

COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"



APRIL

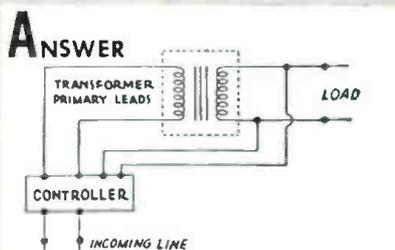
- ★ CAA V-H-F OMNIDIRECTIONAL RANGE
- ★ PHASING OF REMOTE TELEVISION SIGNALS
- ★ REPORT ON THE 1948 IRE NATIONAL CONVENTION

1948

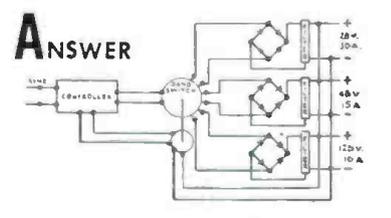
Self Control

Here's how
the CONTROLLER answers
typical regulation problems

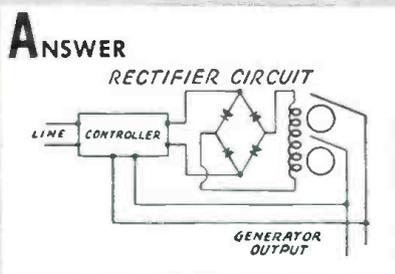
Q. An AC requirement. Can you stabilize the output of a transformer?



Q. Can you selectively regulate a number of DC voltages and currents?



Q. Can the CONTROLLER stabilize a generator field to regulate its output?



—of AC, DC or RF outputs in any one circuit, selectively stabilized over wide ranges of line and load with the new  SORENSEN ELECTRONIC CONTROLLER

The AC output of the CONTROLLER will swing between 85-145 VAC, AUTOMATICALLY adjusting the output of your unit against line and load variations. By referencing this output back to the CONTROLLER you get output regulation.



TECHNICAL SPECIFICATIONS

The controlled circuit must make available at least one watt of power to the CONTROLLER.

Input voltage range: 95-125 volts AC
(50 or 60 cycles)

Load range: 200 to 2000 VA

Regulation accuracy: 0.5% at the controlled point

write today for more information on the new CONTROLLER. Arrange to have a Sorensen Engineer analyze voltage regulation requirements in your plant. He can select a Sorensen unit or suggest a special design to fit your unusual application.

Represented in all principal domestic and foreign cities.



The FIRST line of standard ELECTRONIC Voltage Regulators

SORENSEN

& COMPANY, INC. • STAMFORD, CONNECTICUT

File this under ... **A**
TWO NEW PRESTO AMPLIFIERS

Engineers will welcome these two new additions to the PRESTO line of superior equipment.

Presto Peak Limiting Amplifier (Type 41A)

DESIGNED to control program peaks, Type 41A removes the cause of overcutting and distortion in recording and over-modulation in broadcasting. Proper degree of peak limiting permits an appreciable increase of the average signal with consequent improvement of signal to noise ratio. Serves simultaneously as a line amplifier; its 60 db gain adequately compensates for line losses due to pads, equalizers, etc.

Presto Power Amplifier (Type 89A)

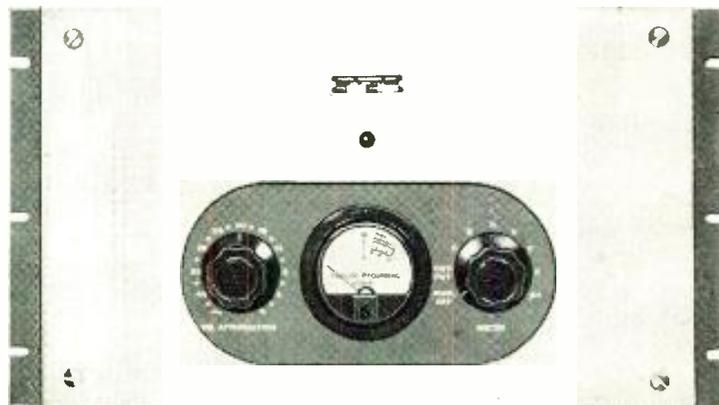
FOR recording, or monitoring use, 89A is the perfect high fidelity, medium power unit. 25-watt output, it fills the need for an amplifier between Presto 10-watt and 60-watt units. All stages are push-pull and sufficient feedback is provided to produce a low output impedance and general performance of the type 807 tubes which is superior to that of triodes.

FULL SPECIFICATIONS OF THESE TWO NEW AMPLIFIERS WILL BE SENT ON REQUEST.

Address Dept. C.



Type 41A. Chassis construction is for vertical mounting in standard racks. Removable front panel gives access to all circuits. Meter and selector switch indicate amount of limiting taking place and current readings of all tubes.



Type 89A. Chassis construction is for vertical rack mounting. Removable front panel for easy access to all circuits. Meter and selector switch provide convenient indication of output level at 1000 cps and current readings of all tubes.

PRESTO

RECORDING CORPORATION
 246 WEST 55TH STREET, NEW YORK 19, N. Y.
 Walter P. Downs, Ltd., in Canada

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.

LEWIS WINNER

Editor

F. WALEN

Assistant Editor

Bryant S. Davis, President

Paul S. Weil, Vice Pres.-Gen. Mgr.

F. Walen, Secretary

A. Goebel, Circulation Manager

Cleveland Representative:

James C. Munn
2255 Delaware Dr., Cleveland 6, Ohio
Telephone: Erievlew 1726

Pacific Coast Representative:

Brand & Brand
1052 W. Sixth St., Los Angeles 14, Calif.
Telephone Michigan 1732
315 Montgomery St., San Francisco 4, Calif.
Telephone Douglas 4475

Wellington, New Zealand: Te Aro Book Depot.
Melbourne, Australia: McGill's Agency.

Entered as second-class matter Oct. 1, 1937 at the Post Office at New York, N. Y., under the Act of March 3, 1879. Subscription price: \$2.00 per year in the United States of America and Canada; 25 cents per copy. \$3.00 per year in foreign countries; 35 cents per copy.

COVER ILLUSTRATION

V-h-f antenna installation on the smoke stack of the Philadelphia Fire Boat Rudolph Blankenburg. Boat is equipped with two-way duplex f-m system similar to that used by the Philadelphia Police Department.

(Courtesy Motorola)

BROADCAST ENGINEERING

- The Broadcast Engineering Conference at the NAB Los Angeles Meeting . . . 9
Complete Program of Two-Day Session; Digests of Papers Scheduled for Presentation.
- Engineering Factors Used to Determine Broadcast Station Time Rates . . . 26
F. J. Sheehan
Relation of Station Location, Frequency and Power to Advertising Rates Analyzed in Series of Graphs. Data Applicable to F-M and A-M Stations.

AERONAUTICAL COMMUNICATIONS

- CAA V-H-F Omnidirectional Range at United Air Lines . . . Frank J. Todd 10
New VOR Navigational Facilities Use 108 to 135.9-mc Crystal-Controlled Receiver, Frequency Selector, Radial Selector, Course Deviation Indicator, etc.

ENGINEERING CONFERENCE REVIEW

- A Report on the 1948 IRE National Convention 12
Highlights of Papers Presented by D. E. Norgaard, W. G. Tuller and John C. O'Brien.

TELEVISION ENGINEERING

- Phasing of Remote TV Signals R. C. Palmer 14
Sync Phasing Equipment Provides Phase Synchronization Between Vertical Sync Intervals of a Remote Composite Picture Signal and Studio Sync.

BROADCAST TEST EQUIPMENT

- Test Instruments in the Broadcast Station Herbert G. Eidson, Jr. 20
Uses of the Capacity Bridge, VTVM and Signal Generator in Modern Broadcasting.

TRANSMITTING TUBES

- Tube Engineering News K. M. Laing 22
Analysis of Eleven Standard Types of Vacuum Gauges Used to Measure Degree of Vacuum During Evacuation of Tubes.

MONTHLY FEATURES

- News and Views Lewis Winner 9
- Veteran Wireless Operators' Association News 28
- The Industry Offers 35
- News Briefs of the Month 38
- Advertising Index 40

Entire contents Copyright 1948, Bryan Davis Publishing Co., Inc.



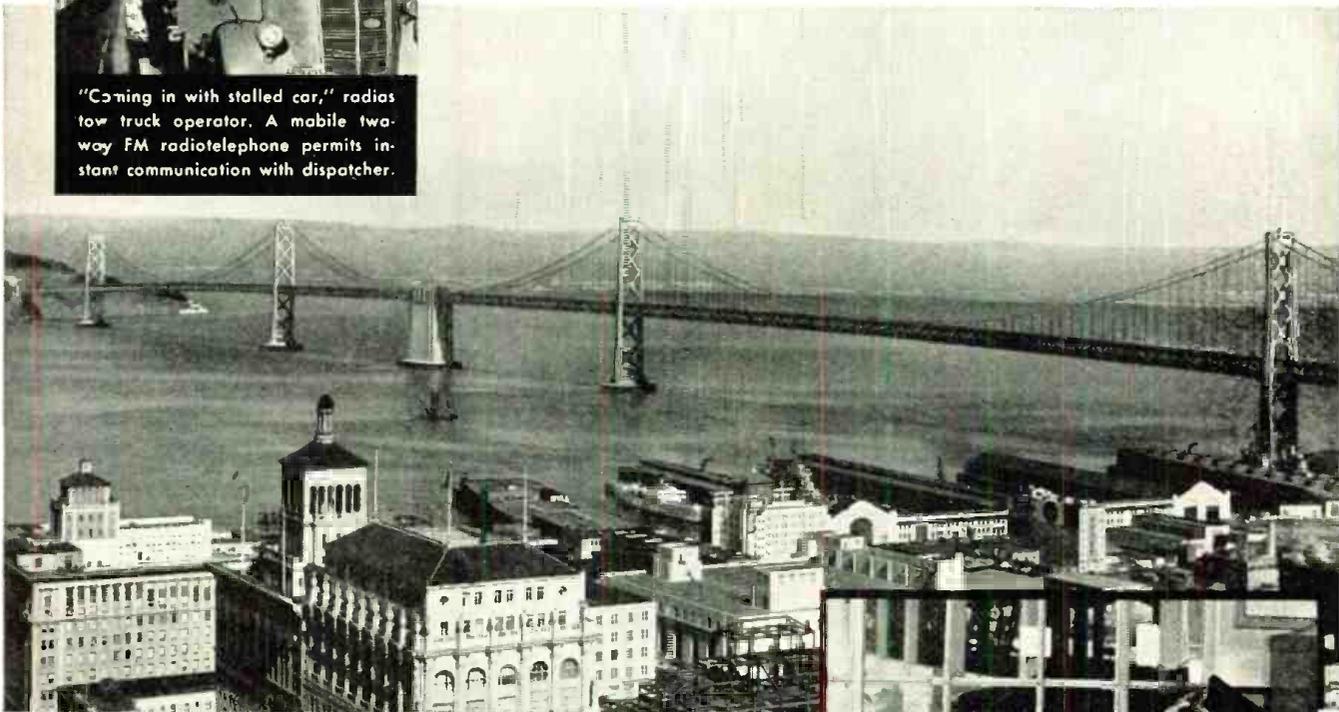
Published monthly by Bryan Davis Publishing Co., Inc.
52 Vanderbilt Avenue, New York 17, N. Y. Telephone Murray Hill 4-0170





"Coming in with stalled car," radios tow truck operator. A mobile two-way FM radiotelephone permits instant communication with dispatcher.

Lock-In tubes in *Motorola* equipment maintain smooth flow of traffic on famous bridge



THE famous San Francisco-Oakland Bay Bridge must be free of stalled cars at all times. A smooth flow of traffic is maintained with the aid of Motorola FM Radiotelephone equipment.

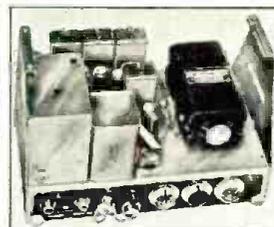
Tow cars, emergency roadside service trucks, electrician trucks, fire units and traffic engineer's sedan constitute the radio fleet. By means of this efficient system, a flow of 70,000 cars per day rolls with minimum delay over the great bridge.

Securely locked in position in the Motorola equipment are *Sylvania Lock-In Tubes*, depended upon day and night to give superlative service under all conditions!

For full information about Sylvania Lock-Ins see Sylvania Distributors or write Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.



Motorola radiotelephone enables the dispatcher at microphone to direct movements of any mobile unit instantly.



High frequency 160,000 kilocycle FM two-way Motorola radiotelephone equipment permits 100% radio coverage regardless of electrical interferences or steel enclosing structure. Sylvania Lock-Ins handle very high frequencies with ease. Have short, direct connections, fewer welded joints . . . no soldered joints—less loss; getter located on top; shorts eliminated by separation of getter material from leads! Cannot be dislodged from sockets no matter how rough the way.



SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

WILCOX . . . First Choice
OF THE
TRANS WORLD
A I R L I N E

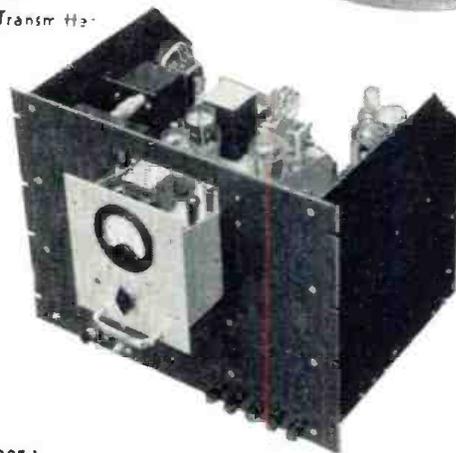


TWA EQUIPS GROUND STATIONS WITH
NEW WILCOX VHF RECEIVERS AND TRANSMITTERS

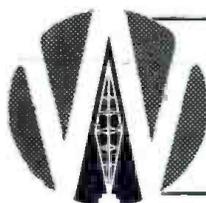
*New Fixed Frequency Equipment Offers New
Performance Features in the 118-136 Mc. Band*

- Selectivity Permits 100 Kc. Adjacent Channel Operation
- Co-Axial Transmission Line Relay Allows Common Antenna
- .005% Frequency Stability Without Temperature Control
- New Noise Limiter Means Better Reception
- Design Simplicity Simplifies Service

364A
Transmitter



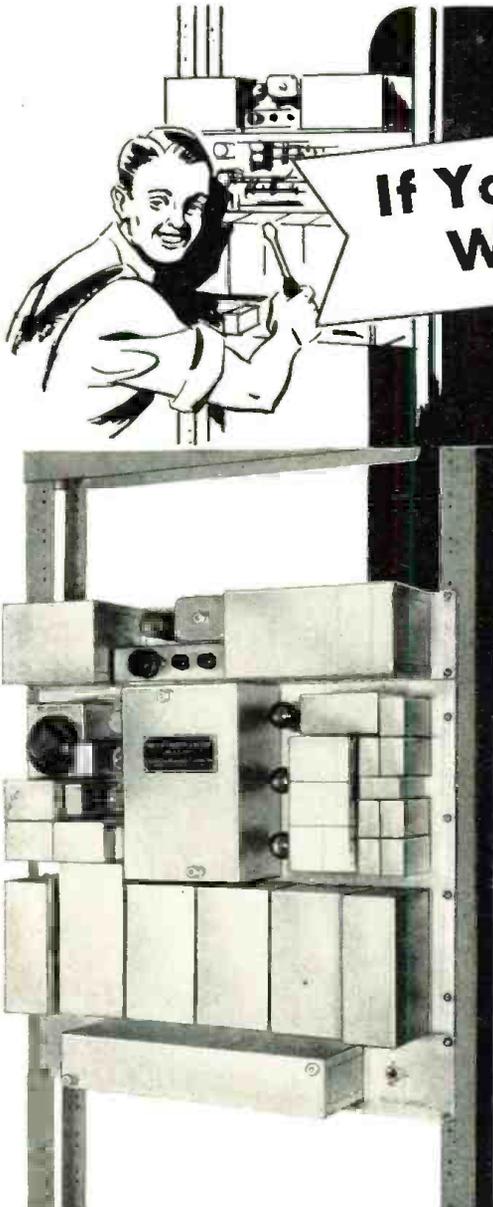
305A
Receiver



Write Today For Complete Information on the
WILCOX 305A Receiver and 364A Transmitter

WILCOX MEANS
Dependable Communication

WILCOX ELECTRIC COMPANY • Kansas City I, Missouri



**If You'd
WATCH YOUR INSTALLER**

**—he'd show you how easy
the **KELLOGG CARRIER**
is to install and maintain!**

If you were to look over his shoulder as he installs the KELLOGG Carrier, you'd see an eye-opening, time-saving routine! For the Kellogg Carrier mounts speedily on any 19" rack. And all components and terminals are marked so anyone can understand them. There are only eight external connections to make—and the job is *done!*

Maintenance? It takes care of itself! All adjustments except voice and carrier output-levels are pre-set at the factory. Sure, a vacuum tube will "go" once in a great while, but that's about all that can happen to *this* carrier!

