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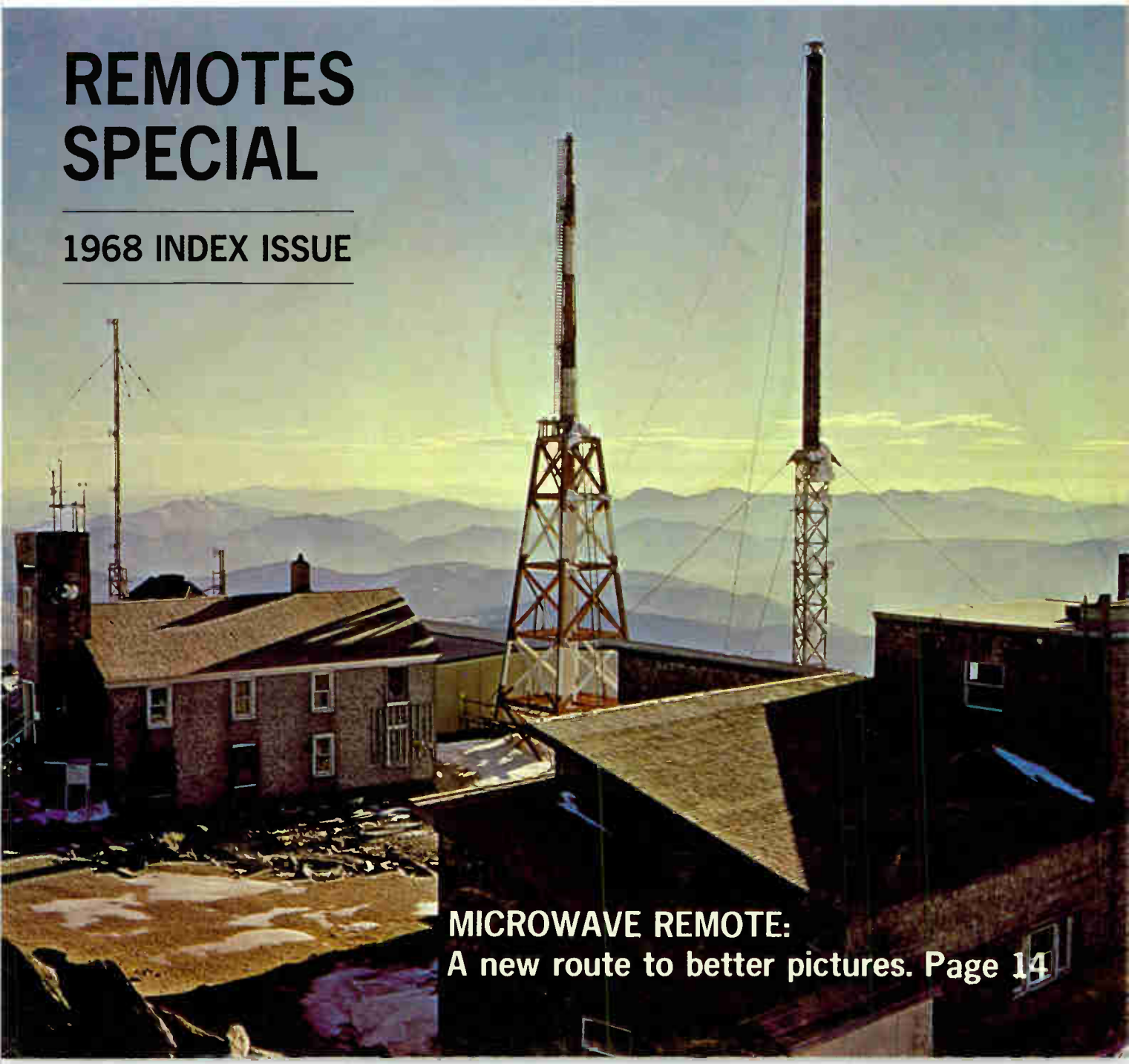
Broadcast Engineering

the technical journal of the broadcast-communications industry

REMOTES SPECIAL

1968 INDEX ISSUE



MICROWAVE REMOTE:
A new route to better pictures. Page 14

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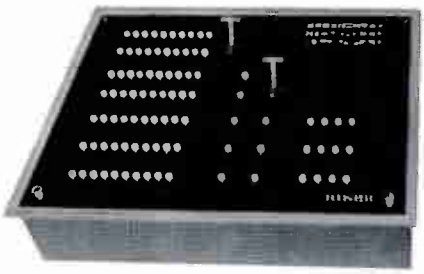

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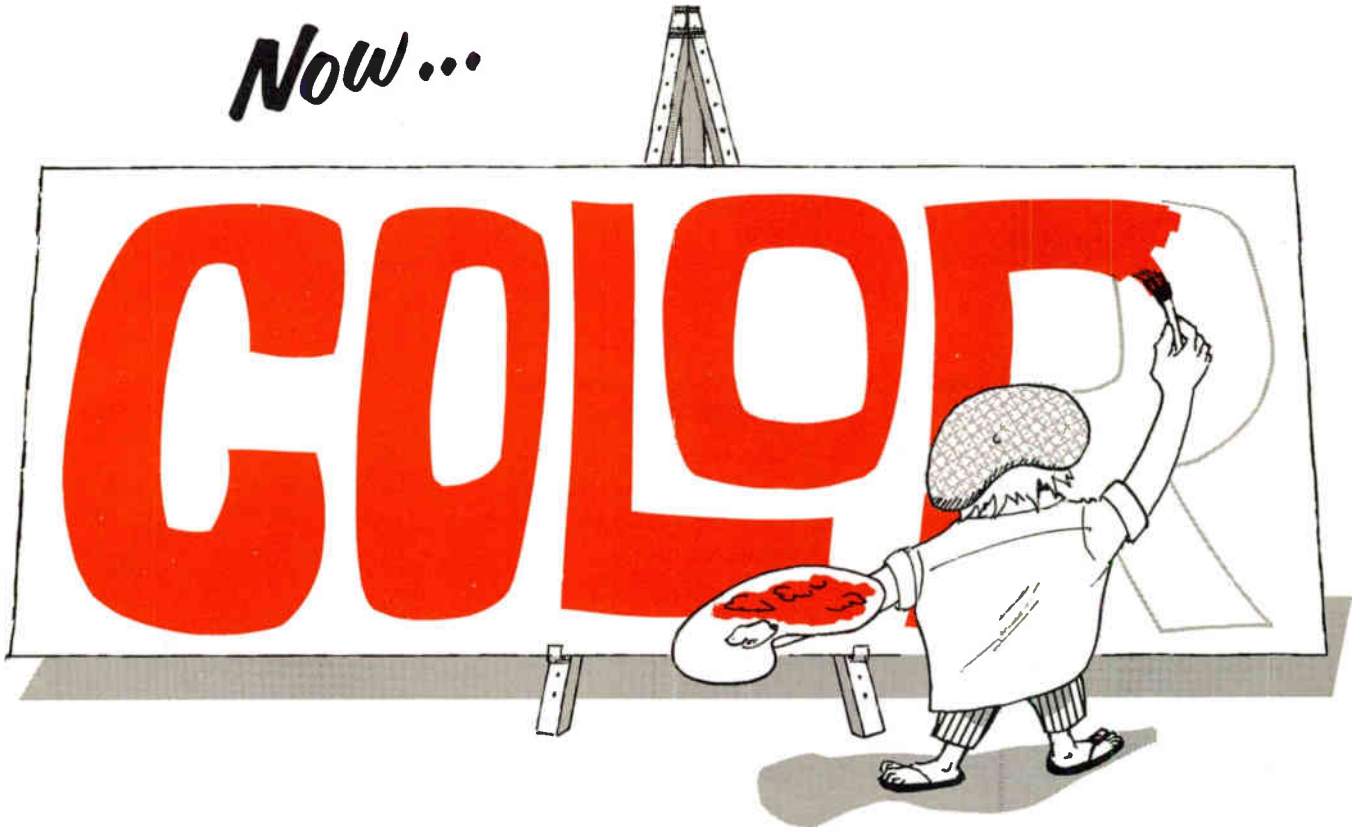

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December, 1968 • Volume 10, No. 12

Broadcast Engineering

The technical journal of the broadcast-communications industry

in this issue...

ABOUT THE COVER

Cover picture shows microwave transmitter site atop Mt. Washington. For inside story on remote relay, see page 14.

DEPARTMENTS

BROADCAST ENGINEERING is published monthly by Intertec Publishing Corp., 1014 Wyandotte Street, Kansas City, Missouri 64105.

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INDUSTRY NEWS

International: State Dept. Host, Overseas Radio Ready

Law enforcement representatives from 15 nations are taking part in seminar sessions on advanced mobile two-way radio communications techniques at General Electric Communication Products Department, Lynchburg, Virginia, under auspices of the Agency for International Development (AID).

The 36 State Department guests are in the United States on a program involving six months of study at Telecommunications Training Division of Leo G. Sands Associates, Inc., New York City. When they return to their home countries, they will plan, install, operate and maintain communications systems for their law enforcement agencies.

AID selected Sands Associates Telecommunications Training Division from a field of 50 leading institutions because of emphasis on mobile two-way radio in its technical courses. Additional classes on base stations and mobile units were conducted at Mechanics Institute in New York.

Paul R. Bartlett, president, Radio New York Worldwide, Inc., and Clark B. George, president, CBS Radio Division, have announced an affiliation agreement, effective November 4, 1968, which will initially send some 85 per cent of the broadcasts of the CBS Radio Network overseas via shortwave. CBS Radio Network lines to WNYW Radio, New York, will start these broadcasts on their way to five high-powered transmitters outside of Boston.

"We are very pleased," George said, "that, through this important affiliation, CBS Radio will again acquire a major overseas audience via shortwave. It has been two decades since CBS Radio Network broadcasts have been available to shortwave listeners."

According to estimates, an average weekly total of some two and a half million English-speaking people will be added to the CBS Radio Network's listening audience through WNYW and Radio New York Worldwide, Inc.

Bartlett added, "Although shortwave listening is not of primary interest in the United States, today there are some 60 million shortwave receivers throughout the world, representing steady growth over the years."

From May, 1942 to October 1, 1948, CBS Radio operated a shortwave service to Latin America that grew to 126 stations at its height. This and parallel facilities were taken over by the United States Government during World War II. After the end of the war, most shortwave broadcasting was consolidated into the Government's non-commercial Voice of America. **WNYW** Radio, then known as **WRUL,** however, continued as the sole commercial operation.

Groups Awaiting FCC Approval of Station Purchases

W. Randolph Tucker, chairman of the board of Cypress Communications Corporation (OTC), New York, announced that agreement in principle has been reached for the acquisition of Dynamic Broadcasting Company (Private), Pittsburgh, subject to FCC approval.

Dynamic operates four AM stations and an FM station: **WAMO AM-FM,** Pittsburgh, **WUFO,** Buffalo; **WOAH,** Miami; and **WILD,** Boston. Leonard E. Walk, president of the broadcasting company will continue in his present position. Dynamic will be operated as a wholly-owned subsidiary of Cypress, free to seek acquisitions on its own to expand its base of operations.

In announcing this acquisition, Tucker stated that "we feel our entry into the radio broadcast field is a logical step at this stage in our growth. Not only do we gain entry into another medium of communication, but we are convinced that the interaction between cable television and broadcasting will be valuable with respect to program origination and commercial sponsorship."

Cypress Communications Corporation operates CATV systems with some 44,000 subscribers in five states, as well as a micro-relay system. It is also constructing a UHF television station to serve the Stockton-Sacramento area of California.

Wechsler Coffee Corporation recently announced the formation of a new subsidiary—Tower Broadcasting Corporation — and pending FCC approval, acquisition of its first property, radio station **WNDR** in Syracuse, N. Y.

WNDR, founded in 1946, is a 5 kw independent (non-network) AM station operating on a 24-hour broadcast day. Its format is "modern sound" music and news.

Mr. Wechsler will assume the presidency of the new company, which will be headquartered in New York under the direction of Robert A. Forrest, since 1966 a corporate vice-president of Wechsler Coffee. Prior to joining the firm, Mr. Forrest was program development director for NBC Films in Los Angeles, and before that, manager of **WCAU-TV,** Philadelphia.

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objective . . . to develop a high quality Audio Console with extraordinary operational flexibility and versatility, required to accommodate a wide variety of studio and mobile programming needs. All signal switching and level changes to be accomplished by means of DC remote control.

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. . . the Ward AC-650, a compact Dual Channel Audio Console. The original objectives were realized by employing advanced engineering concepts and the utilization of the highest quality components and controls. Here are a few of the features that have made the Ward AC-650 so popular with station engineers and studio personnel . . . • Provides 24 inputs selectable to 12 mixing channels • Any mixer may be fed to any one, or all, mixing busses simultaneously, retaining high cross talk isolation between busses • Output obtained from sub-masters at line level, thereby providing 4 channel output if required • Ideal for AM-FM-Video • Momentary contact illuminated push-buttons engraved to customer preference • Employs silicon transistors throughout • All inputs High or Low level • Plug-in audio amplifiers have individual power supplies operated from low voltage . . . • Slider type level controls • Three 10 watt monitoring amplifiers supplied.

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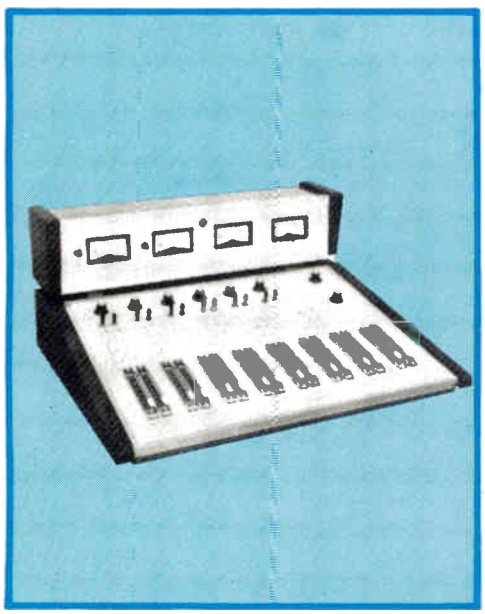

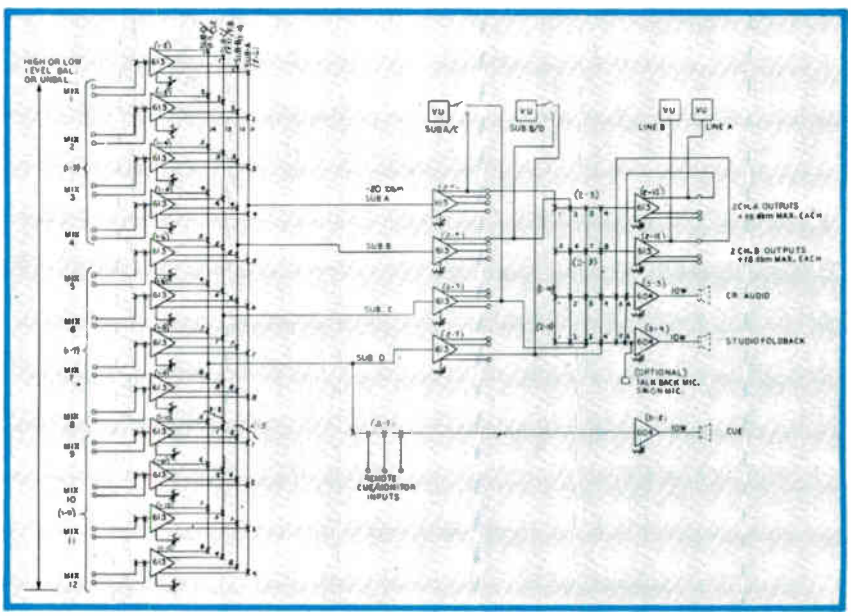

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Circle Item 3 on Tech Data Card

Mutual Broadcasting Handles Audio For Apollo 7 Mission

The splashdown of three orbiting astronauts after their 10.8-day Apollo 7 mission was reported by the Mutual Broadcasting System via an equipment-packed van tucked aboard this famous World War II aircraft carrier, the U.S.S. Essex.

Mutual was responsible for all audio by the TV and radio network pool carrying the Apollo newscasts. Transmission will be handled with a Gates one-kilowatt ST-1A transmitter housed in the rear of the small vehicle.

Outfitted in Manhasset, N. Y., the van was hoisted to the deck two days before the Essex sailed from Quonset Point, R. I. bound for a point in the Atlantic Ocean 200 miles south-southwest of Bermuda.

According to plan, Walter Shirra, Jr., Don F. Eisele and Walter Cunningham splashed down 10 days, 21 hours after liftoff.

Gates Radio, a division of Harris-Intertype Corporation, supplied the ST-1A transmitter (a SG 70 sideband generator and an HFL 1000 linear amplifier) for the project.

Mutual's communications van aboard the USS Essex ready for Apollo 7 coverage.

Twenty-five stations From New York State Form Association

Twenty-five radio stations from the 18-county New York market met in a CBS conference room on October 3 and adopted a set of by-laws that established a new non-profit corporation—New York Market Radio Broadcasters Association, Inc. At the same meeting, the group elected a slate of officers and directors. Efforts to get the association underway started in 1966 with a steering committee headed by Maurie Webster, vice president development, CBS Radio Division.

The proposed association activities will operate on the premise of promoting the best interest of commercial radio in the 18-county New York market; geared to the benefit of all types of stations including suburban, ethnic, urban, AM and FM.

In addition to its primary function in the field of sales promotion, the association has established two major committees: 1) a government committee to assist all stations with local and regional governmental problems; and 2) a public service committee to assist in the dissemination of public service materials.

The group hopes to provide its membership the same benefits that have been seen in Southern California through the activities of the Southern California Broadcasters Association.

The by-laws provide for a full time paid president to be selected in the future. The elected officers are as follows: Chairman, Don Curran, **WABC;** Vice-chairman, Bob Mazur, **WMCA;** Secretary-treasurer, Bob Hosking, **WCBS.** Directors include: Bob Mounty, **WNEW;** Lou Faust, **WPAT;** Lee Hanson, **WNBC;** Mark Olds, **WWRL;** Bill O'Shaughnessy, **WVOX;** Dick Gary, **WPIX-FM.**

Station Activity: WFBM Wins Awards, WATU-TV on the Air

The WFBM Stations and a station management employee were recipients of special service awards presented by the Indiana Heart Association.

Jerry Chapman, Manager of WFBM-Radio and Public Affairs Manager of The WFBM Stations, accepted an award citing the stations for outstanding service in advancing the Heart program and stimulating public support in the fight against diseases of the heart and circulation.

K. C. Strange, Promotion Manager for The **WFBM** Stations, received a personal award for three years of outstanding work as IHA State Chairman of the Station Division of the Heart Committee of the Broadcasting Industry.

Augusta, Georgia's new commercial station—WATU-TV—got on the air during Thanksgiving with an Ampex 30 kw, solid-state exciter, a 1,547-foot tower and a host of other new pieces of equipment.

The channel 26 station packaged by Ampex included equipment from a number of other companies including: Eastman Kodak, Kline Iron and Steel, Gates, Kleigel Brothers, The Grass Valley Group, and Microwave Associates.

Some 32 Georgia radio stations have joined together to bring suit in the New York Federal District Court asking for reasonable license fees. The petition was made in the name of station **WMLT.**

In other Georgia news, **WSB-TV** recently celebrated 20 years of telecasting. American Cancer Society citations have gone to Atlanta stations **WGST** and **WQXI.**

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Circle Item 4 on Tech Data Card

NCTA's Ford: CATV Will Help TV To Economic Heights

NCTA president Frederick W. Ford told the Hollywood Radio and Television Society in October that cable TV "will no more destroy broadcast television than the broadcast TV industry destroyed radio, or than radio destroyed phonograph records."

Speaking before the meeting in Beverly Hills, Calif., Ford said cable TV may change the character of the broadcast industry, "but broadcast television, like its predecessors, will go on with the help of cable television to greater economic heights and popularity."

NCTA's chief executive, reviewing recent judicial and FCC decisions, said "that frequently in communications, today's victory may be the precedent for tomorrow's defeat." In this connection Ford cited the FCC's San Diego decision as a two-edged broadcaster victory over cable. If the Commission has authority to prohibit cable systems from selling advertising on origination channels, "then how much more directly this power must exist over the primary regulated industry," he declared.

"Thus when . . . broadcast groups petition the Commission to ban the origination of entertainment programs and commercials on cable television they may be lucky if a fight does not develop at the FCC to reduce commercial continuity by 50 per cent during prime time on broadcast television. It could happen under the San Diego victory," Ford warned.

Vikoa, Inc. In Peekskill, New York, announced that its Turnkey Division will install the first 21 channel capability CATV operation in New York State.

The new CATV operation in Peekskill is scheduled to run 120 miles at present, and will use Vikoa 21 channel Futura amplifiers with Vikoa aluminum cable, throughout. The system will provide general television productions and locally originated programming.

The Pennsylvania Community Antenna Television Association also held elections at its annual fall meeting in Pittsburgh early this month. John Rigas, of Coudersport TV Cable Co. was the only new officer elected. Rigas will serve as vice-president.

The New York State Cable Television Association elected new officers and directors at the group's annual fall meeting. Leslie Read, TelePrompTer, Inc., was elected president, succeeding Mrs. Dawn Fribley; Michael Arnold, of Allband Cablevision moved from treasurer to vice president; Joel Fleming, of NewChannels, Inc., was re-elected secretary; and Paul Hancock was elected Treasurer.

Industry Seminars Give Help to CATV Owners, Operators

An ambitious schedule of Regional Technical Seminars and Cable TV Workshops is now being conducted by Ameco, Inc., Phoenix manufacturer of cable TV solid-state equipment. The two-day Seminars will be held in every major cable TV area in the United States during the next few months. Stated purpose of the schools is to permit all CATV system technicians and engineers access to a technical training opportunity to learn practical application of equipment, system specifications, operation and troubleshooting, etc.

The first of the 15 Seminars scheduled between September 1968 and the 1969 National Cable TV Convention was held in conjunction with the New York State CATV Association Meeting September 25 and 26, followed by the NY State Meeting September 27 and 28. Conducting the Ameco Seminar and Workshop will be G. C. Kleykamp, Director of Marketing-Engineering for Ameco, and Sid Mills, vice president of engineering, Ameco Cable, Inc.

The Ameco Regional Technical Seminar and Workshop will give cable TV system technicians a comprehensive look at system requirements, system specifications, system design standards, equipment specifications, and methods of comparing equipment. The workshop will involve the technician in practical application demonstrations for equipment troubleshooting techniques and tests, system troubleshooting, plus methods for sweeping, setting signal levels, aligning amplifiers, etc.

The monthly schedule of Ameco Regional CATV Technical Seminars and Workshop is:

December:
9-10 Robert Meyer Inn, Orlando, Fla.

