHz. To observe signals at higher frequencies, a "down converter" can be used (Fig. 7). This is simply a mixer stage into which the signal under test is injected along with a reference signal from a local oscillator. The oscillator may be built into the down converter, or an external signal generator may be used. In a pinch, an RF probe can be used as a mixer by feeding the reference signal into it through a small capacitor, along with the transmitter signal. However, a down converter with an output circuit tuned to the desired difference frequency is better.

By observing the RF signal, it is possible to detect hum and unwanted AM on an FM signal. The scope

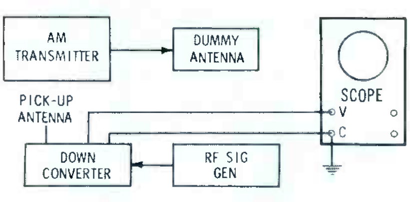

Fig. 7. Method for observing a VHF signal with a scope and converter.

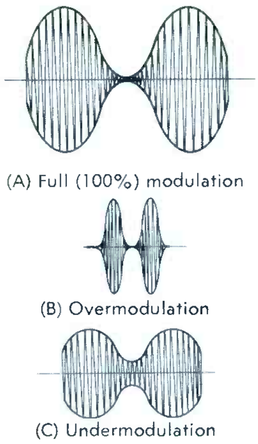

Fig. 8. AM RF waveforms showing 100%, high, low modulation levels.

also provides a convenient way to check the modulation percentage of AM transmitters.[1] The carrier envelopes for various percentages of modulation are shown in Fig. 8.

A scope can be used for checking the performance of transmitter audio circuits. An AF test signal is fed into the microphone-input circuit, and the waveform of the audio signal being fed to the phase modulator of an FM transmitter is observed on a scope. In an AM transmitter, the signal at the output of the modulator can be observed. The distortion and frequency response of the modulator system can be checked by tuning the audio signal generator and by varying its output level. The action of modulation limiters, if used, can be checked by watching the output variations as the input level is changed.

Tone Checks

A scope is very handy for checking tone encoders. You can observe the waveform, and, by using an audio signal generator as a reference, you can measure the tone frequency by means of Lissajous patterns. You can also observe the tone waveform at the input of a tone decoder after the signal has passed through a transmitter and receiver.

Summary

A wideband oscilloscope is an invaluable tool for servicing mobile-radio equipment. However, to do a thorough job, it should be capable of measuring DC as well as AC, AF, and RF. It can be used for many purposes, including checking vibrators, transistor switching, and silicon controlled rectifier operation in power supplies, as well as for measuring dynamotor ripple. When its versatility and capabilities are thoroughly understood, the technician will find the scope a very valuable instrument on his maintenance bench. ▲

[1] For more information about the use of an oscilloscope in the measurement of AM modulation percentages, see "Calibration of AM and FM Modulation Monitors," by Robert A. Jones, November 1964 Broadcast Engineering, page 12. A correction of a printing error in that article is given on page 6 of the January 1965 issue.

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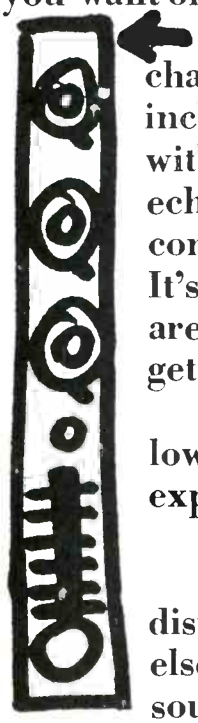

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BOOK REVIEW

FET Circuits: Rufus P. Turner; Howard W. Sams & Co., Inc., Indianapolis, 1967; 160 pages, 5½" x 8½", soft cover; $3.25.

The author devotes the first chapter to the fundamentals of the FET. This section contains 10 pages of field-effect theory, geometry, history, and ratings.

With the necessary theory covered, the discussion moves to amplifier circuits. In the 22-page second chapter, 18 circuits are shown; complete parts data are included for each circuit. Included in the chapter are: a simple small-signal AF preamplifier, AF source follower, two-stage RC-coupled amplifiers, phase inverters, audio mixers, audio bandpass and band-reject amplifiers, video amplifiers, IF amplifiers, etc.

Chapter 3 deals with oscillator circuits. Twelve circuits are shown, ranging from AF oscillators to HF crystal oscillators. Analyzing these circuits, the reader immediately perceives that FETs can be substituted for tubes in nearly all triode applications.

Chapter 4 is titled "Receiver and Receiver-Accessory Circuits." The first circuit shown is a basic broadcast-band superheterodyne receiver. There are several interesting innovations, including the use of ceramic filters instead of IF transformers. Other circuits in this chapter include crystal converters, BFOs, a Q-multiplier, and a squelch circuit.

Chapter 5 deals with transmitters and accessories. Several low-power transmitters are shown, as well as frequency multipliers, a balanced modulator, and two monitors.

Control circuits are explained in Chapter 6. Among the projects are controlled relay units ranging from VOX to light-operated. Also shown is a modulated-light detector/amplifier.

The last chapter covers instruments. Circuits are shown for nineteen different test instruments, from voltmeters to light meters. Included is a circuit for a direct-reading audio-frequency meter. This instrument employs two FETs and eighteen resistors and capacitors; it covers 0-100 kHz in four ranges.

Included in the appendixes are basing diagrams and source guides for all the FETs mentioned in the text. ▲

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Introduction to

FETs

Through a concerted industrial effort, the field-effect transistor (FET) is beginning to find favor with commercial equipment manufacturers. It is actually an old device, but semiconductor manufacturers only recently have been able to produce it consistently and at an economical price.

The FET has a number of features that make it superior to the transistor, diode, and tube for many applications. Some of these are:

1. Square-Law Operation. The FET drain current is proportional to the square of the gate voltage. This feature makes the device ideal for use in mixer stages, since it produces just the second harmonics necessary for mixer operation. Other devices such as tubes, transistors, and diodes also produce third-order and other harmonics; this causes cross-modulaton distortion, a defect that takes considerable effort to reduce.

2. Low Noise. Because the FET is a majority-carrier device, it is not as noisy as transistors, which depend on both majority and minority carriers for operation. This feature makes the FET the logical choice for use in preamplifiers and other applications where low noise is important.

3. High Input Impedance. This feature, similar to that of vacuum tubes, considerably simplifies the design of amplifiers since the input of one stage does not load down the output of a preceding stage. The large coupling capacitors and tapped interstage transformers associated with conventional transistor circuitry are not needed with FETs.

Basic Theory

For anyone familiar with tubes, FETs should present no problem. The nomenclature for the two devices is compared as follows:

Tube	FET
Plate	Drain
Grid	Gate
Cathode	Source

The FET nomenclature was chosen for obvious reasons. The source generates the electrons or holes, the gate modulates (or controls) the current, and the drain receives the current.

In a vacuum triode, electrons leave the cathode and travel through a grid to the plate. A voltage can be put on the grid to either increase or decrease the flow of electrons. FETs operate in almost the same manner, and have characteristics similar to those of tubes.

To gain a good understanding of the FET, first consider a semiconductor diode rectifier. It is composed of two types of semiconductor material as shown in Fig. 1A. The N-type material has a surplus of electrons (represented by − signs in the diagram), and the P-type material has an excess of holes (or places where electrons could fit), represented by + signs.

In Fig. 1B, a bias voltage has been placed across the diode. The electrons from the negative terminal of the battery repel the negative charge (electrons) of the N-type material. The positive charge in the P-type material is likewise repelled by the positive connection of the battery. The negative and positive charges meet at the junction. Now assume one electron from the N-type material combines with a hole in the P-type material. In order to maintain balance, an electron from the negative terminal of the battery enters the N-type material. Likewise, a hole moves from the positive terminal of the battery into the P-type material (or an electron goes from

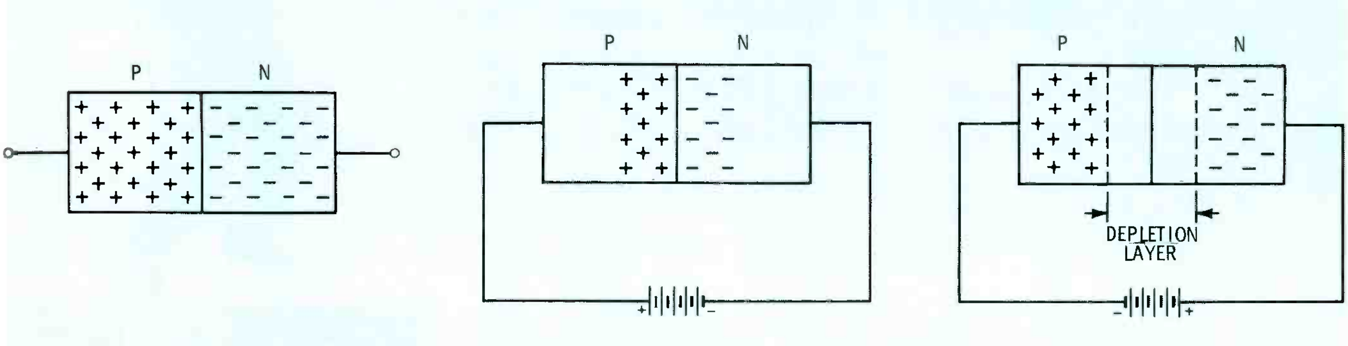


Fig. 1. The unidirectional conduction characteristic of a PN junction is explained by reference to simplified diagrams.

This semiconductor device resembles a vacuum tube in its behavior.

by Thomas H. Lynch

the P-type material to the positive terminal of the battery). This completes the circuit, and one electron has passed through the forward-biased diode. A very large current through the diode can exist, depending on the number of electrons the battery can supply.

Fig. 1C depicts the condition known as reverse bias. In this case, the electrons and holes are forced away from the PN junction by the attraction of the battery. There is no current because there are no electrons or holes at the junction to combine. The area devoid of electrons is called the depletion layer. Its width increases with an increase in applied voltage; here lies the key to understanding the FET.

A cross-sectional view of an N-channel junction FET is shown in Fig. 2. This type is most nearly like a tube in that it requires a positive voltage on the drain (plate) and a negative control voltage on the gate (grid). When the gate voltage is zero, current is allowed to be established from the source to the drain, as shown in Fig. 3A. When a negative voltage is connected to the gate, as shown in Fig. 3B, and the flow of electrons is reduced. This is because the depletion layer becomes larger, and as it does so it restricts the passage of electrons. The action is analogous to that of a water control valve. This phenomenon allows the FET to amplify and perfom the same functions as those of a tube. It should be noted that since the gate junction is reversed biased, there is no gate current. This is the same condition as for a tube grid.

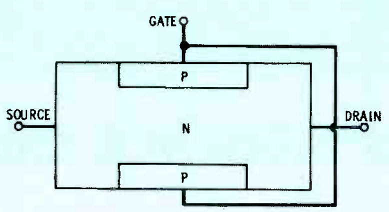


Fig. 2. N-channel junction-gate FET shown in diagrammatic presentation.