Of course you know about the improved transmission that carriers give — free from power-line induction interference frequently present on wire circuits. And with two conversations going over your two-wire circuit at the same time, think what you save in line-wire! Fewer lines means lighter poles and less maintenance, too.

Communications engineers everywhere are showing increased interest in Kellogg Carriers. They're finding out that Kellogg Carriers save manpower and money. Get the full story — contact Kellogg *today!*

Important Facts About the Kellogg No. 5-A Carrier

Operates over a circuit 30db long (measured at 11 KC) and provides a 6db talking circuit. This is equivalent to more than 250 circuit miles of .104 copper wire. Ruggedly-built, with advanced circuit design for long, trouble-free service. Flexible in design for quick, easy circuit-changes and addition of units. Adding a second carrier channel requires only a few external connections. (Other models available too, to meet your every requirement).

**KELLOGG
CARRIER**



KELLOGG SWITCHBOARD & SUPPLY CO.

6650 SOUTH CICERO AVENUE • CHICAGO 38 • ILLINOIS



can you answer these important questions?

How many of your employees are buying U. S. Security Bonds regularly via the Payroll Savings Plan? (35% to 50% of employees buy Security Bonds on the Payroll Savings Plan in those companies in which top management backs the Plan.)

- *How does their average holding compare with the national average? (The national average among P.S.P. participants is \$1200 per family.)*

- *Why is it vital—to you, your company, and your country—that you personally get behind the Payroll Savings Plan this month? You and your business have an important stake in wise management of the public debt. Bankers, economists, and industrialists agree that business and the public will derive maximum security from distribution of the debt as widely as possible.*

Every Security Bond dollar that is built up in the Treasury is used to retire a dollar of the national debt that is potentially inflationary. Moreover, every Security Bond held by anyone means fewer dollars go to market to bid up prices on scarce goods.

- *Can't your employees buy Bonds at banks? Banks don't provide Security Bonds on the "installment plan"—which is the way most workers pre-*

fer to obtain them. Such workers want and need Payroll Savings.

- *What direct benefits are there for your company? In 19,000 industrial concerns operating Payroll Savings, employees are more contented. Worker production has increased, absenteeism has decreased—even accidents have been fewer!*

All these benefits accrue *in addition* to extra security for the individual who gets and holds Bonds. (Every \$3 invested pay \$4 at maturity.)

But even a plan with all these benefits requires the sponsorship of top management for real success.

- *What do you have to do? The Treasury has prepared a kit of material especially for you to distribute among certain key men in your company. This will be your part in the all-out campaign—starting April 15—for America's economic security.*

Make sure you get your kit. Be sure to give it your personal attention. Keep the Payroll Savings Plan operating at its full potential in your company. It's a major factor in America's security—*your best business security!*

For any help you want, call on your Treasury Department's State Director. Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

COMMUNICATIONS



This is an official U. S. Treasury Advertisement prepared under auspices of the Treasury Department and the Advertising Council

COMMUNICATIONS FOR APRIL 1948

The battle of the atoms

Telephone equipment is constantly at war against invisible forces of nature which seek to take it apart, atom by atom. On all fronts, Bell Laboratories chemists must fight corrosion — an enemy able to make a telephone circuit noisy or perhaps to sever it altogether.

An example: for years lead cable had lain protected in wooden ducts. Then in certain areas something began to eat the sheath, exposing wires to moisture. Corrosion chemists of the Laboratories were called in. The corrosion, they found, came from acetic acid generated in the wood during the preservative treatment then in use. They pumped in neutralizing ammonia. Corrosion stopped. Now telephone duct wood is controlled for acidity.

In a large city, smoke-polluted air was coating the silver surfaces of contacts with sulphide. Noisy circuits resulted. Chemists discovered minute traces of sulphur vapor in the air. They filtered incoming air with activated charcoal. Today, the latest telephone contacts are of palladium — not affected by sulphur.

Corrosion in metals is only one type of deterioration which engages Bell chemists against hostile forces. Plastics, paper, metals, rubber, textiles, coils, waxes and woods all have enemies. But knowledge, and persistence, are steadily winning out—to the benefit of the telephone user.

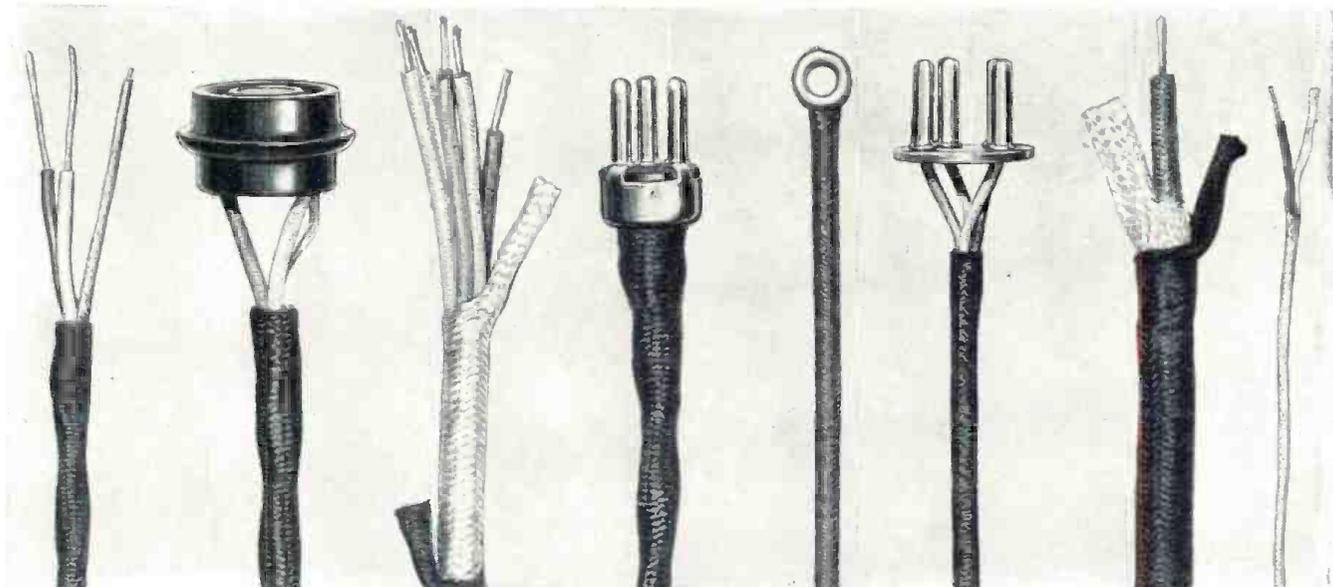


A Bell Laboratories corrosion engineer examining samples during an exposure test on corrosion-resistant finishes and alloys.

BELL TELEPHONE LABORATORIES



EXPLORING AND INVENTING, DEVISING AND
PERFECTING FOR CONTINUED IMPROVEMENTS
AND ECONOMIES IN TELEPHONE SERVICE



WIRES and CABLES

THE *lifeline* OF ELECTRONIC EQUIPMENT

When you list the qualities most desirable in a supplier of wires and cables for your electronic equipment, you will find that Lenz most nearly answers your description of a dependable source.

First, this company has the engineering background and experience, the knowledge of your requirements in wires and cables that are needed to help draft your specifications.

Second, it has the facilities to produce these wires

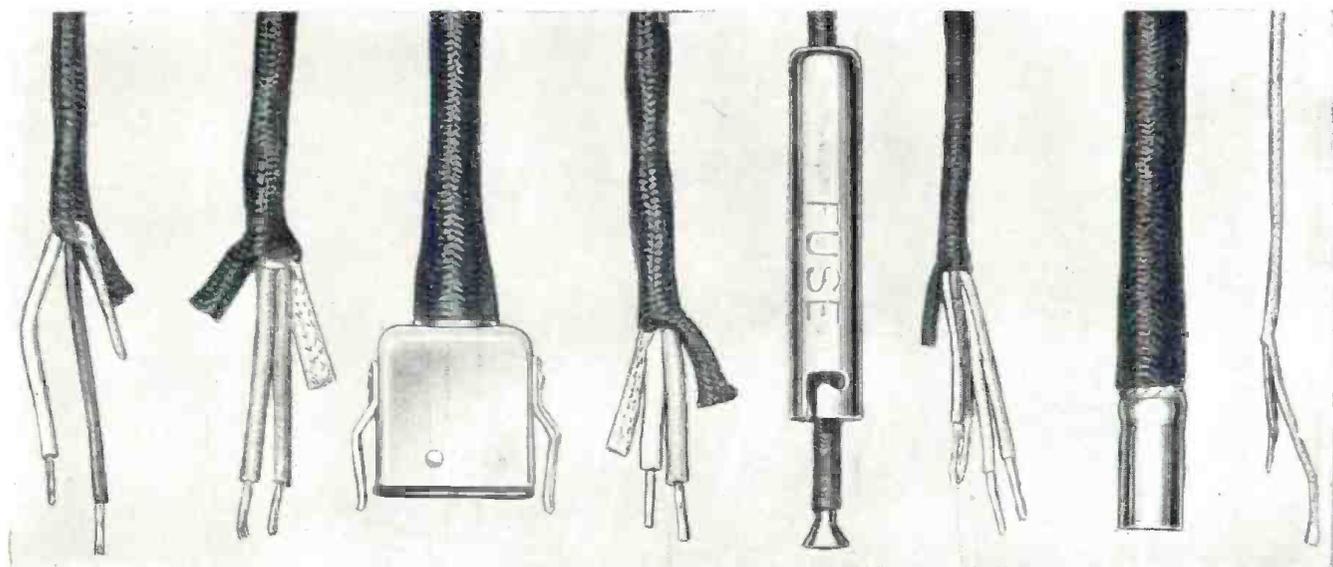
and cables in volume exactly to specifications, economically and promptly.

Third, it is a reliable organization with over 40 years background of dependable service to the communications industry.

Make Lenz your principal source for wires and cables. A Lenz wire engineer will gladly consult with you regarding your special requirements. Correspondence is invited.

"IN BUSINESS SINCE 1904"

LENZ ELECTRIC MANUFACTURING CO. • 1751 No. Western Avenue, Chicago 47, Illinois



COMMUNICATIONS

LEWIS WINNER, Editor

APRIL, 1948

THE BROADCAST ENGINEERING CONFERENCE AT THE NAB LOS ANGELES MEETING

AN EXTREMELY COMPREHENSIVE broadcast engineering program has been prepared for the 26th Annual NAB Convention, which will be held in Los Angeles at the Biltmore Hotel from May 17 to May 21. In a two-day session, some 25 papers will be offered on practically every phase of broadcast engineering . . . measurements, studio design, antennas, recording, remotes, link systems, acoustics, lighting, tubes, propagation, etc., for tv, f-m and a-m.

On Thursday morning, May 20, J. R. Poppele, vice president and chief engineer of WOR-Mutual and member of the NAB Engineering Executive Committee will preside over a six-paper session, in which will be discussed:

Comparative Field Measurements; E. C. Page, consultant, Washington, D. C., for RCA-Victor.

Mr. Page will present a comparative study and analysis of the coverage of two tv stations operating on channel 4 (66 to 72 mc) and channel 7 (174 to 180 mc) in the Washington metro-

politan area, based on simultaneous mobile field intensity recordings of both stations.

Television and F-M Transmitting Plants; Raymond F. Guy, manager, radio and allocations engineering, NBC, and John L. Seibert, project engineer, NBC.

This paper will cover the variety of problems which arise during the design, construction and operation of tv and f-m stations. Among the problems that will be discussed are monitoring, test equipment, adjustments, synchronization control, studio design, etc.

Small Television Stations; James D. McLean, Phileo TV Broadcasting Co.

TV Studio Systems; M. A. Trainer, manager, tv equipment, RCA.

Equipment layouts for small, medium and large size tv studios will be described by Mr. Trainer. Circuit arrangements for inter-connecting, switching and monitoring will be shown.

Light Sources for Television Studio Lighting; F. E. Carlson, illuminating engineer, lamp depart-

ment, G.E., and Richard Blount, engineer, lamp department, G.E.

This paper, which will be presented by Mr. Carlson, will describe characteristics of several types of light sources and provide an analysis of such factors as color quality, efficiency and degree to which available light can be effectively utilized by reflectors or lenses.

Remote Control Television Lighting; Captain W. C. Eddy, USN (Ret.), director of tv, WBKB.

The variety of special types of lighting required in tv today, particularly in restricted staging areas, will be discussed by Capt. Eddy. Equipment described will include remote control ceiling units.

Afternoon Session, May 20

Frank Marx, vice president in charge of engineering, ABC, and a network advisory member of the NAB Engineering Executive Committee,

(Continued from page 29)

Among those who will appear at the NAB Broadcast Engineering Sessions in Los Angeles



Royal V. Howard



Orrin W. Towner



William B. Lodge



Lester H. Bowman



H. W. Paugborn



Frank L. Marx

Neal McNaughten

Paul A. deMars

Raymond F. Guy

David Packard

Capt. William C. Eddy

George E. Sterling



CAA V-H-F Omnidirectional Range At United Air Lines

UNITED STATES domestic airline navigation to date has been based on the use of the low-frequency four-course radio range. The 200 to 400-kc band set aside for these facilities is no longer adequate to provide interference-free channels for the increasing number of routes required to serve communities demanding modern, dependable air transportation.

Because of the lack of additional low frequencies, susceptibility to the ill effects of precipitation static, fading, and *night effect* the four-course range system is being replaced by a new CAA v-h-f omnidirectional range system, referred to as *VOR*. The inherent advantages of the new system include improved accuracy of indication, comparatively static-free operation, greater flexibility, and adequate channel assignments to accommodate the needs of expanding air traffic.

The *VOR* system provides the information necessary for an aircraft to fly a definite path with respect to a known geographical point, this point being the location of the *VOR* station selected by the pilot. The *VOR* station may be compared to a rotating light beacon which provides a multiplicity of paths or radials to its source. At a given distance from this beacon, the light will be visible to the pilot for only a short instant as the beacon scans past the aircraft's position. *VOR* provides the same radio signal scanning

VOR Navigation Facilities, Which Will Replace Present Low-Frequency Four-Course Range, Employ a 108-135.9 Mc Crystal-Controlled Receiver, Frequency Selector, Radial Selector, Course Deviation Indicator, Radial Converter Indicator, Radio Magnetic Indicator and Accessory Unit With a Servo Amplifier and Dynamotor Power Supply.

by FRANK J. TODD

Superintendent of Aircraft Radio Equipment
United Air Lines

of the horizon and at the same time provides the pilot with the necessary timing information from which he can determine the exact instant at which the signal is observed. The timing is done automatically and is converted to magnetic bearing information which is presented in one of several different forms, depending on the particular type of *VOR* instrumentation chosen. The *VOR* system also permits the pilot to orient his aircraft on a definite line of position by using signals obtainable from a single station.

VOR airborne equipment is being built by several manufacturers, accord-

ing to specifications prepared and approved by the Army, Navy, CAA, and Aeronautical Radio. In each *VOR* system there are seven units:

- (1)—A *crystal-controlled superheterodyne receiver*, capable of tuning to each 100-kc spaced channel in the 108 to 135.9 mc band, or a total of 280 channels.
- (2)—*Frequency selector*, comprising two concentric knobs graduated in 1 mc and .1 mc steps which combine to read directly in frequency. A switch is also provided in this unit to



Figure 1 (left)
Radio magnetic indicator.