January:
22-23 Macon, Georgia

February:
6-7 Harrisburg, Pa.
20-21 Seattle, Washington

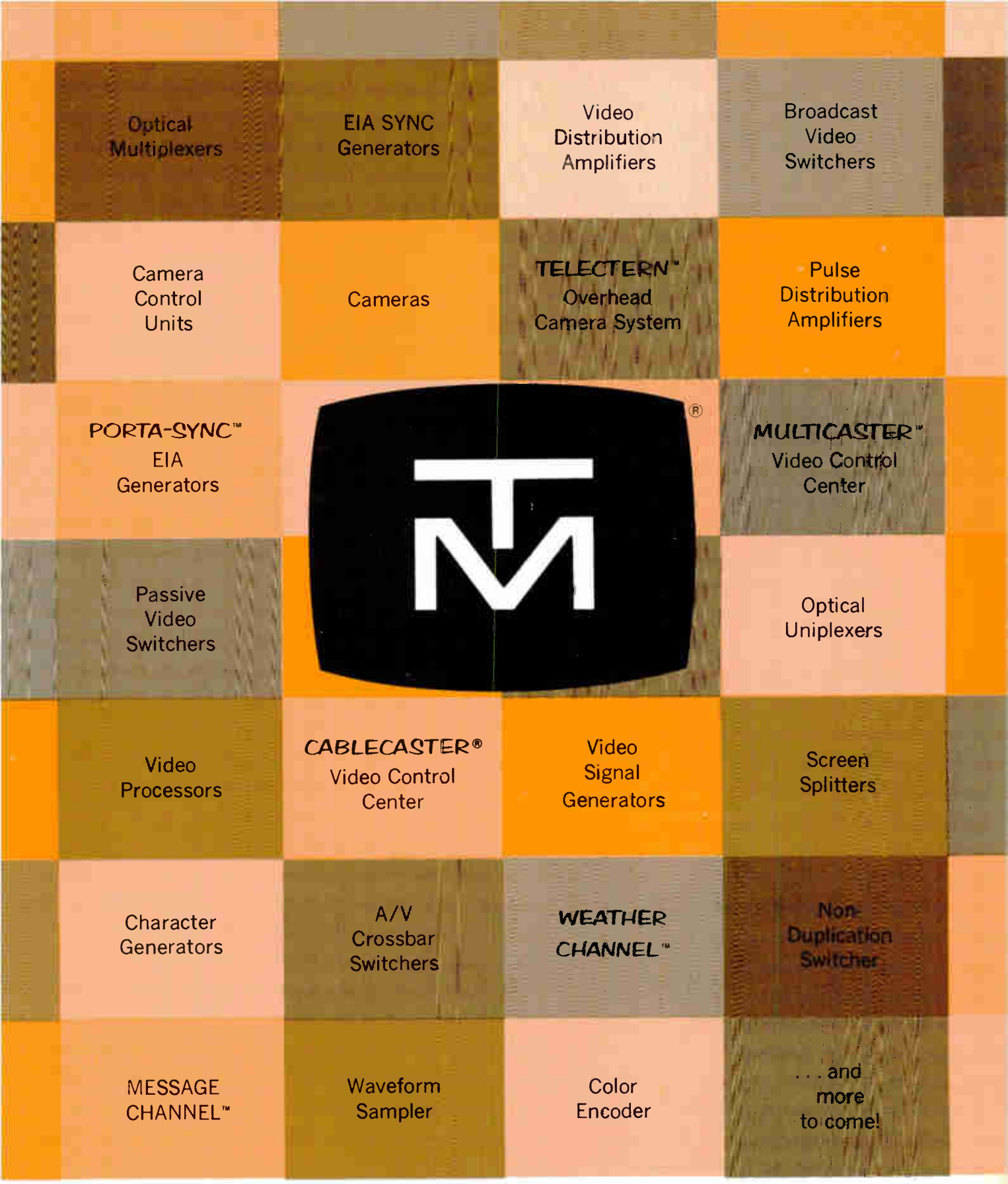
March:
13-14 Riverside, Calif.
27-28 Greensboro, N.C.

April:
14-15 Dallas, Texas
24-25 Akron, Ohio

May:
8-9 Denver, Colorado
22-23 Kansas City, Mo.

June:
12-13 Albany, N.Y.

A 10-day seminar, "Art for Television," presenting all graphic and staging requirements of a television production from script through final production, will be held at Loma Linda University beginning Feb. 3, 1969.



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Circle Item 5 on Tech Data Card

Once upon a time there was a small but worthy communications engineering company (Multronics, by name) that had an rf contactor problem.

No matter where they turned or what they offered, they could NOT find an rf contactor they could count on.

Bad enough, they bemoaned, that an rf contactor should chance the pyrotechnics of recoil. Or the ineconomies of interrupted closure. Or the actual shaking loose of supposedly unloosable connections.

Bad enough, indeed, but worse when they arrived with broken connector arms (painful!) or ceramic-shatttered insulators (messy!).

Why not, mused John *Mul*laney, enterprising entrepreneur and (as you may have guessed) President of *Mul*tronics, Inc., design a new rf contactor. Which is just what they did. Which is just why they bring you this exciting tale of the Multronics Model 160 Double Pole, Double Throw RF Contactor.

Yes, the Model 160 has proved the very "model" of efficiency. A 20 pound spring absorbs all recoil. (Known worldwide as the Multronics BREECH-LOCK Mechanism.) It features two heavy duty solenoids able to do their heavy duty even when voltage varies widely. Hang-up-proof contact sleeves. Shakeproof, self-locking hardware. Microswitch voltage control. Specially-treated Melamine instead of ceramics and micalex. . . .

Oh, there wasn't a THING the Multronics engineers overlooked. The Model 160 a true gem in every respect . . . save one. It costs 58% percent more. Alas! "So be it," commented John Mullaney. "One must be willing to pay more for top quality. Furthermore, I'll wager there are innumerable rf contactor buyers willing to pay $185 if they once learn the truth.

"Indeed, why not tell the anxious communications world about the Model 160 and its as-yet-unnamed-110-volt companion contactor. Tell people to contact me personally (nothing too good for the Model 160) at 5712 Frederick Avenue in Rockville, Maryland. Remind the few who might not know that our Zip Code is 20852, our telephone 427-4666, Area Code 301." "After all," he concluded, "news of this consequence demands immediate action."

Circle Item 6 on Tech Data Card

School Experiments With New 2500 MHz Instructional TV

Northeastern University has in experimental operation a new 2500 MHz instructional television fixed service (ITFS) system that is expected to be in broad curricular use soon.

Part of an extensive program of instructional innovation taking place at the Boston institution, the ITFS system will help improve the curriculum for the largest possible number of students while conserving time of the faculty.

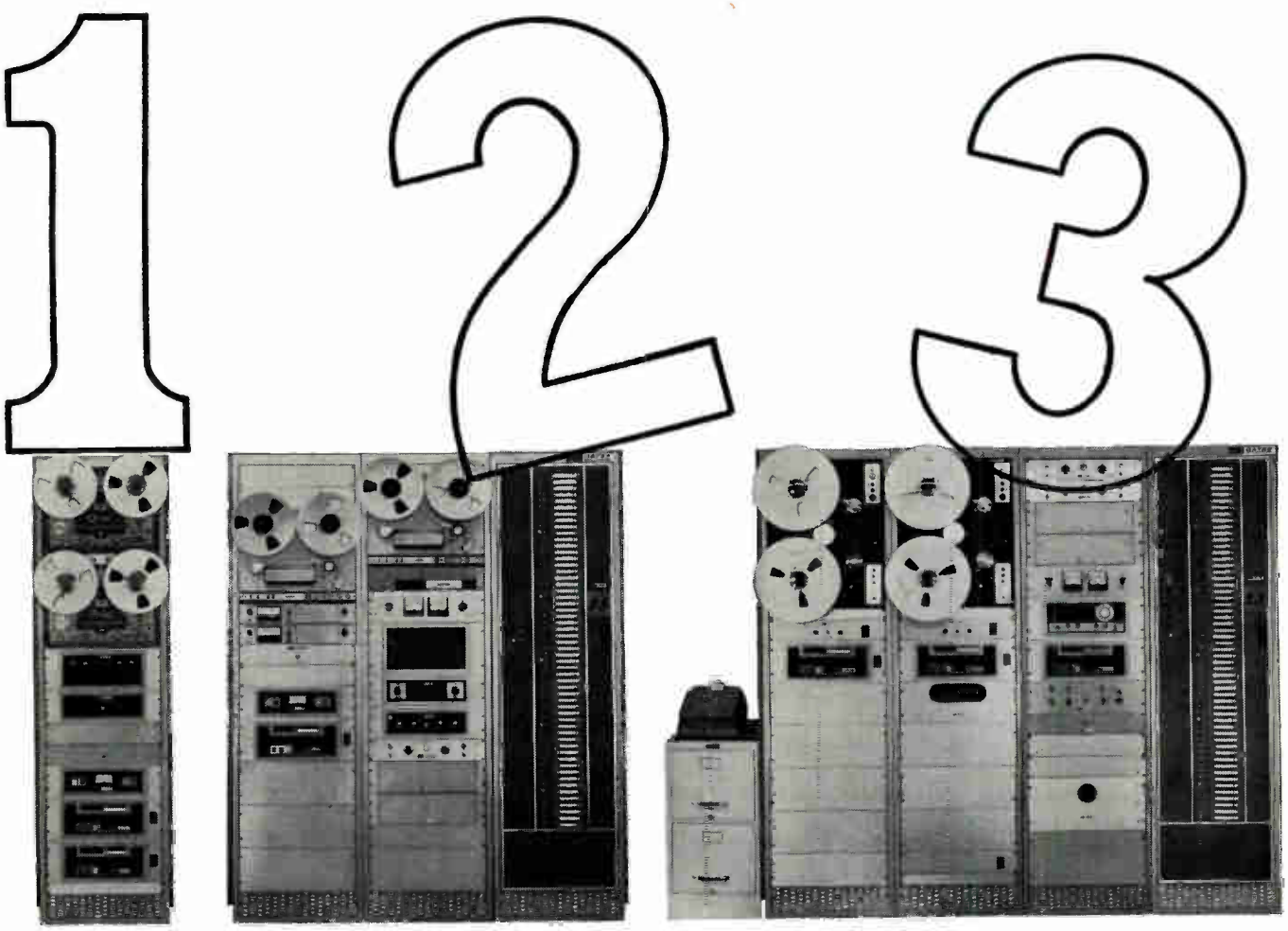
The Northeastern University system, which has been installed by students and faculty, is utilizing the latest type of Jerrold 2500 MHz transmitting and receiving antennas, transmitters, receivers and distribution equipment.

The school system of the Archdiocese of Boston plans to install a repeater station on Nobscot Hill in Framingham, Mass., to increase coverage of its new instructional television (ITV) system.

When it becomes operational before the end of the year, the new repeater station will enable the Archdiocese to reach its schools and institutions within a 12 to 16-mile radius of the station with color and black-and-white programming.

Chris Schenkel appears here during one of the shows sent directly from Europe via microwave and satellite.

We can get you automated quick as you can say



Modern program automation shouldn't be complicated.

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Circle Item 8 on Tech Data Card

An Introduction to Remote Broadcasting

By Phil Whitney*

■ Today's broadcast station operators are creating the image of mobility for their listeners. They give them that which no outsider can possibly supply; the news actualities which daily involve their audience. The basic concept that, "If you aren't listening, you're missing what's happening in the community" is hard to beat!

The small market operator can capitalize on this mobility approach as well as the big market stations which are picking up both the ratings and the good accounts with portable radio pickup gear.

The fact is, remote pickup radio equipment pays for itself! Several hundred broadcasters in all market sizes have discovered that they can get a competitive jump ahead by using radio transmitters in station vehicles and staff cars. Many stations select compatible equipment which operates either on A.C., for fixed locations, or on a vehicle battery, for mobile applications.

This equipment falls into two general classifications: "Communications Quality" for news and sports use, and "Broadcast Quality", for handling any broadcast normally carried over telephone lines. The first is adequate for short, on-the-spot news pickups, such as fires, accidents or traffic reports. This equipment is usually the standard type of two-way gear used by taxis, police and fire departments, without modification. In some cases, Citizen's Band units are tuned up from 27 to 26 MHz. The second category is that equipment designed for continuous operation and with an audio bandwidth greater than a class A telephone line. (100 to 5000 Hz.)

*Chief Engineer, WINC, WRFL.

Most commercial gear designed for mobile use has a short duty cycle. It can be used for a short period, then must be given a cool-down time. This duty cycle can be modified either by using special cooling arrangements or by equipment over-design. When modifying emergency-service radio equipment for broadcast use, an important design consideration consists of operation of the equipment below usual transmitter voltages, or supplying forced-air cooling.

Frequencies Used

The Federal Communications Commission assigns several frequency bands to the Remote Broadcast Pickup Service. Three frequencies in the 1600 KHz region are rarely used. Groups D, E, F, G, H, I and J are in the 26 MHz area and constitute 26 separate frequencies. Groups K, L and M assign 16 frequencies to the service between 152 and 170 MHz. (Puerto Rico and the Virgin Islands also have 9 frequencies assigned in their area.) The last, group N, offers 20 frequencies in the 450 MHz range.

It is probable that the greatest number of remote broadcast pickup transmitters are operating in the 26 MHz region, but these frequencies are slowly being phased out by broadcasters who have discovered that a station on the frequency as much as 2000 miles away can break up a local broadcast. Almost as many stations are using the five frequencies centering about 161.70 MHz, which presently seems to be the most popular band.

As more equipment becomes available, broadcasters are moving in numbers to the 450 MHz bands, where there are more channels and less interference. Volume III, Part 74, Subpart D of the Commission's Rules and Regulations should be consulted for available frequencies and allowable bandwidths. (Some frequencies allow 60 KHz communications channels, others only 30 KHz.) These channels are available to the broadcaster for the purpose of picking up programs and news feeds and for instructions pertaining to these programs, and are not for the purpose of discussion of accounts, availabilities, etc. (For this use, there are frequencies assigned in the Business Service Bands).

A few frequencies in the 26 MHz band are assigned for communications for stations with an STL, (usually FM), which have transmitters on mountaintops and comparatively inaccessible locations. In case the STL should break down, a remote pickup transmitter can be used to feed programs to the transmitter as an emergency measure while the link is being repaired.

Assignments

Remote broadcast pickup stations are assigned to broadcast stations only. However, some of these channels fall among those assigned to certain Commercial services, which have first priority. In these cases the license will bear the note that it is issued subject to the condition that no harmful interference will be created on these business frequencies. After the first license period, all remote broadcast pickup licenses will be renewable at the same time as the station license. All mobile units may be licensed at one time under the same auxiliary license fee, but all remote broadcast pickup stations assigned to a broadcast station will bear different call letters. The service is unlike commercial services where one call letter group is assigned to all units.

Getting Started

How does a station get started using these facilities? Many stations purchase new or used communications transceivers, fill out the simple two-page FCC form 313 and begin operation when the license and construction permit arrive together. Others are purchasing the "broadcast quality" systems made specifically for this service by at least three manufacturers, while some are purchasing used transmitters and re-

ceivers and modifying them according to the several articles which have appeared in this magazine in the past.

When the FCC modified the rules which narrowed communications bandwidths for other services, much of the wide-band gear then in service became available on the surplus market. This wide-band equipment is quite usable in this broadcast service. Link, Motorola, R.C.A. and some GE units can be purchased for from $10 to $200 and modified by the station engineer or a local mobile radio shop. The changes should be made by a first class license holder or under his direct supervision. It is not necessary to obtain type approval on this equipment, but the station should be able to show that it meets the FCC frequency and bandwidth requirements. The yearly frequency check should also be available.

Modifications

When modifying this equipment, the frequency response curve of both the transmitter and receiver will be altered from the original response curve of 300 to 3000 Hz to something better than 100 to 5000 Hz. With some equipment it is not difficult to arrive at a response within plus or minus 2 DB from 60 to 15,000 Hz. Pre-emphasis networks should be built into the audio section of the transmitter and the receiver audio can be "pulled out" with one or two stages of hi-fi amplification following the discriminator. The process is not difficult, as long as the receiver has not been "narrow banded" too much.

Wide bandwidth in the receiver is usually easier to obtain with a relatively high second I. F. frequency. (Most are double-conversion receivers.) With care, quite good response can be obtained with a second I.F. frequency as low as 455 KHz. (Higher second I. F. frequencies are usually more susceptible to adjacent channel interference.)

For the first conversion job at least, it is best for the engineer to feed the bottom of the transmitter modulator grid network with a fairly high level of audio, rather than to try to build a microphone preamplifier inside the transmitter cabinet. R. F. problems in the audio may be negligible in one location, but severe with the same equipment in another. The transmitter should be capable of operation in a wide range of conditions. Many conversions, therefore, presuppose that an external preamplifier will be used in conjunction with the transmitter.

Installation

When installing a unit in a vehicle, many factors should be considered for maximum efficiency. Frequently, vertical polarization is used on mobile units, necessitating a vertical receiving antenna, which should be mounted as high above the terrain as possible. A few feet of extra height for the receiving antenna affords better coverage than several extra watts of transmitter power. Any extra gain which can be realized in the mobile installation will also extend coverage. A 3 DB gain "half wave" mobile antenna on the vehicle will effectively double the coverage in terms of transmitter power.

Of course, the best location for a mobile antenna is in the center of the vehicle roof. This is difficult on 26 MHz because of the long antenna. A low-efficiency loaded whip could be used. This problem is lessened on 160 MHz and is non-existent on 450 MHz.

Most of the older mobile transmitter installations were made in the "trunk" at the rear of the vehicle. Later-design transmitters were generally smaller and some could be mounted under the dash. Many stations prefer to have the mobile units provided with a power plug for the cigarette lighter and a convenient carrying handle on the case, so that they can be quickly transferred from one car to another. In this case the antenna problem is solved with a gutter-clip mounting, making it easy to change it from car to car.

Battery-operated AC inverters are now relatively inexpensive and dependable, so that 117 volts of AC is available to operate transmitters designed for inside use. This adds extra flexibility when a station has but one or two RPU transmitters.

Base Station

Many base installations use the station transmitting tower as the support for the RPU antenna. This is an ideal way to get the antenna as high as possible, but the tower's wind loading capabilities should be checked before it is planned. When the antenna is mounted in this manner, a tower base re-measurement will probably be necessary upon completion of the installation.

An isolation arrangement will also be necessary to prevent the coax downlead from shorting out the broadcast R.F. energy on series-fed towers. To shorten the antenna leadline and reduce its losses, it is often practical to remote-control the base station at the tower base, bringing the receiver audio in on a well-shielded (and R.F.-filtered), audio pair.

The white vinyl-jacketed 50 ohm RG8/AU coaxial leadline will reduce RF losses over those in a standard black-jacketed coax, but several stations have added to the efficiency of the system, as well as its permanency, by using the more expensive solid aluminum foam line. A tower-mounted remote pickup antenna is not something which engineers like to repair too frequently! Although first costs are higher, the long-run expenses are lowered by using this approach.

Remote Costs

The estimated cost of setting up an RPU system will depend upon the capabilities of the station engineering staff and the complexity of the planned system. If the decision is made to purchase a complete "broadcast quality" commercial system, the budget should be set at somewhere around $1500. This includes one transmitter, station receiver and antennas. If the election is to modify a used transmitter and receiver, the installation cost could be estimated at around $400, exclusive of labor on the conversion. Subsequent extra transmitters, for greater flexibility, would be less costly.

It's difficult to visualize a modern, all-news or community-oriented broadcast station today without at least one remote broadcast pickup unit. Portable tape recorders have added to the broadcaster's flexibility and mobility, but to be completely competitive today, there is no substitute for the capability of originating a news story or special event broadcast live, on a moment's notice, with a radio pickup. ▲

MICROWAVE REMOTE:

A new route to better pictures

By Parker Vincent*

■ Many factors influence equipment obsolescense in the broadcasting business, including the rapid advance of the state of the art. Sometimes a seemingly unrelated event, such as the construction of a new high-rise building, can contribute to the obsolescense of a microwave system.

In 1959, Mt. Washington TV, Inc. constructed an inter-city microwave facility between leased studios at 25 Granby Street, Boston and Mt. Washington, New Hampshire. This facility was in the 7,000 MHz band and consisted of five hops. The system went from Granby Street to 2000 Berkeley Street, Boston (John Hancock Building) to Baldpate Hill, Georgetown, Mass.; from there to Saddleback Mountain to the WENH-TV transmitter; then to Mount Hope, Sanford, Maine; and from there to Mt. Washington.

This system was all tube equipment, and back-to-back. Two audio subchannels were multiplexed on the video. AFC was used in the transmitters, and emergency power gasoline generators with automatic start and transfer were installed at all relay stations. All the stations were interconnected by telephone line, and fault reporting and a measure of remote control were thus made possible.

The longest hop in this system was the approximately 70 mile path between Mt. Hope and Mt. Washington. The system as described has had acceptable performance parameters. With the advent of network color it was possible by rigorous maintenance to maintain acceptable values of differential gain, differential phase, envelope delay, signal-to-noise ratio and frequency response.

Emergency maintenance on this system had been accomplished by technicians residing in the towns where the relay stations are located. The disadvantage was that an outage taking place on a weekend or a holiday was difficult to correct quickly.

The obvious disadvantages of maintaining ten separate video strips were felt particularly in the performance of the system when recording VTR's in color from the network.

The construction of the new Prudential Center in Boston with a height above sea level of over 800 feet led us to dream of the possibility of eliminating some of the hops in this system. The advent of heterodyne repeaters and of solid-state equipment was intriguing but difficult to justify economically. Finally, Eric Stromsted of Microwave Associates, Inc., Burlington, Mass. suggested a system on 2,000 MHz with all solid-state equipment having excellent performance characteristics.

The owners of Mid-New York Broadcasting Co. and Vice-President Sheldon Storrier, together with Jack Flynn, WMTW Vice-President and General Manager were "sold" on the economic feasibility of the proposal, and after much study it was decided to construct a three-hop system.

MA2B System

The MA2B intercity TV relay system is entirely solid-state. No tubes (or klystrons) are used in either transmitter or receiver. Terminal links use 115 VAC power supplies. And the Prudential Center repeater site features a 115 VAC float charge DC power supply for uninterrupted microwave service during AC line outages. Power consumption is 25 to 30 watts for receivers and 60 watts for the 2 watt transmitters.

All internal modules are easily accessible through a hinged front panel, and can be easily removed with the aid of a screwdriver. All necessary test metering is built into each unit. In addition, the design of transmitter and receiver units allows maximum accessibility to internal components, and greatly simplifies installation, operation and maintenance.