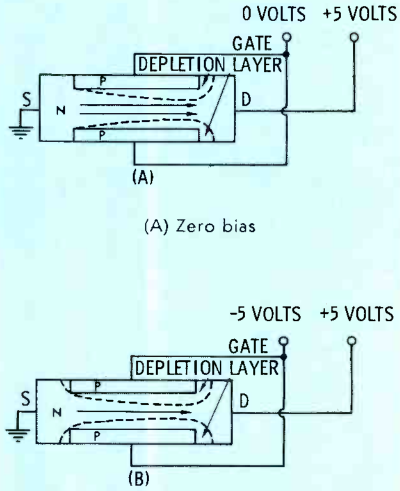
The P-channel junction FET operates in the same manner, except that all the voltages are reversed. Holes then flow from the source to the drain (or, equivalently, electrons flow from the drain to the source).

In both of the preceding cases, conduction takes place with zero gate voltage. For this reason, such a device sometimes is referred to as a "depletion" type, since the correct gate voltage depletes the electron (or hole) flow.

The above discussion has been based on the junction-gate FET. Another type is illustrated in Fig. 4. This device has one more connection to an additional layer called the substrate, which in most cases is connected to the source. The key to the operation of this type of FET is the capacitor formed by the metal gate, the silicon-dioxide insulator, and the silicon semiconductor. From the words Metal-Oxide-Semiconductor is derived the abbreviation MOS, and the device in Fig. 4 is referred to as an MOSFET. Since an ideal capacitor does not conduct current, the gate electrode of an MOSFET has no leakage current with either positive or negative signals (the grid of a tube draws current with a positive voltage).

The MOSFET can be made so that at zero gate voltage there is

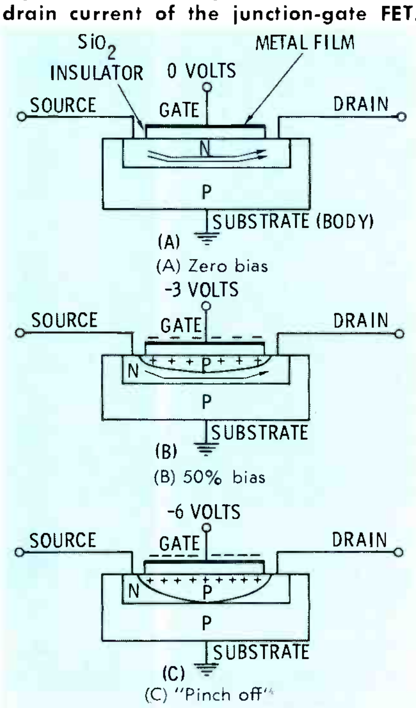
• *Please turn to page 122*



(A) Zero bias

(B) Negative bias

Fig. 3. Gate voltage controls source-drain current of the junction-gate FET.



(A) Zero bias

(B) 50% bias

(C) "Pinch off"

Fig. 4. Operating principle of an N-channel depletion MOSFET is shown.

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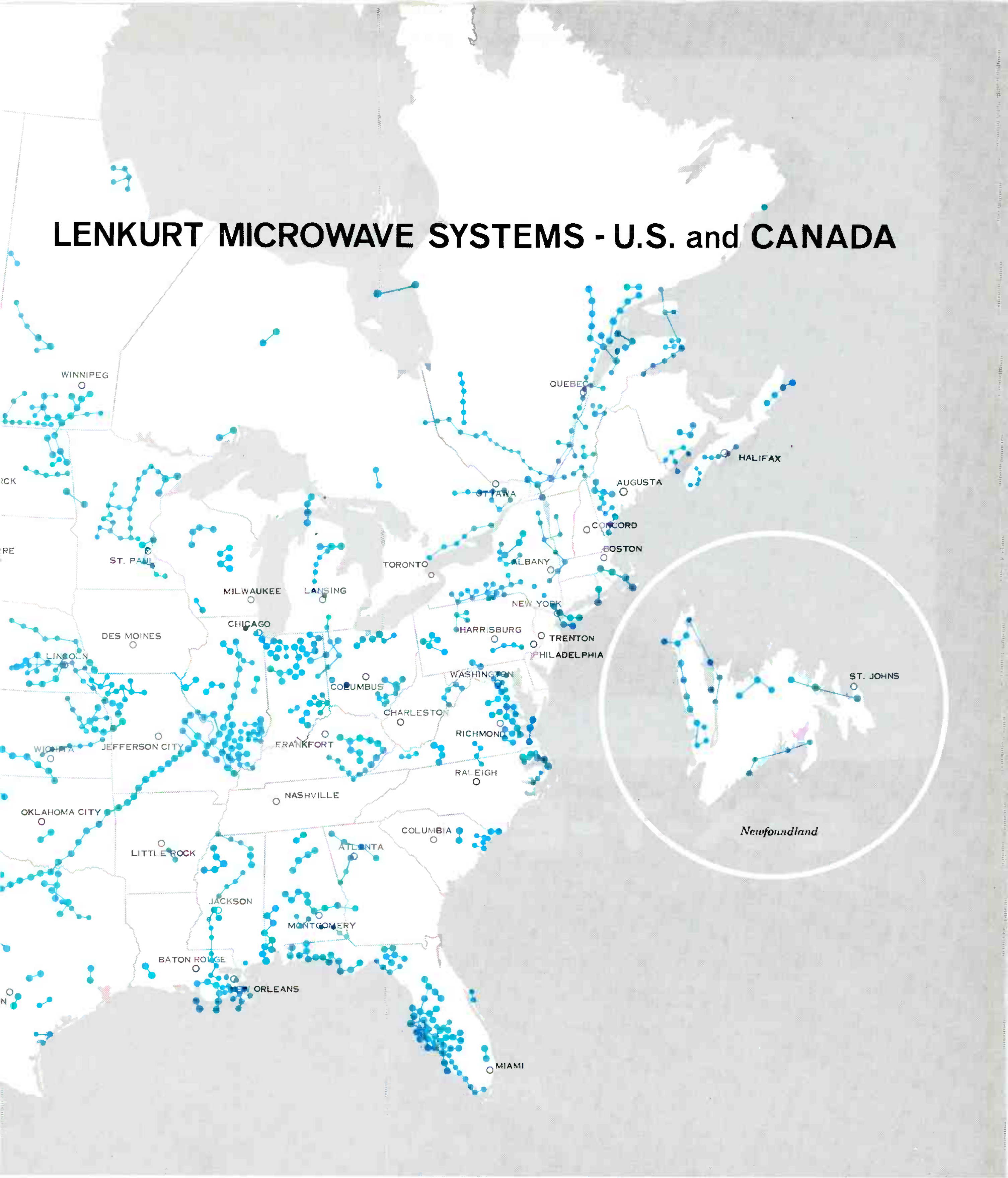

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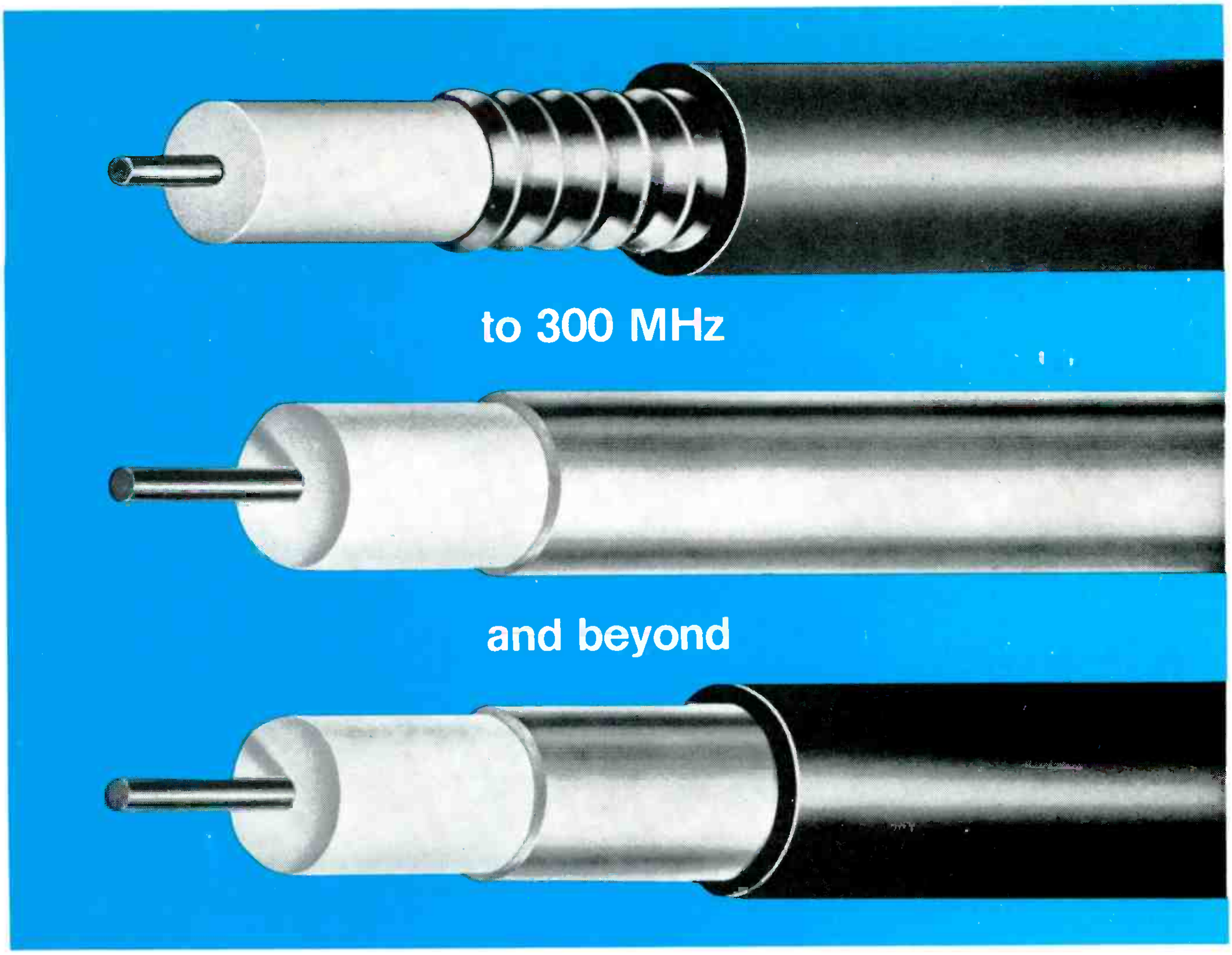

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SUPERIOR CONTINENTAL CORPORATION

Circle Item 29 on Tech Data Card

NEWS OF THE INDUSTRY

NATIONAL

Anniversary Marked

Ameco, Inc. recently celebrated its fifteenth anniversary. The cable-television firm filed articles of incorpration with the Arizona Corporation Commission on December 23, 1952. Among the incorporators were Bruce Merrill, now Ameco president, and Edward E. Furman, physical properties director. J. Earl Hickman, president of **Ameco Engineering Corp.**, a subsidiary, was among the original subscribers to stock. Articles of incorporation were issued on January 13, 1953, and that year Antennavision, Inc. constructed a cable TV system at Globe-Miami, Ariz.