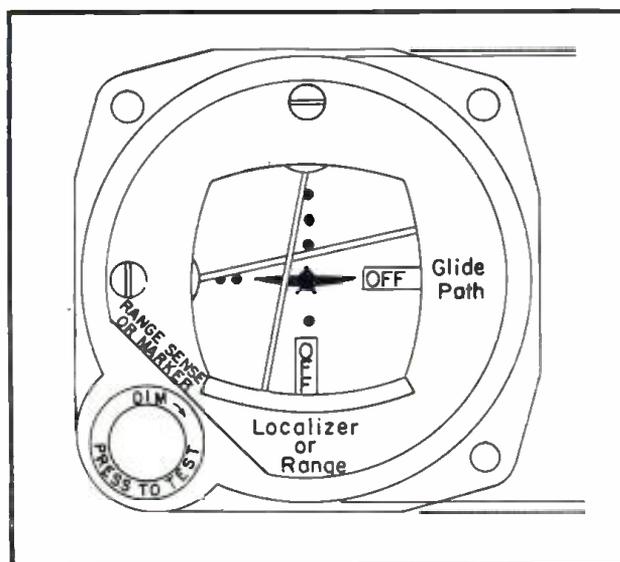


Figure 2
Deviation indicator.

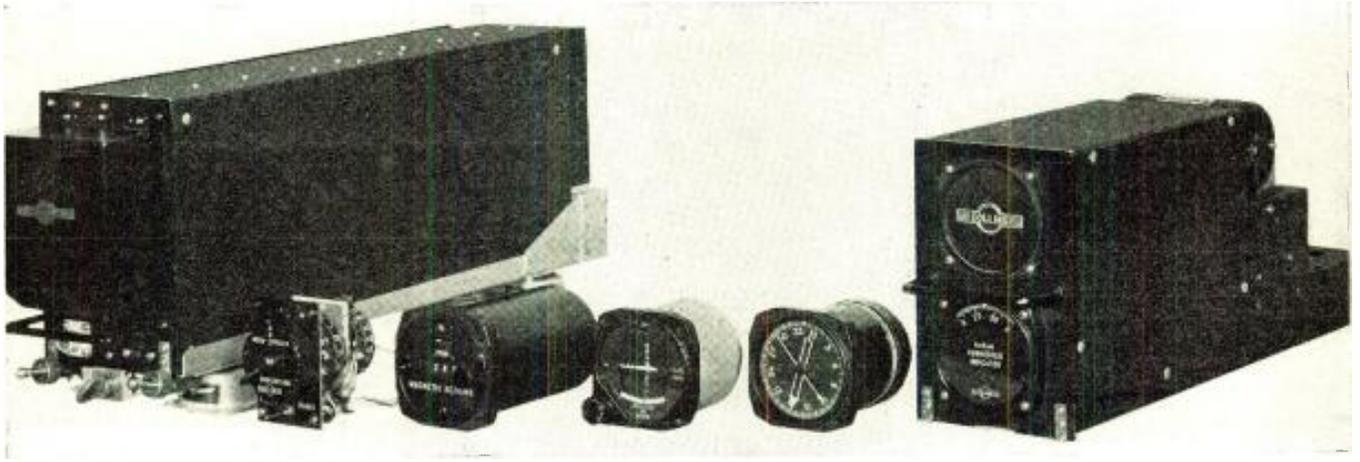


Figure 4

Left to right: VOR receiver, frequency selector, radial selector, deviation indicator, radio magnetic indicator and accessory unit with radial converter indicator.

to permit the use of 90/150-cycle tone or phase-comparison localizer stations.

- (3)—*Radial selector* capable of being manually set to any desired angular reading from 0° to 359°. This instrument also includes a pointer which indicates the radial *to* or *from* the VOR station. A shutter-type switch is provided which automatically gives the reciprocal bearing when desired.
- (4)—*Course deviation indicator*, which incorporates a vertical pointer indicating left or right deviation from the selected radial. A flag alarm indicator also warns of loss of signal or equipment failure.
- (5)—*Radial converter indicator* which combines information from a remote-indicating magnetic compass with VOR station information to give a heading sensitive reading of the actual bearing to the station. This instrument need not be seen by the pilot and is normally installed in the accessory unit.
- (6)—*Radio magnetic indicator*, which includes a rotatable card scale driven by the magnetic compass and a pointer driven by the radial converter indicator.
- (7)—*Accessory unit*, in which are combined the radial converter indicator, servo amplifier for the radio magnetic indicator and dynamotor power supply.

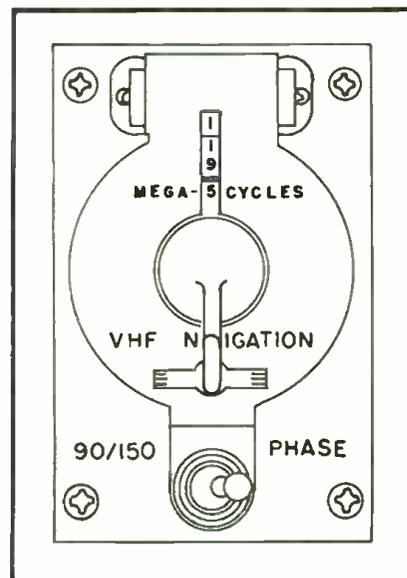
A single basic-aircraft VOR installation requires a receiver, radial selector, deviation indicator, frequency selector, and power supply. The indication given by this minimum basic installation is not aircraft heading sensitive, but shows only the radial on which the aircraft is flying to or from the VOR station, regardless of the

heading of the plane. The full instrumentation version requires the addition of the radial converter indicator, radio magnetic indicator, and servo amplifier. It is also essential that a source of magnetic information, such as a gyrosyn or fluxgate compass, be available to drive the magnetic scale card of the RMI. The type of indication obtained with the full instrumentation version is very similar to that obtained with present ADF installations, since the RMI needle points to the VOR station regardless of aircraft heading and therefore gives, in effect, a v-h-f ADF, which has so long been sought.

In the basic installation, only three operations are necessary:

- (1)—Select the desired VOR station frequency;
- (2)—Adjust the radial selector to the desired radial; and

Figure 3
Frequency selector.



- (3)—Fly the deviation indicator for zero right-left deflection.

For full instrumentation, no additional operations by the pilot are required to obtain the ADF type of presentation.

The total weight of units required for a basic installation is approximately 45 pounds, exclusive of plane wiring. The full instrumentation feature adds approximately 10 pounds per installation, exclusive of the gyrosyn or fluxgate units which are normally installed in large aircraft.

The airborne navigation receiver includes the following facilities in addition to those required for VOR operation:

- (1)—Provision for use of present (90/150 cycle) tone localizer facilities;
- (2)—Provision for use of phase comparison localizers if this type eventually replaces tone localizers;
- (3)—Provision for reception of approach control communications transmitted by simultaneous voice on either localizer or VOR stations;
- (4)—Provision for reception of voice communications from control towers; and
- (5)—Provision for auxiliary reception of airline VHF ground stations.

The VOR system will eventually replace the present low-frequency four course range over the majority of domestic air routes. However, it is probable that for the next 3 to 5 years, the VOR will actually supplement the low-frequency range system by providing parallel airway facilities, new airways, and extensions of existing airways. Incidentally, the new receiver will permit the removal of the military type RC-103 localizer receiver presently used with instrument landing facilities.

The VOR system is well suited to the implementation of the ultimate

(Continued on page 34)

A Report On The 1948

WITH CHANNEL AVAILABILITY becoming a more acute problem daily, there has been an accelerated interest in the development of systems, which will expand the usefulness of the currently assigned channels. This trend was emphasized in several papers presented at the IRE National Convention at the Hotel Commodore and Grand Central Palace. An interesting example was the D. E. Norgaard study on *Selective Sideband Transmission and Reception*.

Mr. Norgaard, who is with G.E., reported that the application of wide band a-f phase-shift networks, disclosed by R. B. Dome, has made it possible to develop a practical and simple single-sideband communications system.

In the Norgaard system, two channels of intelligence can be transmitted as upper and lower sidebands by simultaneous modulation of a r-f carrier with the use of two sets of phase-shift networks similar to those described by Dome. The carrier may be suppressed or attenuated to any desired degree.

The transmitter may be operated to produce a-m, p-m, double sideband with carrier suppressed or attenuated, single-sideband, dual single-sideband, and f-m.

In any of these modes of operation, there appears to be no restriction on the bandwidth of the modulating signal. For example, a bandwidth covering the a-f spectrum from 30 to 15,000 cycles may be used to produce any of the signal types with response uniform to within 0.1 db.

Modulation is accomplished at low level with subsequent r-f amplification to any desired level.

Norgaard System Receiver

The receiver consists of conventional superhet circuits up to the second detector. The i-f signal is fed into two detector circuits which are also supplied with a locally generated carrier signal which locks automatically with the carrier. The outputs of the two detectors drive a pair of wide-band a-f phase-shift networks similar to those used in the transmitter. The algebraic sum of the signals appearing at the output of these two networks contains the intelligence received on one sideband, while the difference contains intelligence received on the other. These sum and difference signals drive two audio amplifiers for dual-channel operation or a single amplifier may be switched to listen to one or the other of the other of the sidebands.

The receiver, in addition to its use for dual channel single-sideband reception, can be used to pick up conventional double sideband signals (a-m or p-m) with exalted carrier detection, double sideband signals (a-m or p-m) using, however, either one of the sidebands, and single sideband signals where the carrier is suppressed or attenuated.

When using either one of the sidebands, it is possible to reject interference existing on either side of the desired signal without impairing the audio bandwidth. This mode of operation also materially

Highlights of Papers Presented by D. E. Norgaard, W. G. Tuller, and John C. O'Brien.

improves reception where selective fading is encountered.

The ability of the transmitter to generate single-sideband signals is based on the performance of the a-f phase-shift networks. The unwanted sideband can be made 40 db below the desired sideband with networks of present design.

Similarly, the ability of the receiver to reject unwanted sideband energy depends on the phase-shift networks, a 40 db ratio being practical with simple configurations.

Bandwidth Reduction

IN ANOTHER BANDWIDTH PAPER, W. G. Tuller of Melpar, Inc., analyzed a method of *Bandwidth Reduction in Communications Systems*.

He pointed out that there are two possible methods of bandwidth reduction. One of these takes advantage of the coherence of the message or the fact that from a knowledge of the past behavior of the message, it is possible to predict its future behavior with a fair degree of accuracy. In the second method, bandwidth is exchanged for signal-to-noise ratio in accordance with the relation:

$$H = BT \log (1 + S/N)$$

where H is quantity of information; B , bandwidth; T , time of transmission; and S/N , the signal-to-noise ratio in the transmission link.

Tuller indicated that in the first method of bandwidth reduction, if it is possible to predict the content of the message in the future to a greater accuracy than that required, working only on a knowledge of the behavior of the message in the past, then the message contains useless information, information which need not be transmitted. In particular, if one can predict the message for a time equal to the reciprocal of twice the system bandwidth then useless information is contained within the message.

Eliminating Useless Information

If such a prediction is possible then further operations on the message can be arranged to eliminate the useless information, leaving only that information which could not be deduced by mathematical means. This remaining information, the basic information content of the wave, will then require less bandwidth, power, and time to transmit than the original message.

The signal resulting from this process has the statistical properties of random

noise filtered through the band pass of the transmission system; in other words, the message is within the accuracy of transmission, uncorrelated over a period equal to the reciprocal of twice the system bandwidth. A corollary of this statement is that the message has a uniform spectrum, one whose amplitude is essentially independent of frequency over the pass band of the communication system. This technique has already been applied in the use of preemphasis and deemphasis in broadcast systems and in recording.

The technique has interesting possibilities in tv. For it has been recognized that there exist many correlations within the television picture and from picture to picture. Evidence is given by the average spectrum of the television stations which is relatively weak in high-frequency components.

The second method of bandwidth reduction is only applicable when excess signal-to-noise ratio is available. For example, if we wish to halve the bandwidth and can square the signal-to-noise ratio by transmitter improvements or noise-reduction schemes, then it is possible to use techniques analogous to those of pulse code modulation. However, in this instance the coding would be carried out in the inverse direction from that usually employed, that is instead of converting a signal of many possible levels into one of a few, or as in the p-c-m system two possible levels, a system could be converted to allow signal levels into one with even more allowed signal levels. This requirement of many more allowed signal levels implies that either signal will be increased or noise decreased according to the relations of the equation.

Another possible method for trading signal-to-noise ratio for bandwidth makes use of the fact that the output of the filter may be predicted if its input wave form in transient response is known.

Combined F-M and A-M

ANOTHER UNIQUE WAY of expanding the usefulness of channels was revealed by John C. O'Brien of the General Railway Signal Co., who analyzed *A Combined F-M and A-M Communications System*.

O'Brien showed that the possibility of simultaneously *duplexing* two intelligence channels, one by a-m and the other by f-m, on a r-f carrier, appears in the expression for the instantaneous voltage of such a carrier:

$$e = E_c (1 + m_a \sin 2\pi f_a t) \cdot \sin (2\pi f_c t + M \sin 2\pi f_m t)$$

Where: e = instantaneous amplitude of modulated carrier

IRE National Convention



At the press luncheon, during the IRE National Convention in New York City, left to right: T. T. Goldsmith, Jr. (*DuMont*), R. M. Bowie (*Sylvania*), L. J. Chu (*MIT*), E. M. Deloraine (*J. T. & T.*), ye editor, and K. McIlwain (*Hazeltine*).

E_c = maximum amplitude of unmodulated carrier
 m_a = degree of amplitude modulation
 f_s = frequency of amplitude modulation audio signal
 f_c = frequency of unmodulated carrier
 M = modulation index ($\frac{\Delta f_c}{f_c}$ for f-m) or ($\frac{\Delta \theta}{f_F}$ for p-m).
 f_F = frequency of f-m audio signal.

The bandwidth required for satisfactory transmission and reception of the *duplicated* carrier is equal to the sum of the modulation side bands of the same signals modulating two separate carriers, by frequency and amplitude modulation, respectively.

However, at u-h-f, the frequency drift tolerances, .005% to .01% of the carrier frequency, and the separation guard bands required for adjacent channel operation, equal or exceed the total useful modulation bandwidth. For example, in the 152 to 162-mc mobile communication band, individual channels are 60-ke wide, of which 16 ke represent drift tolerance, and approximately 10 ke more constitute inter-channel separation guard bands. The application of a signal channel, suitable for speech, or for control, telemetering, identification, checking, selective calling, or other similar purposes, by a-m, to a f-m carrier in this band, can be accomplished with approximately 10% increase in channel bandwidth. If a slight reduction in maximum deviation of the f-m carrier can be tolerated, it is possible to obtain additional intelligence channel without exceeding existing r-f channel limits.

Although the susceptibility of a-m transmission to noise, flutter fading, and interfering signals is much greater than

that of frequency modulation, O'Brien pointed out that the advantage of an additional intelligence channel should be sufficient in many cases to justify its use, with somewhat inferior performance, at the cost of a small percentage of the channel bandwidth.

Simplex Problem

Unless the transmissions by both methods are synchronized or widely separated in time, two-way simplex communication will tend to create conflicts. Citing an example, O'Brien said that it would be impossible for a station to receive an f-m signal, while its carrier is transmitting a-m, on the same frequency. However, it is possible that the facility of *break in* provided by an auxiliary a-m transmission channel, will be a worthwhile addition to such a system. Two-frequency duplex operation can, however, make full use of additional speech channels without difficulty. It was pointed out that simultaneous frequency and amplitude modulation of the carrier by two individual audio channels does not introduce any unusually difficult problems. Any reasonably constant-amplitude frequency-modulated signal can be made to drive a class C amplifier, and the amplitude modulation desired can be obtained by plate modulation. With reasonably flat-frequency response in the plate tank circuit over the frequency excursions used, very little cross-modulation between the two signals is produced, unless regeneration is present.

O'Brien stated that, unfortunately, in reception, separation and demodulation of the two channels are not so easily accomplished. Although there is some possibility of cross-talk produced by the phase shifts caused by multipath propagation,

and the amplitude and phase distortion occurring in highly selective resonant circuits, the principal occasions of inter-modulation are the demodulation circuits, which must separate a-m from f-m with minimum distortion.

Several demodulator circuits were investigated by O'Brien. He found the *ratio* discriminator, and *dual* type, employing a constant-current impedance in the common center connection of the Foster-Seeley discriminator, to be the most effective single circuits for eliminating a high percentage of a-m from a f-m carrier. The use of a large bypass capacitor across the normal output terminals of the Foster-Seeley discriminator, appeared to reduce greatly the f-m cross talk in the a-m output impedance in the common center connection.