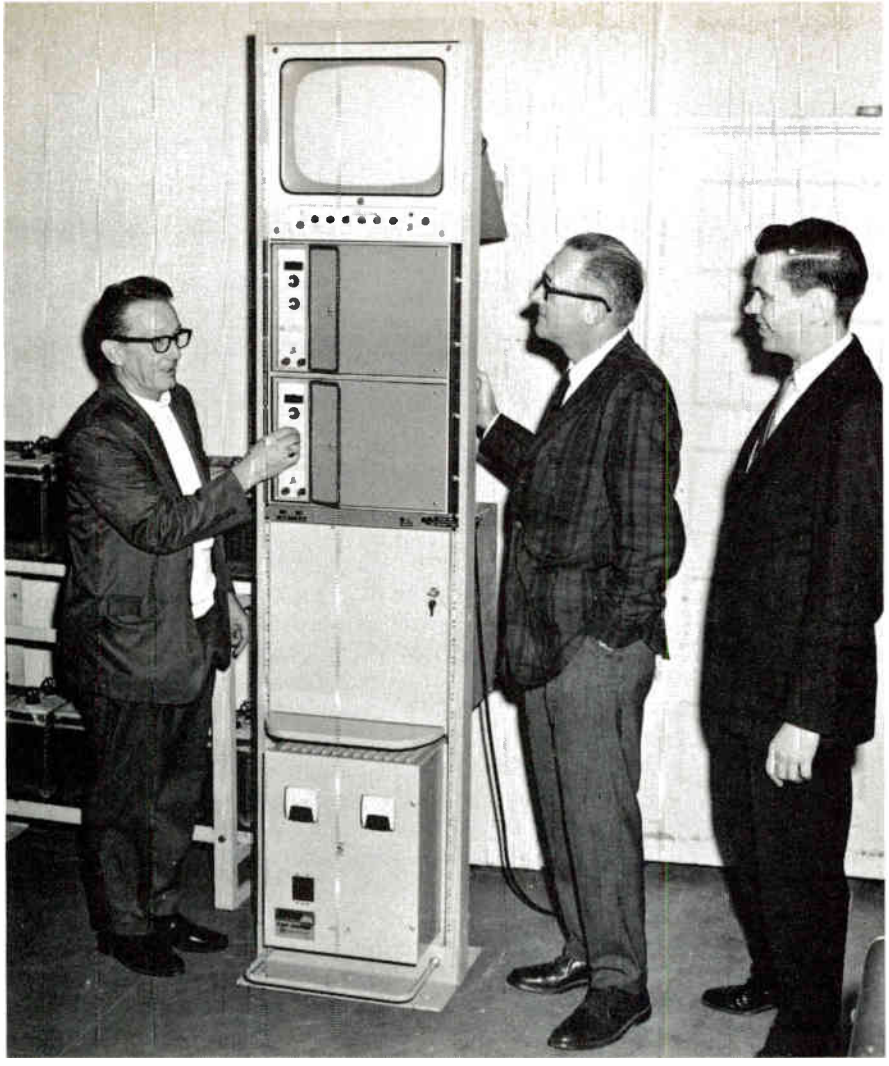
The solid-state circuitry and RF source provide maximum dependability and stability, and eliminate high DC voltages and warm-up delays. Units are on the air instantly. Also, a channel selection switch eliminates tuning, peaking, and tweaking. RF channel change is accomplished simply by turning a knob.

A highly compensated master oscillator is used in the transmitter to keep the RF carrier frequency well within the requirements of the FCC. The receiver is crystal-controlled and equipped with highly selective channel guard filters.

The power converter module accepts wide input voltage variations and delivers precisely regulated voltages, insuring long component life and drift-free performance.

The B-Line fixed intercity relay system is designed for transmitting high quality NTSC color TV. It exceeds the standards and recommendations of the EIA, CCIR and FCC for 525 line systems. Two high quality 15 KHz program channels

*Chief Engineer, WMTW



Prudential Center Terminal equipment, showing batteries and float charger. Left to right are Parker Vincent, John Ricker, and Dick Cushman.

are multiplexed above the video signal at 7.5 and 8.5 MHz. Wideband linear phase and amplitude designs simplify the process of equalization, yielding minimum differential phase, gain and group delay. Signal compression and amplitude distortion are prevented by a wide dynamic range design.

Low Noise Preamplifier

Low noise microwave silicon transistor preamplifiers are used on the long repeater hops and achieve 15 db additional low noise RF gain at a 5 db noise figure into the Saddleback mountain and Mt. Washington relay microwave receivers. Thus, under deep fading conditions reserve preamp gain provides S/N enhancement for improved path reliability.

A low-noise microwave transistor preamplifier is used in this system. It is designed specifically for low-noise preamplification at frequencies below 2.3 GHz. Each preamplifier consists of an amplifier module, microwave matching circuitry, and a DC bias circuit. The preamplifiers provide optimally flat, wideband temperature-stabilized amplification with high dynamic range and burnout characteristics. Solid-state block construction offers excellent performance under severe mechanical shock and vibration. They are easily installed in the field and are well suited for reducing system noise, enabling the use of smaller antennas, extending system range, or increasing fade margin on wideband microwave relay hops.

The preamplifier utilizes three silicon transistor amplifier stages, each stage providing approximately 6 db gain. Transistor-operating parameters are factory-adjusted to assure optimum gain and low-noise amplification.

The preamplifier is intended primarily for installation between the antenna and the microwave receiver. Their use at this point can improve system performance by about 6 db to reduce outages or intensify marginal signal levels during deep fades. Moreover, for a given fade margin, they permit doubling the range between hops, provided path elevations afford satisfactory clearance. Extending the distance between relay points in this manner has an obvious economic value for intercity relay systems. Antennas and radomes used are Decibel Products units, and the transmission lines are from Andrew Heliax.

One short hop was necessary between the new WNAC-TV studio facility and the Prudential Building in Boston. From the Prudential Building, one hop would reach the WENH-TV site on Saddleback Mountain.

The WENH-TV site is presently saturated with 7GC microwave facilities in the Educational Broadcast Service. NET, New Hampshire ETV Network, Maine and Vermont ETV Network signals, both incoming and outgoing, and our own existing facilities are concentrated here. Our use of 2GC will help to reduce the congestion on 7GC.

From Saddleback the system goes directly to the summit of Mt. Washington. An approximate 40 db fade margin exists on each hop.

Since emergency power is available at the WNAC studios and at Saddleback Mountain, standard AC power supplies are used at these points. The system at the Prudential Center is DC-powered from a floated battery. At the WMTW-TV transmitter on Mt. Washington the power supply is a total energy diesel system with redundancy so that AC power is used at this point.

Weather Conditions

The Mt. Washington terminal op-

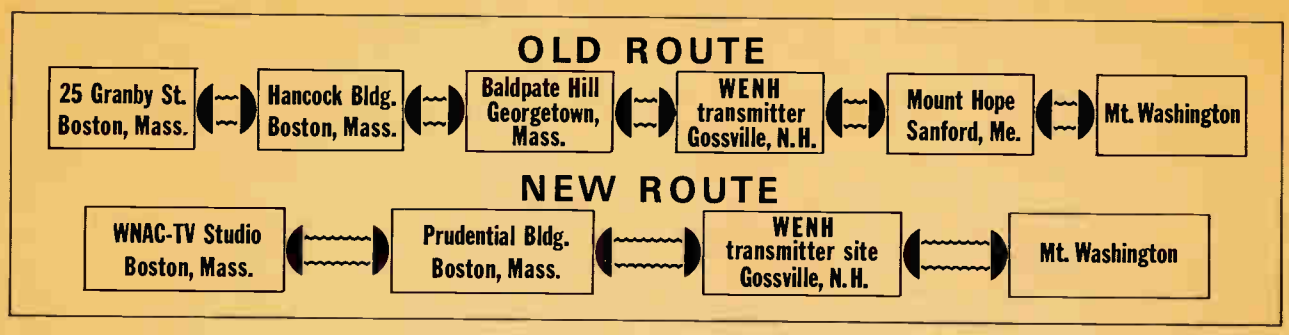


Fig. 1—The new route and its fewer relays means a better signal and fewer maintenance problems.

erates in what is statistically the world's worst weather (highest wind velocity ever recorded—231 miles per hour—was recorded here) and ice forms at rates of up to 6 inches per hour on exposed vertical surfaces.

Fifteen years of experience in this location has convinced us of the futility of electrical de-icing. Frequently, more trouble is caused by the use of this method than is corrected. We have learned that rime ice can form on radomes and on antennas which have been properly constructed with very little effect on signal strength.

The worst condition for microwave operation is freezing rain, which occurs on Mt. Washington during northeast storms when the temperatures are only slightly below freezing. The only cure for this kind of icing is to manually remove the ice periodically from the radome surfaces. Provision for accomplishing this with a minimum of risk was taken into consideration when the dish locations were selected.

Terminal-Repeater

The Mt. Washington station is both a terminal and a repeater. When WMTW is carrying programming from the microwave system, a remote switch controlled from the Poland Spring Studio connects the video output of the microwave directly to the transmitter. Video output of the receiver is also fed to the transmitter of a microwave system extending from Mt. Washington to WEMT-TV in Bangor, Maine.

A new addition to the system is a Microwave Associates' 2 GHz microwave system from Mt. Washington direct to Mt. Mansfield to interconnect WVNY-TV in Burlington, Vermont. An additional microwave link carries the output of this receiver to the Poland Spring Studios of WMTW for cueing, closed circuit, and VTR purposes. One link of the present 7 GHz system will be set up between Saddleback and Mt. Washington parallel to the 2 GHz main line system. The input to this hop will be switched between several off-the-air receivers and can be used as back-up for the main system in the event of failure.

It is anticipated that maintenance on this system will be minimal due to the high reliability inherent in solid-state systems. System parameters measured on a test set up with the calculated path loss simulated between units is: overall differential gain 2 per cent, differential phase, 1°; frequency response within 0.1db to 4.5 megahertz, and a signal-to-noise ratio of 60db with standard EIA weighting.

Overall maintenance time and expense is expected to be reduced by a factor of 90 per cent. With back-up feeds available at both Saddleback and Mt. Washington, reliability of the system during programming is expected to exceed 99.99 per cent.

It was decided not to use land lines to interconnect relay stations and to abandon the use of fault reporting on the new system. It is extremely difficult to provide fault reporting which will pinpoint degradations in the signal which do not result in complete outage of either signal or video. Since most microwave troubles are impairments of this nature rather than complete outages, we felt that installation of outage detection fault reporting on solid-state equipment was not economical.

The installation of the system, including the erection and orientation of dishes, is being completed by the WMTW engineering department. John Ricker, the Assistant Chief Engineer; Phil Labbe, construction expert; Lee Vincent, transmitter supervisor; Marty Engstrom, engineer-draftsman; and Dick Cushman, engineer, are among those who have contributed to the success of this project.

WMTW will complete the installation of the equipment at the relay stations, and a hop-by-hop checkout will then be conducted prior to placing the system in regular operation.

The advent of vertical interval test signals transmitted by the networks have greatly simplified life for the inter-city private microwave operator. On this system it is possible to get almost instant checks at the Mt. Washington terminal and at the Saddleback relay station. Trouble can be pinpointed in a matter of minutes and corrective measures taken for a degradation, if it's serious enough to impair the picture. Since the trunk line of this system between Boston and Mt. Washington supplies three stations with network service, it is essential that outages from all causes be held to an absolute minimum.

The author is grateful for the help that contributed to the success of this project, including: Ed Lamarre of Microwave Associates; Lad Hlavaty and Harry Owen of WNAC-TV; Edward Carlton of Prudential Insurance Co. of America; Edward Breen of the FBI; and Charles Tamm and Walter Swenson of WENH-TV. The cooperation of these men in many different ways have made the project possible. ▲

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The Olympics:

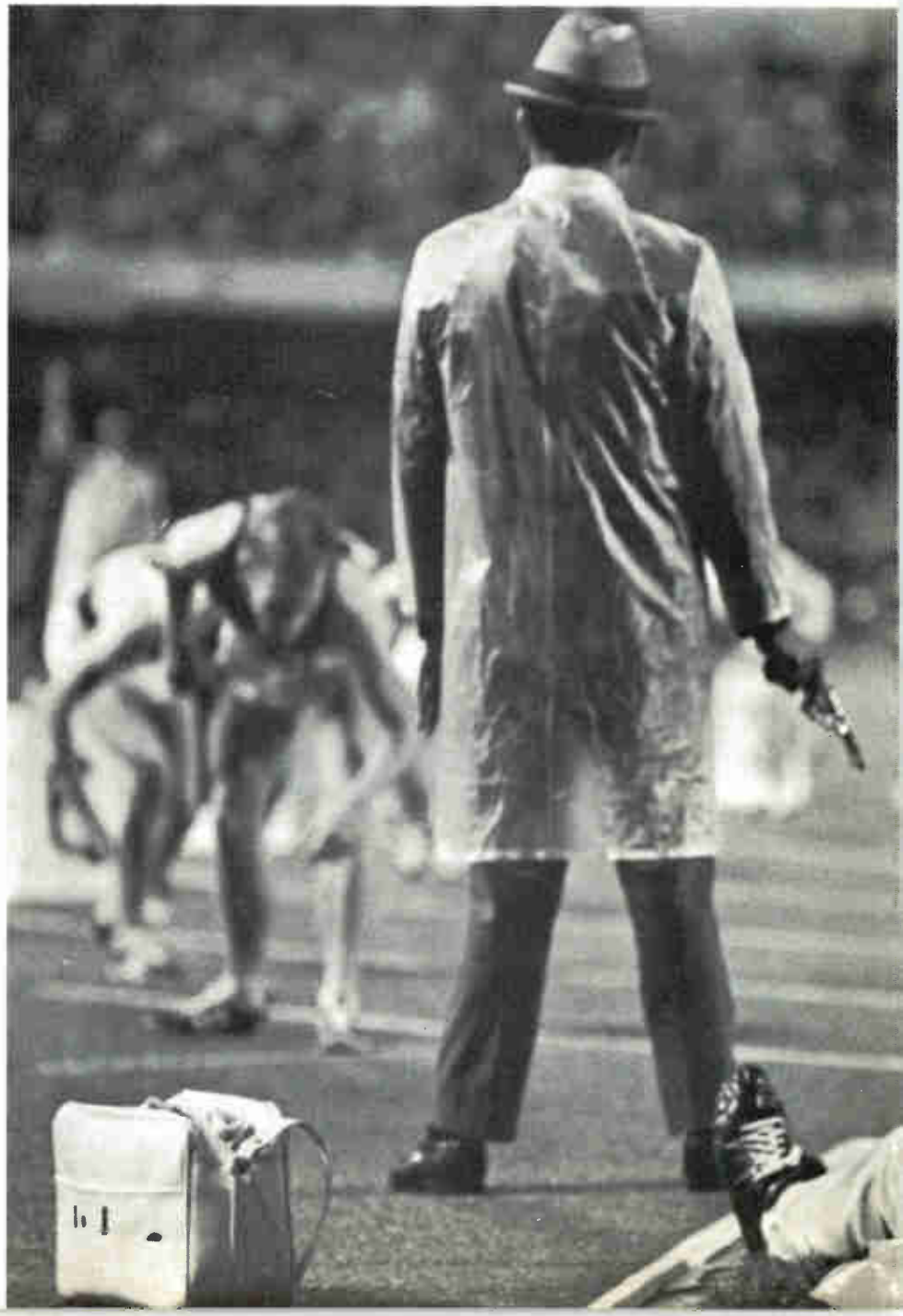
BROADCASTING'S

By Joe Roizen*

■ The television coverage of the Olympic Games in Mexico City fell into a unique category which may never again occur in future Olympiades. In the past, the host country has usually had a national network which became the main coordinator of all coverage. In Tokyo, in 1964, NHK performed this function. In Rome in 1960, RAI provided a slow coverage. Since no national network exists in Mexico and the local commercial network could not hope to cope with so extensive an operation, a pool was set up in which four participating members, NHK of Japan, Telesisitema of Mexico, American Broadcasting Corp., and the European Broadcasting Union (representing 43 individual national networks) cooperated in providing what was described by all participants as the largest television remote in history.

The equipment sent into Mexico City was the conglomerate of wholly owned units such as cameras, mobile cruisers, switching systems, etc., loaned equipment donated by individual networks who were allocated certain areas of responsibility, and leased equipment provided by independent manufacturers.

Athletic activities and the opening and closing ceremonies were held in widely dispersed areas around Mexico City, as well as two additional locations—Guadalahara for tennis and Acapulco for sailing. The major venues in Mexico City itself were within a 20 mile radius of the Telecommunications Tower which served as the hub for transmissions. These included the Olympic Stadium at the University of Mexico which accommodated the opening ceremonies, the track and field events and the closing ceremonies; the Aztec Stadium where the soccer competition took place; the Olympic Swimming Pool, the new building specially constructed for Aquatic events at the junction of Division del Norte and Thurubusco where the major swimming and diving events took place. It also included the Palace de Portes, the geodesic copper-domed arena located near the International Airport and housing the basketball/volleyball type of activities; the National Auditorium in Chapultapec Park used for gymnastics. And there were crew and rowing events in a specially reconstructed section of what most tourists to Mexico know as



*Ampex Corporation

BIGGEST REMOTE

the Floating Gardens of Xomilico.

Microwave and cable links were set up between the major venues and the Communications Tower covering the eleven venues at Mexico City. Those with major activities were semi-permanent installations, others were set up as daily activities required. While the responsibility for coverage at the venue was up to the pool members, the distribution of the signal from the venue to the Tower, and then on to various internal and external links, fell under the jurisdiction of the Ministry of Communications which had set up special facilities to handle the requirements.

Remote Cameras

Camera coverage at a particular venue, if the event was of sufficient international significance, included Toshiba, Norelco, Marconi and General Electric color cameras brought in by the individual pool members. Some monochrome coverage was provided by Telesistema,

Portable color camera captures the start of an Olympic distance race.

Director keeps a close watch on venues from 10 camera sources at the Telecommunications Center, hub of broadcasting activity during the Games.

Television vans played a vital role in remote coverage. Here, vans from ABC, CBC and WFAA were providing remote camera and recorder capability for events scattered around the city.

using Marconi Mark IV and V Image Orthicon cameras. The mobile units at the venues included color mobiles brought from Japan by NHK, several colorpack units brought in by CBC from Canada with their associated General Electric cameras, and leased units such as the WFAA and Seros vans. Some of the vans contained videotape recorders for backup recording on site even though signals going back to the Tower were being recorded on machines located there. In some cases, the control center at the venue was equipped with such sophisticated accessories as HS-100 slow motion disc machines. BC-110 "Scrambler" portable color cameras and several remote portable four-head videotape recorders (VR-3000) were used for on-site coverage.

Video Recording

Because of the programming requirements and the time differentials between Mexico City and other major cities around the world, the bulk of the coverage was handled by videotape recording, subsequent editing and pool or unilateral transmission to selected points around the world. The Telecommunications Tower itself had over 30 quadruplex videotape recorders in daily use for this purpose.

NHK on the 15th floor was recording and editing with six VR-1200's operating on highband color and programming in slow motion sequence through an HS-100 in their control room. Two daily transmissions via satellite were made to Tokyo with highlights of the Games, in addition to tapes being shipped back by jet carriers. Similar activities were going on at the 14th floor with the Australian Broadcasting Corp. using two VTR's and the Telebogota using a VR-1100 and a VR-660. ABN of Manila on the same floor was the only broadcaster using two VR-7800's in the 1" helical format for recording and sending back monochrome pictures of the Games. EBU on the 9th floor had six VTR's accumulating daily events with early morning satellite transmissions scheduled to bring the pictures into Europe early the following day. NHK and the European broadcasters used mechanical editing almost exclusively.

The six VR2000's that ABC was using on the 11th floor of the Center were equipped with electronic editing accessories and were probably the most heavily used machines at the Games, helping to give the U.S. the most extensive coverage.

The Canadian Broadcasting Corp. employed two separate pairs of recorders to handle their French and English language network coverage which was beamed to Canada across the United States by a microwave link.

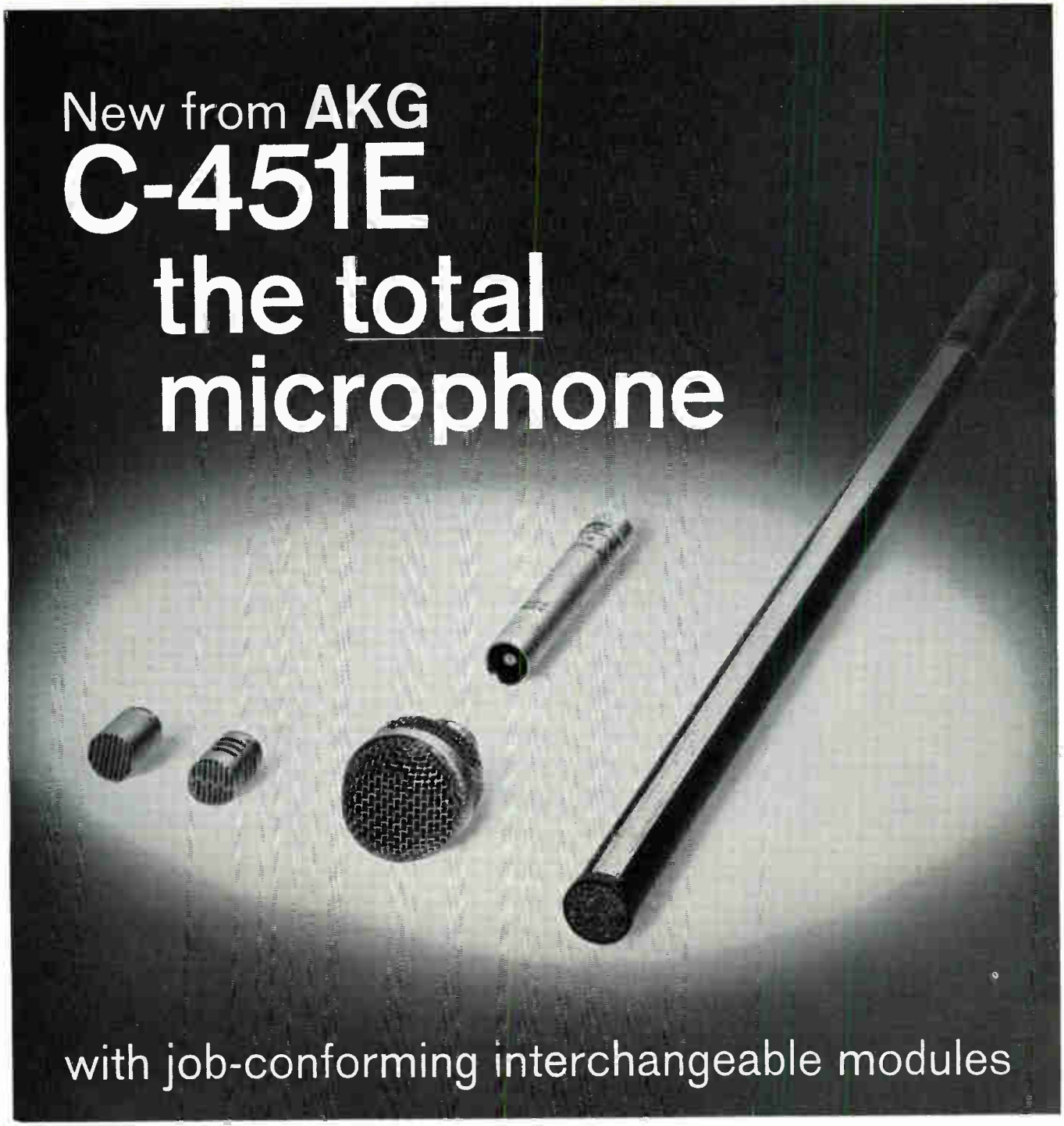
One unique recording operation, set up by an independent television network of the United Kingdom, utilized a pair of VR-3000 four-head portable recorders operated by two separate crews. The daily "takes" were rushed to the 7th floor of the Center where ITV was equipped with a recorder and a mechanical editor to compile the segments for unilateral satellite transmission every morning at 12:30 A.M.