In March, 1956, the company moved its headquarters from Safford to Phoenix and adopted its present name, Ameco, Inc. (Antennavision Manufacturing & Engineering Co.)

Industry Relations Operation Moved

In a move designed to strengthen liaison with FCC consulting engineers and attorneys, government agencies, and trade and professional groups, the **General Electric** Visual Communication Products Department has transferred its Industry Relations Operation from Syracuse, N.Y. to Washington, D.C. John Wall, who has been closely associated with GE's broadcast equipment business, will continue as manager of the operation, reporting directly to William B. Gaither, manager-marketing of the department.

Warehouse Opened

A new warehouse has been opened in Atlanta, Ga. to serve the southeastern region of the CATV Systems Division of **Jerrold Electronics Corp.** The new 6500-square-foot facility will stock all of Jerrold's standard CATV systems equipment and a line of aluminum-sheathed coaxial cable. The region includes Georgia, Florida, Alabama, Mississippi, Tennessee, North Carolina, South Carolina, and Kentucky.

Operating Divisions Formed

Three discrete operating divisions to be directed from the Cohasset, Mass. plant have been formed by **RF Systems, Inc.** The Astro Structures Div. manufactures military and commercial antennas, towers, and scaffolding. The RF Components Div. manufactures and markets large and small wave-guide components plus standard and special feed horns and related equipment. The newly formed Industrial Antenna Div. is responsible for the company's industrial products, including those used in the CATV, ETV, MATV, and broadcast industries.

Douglas R. Vining has been named marketing manager, responsible for all marketing and sales activities of the Corporation. James E. Hayes will be manager of the Astro Structures Div.

West-Coast Office

Jack A. Rickel Associates, Inc., Washington, D. C. communciations consulting firm, has opened a new office in San Diego, Calif. Donald N. Bowdish will head the new facility.

New Jersey Regional Office

ITV, Inc., a division of **Riker Video Industries,** has opened a regional office in Clifton, New Jersey. The new facility houses equipment and personnel for designing, fabricating, and servicing audio-video communications systems. It also contains an equipment display area, a television studio and a videotape duplication center.

ORGANIZATIONS

NAB

In a meeting of 18 representatives of six major broadcasting industry organizations, it was decided to recommend to their governing bodies that extensive research and other activities be conducted to refute arguments of ". . . . those who seem to favor a new, all-wire system, reallocating the television broadcast band to nonbroadcast use." Organizations participating were: the All-Channel Television Society; Maximum Service Telecasters, Inc.; the National Association of Broadcasters; the National Association of Educational Broadcasters; the Television Bureau of Advertising; and the Television Information Office.

A spokesman for the groups noted that proposals for nonbroadcast use of the spectrum include allocation of these TV frequencies to land mobile or business services for such uses as vehicle dispatching. The spokesman said that advocates of the reallocation may be "well meaning," but added, "We know that the American commercial and educational system of broadcasting evolved as a free distributive method of communications, and we are convinced that this system must be maintained and protected. Otherwise, the inner-city dwellers and those who live in the rural areas will, at worst, be completely denied the service they now receive without charge or, at best, be required to pay for getting only a part of what they now receive. Either way, the public will suffer."

The group hopes to provide findings in support of its position to President Johnson's recently appointed Task Force on Telecommunications.

The NAB has asked the Federal Communications Commission to simplify its program-logging rules for AM and FM radio stations. The petition stated that an easing of logging rules for radio to make them compatible with those for television would be of "immense benefit to radio broadcasters" and would relieve them of "burdensome and unnecessary logging requirements."

The petition said a simplification of the AM-FM rules to make them as uniform as practicable with those applying to television would be "of immense benefit to radio broadcasters." The proposed modification, it said, "would not adversely affect" AM and FM reports on station operations but, rather, would "faciltate the compilation" of the required information. Furthermore, it said, the proposed revision would "remove from the rules the apparent inequities" existing between AM-FM and TV stations and would "relieve AM and FM broadcasters of burdensome and unnecessary logging requirements."

SMPTE

Arrangements chairmen for the 103rd SMPTE Technical Conference have been appointed by SMPTE Conference vice-president E. B. (Mike) McGreal. The Conference is set for the Century Plaza Hotel in Los Angeles, May 5-10, 1968.

Topics for the Conference technical program were recently announced by program chairman Alan M. Gundelfinger. Papers are to be presented on the following topics: Instrumentation and High-Speed Photography, Laboratory Practices and Color Quality control, Television, Systems Approach to Television Color Quality Control, Photographic and Allied Science, Photosensitive materials for Motion Pictures and Television, Theater Presentation and Projection, Small Format Films, Studio Practices, Sound, Education, and Medicine.

In addition to the papers program, the Conference will feature an equipment exhibit where equipment will be on display in some 90 booths.

PERSONALITIES

Bill Gleaves, midwestern marketing manager for **Berkey-ColorTran** (a division of **Berkey Photo Inc.),** will be in charge of the company's new sales office at 600 South Michigan Avenue, Chicago.

Elliot Bell has been appointed senior sales engineer for the Commercial Marketing Department at the newly opened **AEL** office at 8939 South Sepulveda Boulevard, Los Angeles.

Benjamin B. Bauer, vice-president of the Acoustics and Magnetics Department for **CBS Laboratories,** has been elected executive vice-president of the U.S. **Audio Engineering Society.** Mr. Bauer has been responsible for many innovations in audio and acoustics, including advanced microphones for radio and television broadcasting, phonograph sound pick-up devices, and tape-recording heads. He is responsible for heading the development of new acoustical devices introduced by CBS Laboratories for the broadcasting industry, including the recently announced loudness-level monitor.

Lawrence J. Cervone has been promoted to the new position of vice-president and general manager of the **Gates Radio Co.**, a subsidiary of **Harris-Intertype Corp.** Mr. Cervone has been with Gates for twenty years. He was named sales manager in 1953, vice-president–sales in 1960, and vice-president–operations in 1965. He was associated with Westinghouse Electric International and RCA International before joining Gates.

Stanley L. Pearl has been elected president of **Kappa Networks, Inc.** Mr. Pearl, previously vice-president–engineering, joined the company in 1965.

John P. Del Favero has been appointed to the newly created position of executive vice-president, Supplies Division, **Memorex Corp.** Mr. Del Favero, who held general management and engineering management positions at International Business Machines before joining Memorex, will head up the technical staff, manufacturing, and marketing operations for all tape and disc-pack products in North America.

John D. Mitchell has been named vice-president, industrial relations, and **David H. Foster** has been appointed vice-president, legal and secretary of **Collins Radio Co.** Both offices are newly created. Mr. Mitchell has been director of corporate industrial relations since 1966; he formerly served in a similar office for the Collins Dallas region. Mr. Foster joined Collins in 1959 as general attorney; in 1963, he was named secretary of the corporation.

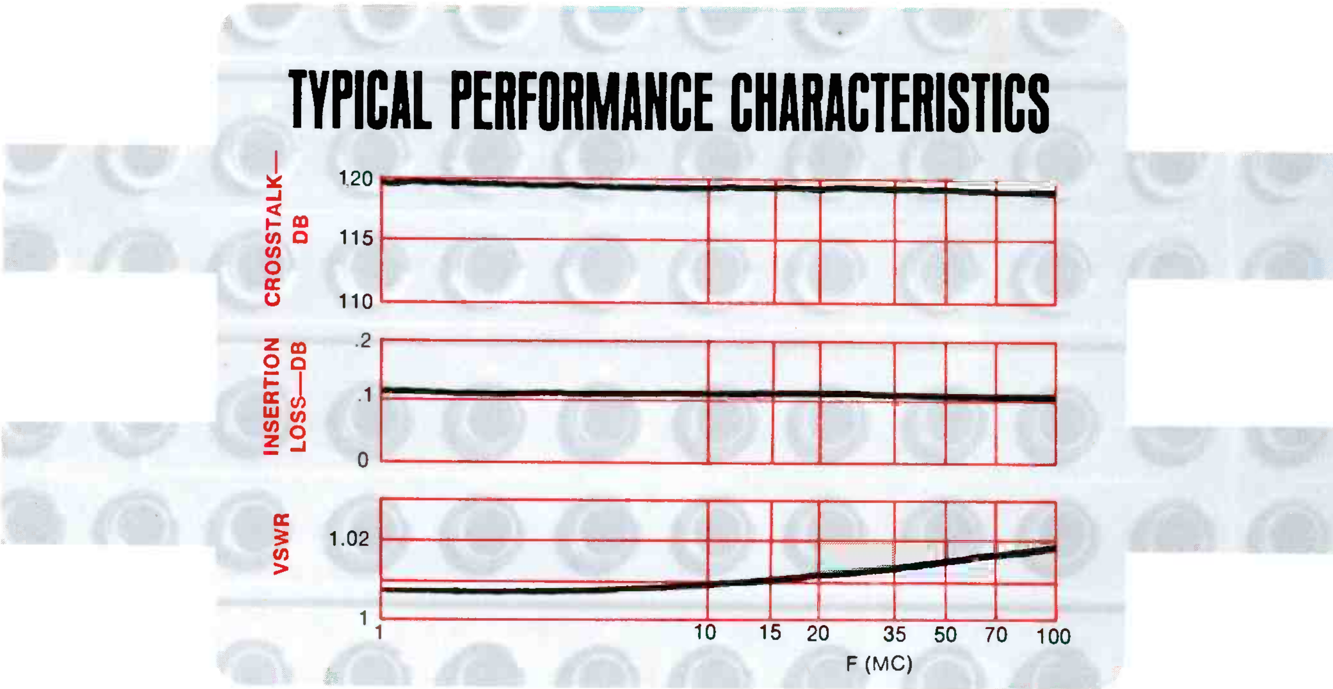
William C. Simonite has been named to the newly created post of director of consumer and distributor sales for **Electro-Voice, Inc.** Formerly he was national sales manager at University Sound. In another announcement, **Harold "Bud" Mosier** has been promoted to chief engineer at Electro-Voice. In this new position, he will be responsible for educational activities relating to the engineering department, in addition to continuing as chief engineer of phonograph cartridges and serving as assistant to the director of the engineering division.

Howard M. Ham, Jr. is the new vice-president–engineering for **Moseley Associates, Inc.** Mr. Ham, who has been with Moseley since 1962, was previously with Raytheon and G.M. Giannini, Inc.

Gene Francis, national distributor sales manager for **Rohn Manufactur-**

• *Please turn to page 114.*

a new concept & performance in coaxial switching



ONLY FROM COOKE Coterm 22T a normal-through coaxial* switching and terminating jack.

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Complete compatibility and Cooke quality combine to make this coaxial switching equipment first choice for TV, radar, communication patching, data handling, etc. Advanced in concept, engineered for the utmost in reliability, it will provide years of dependable, economical service.