Use of Frequency Converter

More complete separation of the two channels was achieved by a frequency converter, driven from the i-f stages ahead of the limiters. In this setup, the injection voltage for the mixer is provided by an oscillator, automatic-frequency-controlled by a reactance modulator tube driven by the audio output of the f-m discriminator. The oscillator frequency is made to follow without time delay the signal frequency deviations, with a constant frequency difference. This difference frequency beat is demodulated in an amplitude demodulator, and led to the output for the a-m channel. This output voltage is also applied, without time delay, as automatic gain control bias to the i-f amplifier which drives the limiter stages, and aids in reducing the percentage of amplitude modulation in the f-m channel output.—L. W.

Also at the IRE press luncheon, left to right: J. R. Weiner (*Eckert-Mauchly*), former IRE president W. R. G. Baker (*G.E.*), Clinton B. DeSoto (*IRE*), president-elect B. E. Shackelford (*RCA*), George W. Bailey (*IRE*), Virgil M. Graham (*Sylvania*), Stuart L. Bailey, IRE treasurer (*Jansky & Bailey*), Ralph A. Hackbusch (*Canadian RMA*).



Phasing of Remote TV Signals

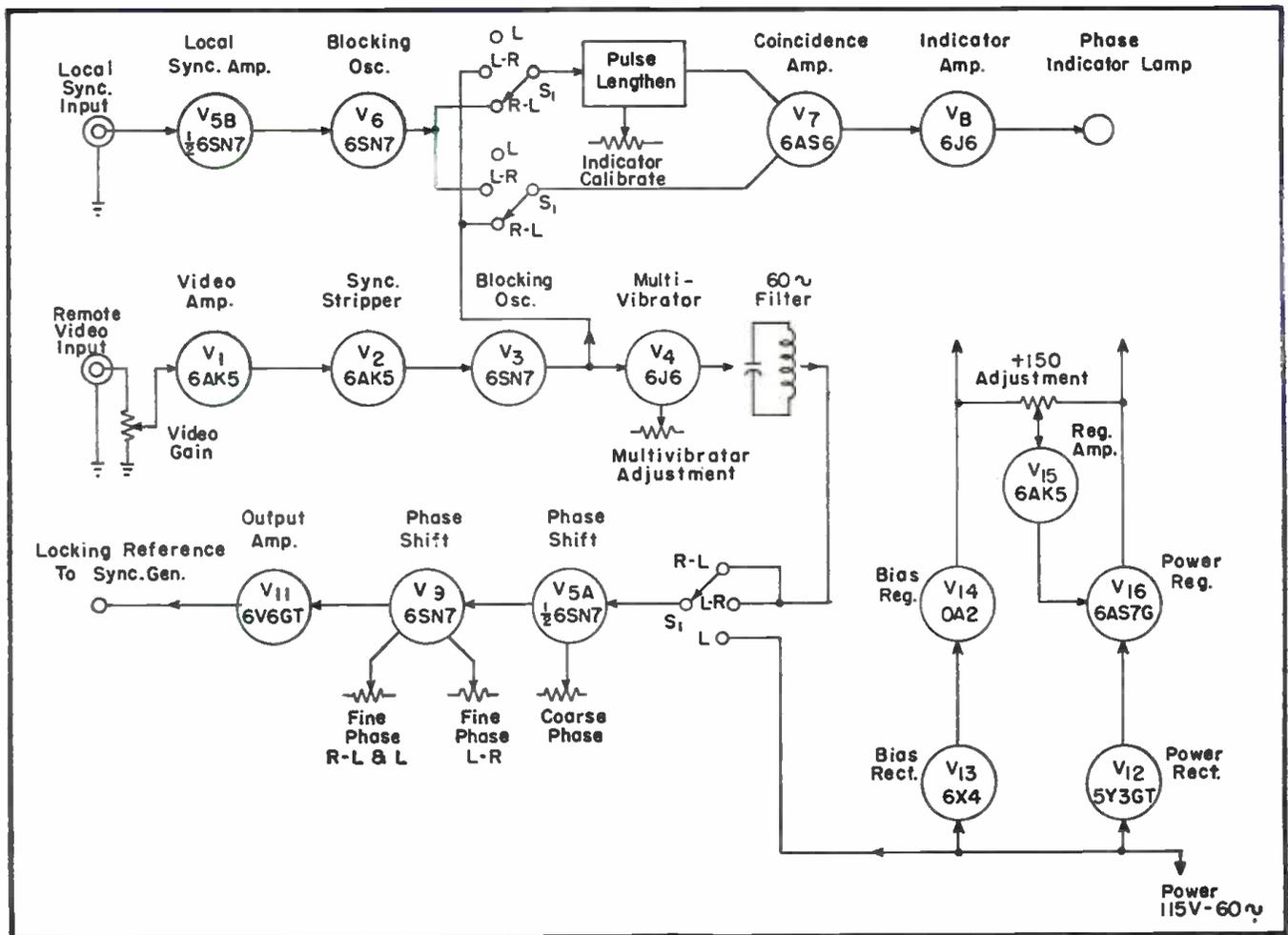


Figure 1

Block diagram of the remote sync-phasing unit. S_1 is a locking reference switch: L is the local position, L-R, the local-to-remote position, and R-L, remote-to-local position.

REMOTE PICKUPS have become a very important part of tv programming today. It is customary to originate the remote picture-synchronization signals at the point of pickup and consequently there is the problem¹ of maintaining continuity of vertical sync when the signal is switched between the studio and the remote point. Such switches are demanded by station breaks and sponsored announcements, and during a typical remote, such as a boxing pickup, may occur as often as ten²

times during the program. The phase problem is also acute in tv-network operation.³ To secure and maintain phase synchronization between the vertical sync intervals of a remote

¹Present operating practice usually allows for fading the picture to black when making a switch so that a vertical roll caused by a large phase error between local and remote vertical sync periods will not be visible to the observer. The RMA has proposed³ limits of 5% leading and 1% lagging for the phase error of succeeding vertical sync intervals, and present tv receivers can easily maintain continuity of vertical sync over this range of phase difference.
²DuMont 5056-A.

composite picture signal and studio sync a remote sync-phasing unit⁴ was recently developed.

Features

In Figure 1 appears a block diagram of the phasing unit. *

In this circuit the remote video input signal is amplified by V_1 , a 6AK5, and applied to a sync stripper, V_2 , also a 6AK5. The sync stripper is a pentode operated at low screen voltage to in-

Instrument Designed To Provide Phase Synchronization Between Vertical Sync Intervals of a Remote Composite Picture Signal and Studio Sync. Sine-Wave Output of Approximately 6 Volts RMS in Amplitude Permits Use of Equipment With Current Studio Sync Generators.

by **R. C. PALMER**

Head, Advanced Development Section
Television Transmitter Department
Allen B. DuMont Laboratories, Inc.

sure sharp cutoff, and is self biased by the black positive signal at its grid. The signal input to this stage is of sufficient amplitude so that only the sync portion is included between cut-off and zero bias. Consequently, only negative sync appears at the plate of V_2 . The vertical sync is separated and applied to a 6SN7, V_3 , which is a combined trigger-tube and blocking oscillator. The output of V_3 is used to trigger a 6J6 multivibrator, V_4 , whose output circuit includes a 60-cycle resonant filter. V_4 thus generates a sine wave at the vertical frequency of the remote sync and with a fixed phase relationship to the vertical sync interval. This sine wave is applied to a phase shifter, V_5 ($\frac{1}{2}$ of a 6SN7), whose output is applied to two more phase shifter stages in V_6 , a 6SNS.* The output of

the phase shifter is applied to a 6V6GT output stage, V_{11} , whose plate circuit includes an output transformer which supplies the locking reference to the controlled sync generator.

Negative composite sync from the controlled sync generator is amplified by V_{10} , ($\frac{1}{2}$ of a 6SN7). After separation, the vertical sync is used to trigger another 6SN7, V_8 , a combined trigger-tube and blocking oscillator. Thus a pulse is obtained, occurring at the vertical interval of the controlled sync generator, and of the same shape and relative timing as that generated by V_3 . These two pulses are applied to a 6AS6 coincidence amplifier, V_7 . If the two input signals to V_7 coincide

*A coarse phase-shift control is common to both V_{5A} and V_{5B} , while V_{5B} is used as a fine phase shifter.

within the limits proposed by the RMA, a signal applied to V_9 , a 6J6, lights an indicator.

A self contained power supply furnishes regulated plate power and bias voltage to the unit.

Circuit Details

While specifically designed for a composite remote video signal, the video amp. and sync stripper stages, V_1 and V_2 , can handle negative composite sync alone, so that two sync generators may be locked to each other. This facilitates tests on the locking stability of a sync generator. The blocking oscillator, V_3 , and multivibrator, V_4 , are biased so as to be inoperative except in the presence of an input signal. This prevents the unit from supplying a spurious signal to the controlled sync generator.

Sync Generator Phasing

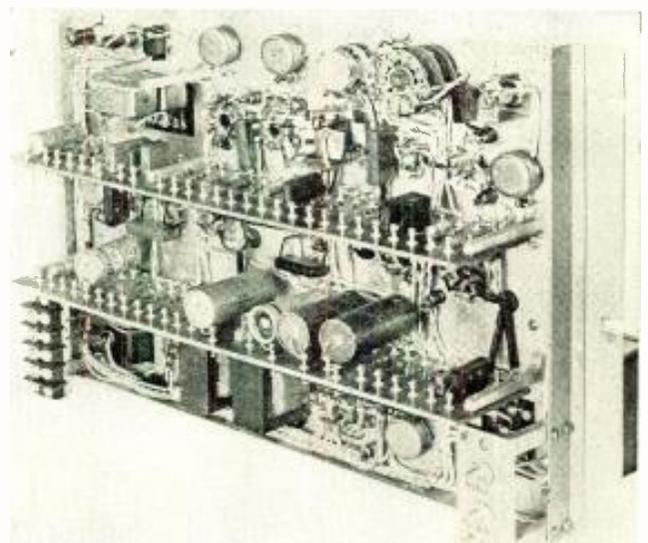
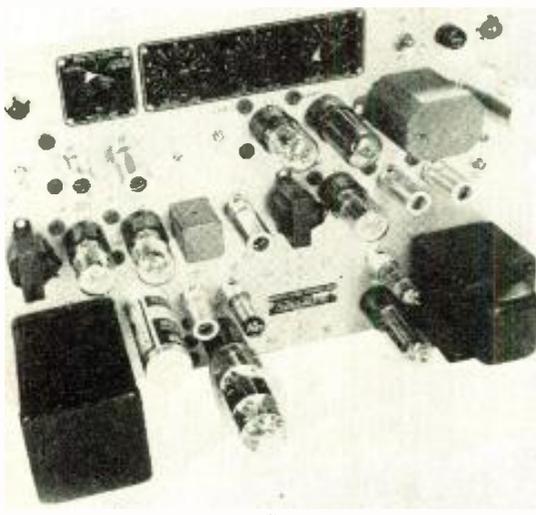
A switch is provided so that the input to the phase shifter may be taken from the local power line. Since the phase shifter has a total range of over 400° , this facilitates phasing the controlled sync generator with respect to studio film pickups.

Differentiating Circuit

Precision separation of the vertical sync from a composite sync signal is accomplished by a differentiating circuit having a time constant of approximately one-third of a horizontal line. This differentiation supplies a positive pulse at the end of the first vertical serrated pulse, as shown in Figure 3.

Figure 2.

Front and back views of remote sync-phasing chassis. At upper left is the remote-to-local switch for reference. In the center panel are the coarse phase, local-to-remote and remote-to-local controls.



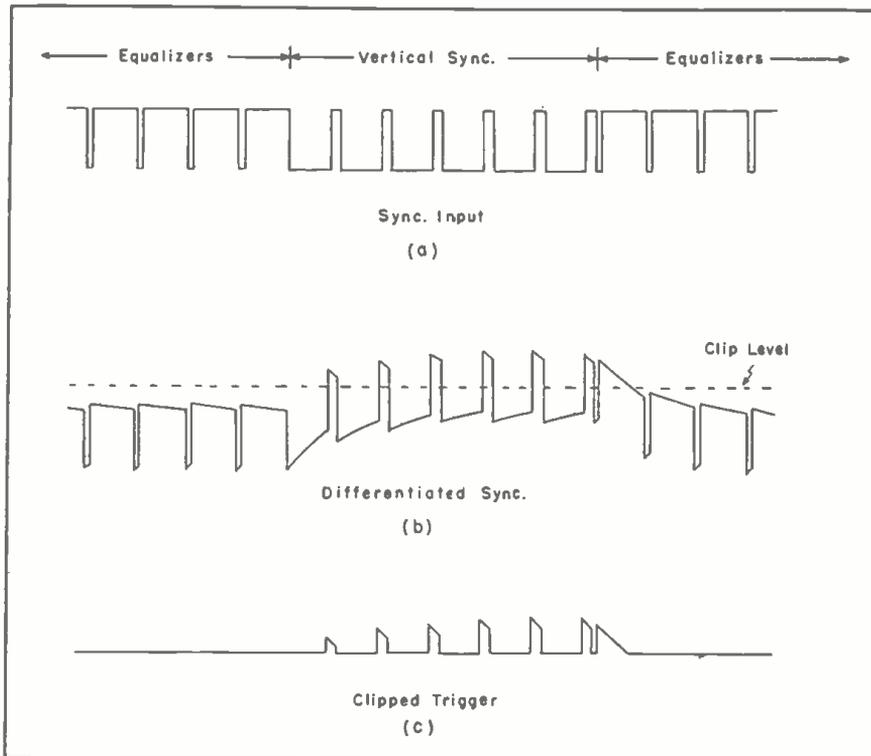


Figure 3.
Sync separation.

This pulse is clipped off and used to fire the blocking oscillator.

RMA proposals specify that at the instant of switching from one sync source to another, the phase of succeeding vertical sync periods should not differ by more than 13.1 horizontal lines leading or 2.6 horizontal lines lagging. To indicate to the operator when this phase relationship is attained a phase coincidence indicator is provided. The remote and local vertical sync pulses from the blocking oscillators are applied to separate grids of a coincidence amplifier; if both pulses occur simultaneously, plate current flows. An integrating circuit removes the 60-cycle component and a direct-coupled amplifier is used to operate a relay controlling the indicator lamp.

Sync Pulse Lengthening

To indicate coincidence over the range allowed by the RMA proposals, one of the sync pulses is lengthened as determined by the position of the locking reference switch. For conditions corresponding to local sync on the air and remote sync on preview, the remote vertical-sync period may occur up to 13.1 lines ahead of or up to 2.6 lines after the local vertical sync period. To secure the leading indication, the remote vertical sync pulse is lengthened before application to the coincidence amplifier; the lagging in-

dication is secured by designing the blocking oscillators to deliver pulses about one horizontal line wide. For conditions corresponding to remote sync on the air and local sync on preview, the local vertical sync pulse is lengthened before being applied to the coincidence amplifier. The amount of lengthening is controlled by an indicator adjustment and set so that the indicator lamp is on over a range of phase difference of approximately 13 horizontal lines.

Adjustment

Numerous test jacks are provided so that adjustments and checks may be made from the front of the chassis, which is of the rack-mounted style. If the remote picture input exceeds 2.5 volts peak-to-peak in amplitude, it is cut down by means of a *video-gain* control until the sync stripper, V_2 , delivers clean stripped sync. The multi-vibrator and tuned filter are adjusted to furnish a good sine wave to the phase shifter. Using a driven-sweep 'scope synchronized from a front-panel jack, the indicator is adjusted to remain on over a range of approximately 13 horizontal lines phase difference between the vertical sync intervals of the two inputs.

Operation

Under ordinary operating conditions, the *locking reference* switch will be in

the *local* position. The controlled sync generator will then be locked to the local power-line frequency at a phase determined by the settings of *coarse phase* and *fine phase, local* controls. Should it be desired to change the phase of the sync generator relative to the power line, these controls may be varied, and together cover a phase range of over 400° . When it is desired to put a remote signal on the air, the *locking reference* switch is put in the *local-to-remote* position. The local sync generator will then be immediately locked in frequency to the remote sync. The phase may be adjusted by means of the *coarse phase* and *fine phase, local-to-remote* controls until the indicator light comes on. If the video switching is done at the time the indicator is on, the phase difference will be within the limits proposed by the RMA. At any time before the program is switched back to a local signal, the *locking reference* switch must be put in the *remote-to-local* position. Then the *fine phase, remote-to-local* control may be adjusted until the indicator lights. If the switching from the remote to the local picture is done while the indicator lamp is on, the phase difference between succeeding vertical sync periods will be within the limits proposed by the RMA. After these phasing adjustments have been made, then ordinarily the indicator will come on for either position of the *locking reference* switch, and the picture may be switched back and forth between the remote and local signals without further attention, except that the *locking-reference* switch must be in the appropriate position corresponding to the picture on the air at the time. At the conclusion of the remote program, the *locking reference* switch will be in the *remote-to-local* position before the picture is returned to the studio. After the switch has been made to the local program, the *locking reference* switch may be put in the *local* position, locking the controlled sync generator to the local power line.