Dramatic Olympic action was recorded on HS-100 disc recorders from slow motion and stop action replay.

Standards Conversion

All of the coverage in Mexico City was in the U.S. NTSC color standard, since the North American continent has this standard established in Mexico City and Canada as well. Japan also employs 525 line, 3.58 MHz sub-carrier system and therefore requires no special handling of the signals to accommodate local viewing. Most of the rest of the world require some form of standards translation through either optical or computer controlled conversion. Those countries with only monochrome services can easily change the picture from one standard to the other by looking at the foreign standard on a precision monitor with a television camera synchronized to the local scan requirements.

The problem becomes more complex in countries with color service since Europe is divided into two separate color systems, the PAL (Phase Alternating Line) in the U.K., West Germany, etc., and



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Operator from the European Broadcasting Union operates recorder that helped to provide coverage for 43 separate broadcasting organizations.

SECAM (Sequential & Memory) in France.

The British Broadcasting Corp. has recently constructed a second conversion of a computer-controlled line store convertor which is capable of accepting 525 line NTSC pictures and converting them into high quality 625 line PAL images.

The signal path from Mexico City began with a selected output signal sent by microwave from the Tel. Com. Tower to the new Mexican satellite tracking station about 80 miles north of Mexico City at Durancingo. This was then beamed over the ATS 3 satellite to the British receiving station at Goonhilly Downs. The General Post Office, which is responsible for communications in Britain, then relayed the signal via microwave to the BBC center at White City where the line store converter would make the transition from NTSC to PAL.

The new PAL encoded signal was then distributed to the UK and all of Europe via the normal microwave links of the EBU and its equivalent OIRT in Eastern Europe and the USSR. For countries such as France and the USSR that employ the SECAM color system, further transcoding before local transmission was necessary. Reports from Europe have indicated that, notwithstanding the multiplicity of signal handling facilities that were involved, the quality of the color images received in various countries was considered good.

Conclusion

By all accounts, both domestic and foreign, television coverage of the 19th Olympiad in Mexico City was considered a remarkable success for the broadcast industry. Cooperation between various participants was excellent. Both pool and unilateral coverages were very well done, especially with regard to unique interest of the different participating networks. Color quality in the U.S. was enhanced by the first time use of Rubidium Time Standard Phase Locking of the various venues with each other and with the N.Y. distribution center for ABC.

Some idea of the magnitude of the job may be realized from the fact that the EBU alone brought in some 850 people, about one-third of whom were technical personnel, to provide the coverage they felt was necessary for their participating networks.

The next Summer Olympic Games will be held in Munich and will come under the jurisdiction of a special combine set up between the first and the second network of Germany. Dr. Schwartz, the Technical Director for television coverage of the Munich Games, will have his work cut out to equalize or surpass the excellent job that was done in Mexico City.

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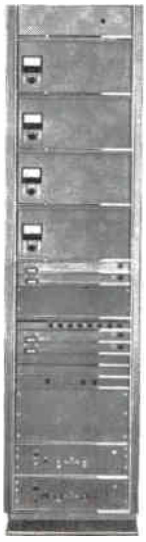

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RAYTHEON

KIRO uses CB for traffic remotes

By R. D. Coonley*

Ron MacDonald, KIRO, relaying traffic reports. CB transceiver is at left of audio console.

■ Disc jockeys Jim French and Ron McDonald have hit on a real public service project that is paying off. In the morning and in the afternoon, these two have complicated their work load by offering traffic information to their listeners.

This is not a new idea. Many stations around the country have been offering this service for years. What is new here is the use of Citizens Band radio to pick up the traffic information. And in some instances, this also has meant relaying calls for help by stranded motorists.

In a ceremony at KIRO recently, the E. F. Johnson Company presented a gold Messenger III Citizens Band radio to the station as an award for contributing significantly to solving traffic problems, especially during difficult weather conditions. The company also recognized the KIRO's emergency relay potential.

At Radio Station KIRO, a CBS affiliate, Citizens two-way radio is the vital element in a successful system of freeway traffic reports in Seattle. Motorists with mobile two-way units flash news of traffic accidents, slowdowns or highway hazards to a base station atop the 6600-foot Seattle landmark, the Space Needle. From there, Station KIRO relays the information to commuters via their 50,000 watt transmitter.

Key man in the system is disc jockey Jim French, who originated the idea and put it into action by using his own call letters (KPD Q216) until KIRO secured its own Citizens Radio license. His Space Needle call now is KRD 2355.

French's routine begins at 6:00 AM, Monday through Friday, when he signs on both his popular wakeup radio show and his Citizens radio rig. Traffic reports start flowing in soon thereafter. French interrupts his regular music and news on KIRO with a tape-recorded sound of an auto horn, to alert motorists of upcoming freeway driving information.

From the 600-foot elevation of the Space Needle where KIRO maintains a studio, the CB signal covers all of Seattle, and is useful as far north as Everett.

French credits Citizens Band radio with having helped listeners to avert possible major traffic jams on numerous occasions. "I often receive word of an accident even before the police or State Highway Patrol," he said. "In those cases, I phone the appropriate authority to send help."

Does the police dispatcher appreciate the efforts of the CBer in the morning rush hours? "At first no radio station's traffic reports were really appreciated," French commented, "because the announcer would take it upon himself to suggest alternate routes for traffic and these often weren't the highways the police might have preferred. But now both the police and the State Patrol have come to depend on the accuracy of CBer's reports and they are enthusiastic over their cooperation."

Incorporating the policies of nationwide REACT, French maintains his traffic watch on Channel 9. His only complaint: "Too many people use 9 for idle chatter, forgetting that stranded motorists and others in real trouble often have to rely on that channel as their only means of communicating a 'help' call."

Due to the relatively easy acquisition of the Citizens Band license and the tremendous sales recorded for Citizens Band equipment by various companies, crowded frequencies in some areas are not uncommon. Some Citizens Band operators make general calls looking for contacts and they even exchange QSL cards.

KIRO is pleased with the results of the Citizens Radio traffic watch. It not only provides the station with an army of potential roving radio cars numbering in the hundreds, but it's also an all-weather alerting system. And it can't be grounded by bad weather, as can airplanes and helicopters which also cover the Seattle traffic scene when weather permits.

As busy as he is, conducting his three-hour record show from the Space Needle, French seldom fails to extend help when the Citizens two-way radio transceiver calls for it. "I look at it as a natural link between the motorist and the radio station," French said, "and it gives KIRO an excellent opportunity to build goodwill while extending a helping hand to the community. I'm sold on CB myself!" So is KIRO's afternoon disc jockey, Ron McDonald, who also uses CB for traffic reports. ▲

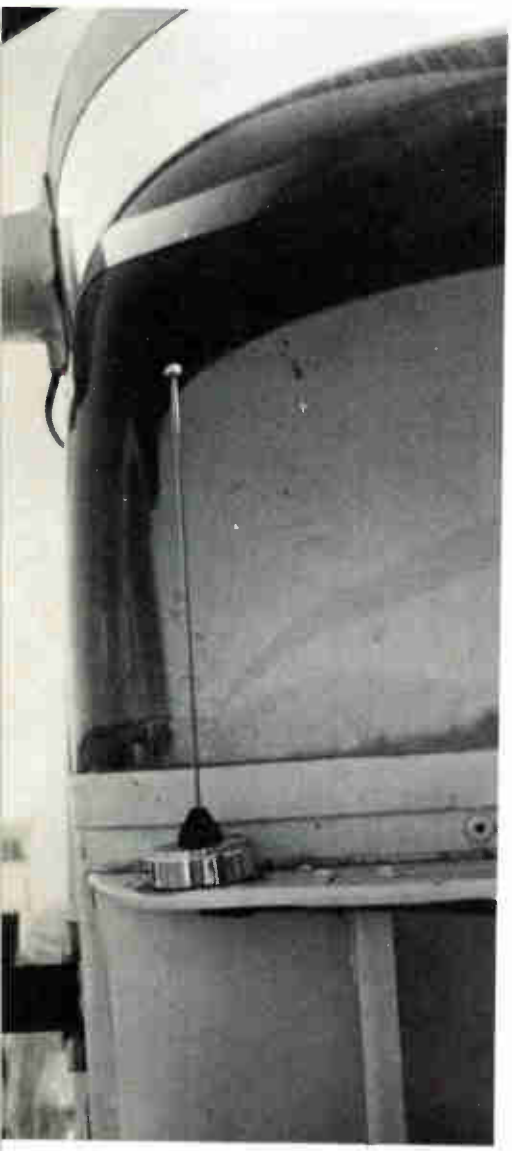
*E. F. Johnson Company

REMOTES in the air

By R. V. Stuart*

The operations of helicopter remote pickups for traffic reporting and special events, as well as the various applications for marine radio remotes, have been well covered in many articles the past few years.

*Engineer, KGO, San Francisco



450 MHz whip antenna mounted on 'copter.

However, little has been written about the problems involved from the standpoint of the engineers who must specify the type of equipment to be installed and then make and maintain the installations. We plan here to explore some of these problems and offer some suggestions for their solution, treating each as a totally different type of installation, since each has its own peculiar problems.

Equipment Selection

First, the factor of equipment reliability must be considered. The forces of vibration and environment become quite awesome factors in installations of this type. Vibration in helicopters and moisture or salt air in boats take their toll, if good equipment and proper installation procedures are not used. Therefore, if you are planning remote pickups of this type, specify the finest, most rugged equipment available, and then install it properly.

From most aspects, the 450 MHz remote pickup frequency band is the best bet for mobile installations, due to the lack of interference on these frequencies, and also the small space required for the antenna. As can be seen in the photos, the small whip-type antenna mounts easily and conveniently at the rear of the 'copter bubble.

Aircraft Considerations

In any aircraft installation, it is mandatory that thought be given to weight and balance. In fact, it will be necessary to figure the weight of all permanent equipment, including such small items as audio transformers and whip antennas, to the ounce. This information must then be filed, by the owner of the craft, with the FAA for recertification of the aircraft, figuring the new center of gravity, as well as the new gross weight and payload.

In making an aircraft installation, good engineering practices must be adhered to more closely than on any other installation. Care must be exercised in routing cabling, and all cables and other items must be well secured. Proper grounding, and most important, proper fusing of all power circuits are absolutely necessary.

Means must be provided so that the 'copter broadcaster can monitor his broadcast station for air cues, in addition to being able to have intercom facilities with his pilot and audio from his two-way receiver. Since the noise level in a 'copter does not permit the use of speakers, it is necessary to feed all of these audio sources to the headset circuitry. This requires tying into the craft's audio system in a manner that does not disturb the pilot's normal headset functions and yet accomplishes all these functions as well as permitting the pilot to monitor the two-way when he desires. This allows the pilot to carry on his conversations with the control tower without interference, yet it allows him to switch his headset in order to hear directions from the studio as to the location of traffic problems, etc. The drawing shows how this has been done on our helicopters with a minimum of modification of the craft's audio system.

On The Air Cues

As mentioned, the requirement for air cues is another problem to be solved. It can be done by using a small transistor radio for an air monitor; however, it is not always

Fig. 1. Barrier strip numbers may vary, but color code follows function. Wiring modifications are made on the barrier strip which is located behind center seat or console. Pilot to Co-pilot switch is existing equipment, but wiring from barrier strip is added and paralleled with existing connections.

and on the sea

possible to get sufficient signal inside the bubble to provide dependable monitoring. We found a more reliable system: a transistorized automobile radio mounted in a small aluminum box with hanger holes cut in it and two screws placed on the 'copter's console for the box to hang on, thereby making a temporarily mounted unit. All power and audio cables are fitted with small twist lock type connectors. A wire about eight feet long, weighted at one end is dropped out the door after takeoff to provide an excellent antenna.

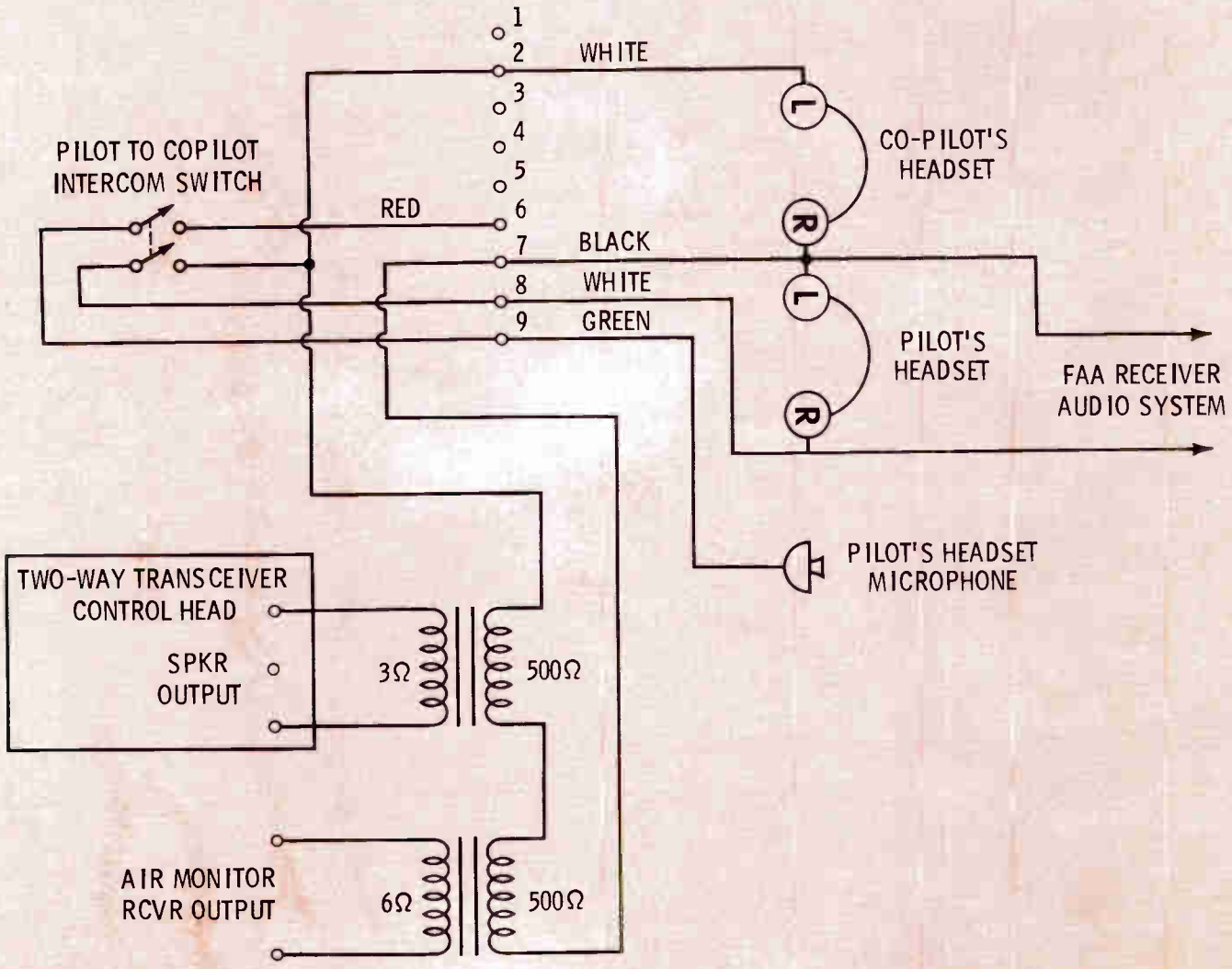
Microphone Choice

It is a basic requirement, due to the high noise level, that a noise-cancelling microphone of the finest quality be used and that any AGC circuits in the transmitter be disabled. AGC has become a standard in the broadcast industry, not only in studio and remote audio lines, but also in many two-way transmitters, including the small handie-talkie types. AGC can cover many errors and has its place in all these functions, but a helicopter is NOT one of those places.

The extremely high ambient noise in a 'copter tends to keep the overall modulation at the noise level, nearly obscuring the microphone signals. Therefore, it is imperative that any AGC circuits be disabled, in order to obtain good intelligence, even with the best noise-cancelling microphones.

Aircraft Installation

Since there is not room inside a small 'copter for the two-way transceiver to be mounted, it must be placed in a watertight container on



the exterior of the craft. When purchasing radio units for this kind of installation, be sure that the equipment manufacturer makes a weatherproof container for that specific piece of gear.

As can be seen in the photos, these units have covers that are easily removed, and the radio unit can be slipped out of the container for servicing. Remember, always make certain that the latches are safety wired after replacing the lid. And double check the safeties before leaving the craft. That lid can cause problems with a rotor if it comes off in the air!

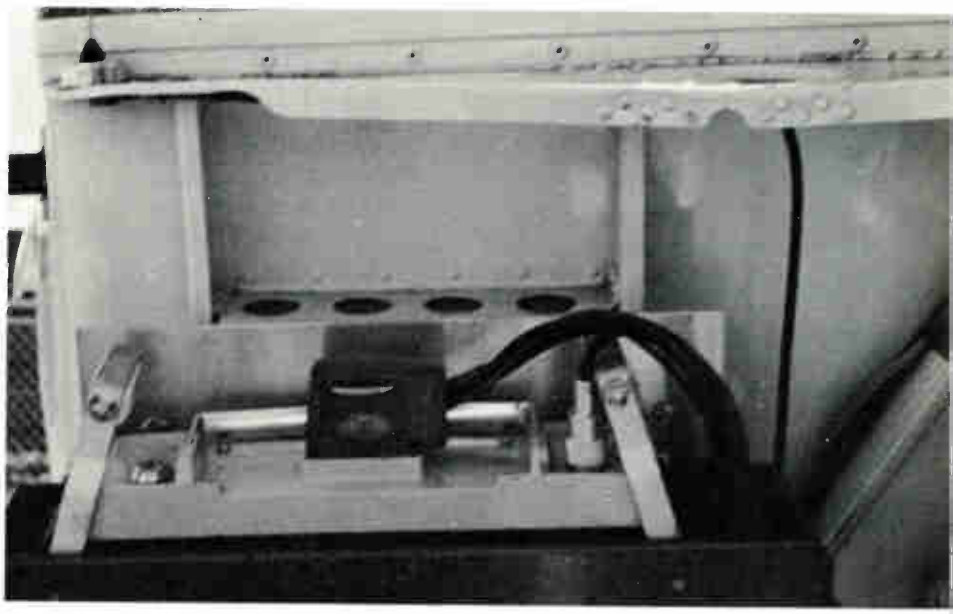
The vibration of a 'copter is punishment of the first order for radio gear but, we have found that our equipment holds up very well, normally requiring service only every six to nine months. The main problem is the movement of tuning slugs in the coils. We begin to notice a weakening of signal strength that becomes more noticeable each day for a period of two to three weeks. This is our signal to pull the gear and readjust the tuning slugs.

The final check on a 'copter installation is to make certain the two-way transmitter does not create any interference with the FAA radio gear on board.

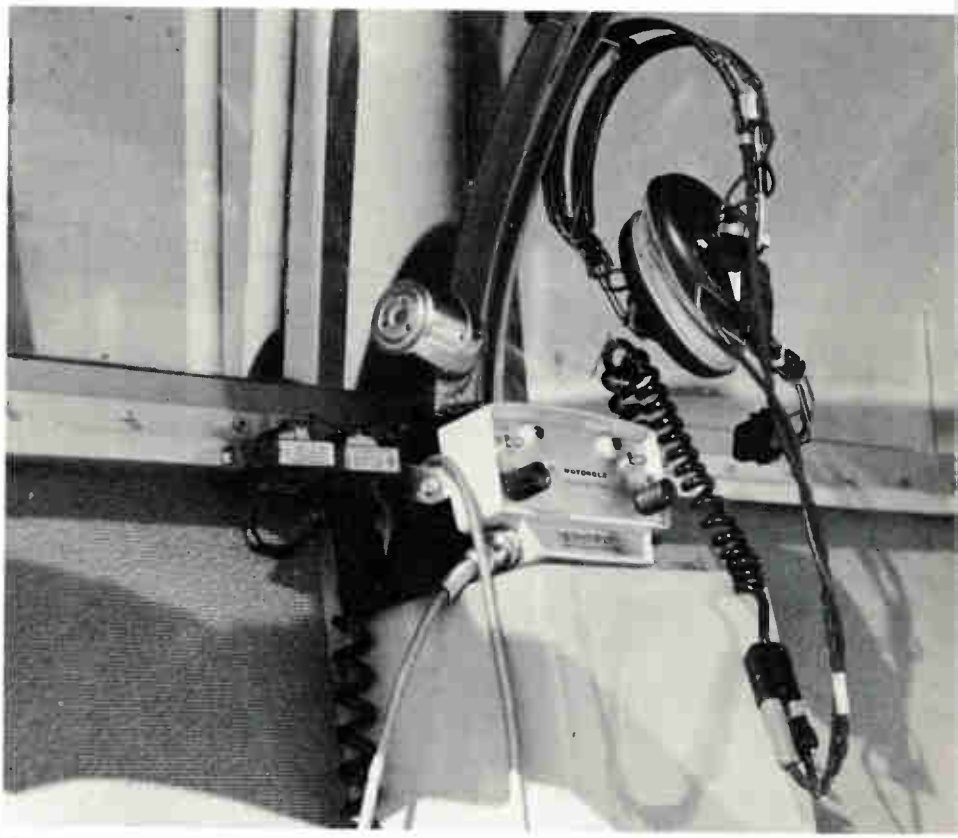
Marine Remotes

Turning to the subject of marine radio installations, these follow more the pattern of regular vehicular installations. Since there is more room on a boat, it is possible to use a gain type antenna. The one pictured provides a power gain of 2, which can be the difference between a good and a poor broadcast, when you consider that the boat is always at a low elevation. The gain type of antenna has a low angle of radiation, thereby it provides a solid signal along with its gain.