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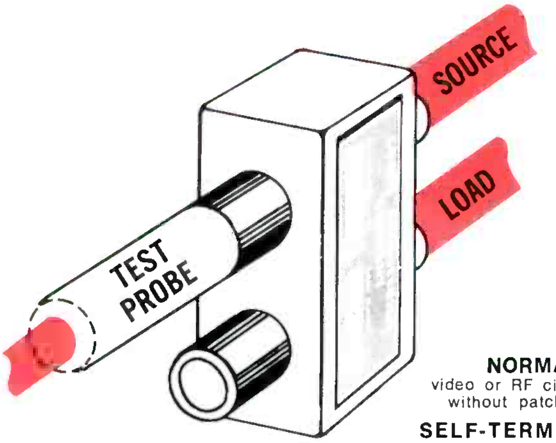
Test probe permits sampling or testing of normal-through circuit without interruption of signal

The Coterm 22T accepts either standard BNC connectors or Cooke-built quick-disconnect connectors.



NORMAL-THROUGH video or RF circuit is provided without patch cords or plugs.

SELF-TERMINATION OF SOURCE without extra terminating plug when load side is patched. Patched in circuit feeds load.

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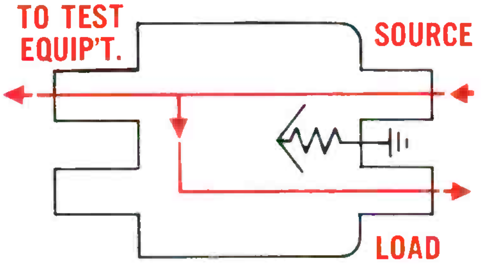

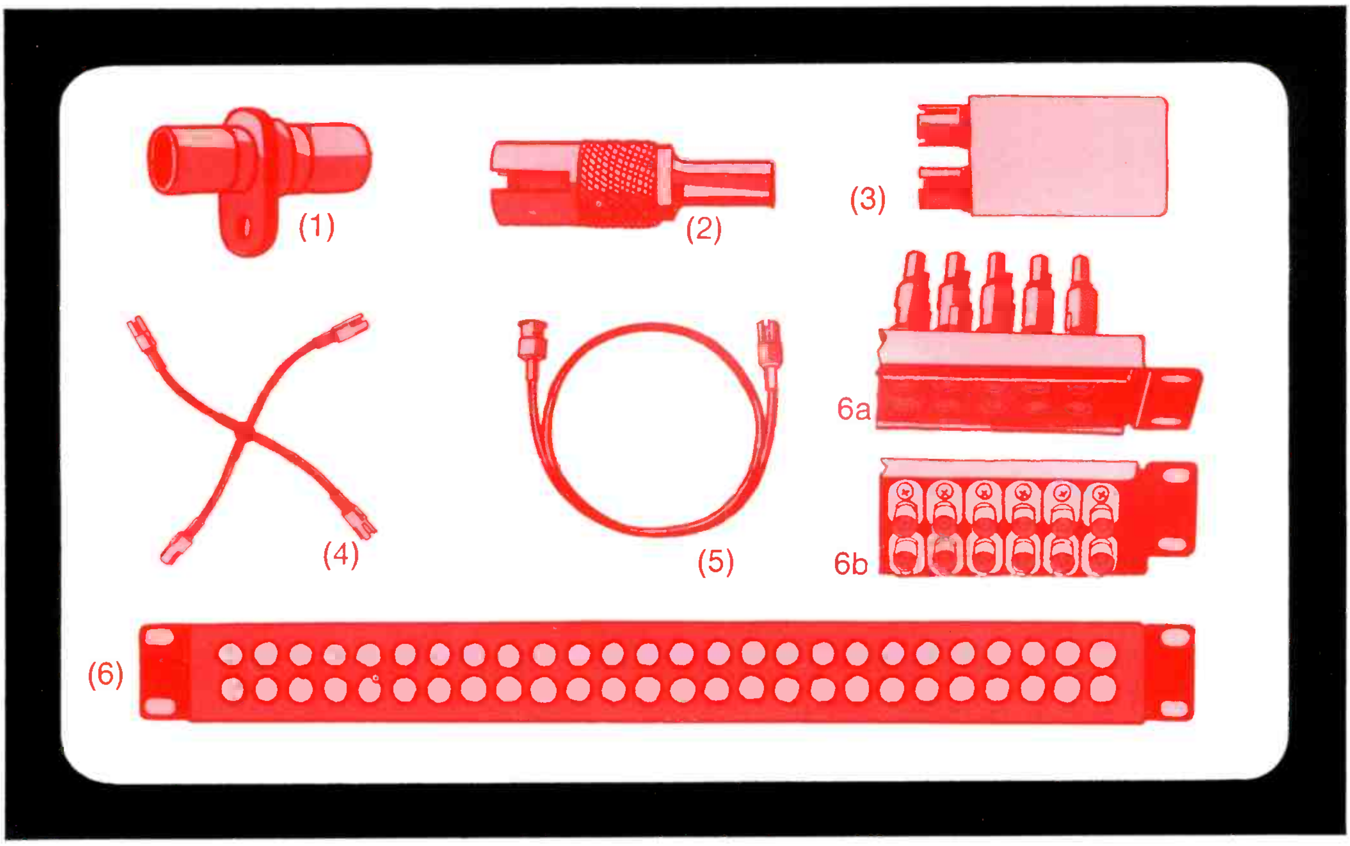

Other Cooke Coaxial Switching Equipment Available

(1) Coaxial Patching Jacks. (2) Quick-Disconnect Snap-Lock Connectors*. (3) Quick-Disconnect Normaling Plugs. (4) Bridging Networks, four and five way (four way shown). (5) Test and Patch Cords. (6) Panels . . . 6a showing permanent cabling, 6b showing Coaxial Patching Jacks, (1) above installed.

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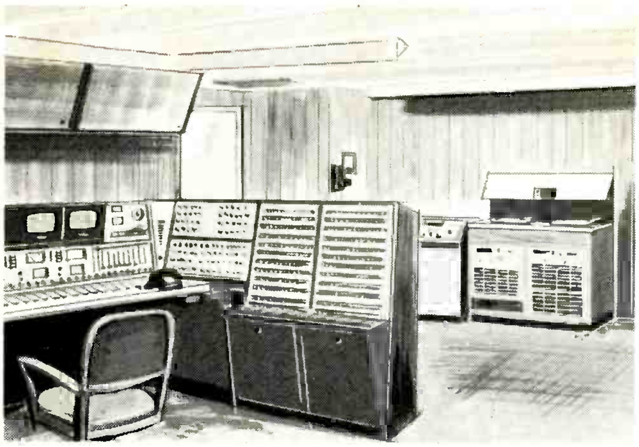

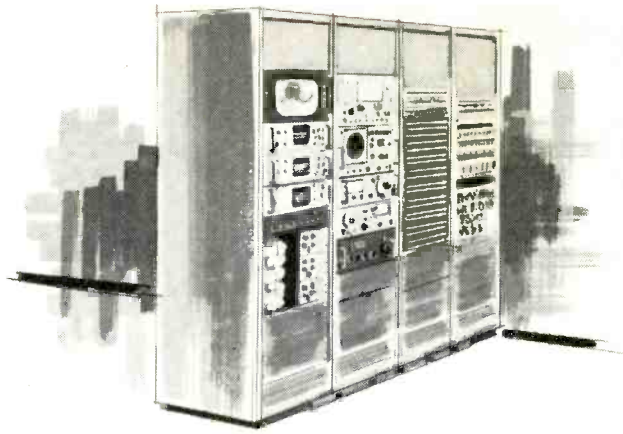

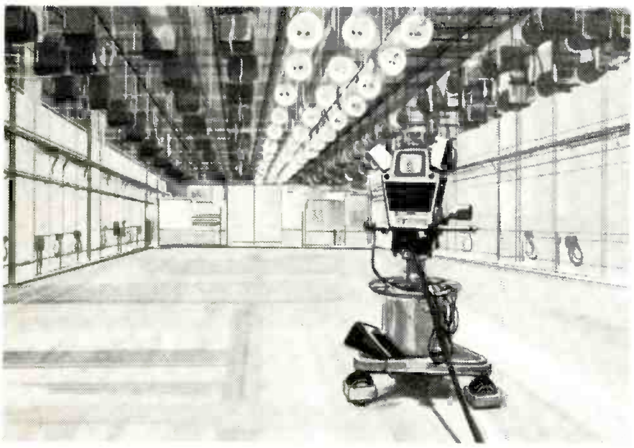

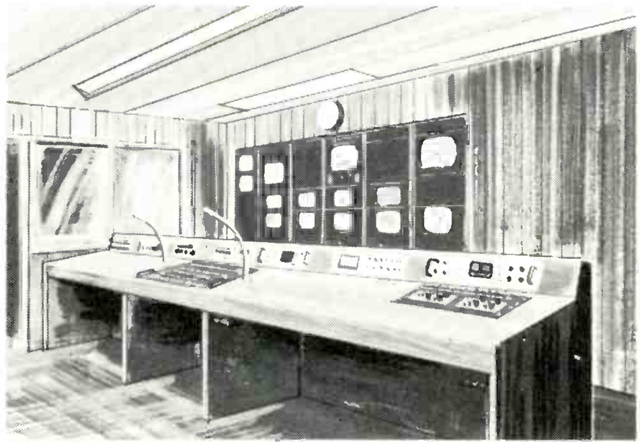

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Circle Item 35 on Tech Data Card

News

(*Continued from page 108*)

ing Co., has been appointed western division sales manager for the West Coast, including Alaska and Hawaii. The main office and warehouse servicing this area are located in Reno, Nevada.

Raymond L. Kelley has been appointed vice-president – finance and treasurer of **Shure Brothers, Inc.** He returns to Shure, with whom he was previously associated as vice-president and controller, from a position as an officer of the Continental Bank.

Eugene A. Tymon has been appointed television sales engineer by **Tele-Measurements Inc.** Mr. Tymon, an electrical engineering graduate of Manhattan College, was formerly with Prudential Insurance Co. of Newark, in the sales promotion department.

Appointment of **Robert M. Williams** to the new post of manager, TV transmitter merchandising, has been announced by the **RCA Broadcast and Communications Products Div.** Mr. Williams has been a salesman of RCA broadcast equipment since 1960. He began his television career as a cameraman and program production manager for KGBT-TV, Harlingen Texas, and later worked as a TV director at KPAC-TV (now KJAC-TV), Port Arthur, Texas.

H. J. Orchard, a senior staff engineer at **Lenkurt Electric Co., Inc.,** a subsidiary of **General Telephone & Electronics Corp.,** has been awarded the grade of Fellow in the IEEE, for his contribution to the theory and engineering design of passive and active circuits.

At Lenkurt, Mr. Orchard is supervisor of the Networks and Mathematics Group in the Advanced Development Department. He is a consultant on network design, and his work includes general investigations into new circuit techniques and mathematical problems. Previously, he held a number of responsible positions with the British Post Office Engineering Department over a 22-year period, including that of principal scientific officer at the Research Department in London.