References

¹W. J. Poch, *Sync Generator Frequency Stability and TV Remote Pick-ups*, COMMUNICATIONS; July, 1947.

²This represents an average of many remotes handled by W.A.B.D., New York, during 1947.

³Proposed Standards of the RMA Studio Facilities Subcommittee.

PHILCO

WORLD'S LARGEST RADIO MANUFACTURER

Now BRINGS •
SENSATIONAL NEW
DEVELOPMENTS AND
ADVANCED ENGINEERING TO
FM RADIOPHONE
COMMUNICATIONS SYSTEMS

For Every Need

30-44 Mc.
and
152-162 Mc.

- Proven Reliability
- Advanced Engineering Design
- New Operating Efficiency and Economy
- Nationwide Service Organization
- Prompt Delivery of All Models

PHILCO

INDUSTRIAL DIVISION

PHILADELPHIA • PENNSYLVANIA

Industrial Division, Dept. A-9
Philco Corporation
C and Tioga Streets
Philadelphia 34, Penna.

Gentlemen:

Please send me information about the new
PHILCO FM Radiophone Communications
Systems.

NAME _____

ADDRESS _____

CITY _____

Only \$1,375 Buys the 76-B4

**DELIVERY
NOW**



Now sold!
Over 1,000
consolettes of the
74-B series

The Features

- Four pre-amplifiers.
- Over-ride facilities for all remote lines. Permits engineer or announcer on remote broadcast to "call-in" by over-ride on control room speaker.
- Six-channel mixer.
- Direct talk-back system to any studio and any remote line. Studio speakers and remote lines are interlocked to prevent feedback.
- Cue feed to remote lines.
- Five spare monitor inputs for monitoring externally produced programs, such as networks, other studios, outgoing channels, etc.
- Large VU meter connected to rotary selector

switch permits accurate program monitoring. Plate current checking system for all tubes and program channel.

- No lost time due to possible failures of amplifiers or power supplies. Emergency operation may be obtained quickly by means of switches.
- Headphone monitoring across output line, monitor and external source, such as network.
- Recorder feed.
- Low-noise, low-microphonic type-1620 tubes.
- Built-in isolation coils for remote lines and turntable booster amplifiers.

-Broadcasting's favorite Consolelette

for AM, FM and TV

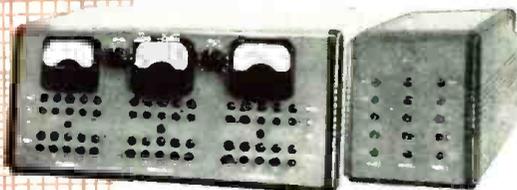
NOTHING like the 76-B4 Consolelette to keep studio programs and rehearsals in motion. Because there's nothing like it for flexibility and easy operation. It provides program quality that meets FM requirements. It has full facilities for simultaneous auditioning and broadcasting . . . for practically any combination of studios, turntables, or remote lines. It performs all the amplifying, monitoring, and control functions of most large and small stations—AM, FM, and TV sound.

Here's where you use it

- For two-studio operation, using two microphones in each—one announce booth microphone, and one control-room microphone.
- For two transcription turntables using external booster amplifiers.
- For single-studio operation . . . using four microphones, one announce booth microphone, and one control-room microphone.
- For remote lines—up to six! With independent control of each.

For complete technical information on the 76-B4, the consolette that's backed by more than 20 years of broadcast engineering experience *in the field*—call your RCA Broadcast Sales Engineer. Or write Dept. 23-D.

NOW . . . Switching Systems for RCA Consolettes



Master Control

Sub-Control

Type BCS-1A—Handles the output of as many as five control consolettes. Feeds three outgoing lines. Enables you to monitor studio, network, recording room, remote inputs. Switches these inputs into transmitter or network lines.

Type BCS-2A—For the smaller station requiring only two RCA consolettes. Handles up to four studios and two announce booths. Routes your program to two outgoing lines (AM, FM, or either transmitter and a network lines).



Sub-Control



BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Test Instruments In The Broadcast Station

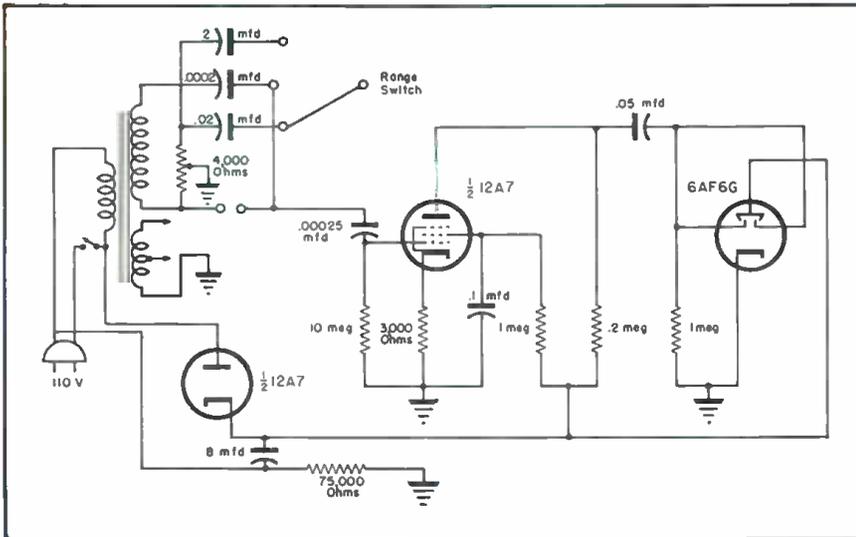


Figure 1. Circuit of the C-D capacitor bridge used at WIS and WISP.

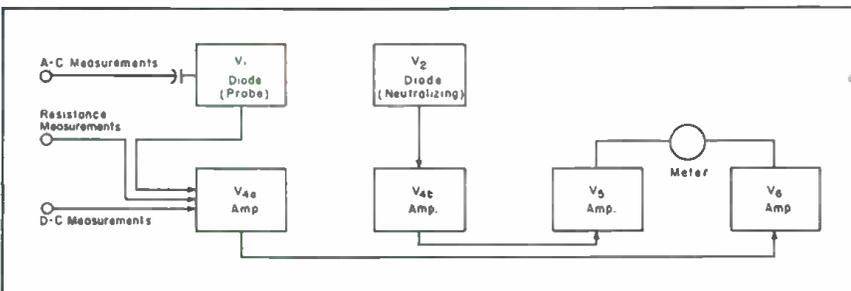
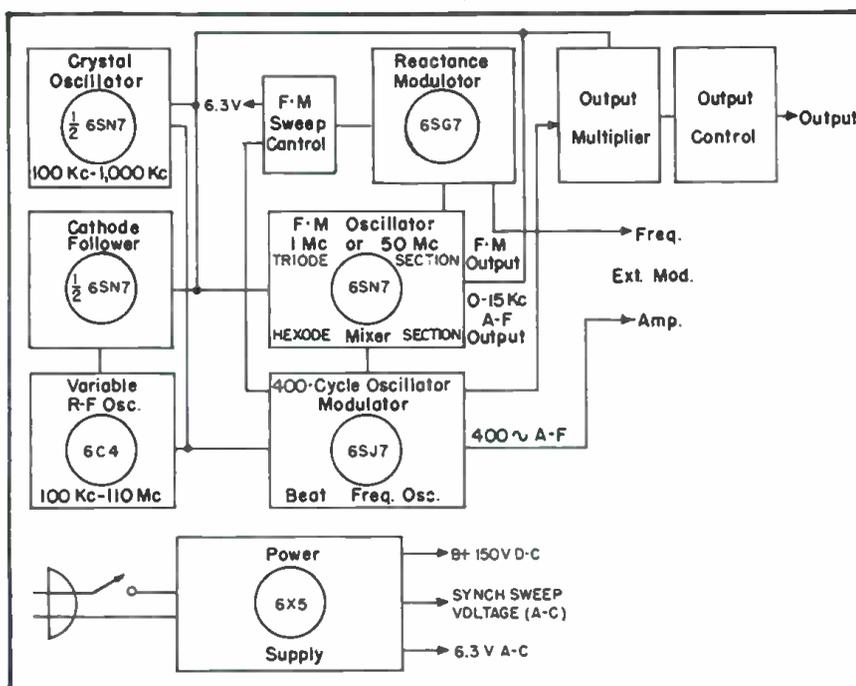


Figure 2. Block diagram of the vtvm discussed by Eidson, *HP 410-A*.

Figure 3. Basic circuit of the crystal-controlled signal generator employed by Eidson for his broadcast-station work; *Hickok 288X*.



IN THE INITIAL installment¹ of this series appeared design and station application data on the volt-ohm-milliammeter, audio oscillator, distortion and noise meter, and 'scope. In this presentation, broadcast-station use of the capacity bridge, vtvm and signal generator are discussed.

The Capacitor Bridge

For many years we have used a 3-range test set² for measuring capacitors ranging from .00001 to 50 mfd. It has given good service, and we would now be hard pressed without the instrument.

Besides measuring quite accurately the value of a capacitor, it indicates if a capacitor is shorted, open, or if the power factor is high or low.

A visual eye using a 6AF6G indicates bridge balance. When this condition exists, the value of the capacitor is simply read from the dial.

The Vacuum-Tube Voltmeter

We use a high-frequency vtvm³ with an a-c range of 1 to 300 volts rms; d-c range of 1 to 1000 volts; resistance of up to 500 megohms; frequency response of ± 1 db from 20 cps to 700 mc; and an a-c input impedance of 100 megohms.

The instrument, particularly designed as a universal measuring instrument for use in audio, supersonic, broadcast, f-m and television circuits, has a high input resistance, while the equivalent shunt-input capacitance is sufficiently low. Accordingly even very-high-frequency resonant circuits are only moderately detuned. To further increase the flexibility and usefulness of this instrument, provision has been made for the measurement of both a-c and d-c voltages and resistance.

A-c voltages applied to the input terminals are rectified by a shunt diode circuit located in the instrument probe. This special diode has low anode-cathode capacity, very short

¹COMMUNICATIONS, March, 1948.

²C-D Model BX.

³Hewlett Packard 410-A.

Part II of Discussion, Covering the Broadcast Station Application of the Capacitor Bridge, VTVM and Signal Generator.

by **HERBERT G. EIDSON, Jr.**

Chief Engineer, WIS and WISP
Technical Director, WIST

electron transit time, and a high resonant frequency.

The output of the diode probe is applied to a d-c amplifier which consists of V_{1a} and V_1 ; Figure 2. Very low voltage is used on the plate of V_{1a} to minimize the magnitude of gas current flowing in its grid circuit. The indicating meter is connected between the plates of V_2 and V_1 in series with suitable range calibrating resistors.

V_2 , V_{1a} and V_3 operate in the circuit which neutralizes the effect of emission velocity current in V_1 . This current consists of electrons which are emitted from the cathode with sufficient velocity to break through the diode space charge area and pass to the anode with no voltage on the anode. However, since this current does flow through the diode, the anode is at a potential relative to the cathode even though voltage is applied externally. This potential difference, though small, would cause a reading on the indicating meter which would destroy the accuracy of the lower ranges of the instrument.

V_3 , with its associated circuit, is used to counteract this effect. This tube, the same type as V_1 , is matched very carefully with V_1 . V_2 operates merely with heater voltage and load resistor. Since diode V_2 is identical to V_1 , a voltage essentially identical to that present at V_1 is also present at V_2 . This voltage is applied to amplifier V_{1a} and in turn to V_2 . Thus, the voltage from V_2 counteracts that from V_1 in the d-c current amplifier V_2 and V_{1a} , and only voltages applied externally to V_1 are amplified independently by the current amplifier.

The d-c voltages to be measured are applied directly to a 100-megohm voltage divider at the input to V_{1a} . V_1 and V_2 are switched out of the circuit.

Resistances are measured by means of the voltage generated by two parallel dry cells. This voltage is applied

to a network consisting of a known resistance in series with the resistance to be measured. That part of the voltage which is thus impressed across the unknown resistance is applied directly to V_{1a} , the first tube of the d-c amplifier.

It must be remembered that the vtvm is a peak reading device but, as in this case we use the meter scale calibrated to read rms volts. This simply means that the meter will read the rms value of a true sine wave. If the wave form of the voltage being measured contains appreciable harmonic voltages or other spurious voltages, errors in measurement will occur, the errors being of a magnitude as indicated by table 1:

Percent Harmonic	True RMS Value	Peak Meter Indication
0	100	100
10% (2nd)	100.5	90-110
20% (2nd)	102	80-120
50% (2nd)	112	75-150
10% (3rd)	100.5	90-110
20% (3rd)	102	80-120
50% (3rd)	112	108-150

Table 1

It is interesting to note that the vtvm used at our station can also be used to measure the positive voltage rise in a pulse provided the reading obtained is multiplied by the factor:

$$1.4 (1 + t_1/t_2 + K/PRF)$$

Where: t_1 is the duration of the positive portion of the voltage;

t_2 is the duration of the negative portion of the voltage;

K is a factor which is a function of the source impedance of the pulse generator and of t_1 (Must be found from supplied curves);
 PRF is the pulse repetition frequency in pulses per second.

Negative pulses can also be meas-

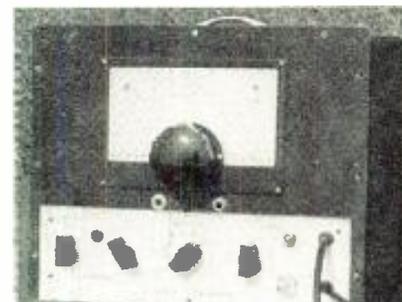
(Continued on page 33)



C-D capacitor bridge.

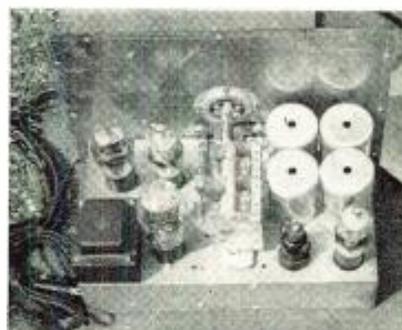


The vtvm used by Eidson (Courtesy Hewlett-Packard).



Composite signal generator built by Eidson.

Internal view of the Eidson signal generator.



TUBE *Engineering News*

Analysis of Eleven Standard Types of Vacuum Gauges Used to Measure the Degree of Vacuum During the Evacuation of Tubes

THE TRADITIONAL way to measure a vacuum is to compare the lowered pressure inside a vessel with that of the atmosphere. This can be done by connecting the inside and outside of the vessel by a tube with a U-shaped portion. Liquid in the U assumes a position that is a compromise between the attraction of gravity and the unequal pressures. The position of the liquid is then used as a measure of the vacuum in the vessel. For more than very moderate vacuums, ordinary liquids are too light, and recourse is had to mercury, which is almost fourteen times denser than water. For this reason, measurements of vacuum are most often given in terms of the height of a mercury column.

The standard value for the pressure of the atmosphere has been taken as 760 mm (29.921 inches). This means that the weight of a column of air, from sea level up as high as the atmosphere extends, is the same as the weight of a column of mercury of the same cross section area, but only 760 mm high. Most vacuum measurements are given as the height of a column of mercury in millimeters that the residual gas will support. This will hereafter be abbreviated to mm Hg.

There are a few applications in tube manufacturing where pressure is measured with columns of mercury, or manometers. These are used to measure the pressures in gas-filled tubes, such as grid-controlled rectifiers, voltage-regulators and gas phototubes, in the range up to 20 mm Hg.

The Manometer

One type of manometer is shown in

by **K. M. LAING¹**

North American Philips Company, Inc.

Figure 1. This type of gauge can be made more sensitive and easily read over this range by substituting a lighter fluid for the mercury. The pressure to be measured must be balanced against a known vacuum instead of the pressure of the atmosphere. Some organic liquids have a vapor pressure low enough to make them suitable for such use. With their aid, the region from the pressure corresponding to the smallest different in level measurable, up to 20 mm Hg can be spread over 300 mm of scale (12"). In this pressure range, the aneroid type of gauge is available. Varying pressures cause motion of a flexible diaphragm in this gauge. The position of the diaphragm is indicated on a dial or otherwise by a pointer with considerable mechanical amplification.