In addition to your broadcast remote gear on a marine cruiser, you will probably be called upon to in-



Top of transceiver in waterproof container with cover removed.



Control head, and added audio transformers mounted in 'copter. Noise cancelling type transistorized microphone is also visible. Barrier strip referred to on drawing is immediately below the control head, under the console cover.

When engineers get together, the conversation turns to pickups.

PHOTOGRAPHED BY FRANZ EDSON AT THE CAPITOL TOWER, HOLLYWOOD.

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

STANTON

Circle Item 12 on Tech Data Card

stall and maintain the low frequency marine band gear normally carried on board. This equipment operates in the 2 MHz to 3MHz band. Therefore, it should not provide any interference problems between the units. Here, the one most important item is to be certain the boat is equipped with good ground plates and that the low frequency transceiver uses heavy ground cables, as short as possible with good clean connections.

Installation

There will be antenna leads, mounting hardware, exterior mounted speakers and perhaps other reasons for drilling holes in decks or through exterior walls. If cables must go through an exterior wall, the holes should be drilled at an angle that will prohibit water from entering the vessel. Where bolts are placed through decks, use neoprene washers and a good sealant. It is also a good idea to use sealant around all openings for cables. Any through-the-deck-mounting will leak water if it is not properly installed and caulked. Make certain the job is done properly. The time and effort will pay off in less maintenance and subsequent troubles.

The task of mounting antennas often requires fabricating mounts and other parts. Be prepared to do a certain amount of this kind of work, as it seems the ideal place for an antenna on a cruiser deck is usually the spot where a sharp slope exists and mounts must be shimmed, modified or built from scratch.

Even though there is room inside for mounting your radio gear on a cruiser, it is an excellent idea to place it in a watertight container. There will be times when a considerable amount of water will be taken into the cabin of any but the largest of boats.

If your cruiser is equipped with a flying bridge, you will want to extend speakers from both the two-way radio and the marine radio to the bridge, plus a parallel microphone and control line. This will allow making broadcasts from the bridge as well as the cabin. The microphone and control lines can be brought up to a small mini-box, mounted in a protected area on the flying bridge and equipped with the proper microphone connector.

On the cruiser a good quality transistor radio can be used for receiving air cues, or an AM radio mounted in the cabin with a deck or bridge speaker and an auxiliary relay can be installed.

Signal Problems

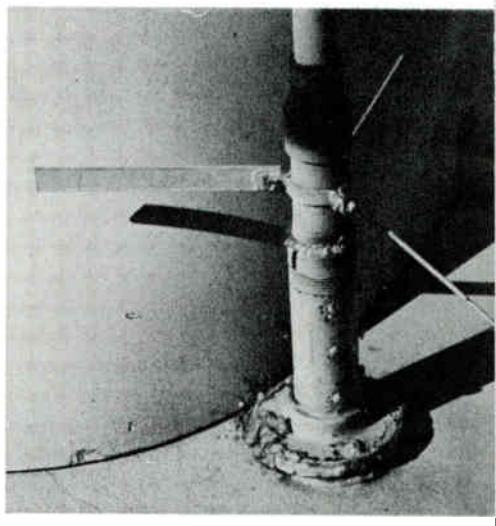
There are likely to be spots where the boat will not be able to broadcast via VHF due to the shadowing effect of hills, high buildings ashore or other obstructions. A few days of checking for such spots, will provide the installation engineer some fringe benefits!

Marine Inspection

A marine installation will usually require complete inspection in intervals of three to four months, mainly for any signs of corrosion or water leaks. Corrosion is the scourge of marine radio gear subjected to moisture, particularly salt water. All connections must be made waterproof and kept clean and free of corrosion. Clean even the slightest amounts of corrosion or replace the corroded connections or hardware if needed. There are several corrosion preventive aerosol type sprays now on the market that do a good job of providing resistance to corrosion, even in salt air conditions. These are well worth using on your installation.

This article is not intended as a complete guide to air and marine remote installation and maintenance procedures, but perhaps it will help you to solve some of the more prevalent problems that arise with radio remotes in the air and on the sea.

Location of deck mounted 450 MHz gain type antenna on marine cruiser.



Gain type antenna mount. Entire mount had to be fabricated and then shimmed when mounted, due to slope of deck. Waterproof caulking around mount is also visible.

Sony and the C37-A have severed connections.

1. Meet the new Sony C37-FET, an improved version of the famous C37-A—but without bulky external cables and power supply. Sony has replaced the C37-A's vacuum tube with a field-effect transistor, making the C37-FET completely self-contained, with its internal 9-volt battery.

2. The C37-FET boasts the same capsule as the famous Sony C37-A, long a standard in professional studios. The superb linearity and transient response of the C37-A plus significantly lower noise level than vacuum-tube models are yours in the new C37-FET.

3. Two directional characteristics, cardioid and non-directional, are easily switched by the use of a simple adjustment to give complete flexibility for any recording application.

4. The C37-FET permits use of standard Cannon XLR-3-12C output connector for battery operation. Now a condenser mike can have the same connector as any dynamic or ribbon mike, providing complete compatibility among all your studio equipment.

5. The C37-FET has exceptional sensitivity and superb cardioid performance.

6. By the use of a field-effect transistor, Sony eliminates overload problems commonly associated with tube-type mikes caused by grid blocking.

7. The C37-FET's low current drain permits at least 300 hours of battery life. An accurate meter indicates battery condition at the flick of a switch.

8. Three low-cut positions are provided for controlling bass response. Also flat and high-frequency-cut positions.

9. We'll be happy to send you the C37-FET's impressive performance chart if you drop us a note.

These are just a few of the reasons that Sony professional microphones are becoming increasingly popular with knowledgeable studio engineers and sound experts. For more reasons and more information, please write to Harold Watson, Sony/Superscope, 8150 Vineland Avenue, Sun Valley, California 91352.

SONY® SUPERSCOPE®

You never heard it so good.

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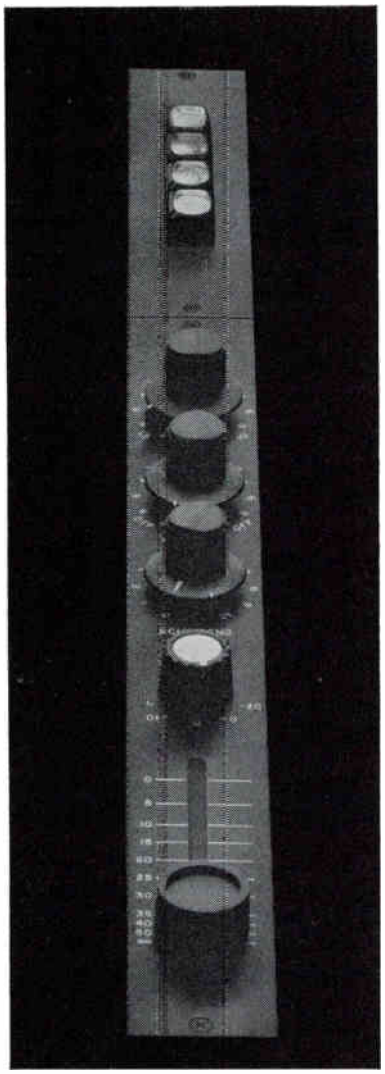

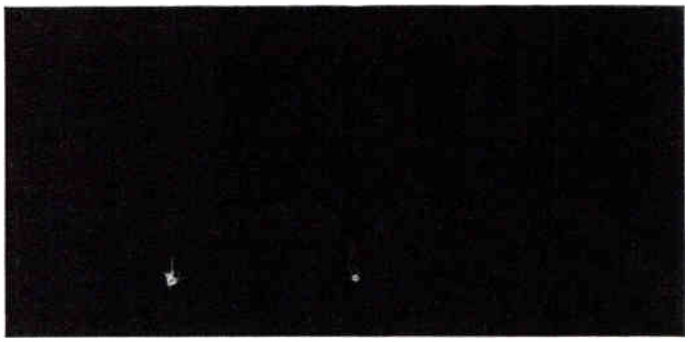

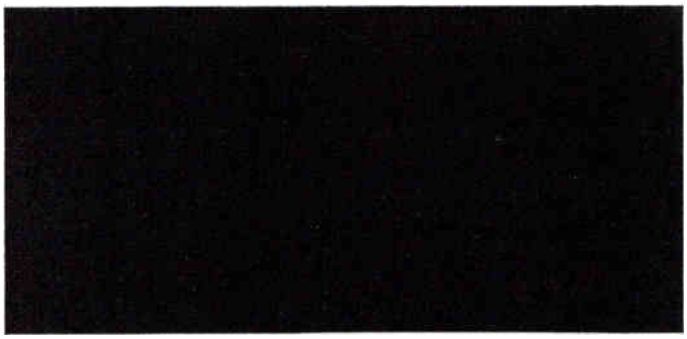

So, why shouldn't Electrodyne sell you input and switching modules for a few bucks less?

No reason. Any more. Because by now we've sold enough of our proven 709L input modules and SM series switching modules to make possible their lower-cost offspring: our new 1700 and SU series modules.

Our new 1700 series gives you a systems-engineered audio input channel with low-noise microphone pre-amp, low- and high-frequency equalizers, echo, and program amplifiers—all in a single plug-in module that uses integrated-circuit amplifiers to deliver unbeatable performance and reliability.

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Let's face it, everybody needs to save a buck from time to time. So, if this is your time to do that, take time to get all the specs on these new budget-stretching modules by Electrodyne.

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Circle Item 14 on Tech Data Card

Look at the Difference

Unretouched photographs of 21" studio monitor. Photographic data: Rolleiflex C-3, CPS color negative film — ASA 100, 1/15 second at f/5.6

...after 3M Color Dropout Compensation

Here's what 3M's Color Dropout Compensator does for your VTR reproduction:

Look at this unretouched composite photograph of a studio monitor. It shows, at the left, a videotape playback with 13 electronically recorded-in dropouts. These dropouts were created by a special test generator which attenuates the RF level to the record driver. On the right, these dropouts have been completely restored by the DOC.

The black dropouts shown on the left are followed by a complete loss of color-lock in the direct color recovery equipment. Since these dropouts include horizontal sync and color burst, they cause transient color flashing not ordinarily attributed to the dropouts themselves. Even shallow dropouts can create a similar problem due to loss of side-band information.

Only the 3M Color DOC corrects all these effects.

After compensation, note the precise color match and complete freedom from switching transients. Also, the dropout disturbance to the time correction unit has been eliminated. Proc amp and servo stability are improved to such a degree that it is possible to play this tape in full intersync or pixloc mode.

In the compensated half of the photo, compare the replacement material with the original signal two scan lines above the dropout due to a *complete* frame being photographed. Try to find the 13 switching transients.

The 3M Color Dropout Compensator is the only system available that can provide proper color and luminance replacement. For details write for the booklet, "Compensating for Dropouts in Color Television Recording."

Mincom Division 3M COMPANY
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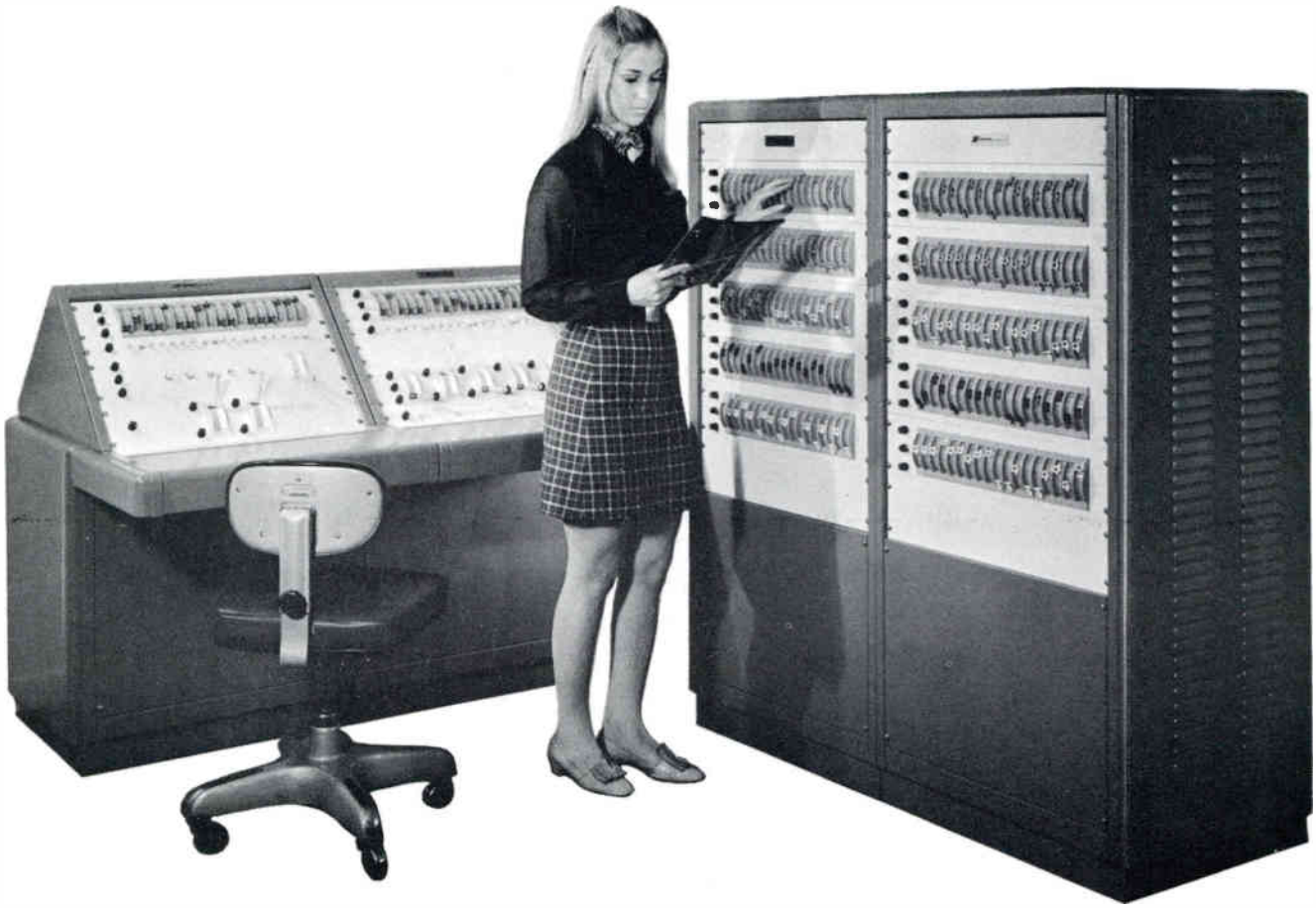
CONSOLE YOURSELF WITH COMPONENTS

A New Modular Concept in Lighting Control Systems by SKIRPAN ELECTRONICS



Now, for the first time, a *truly* custom, expandable, lighting control system with any quantity of control channels, masters, presets and dimmers can be constructed economically and quickly with Skirpan modular relay rack components and open-stock standard enclosures.

Skirpan's new 60-page color catalog describes this breakthrough in system design and presents many new products for lighting control – including architectural dimmers, pushbutton controls, cycle control amplifiers, frequency sensitive programmers and projector dissolve systems – all solid state – and an expanded line of console components. More than that . . . it is a comprehensive text on lighting control theory and practice.

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professional lighting control

SKIRPAN ELECTRONICS, INC.

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Circle Item 16 on Tech Data Card

Late Bulletin from Washington

Television Transmitter Remote Control Under Active FCC Consideration

The Commission is expected to act soon on a second proposal by the National Association of Broadcasters (NAB) to permit the operation of VHF television transmitters by remote control. A similar earlier proposal was turned down by the Commission because the supporting data were considered to be insufficient to establish the feasibility of VHF remote control. NAB subsequently conducted extensive further tests, the results of which have been presented to the Commission in support of the new remote control request.

The Commission's Technical Standards already permit the remote control of UHF television transmitters. Operating experience with UHF remote control has been generally satisfactory, but it appears likely that the new rules permitting the remote control of VHF television transmitters will include some tightening of the requirements for the remote control of UHF transmitters.

Comments Sought On Remote Control Modulation Monitor Amplifiers

The Commission is considering a requirement for type approval for modulation monitor r.f. amplifiers when they are used as part of the remote control installation of a standard broadcast station. In a Notice of Inquiry, the Commission has noted that the accuracy of a modulation monitor which is driven by an r.f. amplifier picking up the signal off the air is "critically dependent on the design and performance" of the amplifier. However, there are no established standards for these amplifiers, and many of those in use have been built by station personnel. The Commission is particularly interested in such characteristics as sensitivity, band width, linearity, and passband characteristics. Comments on the Commission's proposal may be filed by January 17, 1969.

Short Circuits

The Commission has terminated outstanding authorizations to a number of fulltime stations for pre-sunrise operation using daytime facilities with a power in excess of 500 watts . . . The Commission has warned New York City's Board of Estimate that it should not authorize commercial programs to be carried on New York City's CATV system while the Commission considers the matter of CATV commercial originations (see Nov., 1968 Bulletin) . . . An 18 GHz system will be tested at Eugene, Oregon and Farmington, New Mexico, to determine its suitability for providing CATV service . . . The Commission is considering adopting rules requiring UHF television receiver tuning performance to be fully equivalent to VHF performance . . . The Commission has issued guide lines to be followed in establishing broadcaster and CATV responsibilities when program exclusivity requirements are invoked.

Howard T. Head

ACCESSIBILITY

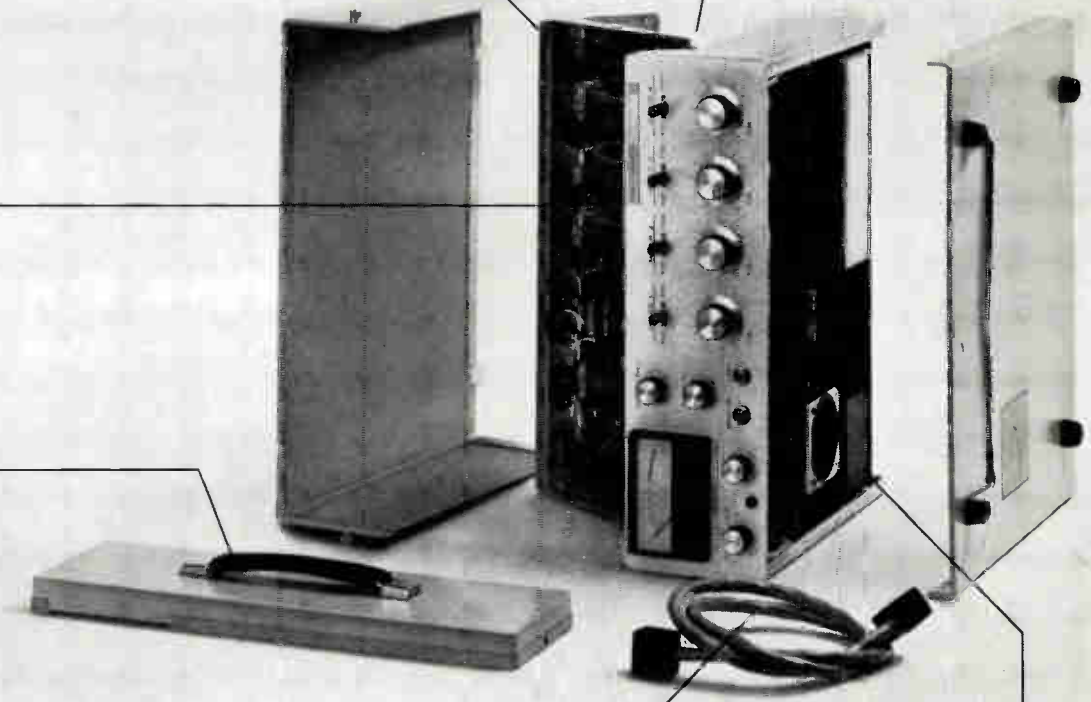
Top and bottom covers removed individually to expose all components. Circuit board hinged for easy access to reverse side and cables.

FLEXIBILITY

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

ELECTRONICS

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



PORTABILITY

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

PARALLEL OPERATION

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

OPTIONAL POWER SOURCE

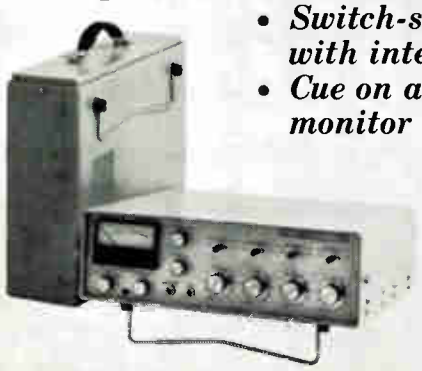
Self-contained power supply that operates the unit on AC also serves as charger for optional internal nickel-cadmium 12-volt battery. Unit switches automatically to battery in the event of an AC power loss. Unit also operates on external 12-volt battery.

a studio production console and remote pickup amplifier in one unit

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

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

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

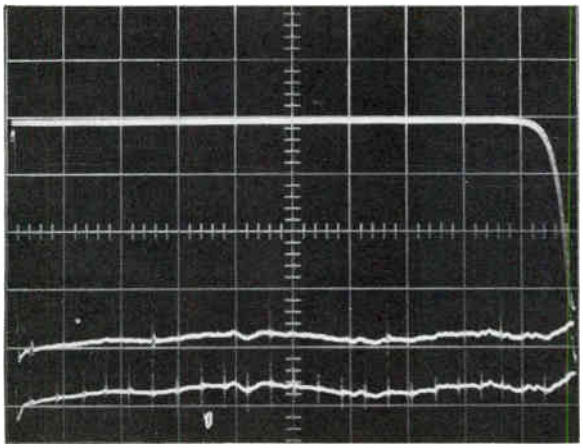


COMMUNICATION / COMPUTATION / CONTROL

COLLINS

24-HOUR DELIVERY.

The C701 Line Extender Amplifier . . .



50MHz **270MHz**

Unretouched photo of oscilloscope trace showing signal bandwidth of C701 amplifier. Upper trace markers are 50 MHz apart. Lower trace markers, 10 MHz apart.

Minimum Full Gain—25 db
Return Loss Rel to 75 ohms in—17db Min.
Return Loss Rel to 75 ohms out—17 db Min.
12 db cable equalization ± ¼ db
Maximum Noise Fig. CH 13—10 db
Maximum Noise Fig. CH 2—14 db
(12 db equalization)
CH 13 Output Capability—44 dbmv
(12 channels—57 db Cross Mod)

- **50 MHz to 270 MHz**
- **linear within ± ¼ db**
- **minimum full gain of 25 db**

Off-the-shelf delivery of the 20-channel C701 Line Extender Amplifier, right now! Unexcelled reliability of the improved C701 is assured by Conductron's long experience in space electronics R&D and manufacturing. And the mechanical design provides ease of installation and servicing that meets or exceeds any other amplifier on the market.