Named to head the sales organization of **Jampro Antenna Co.** is **Bud Blaksley,** who for the past five years has been western sales manager for Rohn Manufacturing Co. Prior to that, he was vice-president of Tri-Ex Tower Co., and for 10 years he was a power-company distribution engineer.

Robert W. Bell is now chief engineer of **WSBT AM-FM-TV,** South Bend, Indiana. He has been with the stations 15 years, previously serving as transmitter supervisor and assistant chief engineer. ▲

 (Continued from page 32)

EXCLUSIVE OR		
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

(A) Truth table

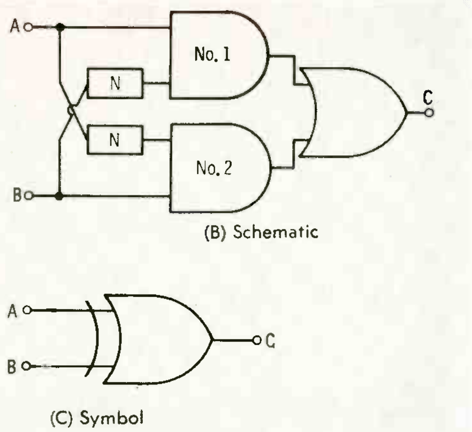


Fig. 4. Exclusive OR is combination of OR, ANDs, and NOTs.

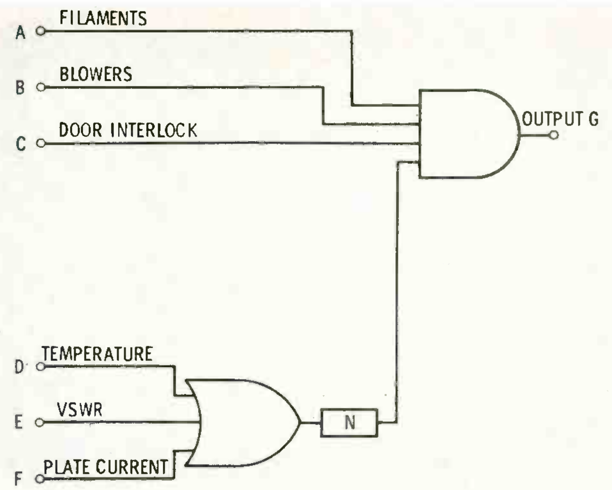


Fig. 5. Basic elements are combined for complex functions.

clusive OR is arrived at by applying the principles of Boolean algebra to the information given by the truth table. It is seen that logic 1 is obtained for two conditions only: when A is not logic 1 AND when B is logic 1 *OR* when A is logic 1 AND B is not logic 1. Algebraically this is written as:

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

This is read as "C equals B and not A, or A and not B." The logic circuit (Fig. 4B) is made up of AND gate No. 1, with input A but NOT B, plus AND gate No. 2, with input B but NOT A. A logic 1 at C is desired when the No. 1 gate OR No. 2 gate is logic 1, so the two are combined with an OR gate.

Because the Exclusive OR is used so frequently, the schematic is simplified to the symbol of Fig. 4C, which represents the same function as that shown in Fig. 4B.

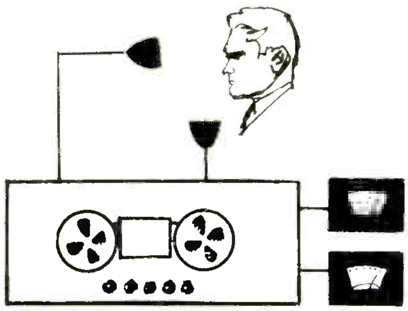
The Exclusive OR is used when it is desired to have an output if the two inputs are not identical. Consider the case in which a broadcast transmitter is switched from high power to low power by changing taps on the primary of the power transformer. The output, C, of an Exclusive OR is used as a control level for applying the high voltage.

Now...
the first lavalier microphone without 'lavalier sound': the MD 214 by SENNHEISER

Among the many reasons for using lavalier microphones are their constant distance from the performer (less need to 'ride gain') and unobtrusiveness. However, *ordinary* lavalier microphones have 'lavalier sound,' a muffled, noisy quality that makes them unsuitable for commercial use.

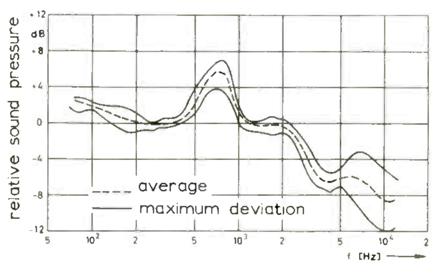
What causes 'lavalier sound'?

1. Directional sound radiation: The mouth radiates sound, especially higher frequencies, in a beam-like pattern, resulting in lower off-axis sound pressures at lower frequencies. Since lavalier microphones are always significantly off-axis, a loss of 'presence' results.



2. The vibrating chest: Extensive research has shown that the chest acts as a radiator in the region of 600-800 Hz, with peak energy radiated around 700 Hz (surprisingly, this figure varies little between the sexes). When ordinary lavalier microphones are placed in position they pick up this energy, imparting a boomy quality to speech and singing alike.

3. Noise problems: Three kinds of noise plague the ordinary lavalier microphone: mechanical noise conducted along the microphone cable, noise from friction generated when the microphone rubs against clothing, and airborne noise, such as cloth rubbing against itself.

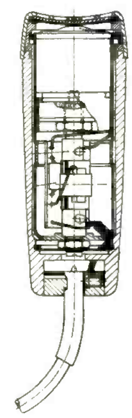


How the MD 214 eliminates these problems:

Contoured response restores lost 'presence': Sennheiser engineers conducted extensive tests, comparing the response of a microphone placed in the lavalier position with an identical one placed on-axis. Using a number of subjects, they were able to plot an average curve of difference. By judicious construction of the transducer assembly, the MD 214's response was tailored to a 'mirror-image' of the difference curve. The result: unusually flat response in the audio range.

Filtering prevents boominess: A specially-engineered filter, unique with Sennheiser, attenuates frequencies in a narrow region around 700 Hz, eliminating the hollow, muffled quality produced by pickup of chest vibrations.

Shock-isolation cuts noise: The MD 214 is built to eliminate noise from the inside out. The transducing assembly is housed in a 'case-within-a-case;' a separate assembly which is pneumatically damped and slides in a permanently-lubricated plastic gasket. This unit, which serves as a noise baffle, is in turn surrounded by a thick cast housing, which has rounded corners to reduce friction, while preventing the microphone from rolling side-to-side. The microphone cable has a flexible internal strain relief, which prevents mechanical noise from reaching the transducer via the cable.



The result of these engineering innovations is a microphone specially-created to meet the stringent pickup requirements of the film and broadcast industries. For technical data on the MD 214 or any other dynamic or condenser microphones in the Sennheiser line, please call or write:

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500 Fifth Avenue, New York, N.Y. 10036
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Circle Item 42 on Tech Data Card

cuts video tape editing costs 75%

EECO's new ON-TIME Video Tape Editing and Control System can now be used with *either* quad-head or helical scan recorders. This means drastic cost reductions — 75%, in many cases — by permitting pre-editing on the helical scan unit, reserving the more costly quad-head machine time for final edit. EECO's ON-TIME pre-editing feature provides a work print and an editing log which allows you to make more than 30 edits per hour on your quad-head recorder. *Edit directly on video tape . . . no tape-to-film and film-to-tape transfers . . . no messy 24 frame-to-30 frame conversion table.* "EECO Time" recorded on the cue track of your video tape lets you find scenes quickly, controls electronic splicing to the precision of one frame, and accurately controls tape transport "stop" and "start" times. Get more information on EECO's money-saving ON-TIME system, and arrange for an early demonstration on your own recorder.

INSTRUMENTS DIVISION

ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA

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Circle Item 43 on Tech Data Card

See the ON-TIME System in action at the NAB Show, Booth C, Writing Room

Circle Item 46 on Tech Data Card

Output (C) is logic 1 if: (A) low combining all three types, an infinite The logic diagram is shown in

FETs *(Continued from page 101)*

either drain current (depletion type) or no drain current (enhancement type). Fig. 4A shows a cross-sectional view of a depletion-mode MOSFET. When the device is conducting current, a channel of N-type material exists between the drain and source. (Only the N-Channel version is shown and discussed; the P-channel type is the exact opposite). When the gate voltage is zero as shown in Fig. 4A, the existing N channel can conduct electrons from the source to the drain. If a negative gate voltage is applied, the MOS capacitor will charge. This action causes positive carriers (holes for electrons) to be drawn toward the negative electrons on the gate and thus force electrons out of the N channel as shown in Fig. 4B. The channel is now smaller, and there is less current between the source and the drain. If a large negative voltage is applied to the gate, enough electrons will be forced out of the channel to "pinch it off" (Fig. 4C). The pinch-off voltage is considered to be that gate voltage which reduces the drain current to a small percentage (usually 1%) of its value with zero gate voltage and the specified drain-source voltage.

The enhancement-type MOSFET operates in the opposite manner, as shown in Fig. 5. With zero gate voltage, there is no channel to conduct significant current. If a positive volt-

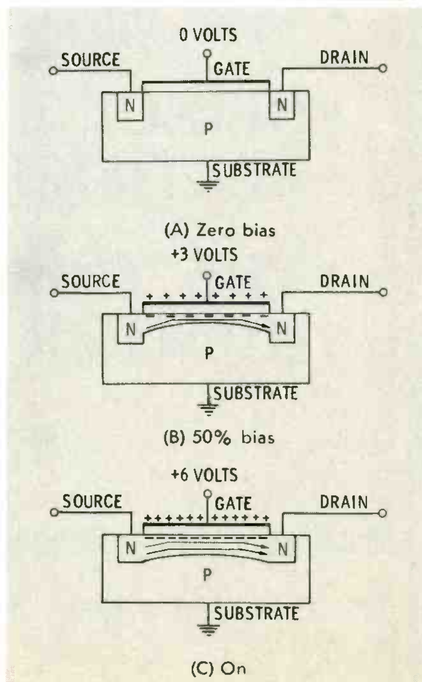


Fig. 5. Simplified diagram shows an N-channel enhancement-type MOSFET.

age is put on the gate, electrons are drawn toward the gate, creating an N channel. A drain-source current can then be established.

Test Procedures

Like virtually any device, the FET can fail. However, it does not, as a rule, degrade in performance over a long period of time as does a tube. The FET is similar to the transistor in that it can be somewhat sensitive to external circuit failures. Therefore, two types of failure problems—catastrophic circuit failure and device failure—can be considered.

Catastrophic Circuit Failure

The FET has certain specified voltage limits, and if these limits are exceeded permanent device failure can result. Therefore, when a device fails or is suspected of failure, the first check should be of the operating voltages to determine if they are in excess of the normal values. The usual result of an overvoltage stress is a short circuit in the device (because of excessive current).

Device Failure

FETs can malfunction in the same way as other transistors by becoming leaky. Usually the gate conducts current when it shouldn't. As with tubes, this problem can be detected in high-impedance circuits by measuring the voltage drop across the gate (grid) bias resistor with a VTVM.

Less common are device failures caused by vibration or shock. Damage results when the internal connections of the device break open.