The pressures in most vacuum tubes are of the order of one hundred-thousandth of an mm Hg. It is impractical to measure heights of columns in this range, and thus other types of measurement are used.

McLeod Gauge

Another type of gauge, the McLeod gauge, also makes use of mercury, which shuts off a bulb of known volume from the vessel in which the pressure is to be measured. Then the residual gas in the bulb is compressed by fur-

¹Mr. Laing, who prepared this paper while at North American Philips, is at present with the Pittsburgh Plate Glass Research Laboratory, Creighton, Pa.

ther motion of the liquid metal into a capillary tube. Here either its volume at a known pressure or its pressure at known volume is measured. A conventional mercury manometer measures the pressure; the volume is determined by measuring the length of the gas-filled portion of the capillary, whose cross section area is known.

The method suffers from three principal defects. Pressure cannot be measured continuously, but only at the instant the bulb is isolated from the main vacuum chamber. Automatic readings and recording of results are almost impossible. Since the sample of gas to be measured is compressed to a pressure which might exceed the condensation pressure of certain vapors, principally water, the gauge does not measure such gases or mixtures containing such vapors accurately. If the latter limitation is allowed for, this gauge needs no calibration. It measures pressure in terms of properties of the gauge mechanism that are evaluated in other ways. These properties are volume, cross-section area and length.

Other vacuum gauges depend upon measurement of certain properties of gases which are proportional to pressure.

Thermal Conductivity

There are two types of vacuum gauges that make use of the pressure coefficient of thermal conductivity. One uses a filament that is heated by the dissipation of a constant electrical wattage. The temperature of the wire is measured by a fine thermocouple. As the gas pressure varies through the applicable range the thermal con-

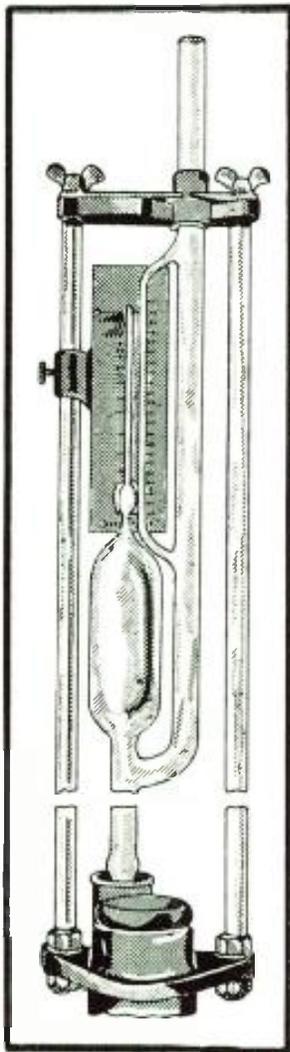


Figure 2

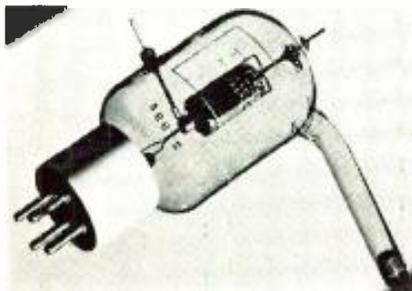
One type of McLeod gauge. In this model the mercury is displaced upward into the glass portion by a plunger. The pressure may be read on the linear or squared scales in the overlapping ranges of 1 mm Hg to 5x10⁻⁶ mm Hg. (Courtesy Central Scientific Company)

ductivity of the gas also varies. For each pressure in this range, the heated wire assumes a temperature that allows the heat input and the heat output to balance. The temperature is measured by the thermocouple, and resulting voltage indicated or recorded.

Gauges of the second type also make use of the variation of thermal conductivity of gas in a certain pressure range. In this case the filament, heat-

Figure 3

Triode frequently used as an ionization vacuum gauge. (Courtesy National Research Corporation)



ed electrically at a constant rate, is made of a suitable metal. The varying resistance of this filament, as the temperature varies with pressure, is measured or recorded in terms of pressures. A similar filament is provided, mounted in a reference vacuum in a tube, otherwise the same as the gauge tube. The two filaments are electrically connected in a bridge arrangement that minimizes error due to changes in ambient temperature.

Viscosity Type

The viscosity gauge utilizes the pressure variation of gas viscosity to indicate the degree of vacuum. One type has a fused quartz fiber, anchored at one end in the vacuum chamber. The fiber is caused to oscillate by being struck with a magnetically operated armature. The time taken by the oscillations to die down to half their amplitude is a measure of the viscosity of the gas surrounding the fiber, and hence the pressure, provided the latter falls within the applicable range.

Other more complicated gauges use the same principle. One type measures the drag caused by the gas between a rapidly rotated disk and a nearby stationary spring-balanced disk.

Thermal Energy Models

In the thermal energy gauge the thermal energy of gas molecules is

utilized. Gas molecules, striking a hot surface, carry away with them, as they are deflected, some heat energy in the form of increased velocity. If these

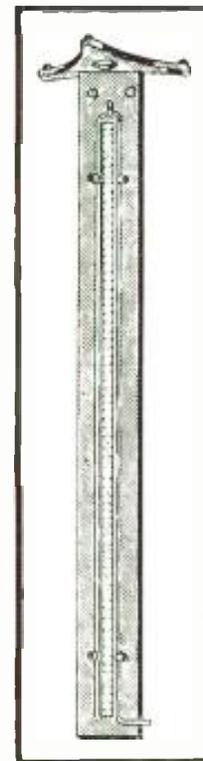


Figure 1

Open-tube manometer. This gauge can be used to measure vacuums where residual gas pressure is as low as a few mm of Hg, provided the pressure of the atmosphere is known at the time. (Courtesy Central Scientific Company)

Table I

Properties of various vacuum gauges

Common Name	Property Measured	Agent Utilized	Means of Indication	Type of Amplification
Manometer	Pressure	Low vapor pressure	Liquid level on scale	None
Aneroid or Bourdon	Pressure	Flexible diaphragm	Pointer on dial	Mechanical
McLeod	Pressure	Mercury	Liquid level on scale	Intrinsic, by volume reduction
McLeod	Volume	Mercury	Liquid level on scale	Intrinsic, by volume reduction
Thermocouple	Thermal conductivity	Filament	Millivoltmeter or potentiometer	None
Pirani	Thermal conductivity	Filament	Ohmmeter, any type	None
Langmuir	Viscosity	Quartz fiber	Stopwatch	None
Gaede	Viscosity	Rotating disk	Spot of light on scale	Optical
Discharge Tube	Ionization	High voltage	Color and form of luminous discharge	None
Ionization	Ionization	Hot filament electron emission	Microammeter	None or d.c. amplifier
Philips	Ionization	High voltage and magnetic fields	Microammeter	None
Alphatron	Ionization	Alpha particle from radium	Milliammeter	2-stage tube amplifier



hp 200 SERIES AUDIO OSCILLATORS

Available in six standard models. *-hp-200A* and *-hp-200B* have transformer-coupled output delivering 1 watt into matched load. Primarily designed for audio testing. *-hp-200C* and *-hp-200D* have resistance-coupled output and supply constant voltage over wide frequency range. The *-hp-202D* is a modification of the 200D, extending frequency downward to 2 cps. *-hp-200I* is a spread-scale oscillator designed for interpolation work and for applications where oscillation frequency must be known with utmost accuracy.



hp 202B LOW FREQUENCY OSCILLATOR

Specially designed for work between 1/2 cps and 1000 cps. Provides excellent wave form, good stability, split-hair measuring accuracy in the very low frequencies. Ideal for vibration or stability checks on mechanical systems, for testing geophysical, electro-cardiograph or electro-encephalograph equipment, checking response of seismographs, or electrical simulation of mechanical phenomena.



hp 201B AUDIO OSCILLATOR

Meets every requirement for speed, accuracy, wave form purity and ease of operation in FM and other fields where high fidelity is most important. Provides 3 watts output into a 600 ohm resistive load. Distortion held to 1% or less, at 3 watts, 1/2% at 1 watt output. Excels in testing high fidelity amplifiers, speakers, and in comparing frequencies.

**hp Resistance-Tuned Oscillators
...For Every Measuring Job
1/2 cps to 10 mc!**

From A to Z in measuring, there's an *-hp-* resistance-tuned oscillator engineered to fit your exact need. Nine precision oscillators in all...and each bears the famed *-hp-* family characteristics of no zero set, constant output, low distortion, great stability, and decade tuning. Brief data on these *-hp-* oscillators are given here. For complete details, write or wire today!

HEWLETT-PACKARD COMPANY
1508E PAGE MILL ROAD - PALO ALTO, CALIFORNIA



hp 650A WIDE-BAND OSCILLATOR

Continuous frequency coverage, 10 cps to 10 mc. Highly stable, versatile. Output flat within 1 db throughout frequency range. Available voltages range from .00003 to 3 v. Other advantages include 94" scale length, 6 to 1 micro-controlled tuning drive, 50 db output attenuator variable in 10 db steps, output voltage divider providing 6 ohm internal impedance (reducing output voltage 100 to 1).

BRIEF SPECIFICATIONS

Instrument	Freq. Range	Output	Distortion	Freq. Response
<i>-hp-200A</i>	35 cps to 35 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc
<i>-hp-200B</i>	20 cps to 20 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc
<i>-hp-200C</i>	20 cps to 200 kc	100 mw/10v	Less than 1% to 20 kc	± 1 db to 150 kc
<i>-hp-200D</i>	7 cps to 70 kc	100 mw/10v	Less than 1% 10 cps to 20 kc	± 1 db throughout range
<i>-hp-202D</i>	2 cps to 70 kc	100 mw/10v	Less than 2% 10 cps to 70 kc	± 1 db, 7 cps to 70 kc
<i>-hp-200I</i>	6 cps to 6 kc	100 mw/10v	Less than 1% above 10 cps	± 1 db, 6 to 6000 cps
<i>-hp-202B</i>	1/2 cps to 1000 cps	100 mw/10v	Less than 1% 1 to 1000 cps	± 1 db, 10 to 1000 cps
<i>-hp-201B</i>	20 to 20,000 cps	3 w/42.5v	Less than 1%	± 1 db throughout range
<i>-hp-650A</i>	10 cps to 10 mc	15 mw/3v	Less than 1% 100 cps to 100 kc	± 1 db throughout range

hp laboratory instruments
FOR SPEED AND ACCURACY

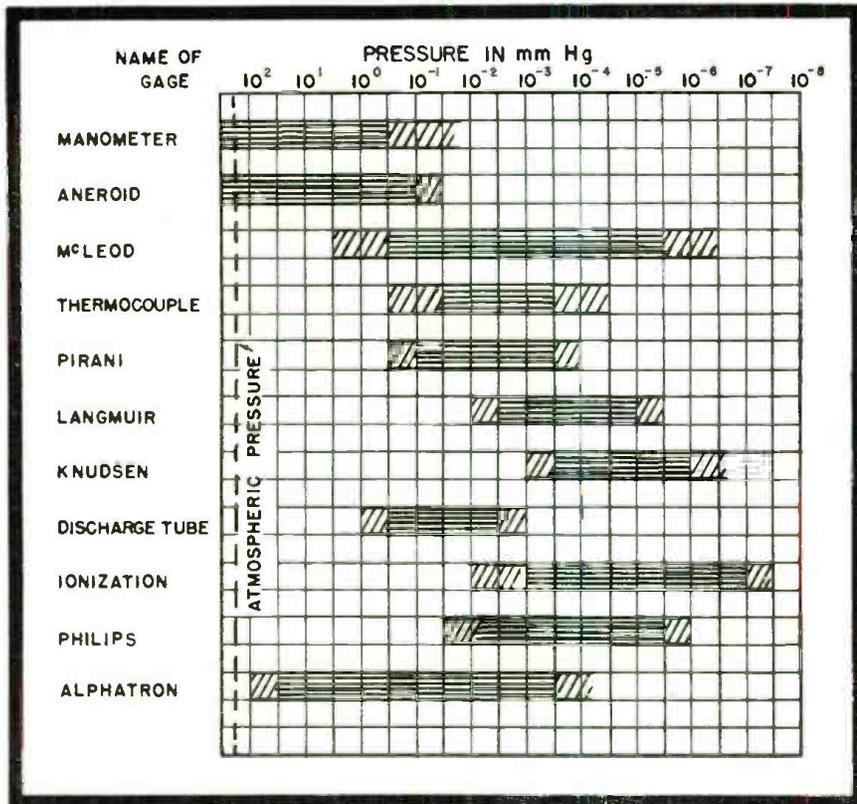


Figure 4

Chart showing pressure ranges covered by eleven types of vacuum gauges.

faster molecules strike a balanced vane, they impart more force to it than the molecules which strike the back of the vane; the latter have not been speeded up by striking a hot surface. The unbalance of forces rotates the vane and twists a suspension wire, restoring the balance. The motion is measured by the deflection of a beam of light reflected from a mirror fastened to the vane. Everything else being constant, the position of the vane

is a measure of the number of speeded molecules striking it, and therefore the pressure of the gas. This gauge can be used for all types of gases. When made according to a specified set of dimensions, it needs no calibration to read true pressures.

Ionization in Gauges

Residual gas molecules can be ionized. In this state they have one or

more electrons removed and they are left with a positive charge. This charge enables them to be attracted to an electrode where the deficiency of electrons is supplied from an external metallic circuit. This supply of electrons is proportional, all other conditions being constant, to the number of gaseous ions neutralized, and hence to the pressure of the residual gas.

For rough indications of vacuums, one method of ionization has been employed. In this method, high voltage is applied to the gas, between metallic electrodes for d-c and low frequency a-c, and through the glass walls of the gas to ionize. The electric field causes the gas to ionize. A feature of this process of ionization, or the subsequent spontaneous de-ionization, is the emission of light. The shape of the luminous discharge, the color and intensity of the light, and the presence or absence of fluorescence caused by invisible radiation, is judged by workers of long experience as an indication of the nature and pressure of the gas.

Another gauge operating on the ionization principle makes use of a triode tube, with the envelope connected to the vacuum system. One of the designs is shown in Figure 3. The filament, usually a pure or thoriated tungsten wire, is heated. Emitted electrons are attracted to a grid by a potential of 100-200 volts. Some of them pass through the interstices of this electrode and proceed toward the plate. However, they are repelled by an inverse field between the plate and the grid of about 20 volts, the plate being more negative. The electrons eventually are collected by the grid structure. The

(Continued on page 32)

Figure 5

Combination thermocouple and ionization gauge. Units in the foreground are sealed to the vacuum system and the pressure over a wide range is indicated on the instruments of the control box. (Courtesy National Research Corporation)

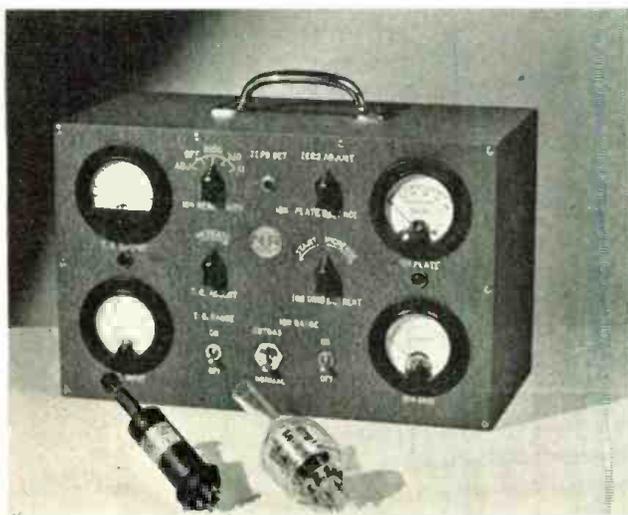
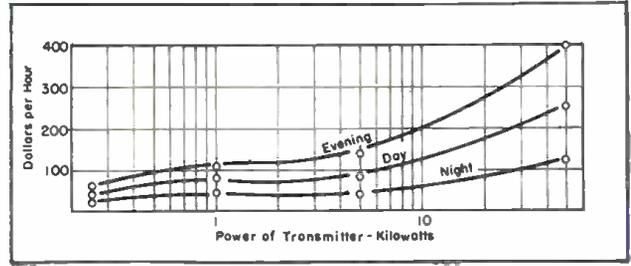
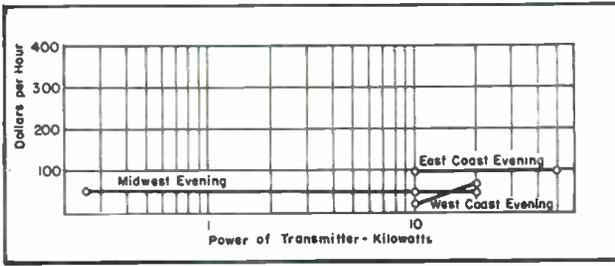


Figure 6

Cylindrical vacuum gauge that utilizes radium to ionize residual gas. Ions are collected and measured by the control equipment. (Courtesy National Research Corporation)

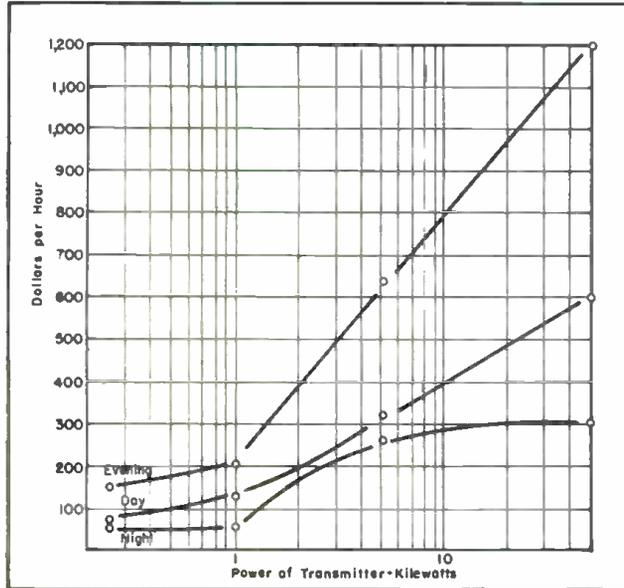


Engineering Factors Used To Determine



Figures 1 (left) and 2 (right)

Figure 1. Curves of day, evening and night rates of f-m broadcast stations, as a function of power for east coast, midwest and west coast. Figure 2. Curves of day, evening and night rates of a-m broadcasting stations as a function of power for the west coast small communities.