For complete specifications of the first solid state line extender amplifier, in its improved form, write: Conductron Corporation, Marketing Dept. H, 3475 Plymouth Road, Box 614, Ann Arbor, Mich. 48107

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Circle Item 18 on Tech Data Card

← Circle Item 17 on Tech Data Card

HUMAN ENGINEERED REMOTE AUDIO

Waterproof case ready for human engineering design.

Front view with cover removed. Note easy access to all control knobs.

By William Wokoun*

When our plane landed in Fairbanks, Alaska, the sun was shining brightly in a cloudless blue sky. It looked as though it always would.

But it didn't. A couple of hours later, a veritable rainspout drenched the airport. And someone had cleverly stored our equipment outside, in a low area. When next we saw it, it was awash directly under a leaky gutter.

While trying to dry it, we remembered some of the other aches and pains that go with operating in the field—the times connectors got clogged with sand, the day an errant cable turned a power switch off, and the inevitability of working in dim, dark corners. Could these difficulties be avoided? Why couldn't we redesign some of the equipment so it would be easier to use in these unkind environments?

We decided to begin by designing a completely new audio mixer, specifically for field use. Electronically, the design was straightforward. Nevertheless, we felt that conventional designs, geared to studio use, had crippling weaknesses in the field. Judging from the problems which had plagued us, the new design needed three specific kinds of improvement:

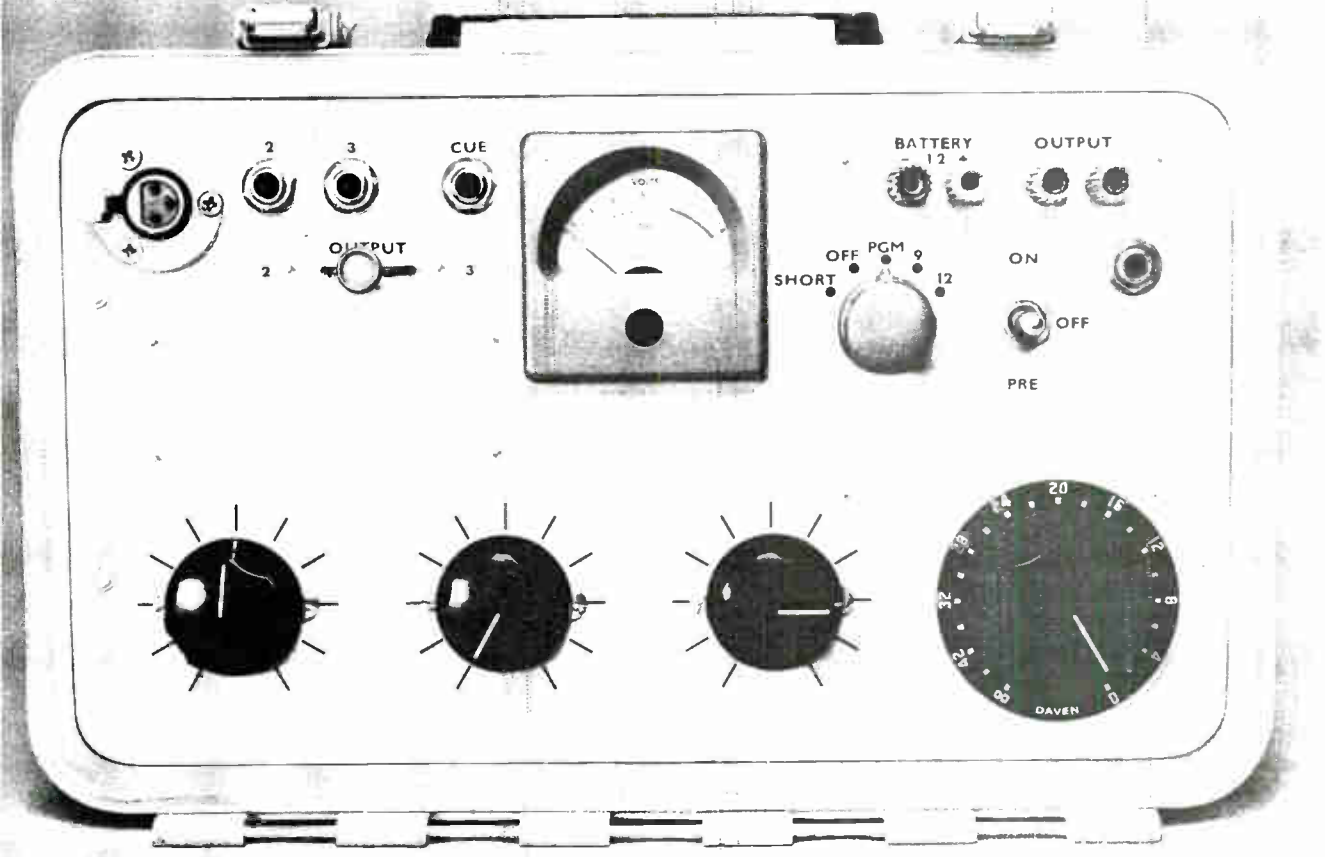
1. Better resistance to weather. Granted that it would be very difficult to weatherproof operating panels, the unit in its closed case must still be protected from rain, snow, sand, dust, and mud. This assures that weather will not damage the equipment during transportation and storage; we have to assume the operator will care for it while he is actually using it.

2. Design for easier, simpler operation. This requirement means that the operator must always be able to see the output meter and reach the controls easily. In particular, it means that cords and cables must not cover or obstruct the operating displays and controls, regardless of the position in which the mixer is used.

3. Good visibility under extremes of illumination. The operator must see panel components well enough to do his job in either dim light or bright light. Components and their background must contrast enough

*Human Engineering, Muzak

Cables shown pulled through handle, keeping them out of the operator's way.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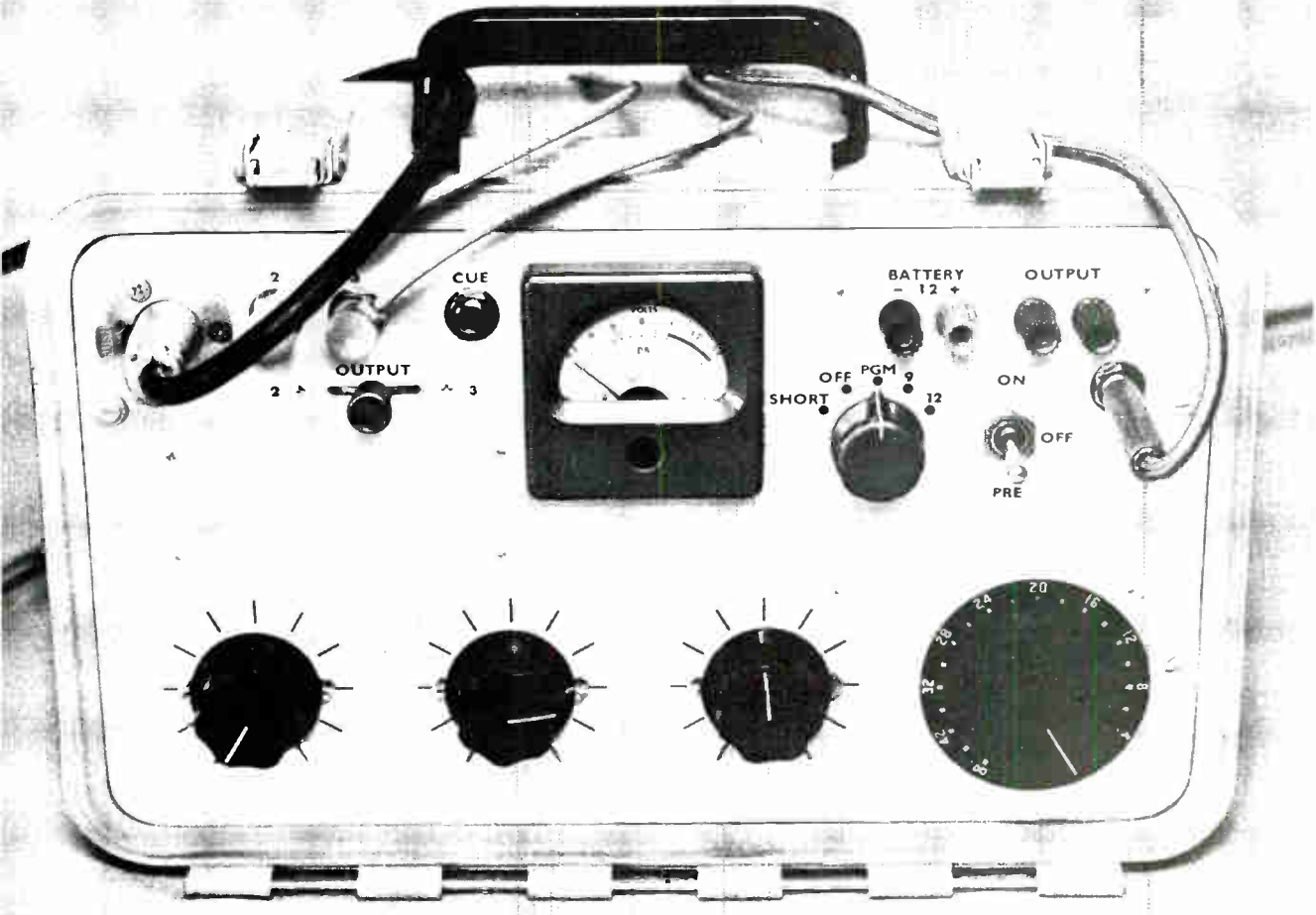
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for good visibility under poor illumination, yet they must still allow comfortable viewing in normal room light.

While these requirements seem to add up to a tough order—and sometimes even to conflict with each other—careful design made it possible to realize all three of them.

Watertight Enclosure Protects Mixer

The first step was locating a metal box or case that was watertight, small, and as light as possible. Our local surplus store had several sizes and shapes that had once housed military test sets. We finally selected an aluminum case measuring roughly 14 inches wide by 9 inches high by 8 inches deep. This size has a priceless advantage: the box is small enough to fit under an airplane seat, so it can be hand-carried. Although checking equipment is easier than carrying it by hand, checked baggage inevitably gets rougher handling and, embarrassingly often, finds its way to unexpected destinations.

Our box, complete with rubber gasket—and, unlike so many "portable" items, even a handle—cost less than five dollars. Considering the value of assorted pilot lights and switches that we salvaged from the panel inside the box, the box itself was probably free.

Eagerly, we began checking how the box performed in our environmental testing facility. After a couple of hours, the results convinced us. Despite submersion in the bathtub, the box's interior was still completely dry.

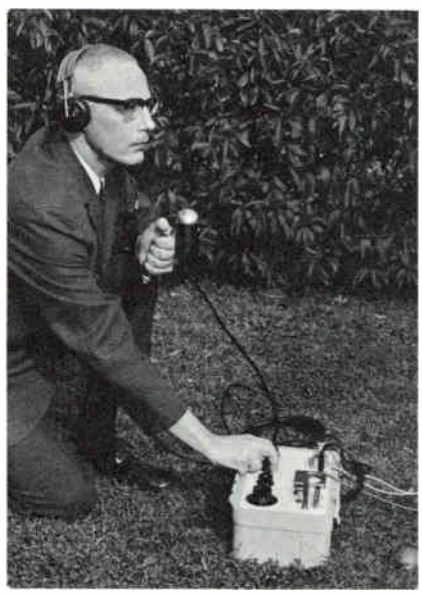
Since completing the mixer, we have tested it in rain and drizzle, as well as light snow. No water leaks into the box. We have not yet had an opportunity to test it in a humid, tropical climate, but it should exclude moisture satisfactorily. However, we will use packages of desiccant to remove moisture from the air inside the box, so it will not condense on the cool metal surfaces. Unlike tube amplifiers, the transistorized amplifiers in this mixer will not generate enough heat to dry themselves.

Operating Requirements Dictate Panel Design

The most important step in designing the panel inside the box was listing just what the mixer had to do. We decided it should have three input channels and a master attenuator. We also needed a meter for checking output level and testing batteries. Finally, there had to be jacks for monitoring the output and for cueing at least two of the inputs.

The weatherproofing requirement ruled out several very common practices. Connectors ordinarily belong on the back panel, so dangling cords won't disturb controls or get in the operator's way. Unfortunately, these connectors would have left several gaping holes that could not be waterproofed. Likewise, circuit boards and subassemblies could not be mounted to the box itself. Keeping the box watertight meant that each component had to be mounted to the small interior panel—approximately 12 inches wide by 7 inches high. Satisfying this requirement was not especially difficult or tricky, but it did force us to plan ahead in tedious detail before we could begin mounting the components.

We gave highest priority to the really difficult problem—not merely finding enough space to mount all the components, but developing a panel design which streamlines and simplifies the operator's job. Then, using the remaining space, the electronic assemblies behind the panel were arranged so they would be as accessible as possible for maintenance. But ease of operation came first; it was never sacrificed merely to simplify maintenance. Maintenance can usually be pondered at leisure, but operating problems become crises immediately.



Wokoun field testing the unit. Note that it can be placed on its back as well as on its bottom.

The most basic problem seemed to be: what position will the box be used in? Because field conditions vary so much, there cannot be any single answer. The engineer will probably try to set the mixer on a table, so the control panel is vertical. Yet sometimes he may have to set it flat on the floor, or even on the ground, with the panel horizontal.

Either way, the bottom of the panel will be nearest to the operator's hands. Thus the bottom edge is not only the traditional location, but also the best location for the most critical controls, the four attenuators.

Notice that all of the fader knobs are large, to give good grip even when the engineer's hands are damp or when he must wear light gloves. Each knob has a prominent white mark to show the attenuator setting. If the operator has enough light to see the meter, he can also see these white marks.

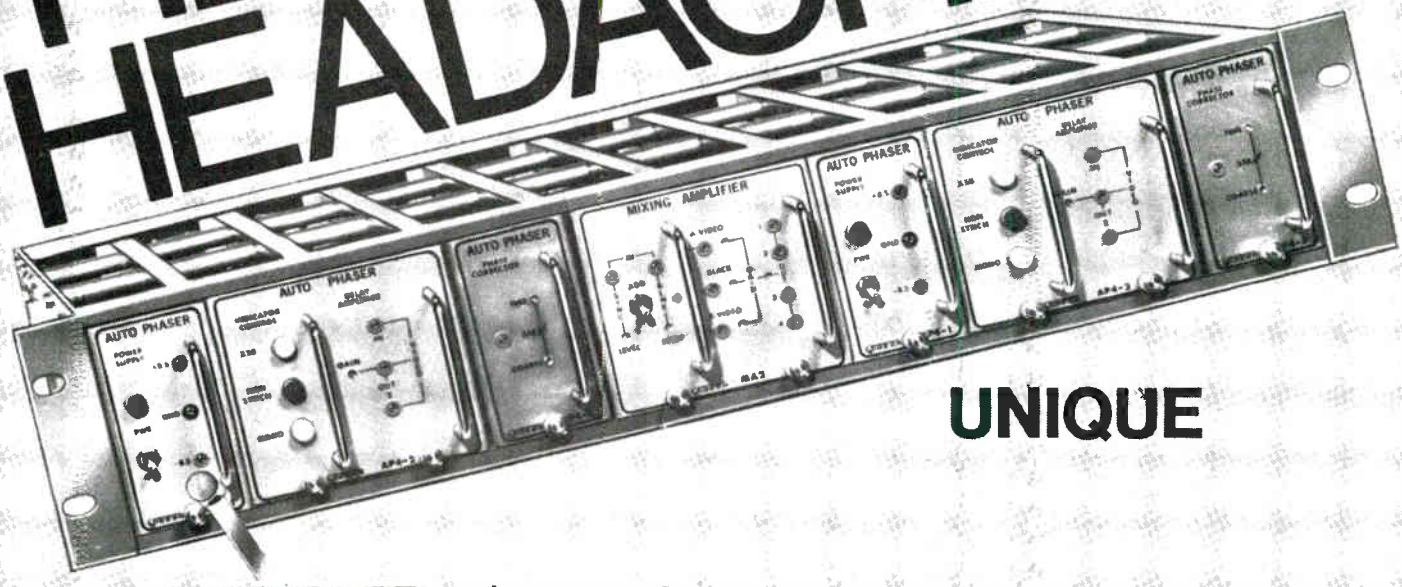
However, there may be cases where light is so dim, or the engineer is so busy, that he can only sense a knob's position by feeling it. If this is a critical consideration, select a knob with a raised, rounded "bump" to indicate pointer positions. Bar knobs will not be satisfactory, because it is hard to flick them from full-off to full-on.

The faders are spaced apart generously, so the engineer can crossfade inputs easily. Most important of all, no other components are in this bottom area, so nothing obstructs access to it.

There is only one display—the output meter, which is centered at the top of the panel, where the engineer can see it most clearly.

Controls used less often are at the right of the meter: the meter's se-

END COLOR FIDELITY HEADACHES



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lector switch, which allows checking batteries; and the power toggle switch. The cue-selector lever switch is at the left of the meter. While this area is less accessible, the cue selector is not used often enough to justify a handier location.

You may be surprised to see that all of the connectors are arranged along the top of the panel. It might seem more sensible to put them at the side or the bottom—but it isn't. Because connectors and plugs (and their cords) project out from the panel, it is very important to keep them separated from frequently used controls. Neither can they block the engineer's view of the meter. The only way to keep these connectors out of the engineer's way is putting them in the panel's top corners.

The microphone connector, which projects most, is at the extreme left. All of the other connectors are standard phone jacks; here, we can minimize projection simply by using right-angle plugs. Thus these connectors use the less-desirable areas that the operator would have difficulty reaching anyway.

The box's handle serves as a "keeper" to hold stray cords away from operating areas. Each cord is brought to the mixer from the back, threaded through the handle, and then connected to the front panel. Regardless of whether the box is horizontal or vertical, the handle holds all cords so they cannot block the operator's view of the meter or obstruct his access to critical controls.

Functional Colors: Better Visibility

Portable equipment must be used under a wide range of illuminations, from television glare to opium-den murk. Therefore, the mixer must be designed so it will always provide the best possible visibility. More specifically, the colors and brightnesses of both components and the panel itself must be chosen very carefully, to assure that components will stand out clearly against their background. The heart and soul of good visibility is providing good contrast.

If we consider only very dim light, it is easy to maximize the contrast between components and their background. All we need do is make the background as bright as possible (preferably white), while making the components very dark (preferably black). The operator must always have some light—even cats can't see in complete darkness—but the strong contrast between black and white would give maximum contrast in very dim light.

However helpful this extreme contrast would be under very dim illumination, it would prove quite unsatisfactory in normal light. A black-and-white panel can hardly capitalize on the attractive color combinations that can add so much to eye appeal and help enhance station prestige. What is worse, its exaggerated contrast causes glare and produces visual fatigue when illumination is good.

Clearly, contrast should be variable: high in dim light, but only moderate in bright light. What we really need is a device that can adjust contrast automatically, to suit the illumination level.

By taking advantage of the nature of the retinal receptors, we can approximate precisely this self-adjusting contrast. The eye's retina has two kinds of receptors: cones, which are used for seeing colors in bright light; and rods, the much more sensitive receptors that give sensations of brightness (but not colors) in dim light.

Rods and cones have different spectral sensitivities. The cones, our bright-light receptors, are relatively sensitive to reds, but relatively insensitive to blues. The rods' response is just the opposite: rods are comparatively less sensitive to reds, but more sensitive to blues. As we adapt to dimmer and dimmer light levels, shifting from cone vision to rod vision, a phenomenon called the Purkinje shift occurs. Reds seem to grow darker, while blues grow brighter. If we choose our panel colors carefully, so they put this Purkinje shift to work, we can enhance the brightness contrast in dim illumination.

Since rods are more sensitive to blue, the panel background should be a light blue. The particular warm, light blue used here is automobile touch-up paint (Duplicolor DS-GM 66). This color appears moderately bright in good light, yet it is discriminable from components because it is a different hue. In dim light, this light blue will seem relatively lighter, giving better contrast so controls seem to stand out. In low illumination, a carefully chosen light blue "goes white."

The four attenuator knobs are the most important controls. Making them black gives them greatest possible contrast with panel background. The master fader has been differentiated from the three mixers in several ways—by its position (far right), by its black dial plate, and even by the "feel" of its larger knob.

The meter frame and some of the less-important controls were spray-painted with a coordinated warm dark blue (Duplicolor DS-GM 105). This deep blue gives reasonable contrast with the panel background, but without diluting the emphasis on primary controls.

The meter was also chosen for its visual advantages. Since its face is white, rather than the usual buff, it reflects more light, making the needle more visible.

While the paint colors and brightnesses give the mixer a pleasant, attractive appearance, they are far more than sheer decoration; they are functional. These colors give subdued, comfortable contrast in normal light, as well as unusually good visibility in poor light.

The same technique can be used with almost any equipment operated in dim illumination.

Conclusion

There is a saying that perfection depends on trifles. So, too, does ease of operation depend on many small facets of the design. If we ignore these crucial refinements, users may spend more time fighting the equipment than operating it. Really well-designed equipment must offer more than low distortion and wide frequency response. A really effective design must orient itself around the operator's tasks and try to compensate for his limitations. ▲

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Circle Item 20 on Tech Data Card

Dynamotors live on:

Power source for aircraft remotes

By Marvin J. Beasley*

Have you ever been confronted with using a remote pickup transmitter in an aircraft with a 28 volt electrical system? Can't justify spending $150 to $300 for an occasional use power supply? Interested in a reliable solution to the problem with a cash expenditure of less than $20? If the answer to these questions is yes, consider this practical solution. (Although the popular Marti M-3-60B is used here as an example, the ideas can be applied to many types of remote pickup transmitters.)

The Marti transmitter requires 300 VDC at approximately 150 ma. and 12 volts at 3 amps for the filaments. The filament supply should be regulated to maintain overall transmitter stability and extend tube life. Regulation is necessary to compensate for the aircraft electrical system voltage fluctuating between 24 and 28 volts.

Built-in B+ regulation is available in the Marti for the critical circuits; however, the 300 volt supply should not vary over ±15 volts. This is not to say the Marti or other transmitters will not operate properly with 275 volts or 325 volts B+, but that rapid large variations in the B+ supply are not desirable. The RF output power will decrease or increase slightly with a corresponding change in B+.

Limitations of the aircraft electrical system also have to be considered in the selection of a suitable power supply. Power consumption must not be excessive since aircraft do not have large capacity alternators or batteries. Battery and alternator capacity is sacrificed to keep the system weight at a minimum. Taking into consideration the power demand of the aircraft electronic equipment and the charging rate of the alternators, 400 watts is normally the absolute maximum power available for the remote pickup equipment.