Simple ohmmeter tests usually can be performed to check an FET for failure. Advantage is taken of the fact that a PN junction allows current to pass in one direction only. If the ohmmeter shows first a low resistance and then a high resistance (or vice versa) when the probes are reversed, this result gives a good indication of a diode. When a PN junction of an FET fails because of over voltage or current stress, the usual result is a short. Because of this fact, the device can usually be checked first in-circuit. When checked out-of-circuit with an ohmmeter, the various types of FETs show the characteristics indicated in Fig. 6. Compensation should be made for the shunting resistors when the FET is checked in-circuit.

Circle Item 50 on Tech Data Card

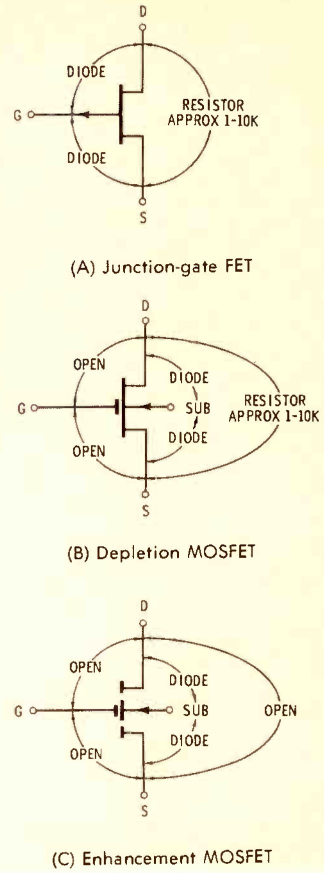


Fig. 6. Resistance checks may be used in testing of a field-effect transistor.

Special Precautions

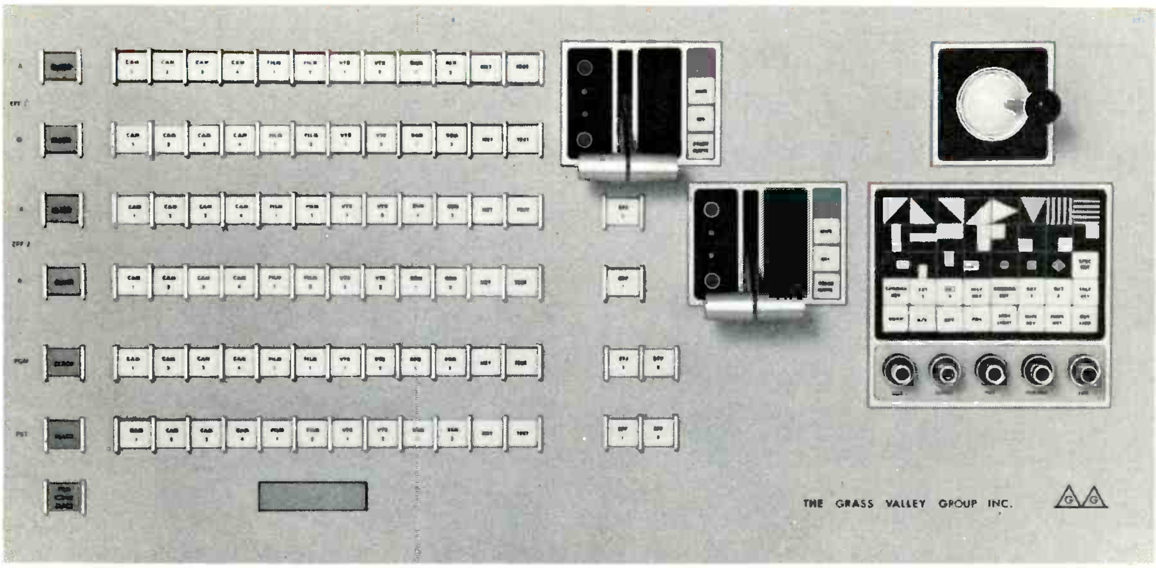
Some special techniques are necessary in handling the MOSFET because of the delicate nature of the gate-to-channel capacitor. The dielectric is approximately four microinches thick and has a very high resistance. As a result, the capacitor can hold a charge for a long period of time. A charge sufficient to exceed the breakdown voltage of the capacitor can be developed merely by stroking the device leads through the hair. If the following handling precautions are observed, however, there should be no difficulties:

1. Out of Circuit: Keep MOSFET leads shorted together.
2. Installation: (a.) Short MOSFET leads, (b.) Ground soldering iron tip.

Additional Information

Semiconductor manufacturers have available many good application notes on FETs. Also, additional information on this subject may be found in the book *Field Effect Transistor Applications*, by William Gosling (John Wiley and Sons, Inc., 1965). ▲

THE GRASS VALLEY GROUP, INC.



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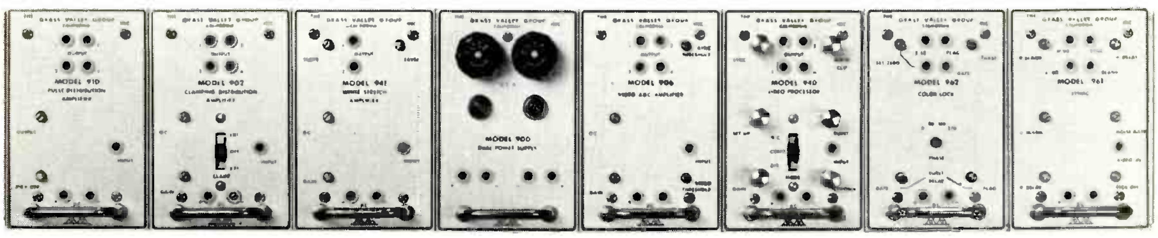

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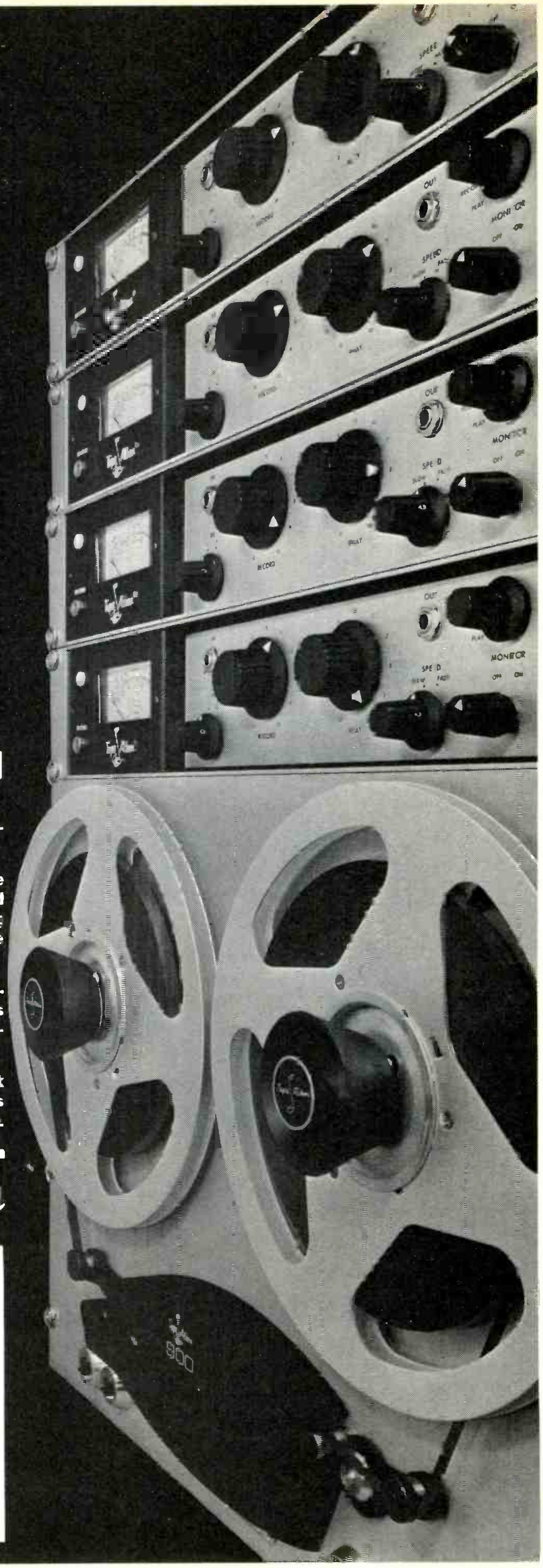

NEW PRODUCTS

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

Professional Audio Recorder
(100)

A line of magnetic recorders featuring console mounting, straight-line tape threading, and front-panel controls has been introduced by **Metrotech Inc.** The Model 500A professional recorder offers two-directional record and reproduce capabilities: this feature doubles unattended reel times at any speed. Edit and cue controls provide tape positioning for addition, deletion, or playback of specific program segments.

The 500A is equipped with separate front-panel high/low torque switches for each reel-drive motor. A two-speed capstan motor is also front-panel controlled for high and low tape speeds, with automatic equalization switching. Any adjacent pair of standard speeds from $1\frac{7}{8}$ to 15 ips is available. All operating controls of the 500A can be remoted. Capstan closure is adaptable for playback control by an automation system.

The 500A Series recorders and compatible reproducers are available in mono and stereo options for full-track, half-track, two-track, and four-track operation. Single-speed logger models are available with 5/16, 15/32, or 15/16 ips tape speed. ▲

Bulk-Tape Eraser
(101)

The Model TM-88 hand-held bulk-tape eraser, from **Robins Industries Corp.,** is intended to handle any size reel of magnetic recording tape or magnetic stripped movie film. The eraser has a handle with a built-in momentary switch and is designed for erasing entire reels, with recorded material and background noise reduced to below the normal erase-head level, by moving the unit over each side of the reel. The TM-88 weighs two pounds, and operates on 4 amperes, 110-120 volts, 50-60 Hz. It lists at $17.50.

Color Camera With Zoom Lens
(102)

A new compact compatible color TV camera contains a beam-splitting prism assembly feeding four lead-oxide vidicon tubes. The camera measures 29″ x 15″ x 15″, including the integral zoom lens. Designed by **E.M.I. Electronics, Ltd.** to produce broadcast-quality 525-line output, the 2001 camera processes the signals from its four tubes to produce three outputs, R, G and B, for direct application to standard NTSC encoders and to standard RGB color monitors. Weight of the camera (without lens package) is 160 pounds.

Alternative 10:1 zoom lens packages can be supplied. The relevant servo amplifiers are contained within the camera and are used with all zoom-lens packages. Zoom rate is controlled from a twist grip on the camera panning handle, and preset zoom positions can be selected by push buttons.

Cueing and communications facilities are included, and provision is made for mounting a visual prompter. The tilting electronic viewfinder is powered from the camera but can be used up to 33 feet away, if required. Solid-state circuits are built onto plug-in printed circuit boards, and extensive use is made of stage-by-stage and over-all negative feedback, together with close component tolerances, for long-term stability.

Solid-State Video Monitor

(103)

The Model VM-218 video monitor, from **Maryland Telecommunications, Inc.,** employs all-solid-state circuitry, including the high-voltage rectifier.