Figures 3 (below) and 4 (left)
In Figure 3 appears curves of day, evening and night rates of a-m broadcasting stations as a function of power in west-coast metropolitan areas. Curves of day, evening and night rates of a-m broadcasting stations, as a function of power in east-coast metropolitan areas, appear in Figure 4.

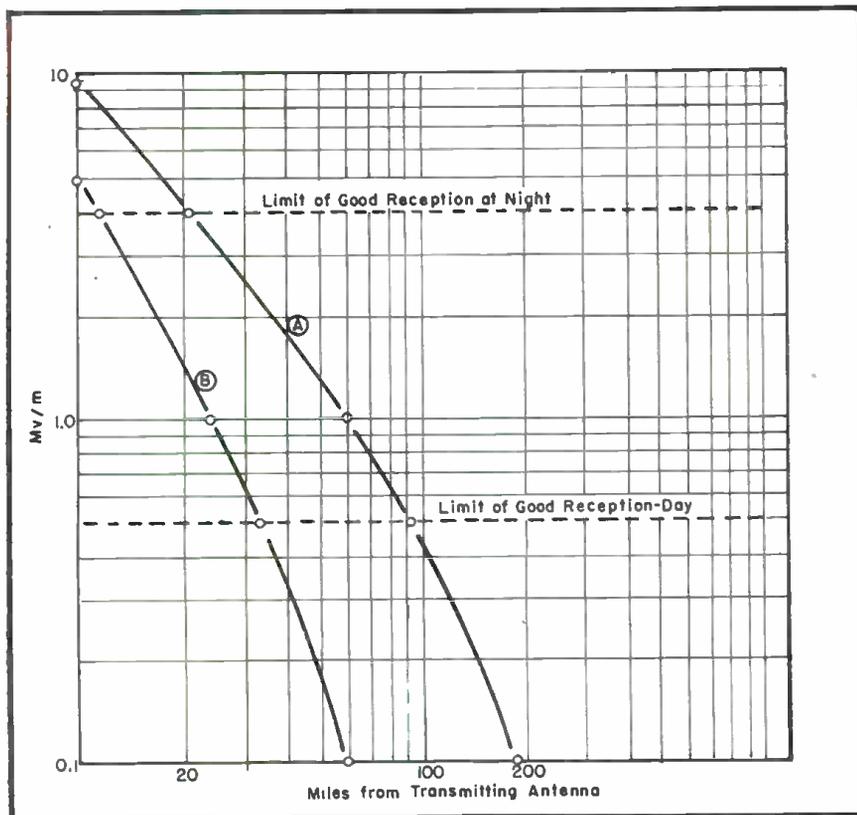
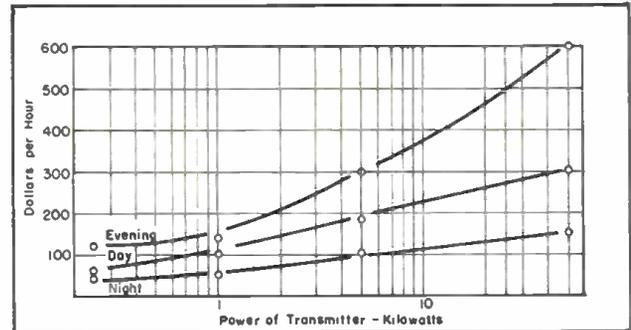


Figure 5
Curves of night and day coverage for the extreme limits of the a-m broadcast band, with an antenna power of approximately 500 watts. In this plot, the midwest ground conductivity was used as a base factor. The curve in A is for a frequency of 550 kc and the curve in B for a frequency of 1600 kc.

Daytime coverage rate for 8:00 A.M. to 6:00 P.M.; evening, 6:00 P.M. to 11:00 P.M., and nighttime, 11:00 P.M. to 8:00 A.M.

Broadcast Station Time Rates

Graphical Analysis Reveals How Engineering Factors, Such as Station Location, Frequency and Power Control Advertising Rates. Plots Applicable to F-M and A-M Systems.

by **F. J. SHEEHAN**

Chief Engineer
WTOL

Fig. 6

The cost of a transmitting plant as a function of transmitted power.

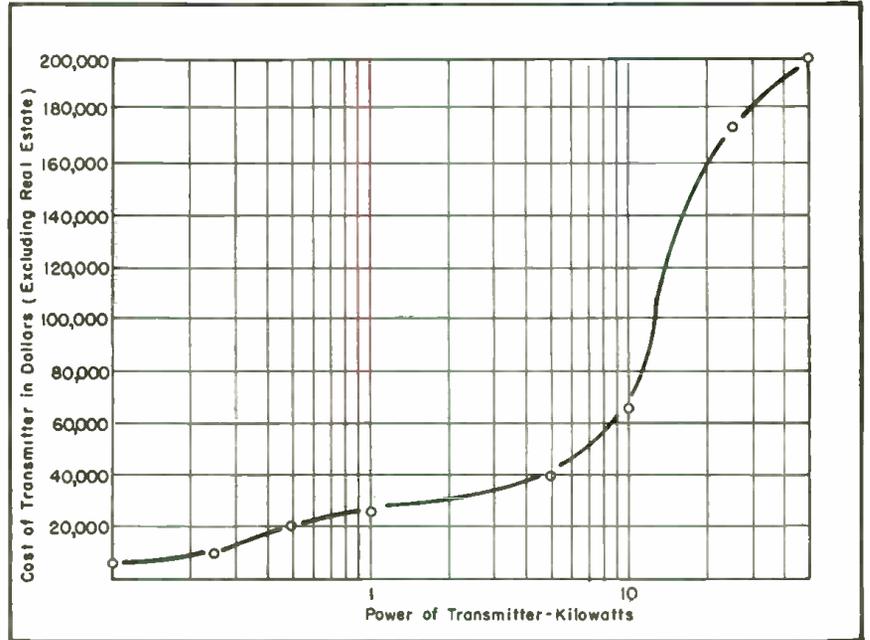
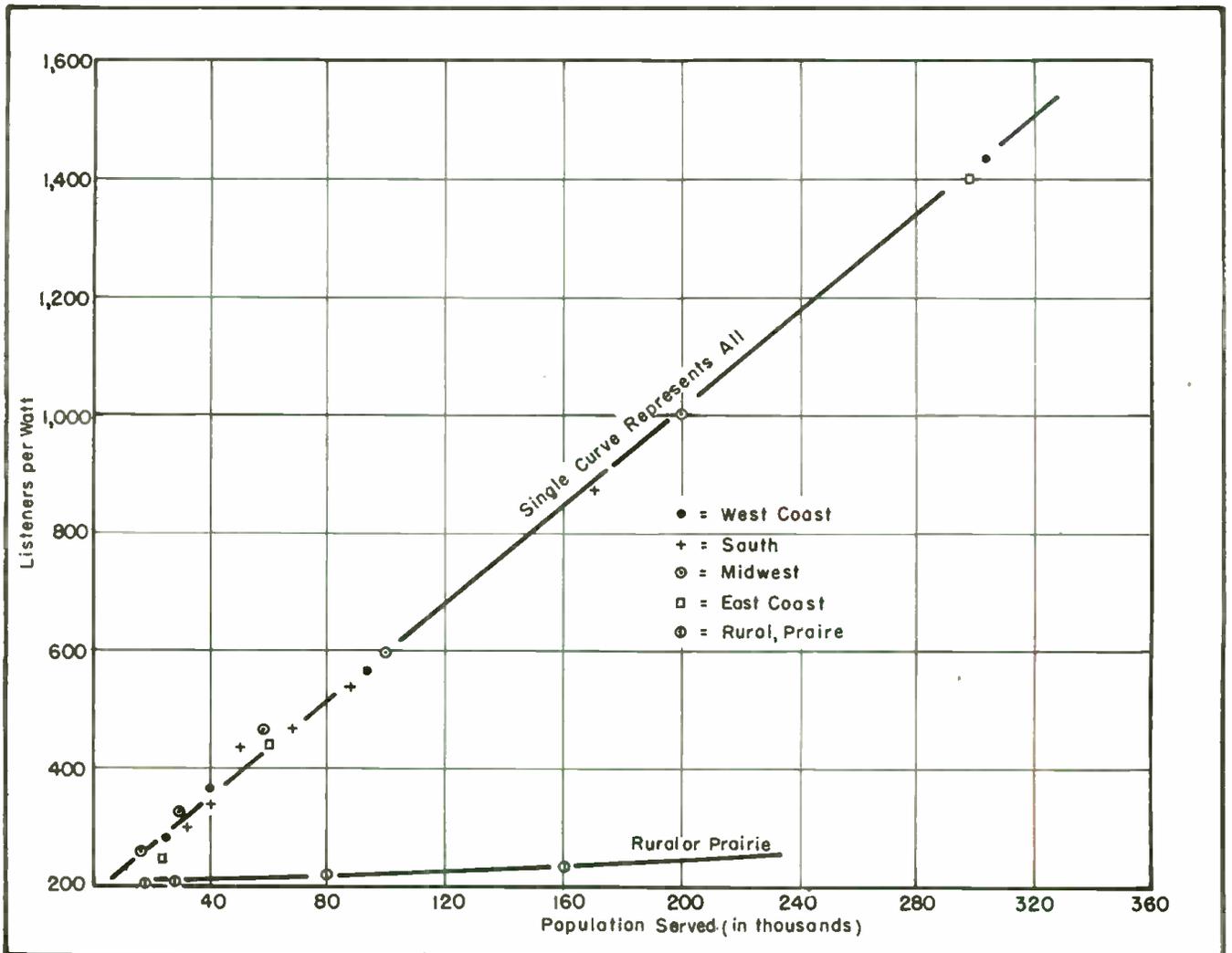


Figure 7 (below)

Plot illustrating the listeners-per-watt as a function of population served.





VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

RCA BUILDING 30 Rockefeller Plaza, New York, N. Y.

Personals

AT THE RECENT ANNUAL dinner-cruise in New York City, veteran VVOA member G. Porter Houston, who is chief engineer of WCBM in Baltimore, Maryland, disclosed he's quite an old timer, having begun his key pounding days with Marconi and then going on to RCA. GPH has been an active amateur, W3AHA, for years. He has also served on the NAB Engineering Committee as chairman and is a member of the IRE. . . . Life member Jim Rigby, who was formerly personnel director of RCA Communications is now with McElroy as vice president. . . . Vet member Samuel Freedman, who was a commander during World War II as a member of the USNR, is now with DeMornay-Budd in sales engineering. Sam also is quite an old timer having begun his key-clicking days with Marconi in 1919 and following along with RCA up at Cape Cod. Sam has written a very authoritative book on *Two-Hay Radio* which is becoming a best seller. . . . H. H. Parker, now with Consolidated Edison Co., also began his radio activities with Marconi and later on shifted to the United Fruit group. . . . Charter member Jim Maresca is now with the Naval Supply Depot in Bayonne, N. J. . . . B. Frank Borsody now checks in at the Micamold Radio Corp. in Brooklyn. . . . Sam Bokovoy now spends his time with August Miller Crystal Research at North Bergen, N. J. . . . Commander E. J. Quinby, USNR, who came all the way up from Key West, Florida, to attend the dinner cruise, spent his early days at WII, New Brunswick, N. J. He also served on Marconi and RCA ships for many years. He was also with RCA Labs and at present, is with the research and development lab in the Bureau of Ordnance. . . . Old timer E. N. Pickerill, who was also at the dinner-cruise, is now at the Central Radio Office of RCA in New York City. . . . Many members of Radiomarine Corp., who are very active in VVOA, were at the dinner cruise. These included George P. Aldridge, L. H. Strong, Lester T. Gates, H. B. Martin, Harvey Butt and George Shecklen. . . . Sam Medford, vet VVOA member, reported at the dinner-cruise that he is



Gilson V. Willets, co-founder of the VVOA, at the microphone of WRNY of which he was general manager in 1925, the year VVOA was born. G.V.W. is now chairman of the San Francisco chapter of VVOA.

with the Isthmian Lines. . . . Harry Cornell another VVOA vet, is with the Standard Oil Co. of N. J. . . . E. J. Wakefield was also at the dinner-cruise. EJW is with United Fruit Co. . . . R. K. Davis of Tropical Radio was also at the affair. . . . Conrad B. Lee of Westinghouse Electric International, was also at the Hotel Astor annual get-together. . . . VVOA life member Commander Arthur Van Dyck disclosed at the banquet that he'd like to be an operator on the rocket line between Earth and Venus. . . . Admiral J. F. Farley unfortunately could not attend the banquet and sent a wire stating that Congressional hearings prevented his appearance at the gala affair. He sent his best to everyone. . . . Robert E. Barber also was unable to attend, being out at sea at the time. In a note to the boys and girls at the banquet he said: "While you fellows are wining, and dining and dancing, eating caviar and filet mignon, think of us fellows who are still out there twisting a bug's tail and glad to get even beans. . . . Have a good time, smooth sailin' and 73's. . . . Have completed the first 50,000 words of what promises to be the most informative,

humorous work on radio today. Perhaps, a best seller." Hope we'll see you REB at the next meeting. . . . Vet member Rodney Duane Chipp is now assistant manager for the Dumont tv network. RDC was formerly with ABC as a radio facilities engineer. Rod has had a varied experience in radio since 1928. He was on the staff of the RCA Institutes in Boston and later spent a bit of time as lab assistant at MIT. After a period as chief engineer of WKAV, Laconia, N. H., he joined NBC in 1933 as control engineer and was transferred to the tv group in 1938. During the war, he was on active duty with the USN as a staff radio officer. He was later transferred to the radar section of the Bureau of Ships in Washington. He became a Lt. Commander and his work with the Bureau of Ships won him the Commendation Ribbon. Rod is a senior member of the IRE, an active member of SMPE, as associate member of the Naval Institute and a member of the New York State Society of Professional Engineers. His education has been quite complete, having studied at MIT and George Washington University. Good luck, Rod, in your new post.

NAB Meeting

(Continued from page 9)

will preside over the afternoon session on Thursday. Six papers will be offered:

The CBS Grand Central Television Studios; William B. Lodge, director of general engineering, CBS, and A. B. Chamberlain, chief engineer of CBS.

Physical and technical facilities of the new WCBS-TV studios including a discussion of the video and audio facilities systems, studio cue-communications facilities, studio lighting and control, etc., will be offered in this paper, which will be presented by Mr. Lodge.

Television Field Broadcasts, including Radio Relay; Robert Clark, tv operation supervisor, NBC.

Mr. Clark will cover problems encountered in presenting tv field programs, preliminary surveys, equipment setup, microwave relay equipment.