A dynamotor power supply was selected. A search of electronic surplus catalogs revealed the PE-94C dynamotor met the requirements of the Marti and required very little modification. Several other possibilities were considered before selecting the PE-94C. The Marti Company advised me that a 28 VDC power supply is not available. Using a 12 VDC Marti supply with dropping resistors was ruled out because power demand was excessive and regulation poor. A 28 VDC to 12 VDC converter was too expensive.

A PE-94C priced at $4.95, including a spare set of brushes, is available from various surplus stores. The dynamotor requires 28 VDC at 10.5 amps and is rated for continuous duty. Output is 300 VDC at 260 ma. and 13 VDC regulated at 5 amps. The entire power supply is housed in a metal case with shock mounts. Install a large handle on top and the unit is easily hand carried.

The required conversion is to change the power connectors to the desired type, build a remote control box and install a power connector on the Marti.

A block diagram of the system is shown in Figure 1, and a composite diagram of the entire system in Figure 2. A composite diagram is provided because a diagram of the PE-94C is not available. The input and output power connections are RF filtered. RF filtering is desirable on the input to keep electrical noise generated by the dynamotor brushes out of the aircraft electrical system, and prevent radiation of the noise from the power cables. Interference to other communications equipment could result if filtering is not used.

Output filtering keeps brush sparking noise out of the equipment being powered. The noise generated by brush contact against the rotating armature is of spike nature and easily removed with small LC filters. The mica capacitors in the output filter assembly should be changed to ceramics, although not absolutely necessary. Old mica capacitors are subject to leakage and breakdown when voltage is applied.

The capacitors in the PE-94C I modified were in good condition, but

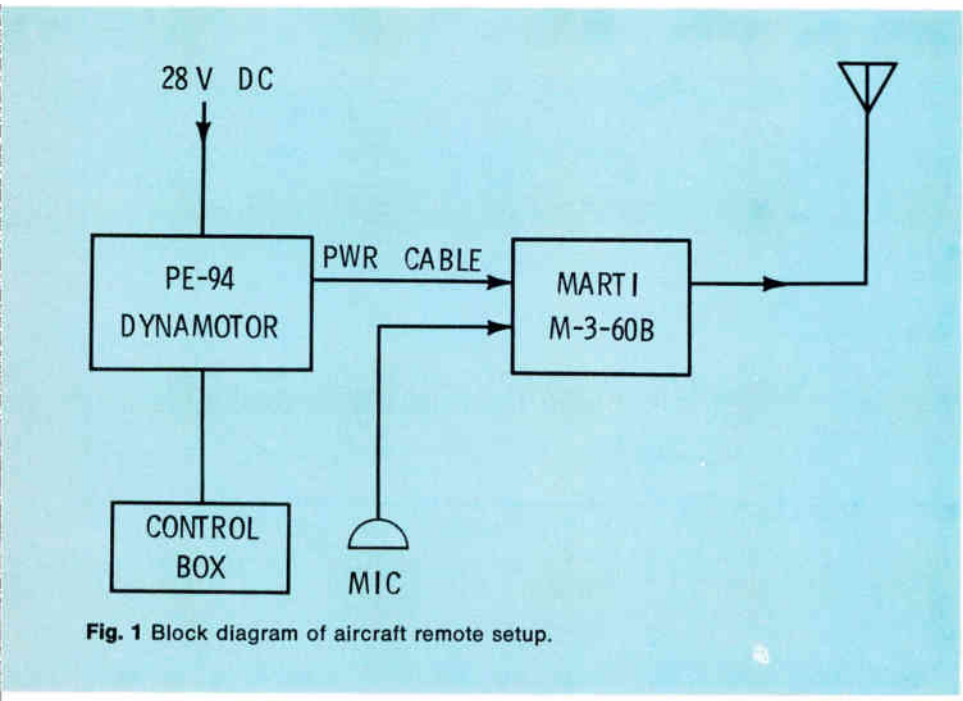
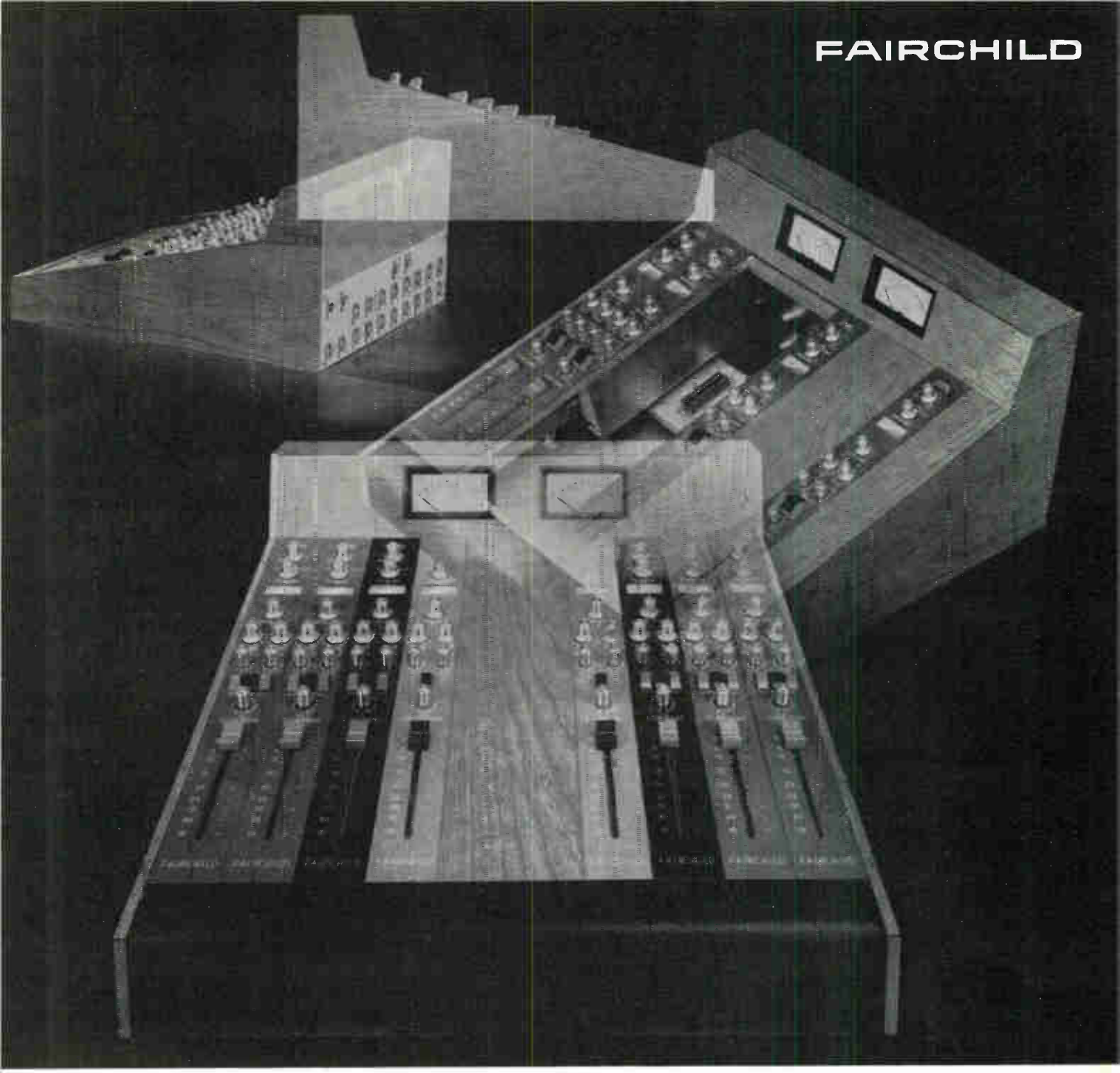


Fig. 1 Block diagram of aircraft remote setup.

*CE, WJBC, WBNQ, Bloomington, Ill.



The Desktop Console above is comprised of

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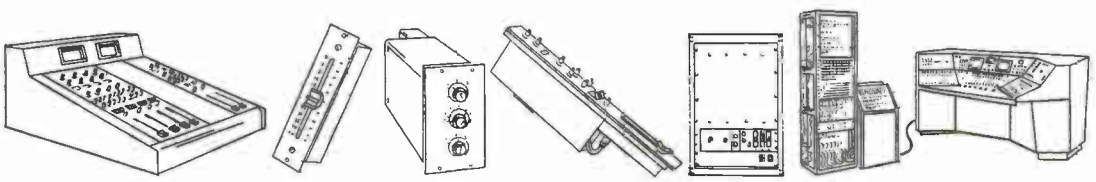
The Module includes these functions: Input Level Selector Switches and Pads, Input Preamplifier, Input Fader with or without cue, Echo Feed Control, Echo Feed Selector, Compressor, Full Spectrum Program Equalizer, Output Amplifier, Metering, Channel Selector Switch.

Each Fairchild Desktop Console is assembled to meet individual requirements; the one above accepts up to ten modules. Other Fairchild modules include the Integrated Control Output Module, which processes the signal from the mixing buss to the console output, and the Monitor Module, which provides complete flexibility in the selection of recording channels.

Contact your Fairchild Recording Distributor or write Fairchild for more data.

FAIRCHILD RECORDING EQUIPMENT CORPORATION, Dept. BE-12, 10-40 45th Avenue, Long Island City, New York 11101



DESKTOP MODULE CONSOLE / LUMITEN / REVERBERTRON 658B / INTEGRATED CONTROL MODULE / REVERBERTRON 658A / REMOTE AUDIO CONSOLE

were replaced as a safety measure. The input filter capacitors are bathtub type and of sufficient voltage rating to warrant continued use.

Due to space limitations, two six-foot number 8 wires are soldered to the input filters and a suitable male twist-lok connector installed on the other end. Also, the input connector was removed. Large battery clamps could be used, but I prefer a permanent power receptacle in the aircraft. The output connector was changed to a 12 pin Cinch-Jones socket. The output filter assembly needs to be opened to change the connector. A small 24 volt switching relay should now be installed in the filter assembly box. There is ample space for a Potter-Brumfield KHP 17D11 or a Comar 1604A-1.

The remote control is built into a mini-box and contains two switches. The control box is of utmost simplicity. Pilot lights are not used since no practical purpose is served and they consume extra power. The control cable is about 8 feet in length and is adequate to allow the announcer to move around in the aircraft.

One switch is labeled Power Supply On-Off and the other is labeled Standby-Transmit. The power supply switch starts the dynamotor and supplies filament voltage. Filament voltage is present only when the dynamotor is running. The Standby-Transmit switch energizes the B+ switching relay to apply 300 VDC to the transmitter. The control box is not permanently installed in the aircraft, as this allows the announcer to pick the location that is most advantageous and still have control of the transmitter.

An octal socket is installed on the rear of the Marti for the power connections. The wiring is shown in Figure 2. A dummy plug is used for 115 volt operation. The octal socket was selected because of local availability. A matching Marti connector can be used if desired, eliminating the need for installing an additional connector.

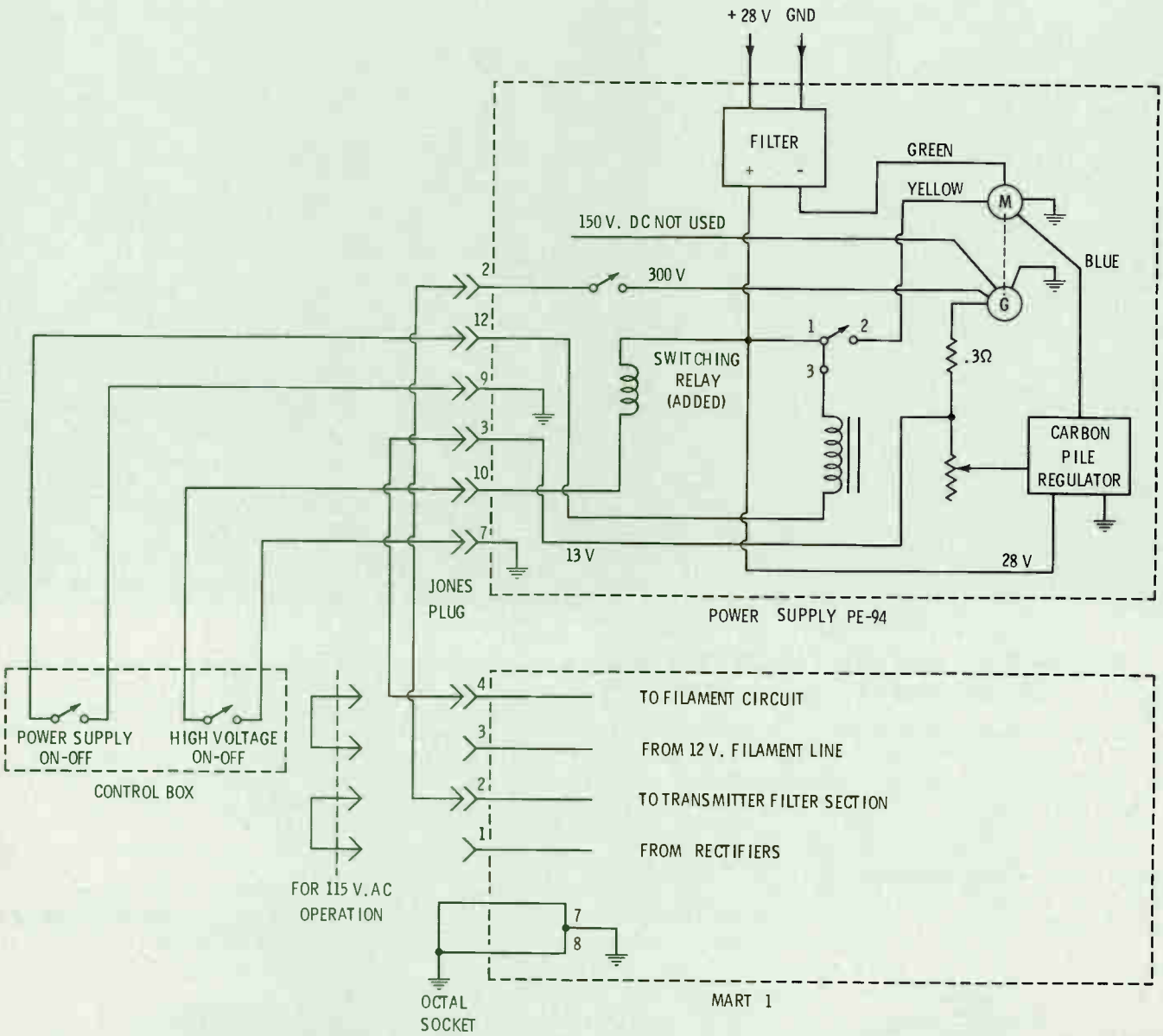


Fig. 2 Power connections and switching arrangement.

The Marti, power supply, control box and microphone are stored at the studios. Less than three minutes are required to install the equipment in the aircraft. The complete system, ready to install, is shown in Figure 4. Our present aircraft is a Cessna Super Skymaster with a permanent VHF antenna for the Marti. A fused 15 amp circuit is provided for power. These are ideal operating conditions, but many times in the past when using different aircraft, the antenna had to be taped to some exterior point and jumper wires attached to the battery. Performance of the system is excellent under either condition. The transmitter and power supply have been used for several one-hour continuous transmissions with complete reliability.

The earlier Marti M-3-60 has 6 volt filaments requiring 6 amps. The most logical way to use the earlier model is rewire the filaments for 12 volts and install a 12 volt filament transformer for normal line operation. The M-3-60 becomes the equivalent of the B model when the changes are made.

No tube replacement is required as a series-parallel circuit is used. An alternative to rewiring the M-3-60 is shown in Figure 3. R 1 can be three automobile-type 12 volt to 6 volt dropping resistors in series. The resistors dissipate large amounts of heat, and should be mounted in a separate well ventilated enclosure.

R1, R2 and the Amperite 55-4 ballast regulate the 6 volts to the filaments. The 55-4 is a standard item used in the Marti TPS-1 12 VDC power supply. The later high power Marti's require 490 VDC B+. A DM-43 dynamotor could be used to supply 515 VDC at 215 ma. and an Amperite ballast to regulate the filaments. Amperite will suggest which ballast to use if advised of the requirements.

Only the 28 volt applications have been discussed here. An economical 12 volt mobile or aircraft dynamotor power supply is the 12 volt version of the PE-94C. The PE-98 (12 VDC) can be purchased for about $5.95.

The lowly dynamotor still has many uses in the broadcast field. Low initial cost, reliability and low maintenance costs are difficult to overlook by a budget-minded engineering department. ▲

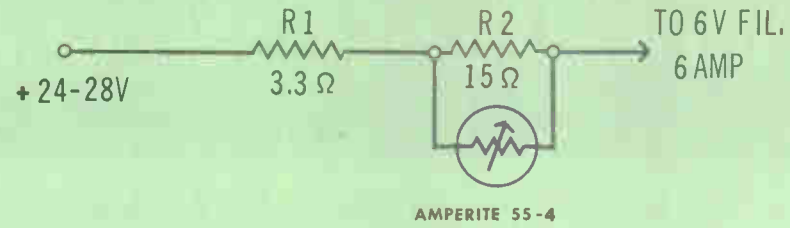


Fig. 3 An alternative to rewiring the M-3-60.

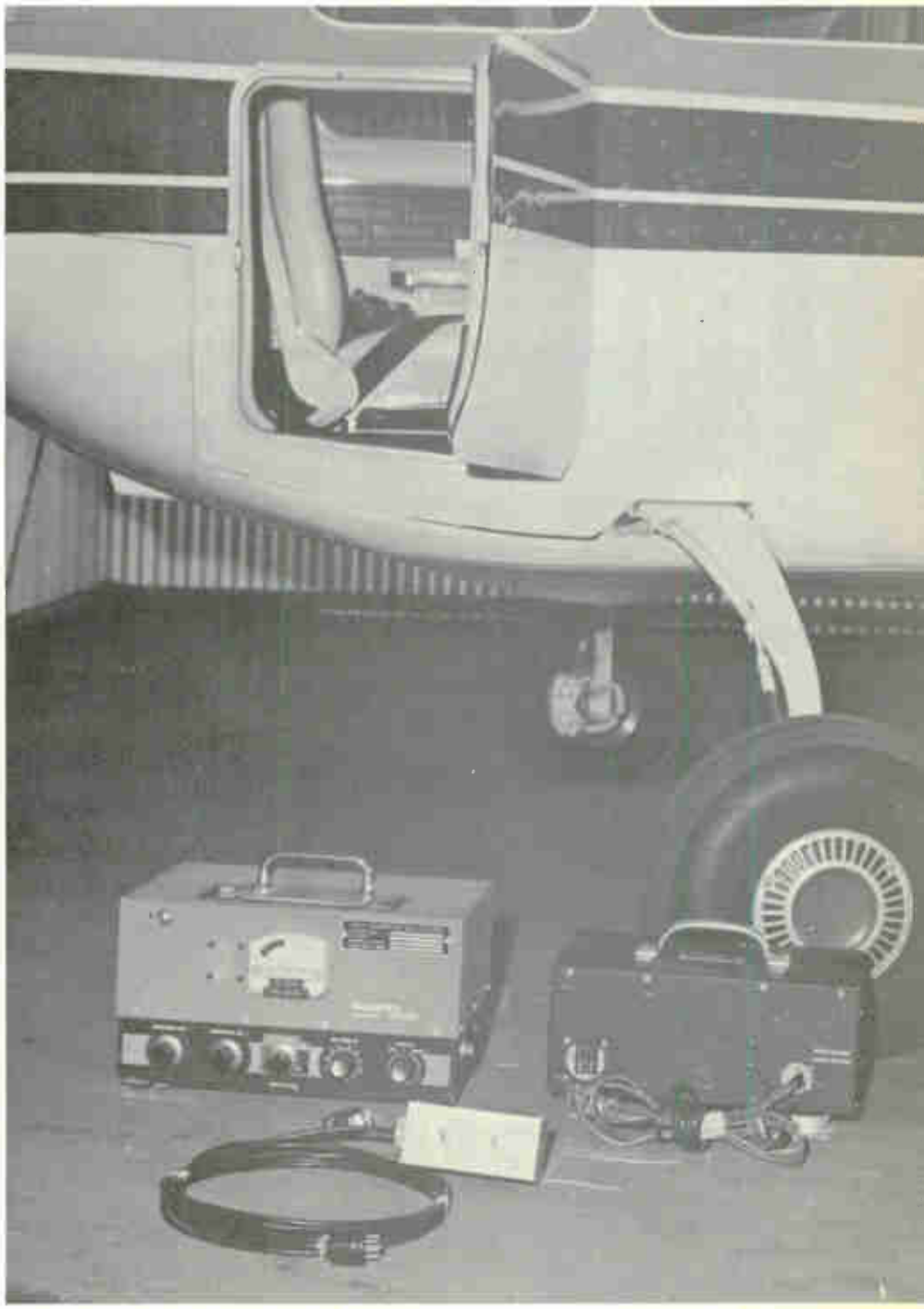


Fig. 4 Entire remote system ready for loading. System is placed to right of seat in background.

1968 Annual Index

NEW PRODUCTS

Super Magnet

The most powerful superconductive magnet ever to be offered commercially was announced recently by **RCA Electronic Components** at the 1968 Applied Superconductivity Conference.

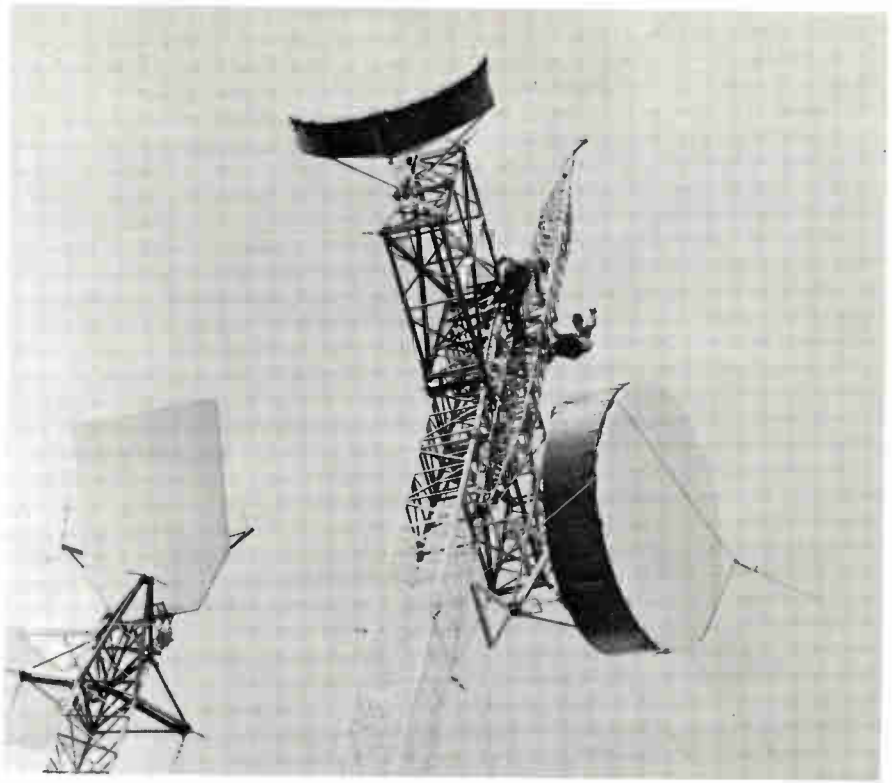
"The RCA designed and manufactured high-field solenoidal magnet attained a field of 150 kilogauss in a 1½-inch clear bore, using a new developmental copper-clad 'VAPODEP' ribbon," according to C. H. Lane, division vice-president and general manager, Industrial Tube Division. Lane said "this announcement represents another milestone in the rapidly advancing technology of high-field superconductive magnets. A little over a year ago, RCA announced the industry's first commercial superconductive magnet to achieve a field of 125 kilogauss with a 1-inch clear bore."