The design includes regulation of both the low-voltage and high-voltage supplies, a 9-inch bonded-face rectangular kinescope, switch-selectable DC restoration (0 to 100%), switchable raster size, loop-through operation, and input of 2.2 megohms in parallel with 15 pf or terminated into 75 ohms (switch selectable).

Some specifications are 525-line, 30-frame or 625-line, 25-frame scanning; 10-MHz bandwidth, differential gain less than 5% with 75-volt kinescope drive; 800-line resolution; and external sync, 1 to 100 volts negative, composite or separate sync (switch selectable).

Available models are: Model VM-218-NC (chassis only), $415; Model VM-218-WC (portable cabinet), $455; Model VM-218-RT (twin rack), $865; and Model VM-218-RS (single rack), $450.

TAPECASTER

Model 700-P

Solid state playback unit

Broadcaster net price $300.

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*TCM

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get the turntable a studio needs ...and rek-o-kut durability, too!

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specifications:

SPEEDS: 33⅓, 45, 78 rpm. NOISE LEVEL: — 59db below 5 cm/sec average recorded level. MOTOR: custom-built computer type heavy-duty hysteresis synchronous motor. 45 RPM HUB: instantaneously removable by hand. PILOT LIGHT: neon light acts as an "on/off" indicator. FINISH: grey and aluminum. DECK DIMENSIONS: 14 x 15$^{11}/_{16}$". Minimum Dimensions: (for cabinet installation) 17¾" w. x 16" d. x 3" above deck x 6¼" below. PRICE: B-12H Turntable $165. S-320 Tonearm $34.95. Optional BH Base for audition room $18.95.

Rek-O-Kut Turntables by

KOSS

Koss Electronics Inc., 2227 N. 31st St., Milwaukee, Wis. 53208
Export Cable: STEREOFONE • Koss-Impetus/2 Via Berna/Lugano, Switzerland

Circle Item 60 on Tech Data Card

Translators
(104)

A line of solid-state VHF and UHF television translators with power output levels to 20 watts is offered by **Rodelco.** Shown is the Model VHFT translator for converting any VHF TV channel to any other VHF TV channel at a power output level of 1 watt. The unit has a typical specified noise figure of 2 dB and 6-MHz bandwidth.

Cable Identification
(105)

Transparent, reusable protectors for message identification of harnesses, harness breakouts, cabling, tubes, and pipes have been introduced by **Thomas & Betts Co., Inc.** Identification is achieved on the spot by writing the message with pencil, or other marking instruments, on paperboard cards that are torn from perforated sheets and inserted into the preformed pocket of the protector. The protectors are hole-punched and secured to the bundle

with Thomas & Betts "Ty-Rap" ties. Ends of the protector may be sealed to provide moisture protection for the identifying message.

The protectors come in two sizes, 1 9/16" x 1 5/8" and 1 9/16" x 2 9/16". Each size has a minimum bundle diameter of ½ inch and a maximum of ¾ inch.

16-mm Projector

(106)

A projector designed for television use is available from **Traid Corp.** Some features listed for the Selecta-Frame Model 16N/TV are instantaneous stop-action, frame-by-frame slow motion, flickerless operation, and damage-free safety to film. A synchronous motor maintains the speed of 24 frames per second with AC line synchronization. A special shutter is intended to provide exact synchronization in television chains, eliminating "shutter-bar" effect.

Audio Connector Adapters

(107)

These audio connectors are designed by **Switchcraft, Inc.** to solve common interconnecting problems on components that do not have mating connectors. One adapter accommodates a standard two-conductor phone plug to equipment that uses a three-pin audio receptacle. The other adapts a standard two-conductor phone plug to equipment using a three-contact audio receptacle.

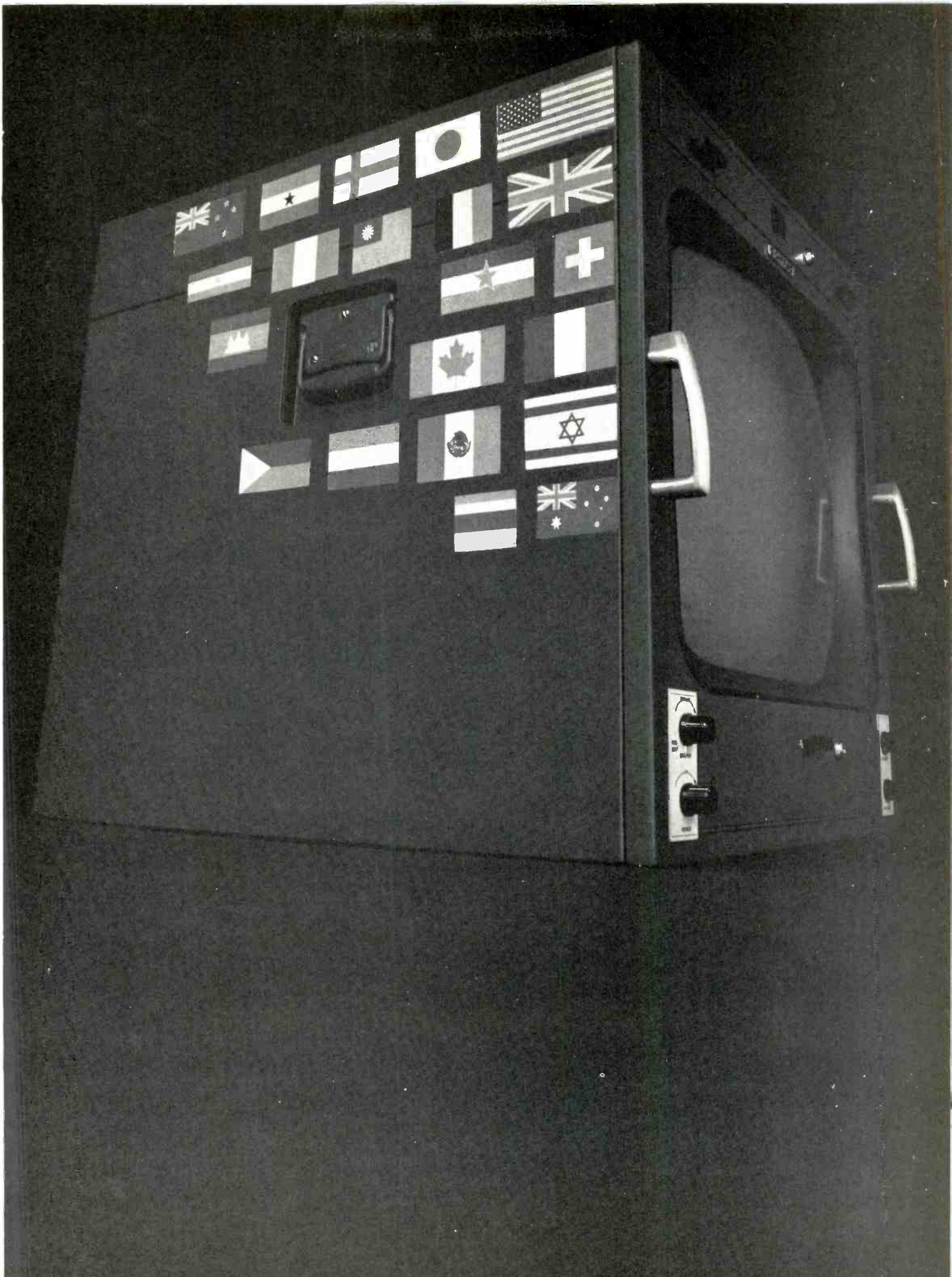
The adapters feature a separate "ground terminal" which is electrically integral with the connector shell, "ground contactors" which provide ground continuity between mating plugs, and left-hand-threaded "captive design" insert screw, which eliminates loss of the screw during assembly. To reduce hum and noise problems normally encountered in high-impedance circuits, pins and contacts are insulated by a high-impact thermosetting plastic.

Stereo Headphone
(108)

The Model ST-PRO-B stereo headphone is designed by **Superex Electronics Corp.** for professional use. A dynamic woofer is used for the low-frequency response, and a ceramic tweeter is interconnected by a full crossover network. This woofer-tweeter combination is coaxially mounted in the ear cups. An ear seal is provided by removable vinyl cushions filled with urethane foam. An adjustable spring-steel headband is provided. An impedance of 8-16 ohms is standard; 600- 2000- or 15,000-ohms impedance is available. Net price is $50. ▲

Circle Item 65 on Tech Data Card

Circle Item 66 on Tech Data Card



Circle Item 67 on Tech Data Card

HD Meters

(Continued from page 27)

from 0.1 to 0.25% residual harmonic distortion in the range from 50 Hz to 15,000 Hz.

The techniques of running a complete audio proof have been well covered elsewhere (4, 5, 6, 7, 8, 9, 10). Distortion measurements, however, require special considerations. First, it is a good idea to make a distortion run using only the generator, a dummy load, and the HD meter. This control run will indicate the performance of the measuring instruments themselves. Usually, if the equipment is in good shape and there are no ground loops, residual distortion below 0.5% should be indicated between 50 and 15,000 Hz. Since the Commission does not require measurements for fundamental frequencies outside this range, there is no need to insist on very low distortion, for instance, below 50 Hz.

It is generally considered to be a good idea to make separate distortion measurements on the console, the amplifiers, and the transmitters (11, 12). If one equipment item contributes several times the distortion of any other unit, it is the piece to troubleshoot. "Creeping distortion" usually starts in a single amplifier, and eventually the entire audio chain exceeds FCC limits. Preventive maintenance at the proper time helps prevent this from happening.

Most technicians ignore residual distortion contained in the measuring instruments, as long as it is below about 0.5%. Of course, a copy of the control run with the instruments alone should be kept on file. It should be pointed out that subtracting the residual figure from the equipment measurement may yield an erroneous result, since distortion does not always add directly. The lowest FCC limit is 2.5% distortion from 100 to 7500 Hz for FM stations. Most stations can show only 1.5 to 2.0%, which gives room to spare for residual distortion. If the instruments check out over 0.5% residual, they probably need troubleshooting.

It has been said that an instrument with six-digit resolution is useless when manipulated by a two-digit operator. The technician must know the limitations of his measuring equipment; only then can he make truly accurate measurements. ▲

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11. Haskett, Thomas R. "Audio Studio Maintenance," BROADCAST ENGINEERING, 4 (June 1962), 14, and (July 1962), 12.
12. Murdoch, Ed. "When the Proof of Performance Fails," BROADCAST ENGINEERING, 5 (May 1963), 20; (June 1963), 20; (October 1963), 16; (December 1963), 12; and, 6 (February 1964), 28.

ENGINEERS' TECH DATA

ANTENNAS, TOWERS, & TRANSMISSION LINES

116. ANDREW—Information is available about **Heliax** Type HF10, a new 8-inch flexible coaxial cable.
117. DELHI—Twelve-page catalog concerns towers and masts for citizens-band and similar applications.
118. FINNEY—Information about **Finco** 75-ohm master-system antennas is contained in brochure.
119. HUGHEY & PHILLIPS—Bulletin HPS-184 describes new combination photoelectric control and beacon flasher for tower obstruction lighing; Specification Guide SG-2 for tall-tower obstruction lighting also is offered.