Andrews Develops A Unique Tower

A completely new tower form has been developed by **Andrews Tower, Inc.,** Fort Worth, Texas, for **General Telephone Company** of the Southwest. The T-structure tower is located three miles west of Brownwood, Texas. It is 220 feet high and is designed to support two 12-foot parabolic antennas, and two 10-foot parabolic antennas at the same elevation.

The tower was built to the owner's specifications that 4 antennas on the tower be at the same level, and the feat was accomplished by putting a T-structure atop a 220 foot tower. An ordinary tower would not provide sufficient room for the installation of the antennas.

Normally such a specification is met by building two towers and putting a bridge between them, but this technique necessitates double maintenance, double installation



costs, double fabrication costs, and additional transportation costs. The problem was solved by Andrews by developing its T-structure.

The new tower is square and is fabricated from A-36 galvanized steel, with 3-foot cross sections. One 6-foot parabolic antenna will be installed at the 50-foot height.

Andrews Tower, Inc., says this

is the first T-structure tower built, and represents a new form of antenna towers. The cross section on the tower is 20 feet long, 12 feet high and 3 feet thick. The configuration allows the design opportunity to stack T's or bridges at right angles or parallel to each other, thus accommodating more paths at a single junction than heretofore has been possible from a single guyed tower. Although only four parabolic antennas are designed for this particular tower, it could easily accommodate ten antennas at one elevation.

Quartz Light
(60)

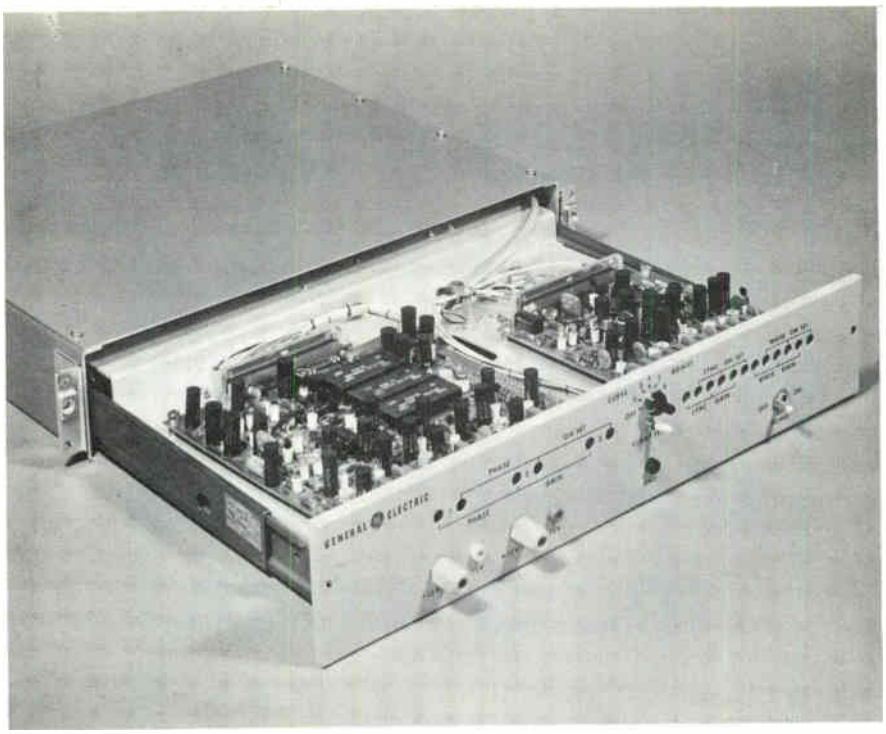
Berkey-ColorTran, Inc., a division of Berkey Photo Inc. announces the introduction of the 2000 watt lightweight, compact and high intensity Multi "20" focusing "quartz" light which provides uniform light distribution with smooth focusing control from flood to spot.

The Multi "20" can be stand-mounted or supported by standard grip equipment for both studio and field applications in motion pictures, television and still photography. At 20 feet, using a 2000 watt (3200°K) "quartz" lamp, intensity can be varied from 106 footcandles in the flood position to 799 footcandles in the spot position. The rugged and well-ventilated construction allows for continuous duty operation.

The LQF-20 stand-mounted model weighs 14 lbs. incorporating a cast aluminum yoke with an integral mounting bracket. Focusing is easily accomplished with a fingertip knob control (for hand operation) at the bottom of the housing. The LQF-20/TV hanging model weighs 8 lbs. and is equipped with a yoke and C-clamp for mounting on an overhead rail or pipe. Focusing is achieved by a pole-operated steel ring at the bottom of the housing.

Color Television Compensation Unit

Development of a new electronic product for compensation of the



(61)

color television hue and brightness errors inherent in TV transmitters was announced here today by **General Electric's Visual Communication Products Department.**

The new compensation unit can be added to any existing VHF or UHF TV transmitter broadcasting

NTSC color in accordance with EIA Standards, according to William B. Gaither, VCPD manager-marketing. He said it will "measurably improve" a transmitter's color signal.

The new device, the type TZ-8-A differential phase and gain linearity compensation unit, is the only one of its kind designed specifically for TV transmitters, Gaither said.

Gaither explained that the device precorrects the video to compensate for the non-linear transfer characteristic and differential phase distortion inherent in the modulation and power amplifier circuits of a television transmitter. It makes these corrections without introducing adverse errors in other areas of performance of the transmitter, he said.

The EIA transmitter standards specify a maximum differential phase variation of plus or minus seven degrees at 3.58 MHz, with the total not to exceed 10 degrees. The new TZ-8-A, he said, offers a maximum of 15 degrees compensation of transmitter differential phase error, and a maximum of 6 db white stretch and 12 db sync stretch for gain linearity errors.

The new unit was originally designed into General Electric's new TT-49-C/D VHF and TT-55-B UHF solid-state TV transmitter drivers which the company introduced earlier this year.

For use with existing transmitters, its all-solid-state circuits and self-contained power supply are packaged in a standard 19-inch tracked rack drawer. Installation and adjustment can be accomplished in a short time with normal transmitter maintenance capability and test equipment.

Directional RF Wattmeter

(62)

The new Thruline® model 4522 RF Wattmeter by Bird Electronic Corp. is a flexible directional power monitor for continuous indication of forward or reflected CW power under selection of plug-in elements. The model 4522 covers a full scale power range from 1 watt to 10,000 watts and from 0.45 MHz to 2.3 GHz.

DC currents proportional to the RF power level in the main line are switched to a meter—calibrated in watts—from the forward or reflected element sockets. No batteries or AC

power is required, and full scale accuracy is maintained at ±5%.

Since the new model 4522 is a rackmounted version based on the model 43 Thruline industry standard, Plug-in elements are interchangeable between the two units. Panel size of the new wattmeter is 5-7/32" x 19" and it is only 1-11/16" deep.

PIN Diode Series

(63)

Microwave Associates has developed a PIN diode series consisting of application-characterized silicon PIN junction devices functionally segregated by power-handling capabilities and switching speeds.

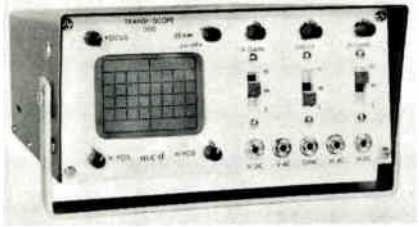
The MA-47000 series of switching diodes is a complete family of twenty seven diodes designed for control applications such as RF switching, limiting, duplexing phase-shifting, modulation and pulse forming. The diodes are also useful in variable attenuator applications.

The diodes feature peak power to 3 kW, switching speed of 100 to 500 nonaseconds. Minimum breakdown voltage ranges from 500 to 800 V. This diode series is also available in styles designed for use in microwave integrated circuits.

Portable Scope

A new portable oscilloscope weighing less than 7 lbs. yet with almost all the features of its bigger brothers has been developed by **Measurement Control Devices, Inc.** of Philadelphia, Pa. Designated the Model 300, the unit is fully solid-state, features identical DC vertical and horizontal amplifiers and has a sensitivity of better than 10 MV P-P.

The Model 300 has been designed



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specifically for those assignments where a good, reliable laboratory-quality scope is required for use in the field. With a convenient carrying handle which doubles as a stand, the scope can be taken on-location as easily as an attache case.

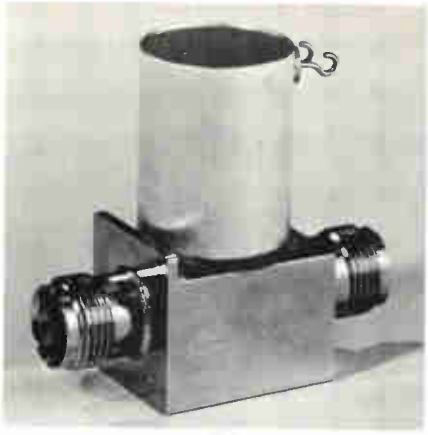
Emphasized with the Model 300 is the ease of operation, the rugged construction, the big case reliability and the low power consumption (less than 25 watts). Adapters for full-rack mounting and half-rack mounting are available options.

The display tube is a 3-inch CRT with a quarter-inch divided graticule. The housing is aluminum with a brushed aluminum front panel and measures 3½" H by 7½" W by 12" D. Vertical and horizontal amp. response is 0-100 KHz (—3 db) DC and 10 Hz to 100 KHz (—3 db) AC.

Coaxial Shutter

A coaxial shutter switch with mgh isolation characteristics has been developed by **Amphenol RF Division** of **The Bunker-Ramo Corporation.** Basic applications for the unit include systems and countermeasures equipment where critical circuitry must be shielded from extraneous signals and outside fields.

The SPST shutter provides 60 dB of isolation at 12.4 GHz. VSWR at this frequency is under 1.5 and insertion loss is only 0.5 dB maximum. The shutters are available with Type N or Type TNC connectors. They measure .750 by



(65)

1.620 by 1.780 inches.

Rated at 50 w of RF power, the shutters have an operating time of 15 milliseconds and low contact resistance—60 milliohms.

Temperature range of the shutters is —55 to +85 C; altitude range is zero to 70,000 ft; shock characteristics are per MIL-S-3928B, namely 10 G's operating and 100 G's non-operating; vibration (also per MIL-S-3928B) is non-operating 20 G's from 10 to 2000 Hz. Shutters can be supplied with coil voltages of 6, 12, 28 v d-c and 115 v a-c.

Optical Multiplexer
(66)

A new four-input, two-output optical multiplexer has been developed by **TeleMation, Inc.,** Salt Lake City television equipment manufacturer. The unit, Model TMM-212, is specially adapted to broadcast color television.

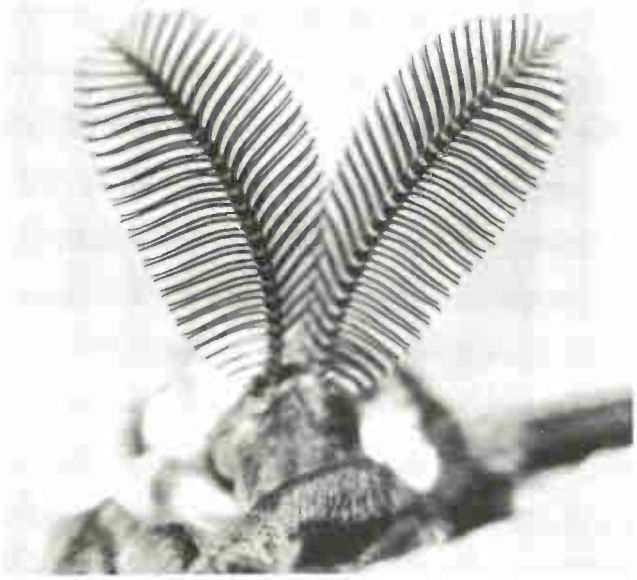
Four movable mirrors on the TMM-212 optically switch any of four film and/or slide projectors into either of two cameras. The unit's precision and durability are largely due to the movement, construction and alignment of these four mirrors. One edge of each mirror is mounted on two precision ball-bearing pillow blocks to insure exact vertical and horizontal alignment and to prevent even the slightest distortion by mounting stress.

The optical assembly "floats" on a three-point mounting, preventing impairment or optical alignment from external stress. The mounting also provides a means of adjusting the optical plane. Cameras used with the TMM-212 need not be equipped with field lenses, since such lenses are mounted on the mirror assembly.

Waveguides Bugged for Light

Some insects can detect electromagnetic radiation by a method similar to that used by German radar engineers, during World War II, to find allied radar transmitters. The night-flying moth pictured here is just such an insect.

Dr. Callahan has demonstrated that these insect waveguides are sensitive to predicted wavelengths. In this application, the waveguides are sensitive to light waves. This helps to explain why moths quickly settle when a light is turned on, but it doesn't help us get rid of them.



PEOPLE IN THE NEWS

Benjamin B. Bauer, an audio research scientist for CBS Laboratories, has been elected president of the internationally-renowned Audio Engineering Society.

Bauer, who is known throughout the scientific community for his pioneering research in audio and acoustics, has been responsible for many innovations in these fields, including highly advanced microphones for radio and television broadcasting, phonograph sound pick-up devices and tape recording heads.

Joseph H. Altman, research associate, Eastman Kodak Co., Rochester, N.Y. has received the Journal Award of the Society of Motion Picture and Television Engineers.

Kenneth B. Schneider, who joined Visual Electronics Corporation of New York as a Product Manager for Video Switching Systems late in 1967, has been promoted to the position of District Sales Engineer for Visual in the states of Georgia and Florida.

Felix Bonvouloir, midwest regional manager, Visual Electronics Corporation of New York, has announced that **Forest C. Eckhoff** has joined the company as district sales engineer for the Midwest region.

In 1956 Eckhoff personally designed and built the technical facilities required to create FM Radio Station KCJC in Merriam, Kansas. The station is now a part of the Starr Broadcasting chain.

Frank Egenstafer and **Norman Everhart** have been promoted to CATV engineering section leaders at the Hatboro Laboratory of Jerrold Electronics Corporation, according to **Caywood C. Cooley,** director of engineering.

INDUSTRY CALENDAR

Jan. 9 This is last day for filing reply comments on the FCC's proposed rulemaking dealing with television programs produced by independent suppliers and not made available to certain stations.

Jan. 9 American Research Bureau seminar on the use of ARB reports, Washington, D.C.

Jan. 10 International Radio and Television Society will hold its network newsmen and newsmaker luncheon, Waldorf-Astoria Hotel, New York.

Jan. 14 American Research Bureau will hold its seminar on the use of ARB reports by television stations.

Jan. 16-18 Florida CATV Assn., annual meeting at Marco Island.

Jan. 17 Cable Television Assn. of New England will meet at the New Hampshire Highway Motel, Concord, N.H.

Jan. 13-17 Annual winter meeting of the National Assn. of Broadcasters to be held by Board of Directors at the Americana Hotel, San Juan, P.R.

Jan. 21-23 Twenty-fourth annual Georgia Radio and Television Institute at University of Georgia, Athens.

Jan. 27 Idaho State Broadcasters Assn. annual midwinter meeting, Downtowner Motel, Boise.

Jan. 28 Deadline for filing reply comments on FCC's proposed rulemaking to limit station acquisitions one full-time outlet per market.

Feb. 7-8 New Mexico Broadcasters Assn. annual winter convention at the Hilton Hotel, Albuquerque.

Feb. 12-14 National Assn. of Television Executives annual convention, Los Angeles.

Feb. 14-15 Meeting of the Board of Trustees, educational foundation, AWR&T. Executive House, Scottsdale, Ariz.

Feb. 25-28 Western Radio and Television Assn. and West Coast Instructional Television 1968 Conference at the Olympic Hotel, Seattle.

March 13 International Radio and Television Society annual anniversary banquet. Gold medal award ceremony. Waldorf-Astoria Hotel, New York.

March 23-26 Annual Convention of the NAB. Sheraton-Park and Shoreham hotels, Washington, D.C.

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New Effect Boosts Solid-State Research

Discovery of a new electron diffraction effect has been made at North American Rockwell's Science Center in California. The observation, in addition to confirming a theoretical prediction, will contribute to a fundamental understanding of materials whose magnetic properties are relevant to solid-state devices.

The effect, which is called coherent exchange scattering, was observed by Dr. Paul W. Palmberg with the collaboration of two theorists, Drs. Roger E. DeWames and Lawrence A. Vredevoe. Their work is reported in the Sept. 2 issue of "Physical Review Letters," a publication of The American Physical Society.

Electrons, in addition to possessing a negative electric charge, also have a magnetic moment (spin) in that they act like tiny magnets. Beams of electrons moving at known velocities have been used extensively to study the chemical structure of crystals.

The incoming electrons are so indistinguishable from the electrons of the crystal as to lead to an additional quantum-mechanical exchange force between spins. When the periodicity of the spin system in a crystal differs from the atomic periodicity, this exchange force produces additional scattered beams (magnetic beams).

It is predicted theoretically, that except for very low velocity incident electrons, the intensities of these magnetic beams are extremely low. Because the experimental conditions required to detect the weak magnetic beams are difficult to achieve, the effect has not been observed previously.

The results of this experiment are of special significance because magnetic scattering offers a tool for revealing aspects of the dynamics of the spin system previously inaccessible in neutron scattering experiments. In addition to its use as an alternate probe of magnetic structure, electron diffraction provides the most direct means available for studying the role of exchange in electron scattering.

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Needed Immediately—Broadcast Technicians with television camera operating experience, for studio and remote camera operations. Permanent Civil Service position and excellent fringe benefits. Send complete resume or contact Mr. John Hollenbeck, Civilian Personnel Office, Redstone Arsenal, Alabama 35809, phone Area Code 205, Extension 876-5798. Federal Civil Service Procedures apply. An Equal Opportunity Employer. 11-68-2t

Video design engineers and technicians needed in rapidly expanding Vital Industries, Inc., in Gainesville, Florida. Write or call Mr. Donoyan (3614 S. W. Archer Road, tel. 904. 378-1581). 12-68-1t

FIRST PHONE—Combination man needed —Call collect. Ron Clark, WHLT, Huntington, Indiana. 219-356-1641. 12-68-2t

IMMEDIATE OPENINGS: Qualify for any of the following positions: RCA CCTV Equipment, monochrome or color, TV Systems Engineers-maintenance technicians-video engineers. RCA Rep., 1559 Jericho Tnpke., New Hyde Park, New York or (516) 352-2228. 12-18-tf

Equipment for Sale

CO-AXIAL CABLE Heliax, Styroflex, Spiroline, etc. Also rigid and RG types in stock. New material. Write for list. Sierra-Western Electric Co., Willow and 24th Streets, Oakland, Calif. Phone 415 832-3537. 5-66-tf

ADC Jack Panels and Patch Cords. Audio and video new and used. Repeat coils 500-500 OHM flat to 20 KC $4.00. Write for free catalog. Gulf Electro Sales, Inc. 6325 Beverly Hill, Houston, Texas 77027. 11-68-tf

Equipment for Sale (Cont.)

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

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

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

EQUIPMENT FOR SALE—Generator, gas, 25 kw three phase 110-220 volt, Onan model 25 kwED, total time—134 hours, $1500.00. Ampex 300 console, $850.00. CBS Audimax tube, $350.00. Magnecorders PT 6's, $150.00. Mastertone Co., 8101 University, Des Moines, Iowa 50311. (515) 274-2551. 12-68-1t

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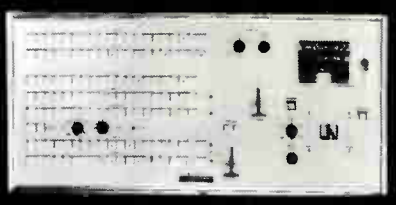

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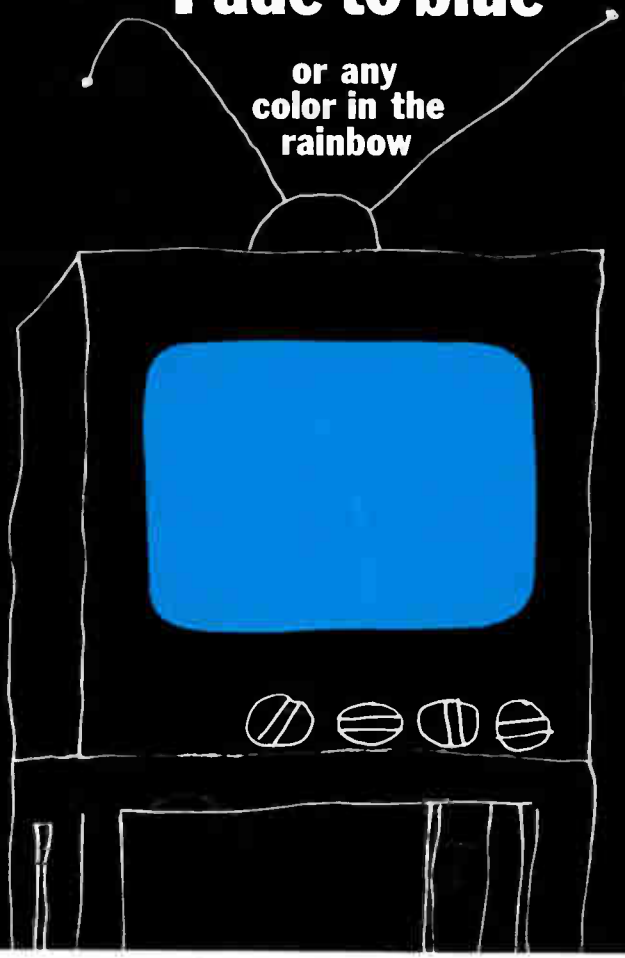

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