AUDIO EQUIPMENT

120. ATLAS SOUND—Form PP-1840 describes microphone stands, microphone booms, and studio accessories.
121. BELL P/A PRODUCTS—Specification sheet giving details of the BE-M4 "A" transistorized mixer is offered.
122. FAIRCHILD RECORDING—FICM integrated control module is subject of technical bulletin.
123. NORTH AMERICAN PHILIPS—Booklet describing AKG transistorized (FET) condenser-microphone system is subject of literature offer.
124. RYDER MAGNETIC SALES—Information about Sela 2880 audio mixer for use with Nagra recorders is offered
125. SUPERSCOPE—31-page catalog, "All the Best From Sony," features Sony/Superscope tape recorders, magnetic tape, microphones, and accessories. Additional catalog has technical specifications of consumer and professional microphones.
126. UNIVERSITY—28-page Commercial Sound Product Catalog lists speakers, horns, drivers, microphones, and sound columns; includes sound-system design chart, formulas, and technical data.

COMPONENTS & MATERIALS

127. MOTOROLA SEMICONDUCTOR—HEP Cross-Reference Guide lists 12,000 transistors, rectifiers, diodes, and SCRs.
128. PITTSBURGH CORNING—A 12-page bulletin, GC-7, describes use and installation procedure for **GEOCOUSTIC** acoustical units using "patch technique."
129. TECHNICAL WIRE PRODUCTS—Eight-page short-form catalog has information on shielded enclosures, EMI/RFI air filters, shielding gaskets and strips, conductive epoxy, and glass shielding panels.
130. TROMPETER—Catalogs T-6 and M-4, listing coax, twinax, and triax products for patching, switching, and matrixing, are offered.

LIGHTING EQUIPMENT

131. BERKEY-COLORTRAN—Vari-Beam "1000" variable light sources and accessories for use with them are described in Catalog No. Q-1024.

MICROWAVE & STL EQUIPMENT

132. LENKURT ELECTRIC—32-page catalog listing microwave-radio, multiplex, data-transmission, and related equipment in product line is offered.
133. MICRO-LINK/VARIAN—Specifications and prices for TVL Series TV-relay equipment are given in 2-page specification sheet.
134. MICROWAVE ASSOC.—Data sheets are about MA2B, MA7B, and MA13B equipment for TV intercity, STL, TSL, and remote-pickup uses.
135. MOSELEY ASSOC.—All-solid-state Model PCL-303B/C stereo STL is described in Bulletin No. 219A.

MISCELLANEOUS

136. WALLACH & ASSOC.—Cabinets for records, tapes, slides, film, and film strips are shown in 8-page catalog.

MOBILE RADIO & COMMUNICATIONS

137. CUSH CRAFT—New catalog CB-68 describes CB and business-band antennas and lightning arrestors.

POWER DEVICES

138. ONAN—Publications are "Standby Electric Power Systems" (No. 30d/On), catalog sheet "Automatic Line Transfers for Microwave Stations" (Form A364-B), and 8-page catalog F-205-D of Onan electric plants.

RECORDING & PLAYBACK EQUIPMENT

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

140. RUSSCO—Data sheet describes turntable, mono and stereo phono preamplifiers, and companion power supply.
141. TELEX—Descriptions of Viking Studio 96 and Magnecord Models 1021 and 1022 tape recording and reproducing equipment are given in literature.
142. TEXWIPE—Information and prices for tape-head cleaning kit and its individual components are offered.

REFERENCE MATERIAL & SCHOOLS

143. CLEVELAND INSTITUTE OF ELECTRONICS—Pocket-size plastic "Electronics Data Guide" includes formulas and tables for: frequency vs. wavelength, dB, length of antennas, and color code.

TELEVISION EQUIPMENT

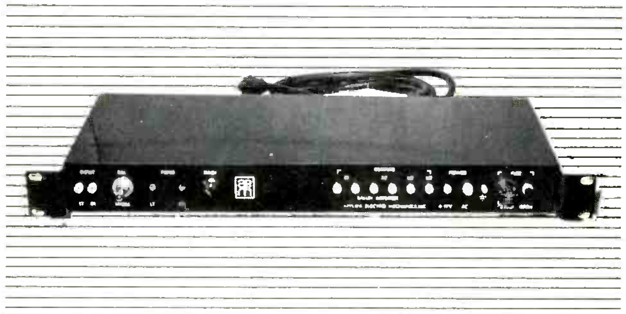
144. ALMA ENG'G—Brochure has to do with video switching systems, and specification sheet concerns audio console.
145. CANOGA ELECTRONICS—Data sheets for VT-5000 video transmission and terminal equipment, 1270 miniature camera control, and CH-1400 miniature vidicon camera are available.
146. CLEVLAND ELECTRONICS—A 52-page quick-reference catalog gives information on vidicon, **Plumbicon**, and image-orthicon deflection components.
147. COHU—Data sheets 6-488, 6-470, and 6-464 give specifications for the 2610/2620 series black-burst generator, drive generator and colorlock, and chroma detector, respectively.
148. COLORADO VIDEO—Preprint No. 102-25, "A Magnetic Disc Video-Scan Converter," presented at the 102nd SMPTE Technical Conference, is offered.
149. CONCORD ELECTRONICS——TV cameras, monitors, control panels and related accessories for CCTV and VTR systems are covered by descriptive literature.
150. KAPPA—Specification sheets describe the Model KR-250-4 video-cable simulator, and Series D, K, and L delay lines.
151. METRO TEL—Bulletin No. 21 describes TV line equalizer No. 323E and TV delay line No. 7292.
152. TELEMATION—Brochure describes and gives prices for Model TMV-707 universal camera control and accessories.
153. TV ZOOMAR—Literature covers H.T.S. studio equipment, Newsbreaker 400 cilor-film processor, and TV Colorgard meter to balance color TV monitors.
154. VITAL—Model VIX-108, new integrated-circuit vertical-interval switching system, is subject of literature.
155. ZOOMAR—Literature describes the 500 Sport Reflectar, a 20-inch, F/5.6 lens; and the Variospeed-Hightorque-Control for ITV lenses.

TEST & MEASURING EQUIPMENT

156. ALFORD MFG.—Bulletin 701 gives descriptions and prices of the complete new line of **Hybridge** reflectometers.
157. BALLANTINE—Price list and twelve-page 1968 catalog are offered.
158. BARKER & WILLIAMSON—Sales Bulletin No. 111 illustrates and describes Model 210 audio oscillator and Model 410 distortion meter.
159. B&K—Bulletins are available for the following instruments: Model 2409 AC voltmeter/amplifier; Model 4240 simulated voice mechanism, for testing telephone transmitters and handsets; Model 2410 AF voltmeter/amplifier; Model 2417 rms voltmeter; Model 2006 heterodyne voltmeter; and Model 3350/51 electroacoustic transmission measuring system, for tests on telephone handsets.
160. DELTA—Information sheet has as its subject the Model RG-1 receiver/generator for use with antenna-impedance bridges.
161. EICO—1968 full-line catalog is offered.
162. TEKTRONIX—Specification brochures for Type 529 waveform monitor, Type 520 NTSC vectorscope, and Type 453 oscilloscope are available.
163. WEINSCHEL ENG'G—Line of barretters and thermistors is subject of 4-page publication.

TRANSMITTERS & ASSOCIATED EQUIPMENT

164. BARNSTEAD—Coolant repurification equipment is presented in Bulletin No. 201.
165. BAUER—Specifications of Model FB-10J, 10-kw AM transmitter are contained in catalog sheet.
166. GATES—Brochure describes Model FM-40H 40-kw FM transmitter; FM isolation transformers are subject of product information bulletin.
167. MARCONI—Technical description gives details of Type B.0502 10-kw UHF transmitter using vapor-cooled klystrons.



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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 opening for broadcast engineer with Second Class or First Class license to work in instructional television operation. Send resume to Barton R. Derby, Chief Engineer, ITV, Kent State University, Kent, Ohio 44240. 3-68-1t

TECHNICAL DIRECTOR

Required by large MSO headquartered in New York City. Experience required in all phases of CATV engineering and operations. This is a fine advancement oportunity for a seasoned field engineer or system chief technician. Offer open to anyone qualified. Send resume to Box 199. All information held in strict confidence. 3-68-1t

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

IMMEDIATE openings for qualified technicians in all-color station. Experience desirable, first class license required. Contact R. L. Renaud, Chief Engineer, WWJ-TV, 622 Lafayette Boulevard, Detroit 48231. 313-222-2812. 3-68-1t

Wanted: Chief Engineer for medium market AM FM station. Northeast U.S. No announcing. Market leader. $130/wk. Send resume to Box 190. 12-67-4t

WANTED—First Phone licensed engineer to work in South. Must have four to five years experience in TV broadcasting as studio maintenance engineer. Send resume with salary requirements to Box 191. 1-68-3t

WANTED—Experienced CATV technician to work in South. Send resume with salary requirements to Box 192. 1-68-3t

Established western manufacturer & distributor needs SERVICE MANAGER.
Must be experienced in:
Broadcast Studio Equipment, Including VTR
Color TV Equipment
Supervision of Technical Personnel
Limited travel. Excellent benefits.
Salary dependent on qualifications. Send resume to Box 197. 2-68-2t

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Exclusive territory for sale of rapidly expanding line of broadcast equipment requires highly motivated, sales-minded individual with strong technical knowledge of equipment primarily to AM, FM, and TV stations. Leading company with history of high profit and rapid growth. Salary plus commission—with full fringe benefits and travel expenses paid. An equal opportunity employer. Send resume to Box 196. 2-68-2t

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Leaving USAF after 20 years. Desire permanent engineer/management employment in New Hampshire or Maine. First Phone since 1957, 2nd since 1951. Experienced in TV/AM/FM. Trained and experienced in technical management. Excellent references. Will relocate at my expense after mid June. Salary open depending on location. Resume on request. Mr. E. Y. McKay, 4813 Lawrence Street, Alexandria, Virginia 22309. 3-68-1t

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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

TAA1 Preamplifier

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

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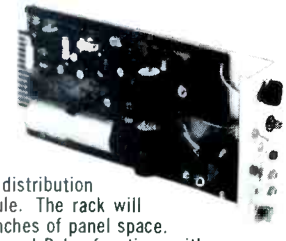
Circle Item 80 on Tech Data Card



TDA7 Video/Pulse Distribution Amplifier

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

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TC1 Clamping Amplifier

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

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TCA3 Transistorized Camera Amplifier

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

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TBG2 Black Burst Generator

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

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Circle Item 84 on Tech Data Card

TVA1 Transistorized Video Stabilizing Amplifier

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

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Circle Item 85 on Tech Data Card

TDA2D Video/Pulse Distribution Amplifier

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

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Circle Item 86 on Tech Data Card

TSA1 Clamping/Equalizing Video Amplifier

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

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Circle Item 87 on Tech Data Card