Network Facilities for Audio and Studio Broadcasting; Ernst H. Schreiber, engineer, The Pacific Telephone and Telegraph Company.

Current methods and equipment used for audio and video-program channels, which include regular cables, coaxial conductors, shielded wire and microwave radio systems.

Installation and Maintenance of Television Receivers; Edward Edison, field engineer Los Angeles tv operation, RCA Service Company.

A review of some related problems between the tv broadcaster and the installation and servicing organization will be offered in this paper.

Absolute Speed for Magnetic Tape; R. H. Ranger, president, Rangertone, Inc.

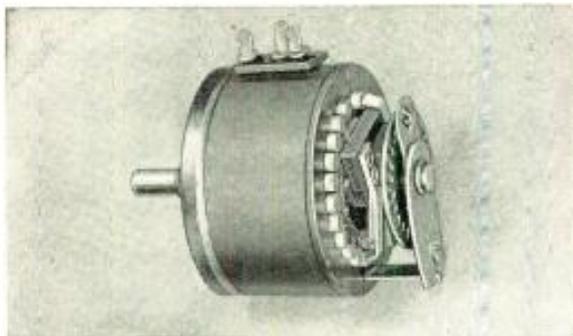
A demonstration of tape reproduction at 30" per second, and discussion of professional type magnetic recorders will be offered by Colonel Ranger. Data will be offered on new type hysteresis motors now being used in tape recorders.

Magnetic Tape Editing Device; H. W. Pangborn, assistant chief engineer, KNX-CBS and R. S. O'Brien, general engineering department, CBS.

A unique tape-editing machine, which enables the precise location of words or portions of words, will be described in this paper to be presented by Mr. Pangborn. The equipment uses a variable speed forward-reverse drive to provide rapid reeling of the tape. A pickup

(Continued on page 30)

Shallcross ATTENUATORS

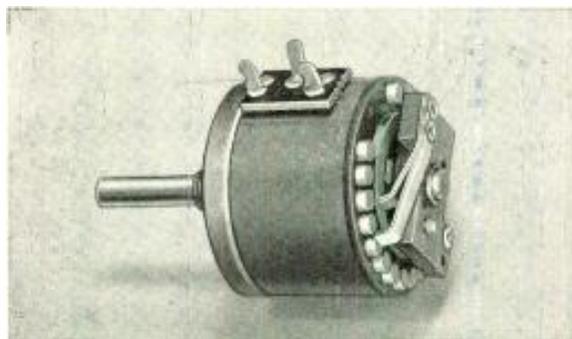
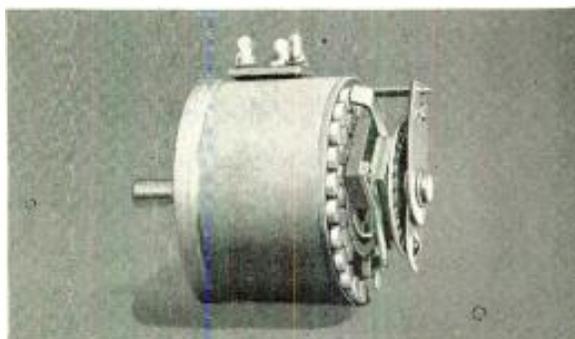


**BRIDGED 'T'
ATTENUATOR
Type 410-4B1**

10 steps, 4 db/step.
Linear attenuation with detent. 2 1/8" diameter, 2 1/8" depth.

**BRIDGED 'T'
ATTENUATOR
Type 420-2B2**

20 steps, 2 db/step.
Linear attenuation with off position and detent. 2 1/8" diameter, 2 1/8" depth.



**POTENTIOMETER
Type C720-2A3**

20 steps, 2 db/step,
tapered on last three steps to off, composition resistors. 1 3/4" diameter, 1 3/4" depth.

These Shallcross Features Mean Better Performance— Better Value!

Off position attenuation well in excess of 100 db.

25% to 50% fewer soldered joints.

Noise level ratings that are factual. (130 db. or more below zero level.)

Non-inductive Shallcross precision resistors used throughout assure flat attenuation to and beyond 30 kc.

Types and sizes engineered for all needs. Attenuation accuracies of 1%. Resistor accuracies of 0.1%, on special order.

SHALLCROSS ATTENUATORS

Shallcross variable attenuators have proved their remarkable quietness and serviceability in dozens of applications for leading users in all parts of the world. Such important details as the use of spring-temper silver alloy wiper arms, silver alloy collector rings and contacts, non-inductive precision resistors, and sturdy, substantial mounting plates have made possible the high standard of performance attributed to Shallcross.

Standard types include ladder and bridged T mixer controls, bridged T and straight T master gain controls and V.U. meter multipliers, wirewound and composition potentiometers for grid control. Cueing attenuators, and fixed pads, both composition and wirewound, in all circuit configurations are also available.

Write for Catalog and Attenuator Specification Sheet.

SHALLCROSS MANUFACTURING COMPANY

Department C-48, Collingdale, Pa.

Designed for



Application



92101

The No. 92101—Antenna Matching Pre-amplifier

The Millen 92101 is an electronic impedance matching device and a broad-band pre-amplifier combined into a single unit, designed primarily for operation on 6 and 10 meters. Coils for the 15 and 20 meter bands as well as television channel 2 thru 6 inclusive also available. This unit is the result of combined engineering efforts on the part of General Electric Company and the James Millen Manufacturing Company. The No. 92101 is extremely compact, the case measuring only 6 1/4" x 3 1/4" x 3". The band changing inductor unit plugs into the opening in the front of the panel. Plug is provided for securing power requirements for the 6AK5 tube from the receiver. Coaxial connectors and plugs are furnished for the antenna and receiver connections.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS



NAB Meeting

(Continued on page 29)

head mounted on a drum is rotated to scan a 2-to-5 word section of the tape repetitively. Aural and 'scope methods for locating an exact cutting point within the scanned section will also be discussed.

May 21, A.M. Session

Paul A deMars, consultant, Raymond M. Wilmotte, Inc., Washington, D. C., and a member of the NAB Engineering Executive Committee, will preside over the Friday morning session during which 5 papers will be offered:

The Economics of Coverage in F-M Broadcasting; Everett Dillard, general manager of WASH and KOZY and member-elect, NAB Board of Directors.

Mr. Dillard will discuss the engineering considerations which contribute toward the best coverage consistent with the economy of investment and operation. Topics will include engineering aspects of combined f-m/a-m operation at a single site; review of the relative importance of transmitter power, antenna height and antenna gain; planning for future f-m expansion; effects of topography on coverage; factors to be avoided in selecting sites; how to avoid multipath distortion problems; the use of f-m for relaying in networking, etc.

A Studio - Transmitter - Link Radio System; W. G. Broughton, assistant sales manager, broadcast equipment division, G.E., and D. J. Nigg, engineer, transmitter division, G.E.

Measuring Equipment and Techniques for F-M and A-M Broadcast Transmitters; David Packard, president, Hewlett-Packard Corp.

Mr. Packard will offer a review of audio frequency, measuring equipment and techniques. He will discuss the application of low distortion oscillators, distortion analyzers and intermodulation measuring equipment. Various problems and techniques involved in making gain measurements, and measurements of noise and residual hum will also be discussed. In addition, Mr. Packard will analyze the application of monitoring equipment to obtain measurements of residual a-m modulation on f-m transmitters, together with the normal measurements of distortion, noise and residual hum.

Factors Affecting Performance of Directional Antenna System; A.

ANOTHER *New* BROWNING DEVICE

**SWEEP CALIBRATOR
MODEL GL-12**

Pulsed timing marker oscillator for standard oscilloscopes and synchroscopes. Variable amplitude markers. Markers available at 0.1 to 100 microseconds.

Frequency meters. WWV standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

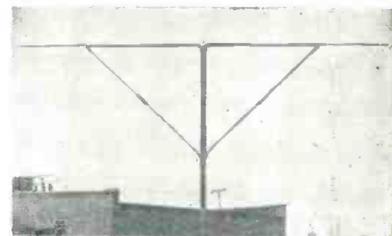
WRITE TO
DEPT. A
FOR
CATALOG

KNOW THE ENTIRE
BROWNING LINE
ENGINEERED for ENGINEERS



BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

PREMAX



NOW!

**TV and FM
On the Same Antenna**

Cover all frequencies between 44 and 216 mc. with ONE low-cost, light weight Antenna Gives excellent response for all television and FM bands. Requires 15% less space than any other conventional dipole. Ask your radio jobber for Premax Antenna FMT-254.

Premax Products

Div. Chisholm-Ryder Co., Inc.
4809 Highland Av., Niagara Falls, N. Y.

Earl Cullum, consultant, Dallas, Texas.

A System for Measuring Co-Channel Interference; Robert A. Fox, general engineering department, WGAR, WJR, and KMPC.

System for continually recording the ratio of desired-to-undesired signal for stations operating on the same channel will be described by Mr. Fox. The setup employs a receiver having a constant output over a wide range of input voltage followed by a selective amplifier, which isolates the heterodyne voltage when an undesired signal is present. The selective amplifier operates a graphic recorder whose reading is proportional to the ratio of the desired-to-undesired signal.

At a luncheon session, Dr. Haldon A. Leedy, acting director, Armour Research Foundation, Chicago, Ill., will discuss:

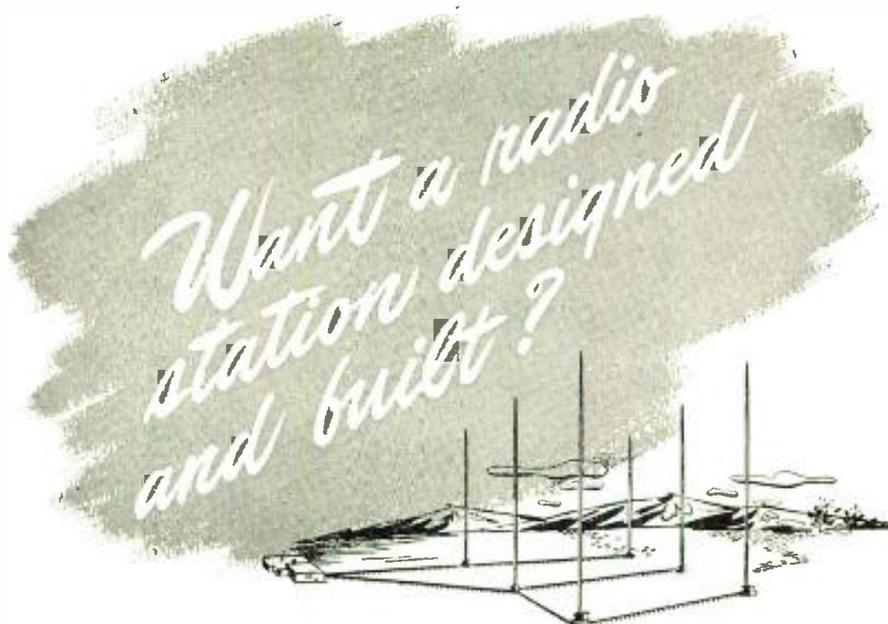
The Development of Magnetic Recording Leading to Stereophonic Sound. In this paper, which will feature a demonstration, Dr. Leedy will describe the stereophonic sound system which consists of sound recorded on 3 magnetic tracks simultaneously, on a single paper tape, with reproduction obtained by placing loudspeakers in positions corresponding to those of the original sound source.

Afternoon Session, May 21

Orrin W. Towner, technical director of WHAS, Louisville, Kentucky and chairman of the NAB Engineering Executive Committee will conduct the afternoon session on Friday, when two papers will be offered and an FCC industry round-table session will be held.

The first paper on the afternoon session will be presented by J. L. Hathaway, assistant manager, engineering developments, NBC, and cover *Developments in Sound and Relay Broadcast Equipment.* A pack-type transmitter and a miniature field pick-up amplifier which can be carried in a standard briefcase will be described by Mr. Hathaway. The second paper will be on *Modern Design Features of the CBS Studio Audio Facilities.* This paper prepared by R. B. Monroe and C. A. Palmquist of the general engineering department, CBS, New York, will be presented by Lester H. Bowman, manager technical operations, western division of CBS. Mr. Bowman will describe a recently completed broadcasting studio audio-control console which although comparable in size to a standard office desk, is said to contain as much equipment as formerly required in three or four standard equipment racks.

Royal V. Howard, director of NAB Department of Engineering, will preside over the FCC industry round-table panel. He will be assisted by Neal McNaughten, who is assistant director of the NAB Department of Engineering.—L. W.



LET Andrew DO IT!

The Monona Broadcasting Company, Madison, Wisconsin, had the money but no station. Faced with "impossible" allocation difficulties, they called on Andrew engineers, who succeeded in finding a frequency and designing a directional antenna system. Thus, WKOW was born. Within ten months after the construction permit was granted, Andrew engineers completely designed, built, tuned, and proved performance of a six-tower 10 kw. station — an unusually difficult engineering feat accomplished in record-smashing time. A complete "package" of Andrew transmission line and antenna equipment was used, again emphasizing Andrew's unique qualifications: Complete

engineering service with unsurpassed equipment.

Mr. Harry Packard, General Manager of WKOW, wrote:

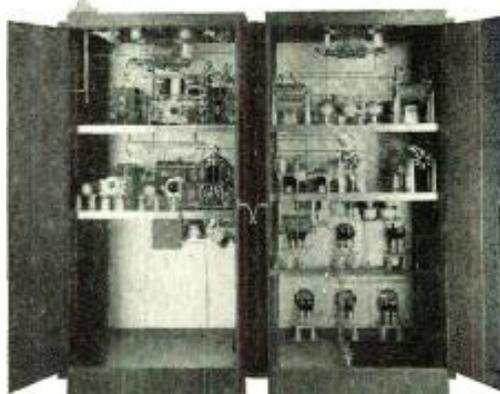
"Speaking for the entire staff of WKOW, I would like to congratulate the Andrew Corporation on the remarkable engineering job it performed in helping us get WKOW on the air.

We feel that the technical perfection of our installation is due in great part to the efficiency of Andrew equipment and engineering service.

In particular we wish to thank Mr. Walt Kean of the Andrew Broadcast Consulting Division who was responsible for conceiving and designing the installation, supervising construction of all antenna equipment, and doing the final tuning and coverage surveys."

A total of 13,618 feet of Andrew transmission line and complete phasing, antenna tuning, phase sampling and tower lighting equipment went into this job, complementing the best in engineering with the ultimate in radio station equipment.

So, just write Andrew when you are ready to enter the broadcasting field. Andrew will get you on the air.



Andrew
CORPORATION
363 EAST 75th STREET - CHICAGO 19
TRANSMISSION LINES FOR AM, FM, TV - DIRECTIONAL ANTENNA EQUIPMENT - ANTENNA TUNING UNITS - TOWER LIGHTING EQUIPMENT - CONSULTING ENGINEERING SERVICE

ANOTHER

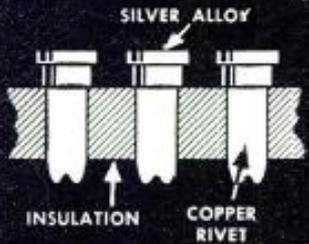
TECH LAB FIRST!

NOW ON ALL
**ATTENUATORS
AND
POTENTIOMETERS**

Silver Alloy Contacts

New Silver Alloy contacts make possible improved Attenuators and Switches in smaller sizes.

- 1 Greater Creepage Distance—thus better insulation.
- 2 No silver migration.
- 3 Greater silver surface to carry current.
- 4 Lower contact resistance.
- 5 Better mechanical operation of switch.
- 6 Less capacity between contacts—better frequency characteristics.
- 7 Better clearance to ground.



TYPE 800 UNIT
with new contacts



Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

Tube News

(Continued from page 25)

resulting grid current is kept constant. While the electrons are in the space between the grid and the plate, they collide with gas molecules in this region and ionize them. The positively charged gas ions are attracted to the plate, often called the collector in this specialized form of triode. The plate current necessary to neutralize the ionized molecules of gas is proportional to their number, and hence to the pressure.

Vacuum-Gauge Modification

In a modification of this arrangement,¹ the electrons are impelled to follow a long spiral path by combined electric and magnetic fields. As a convenience the electrons are not emitted by a hot filament, but from a cold cathode by a potential of 2,000 volts. The current due to the electrons is small and constant compared to that caused by the ions, which is proportional to the pressure of the gas.

Medium Type Gauge

Another gauge uses a small amount of radium to produce gaseous ions, which are collected and measured in the usual way. The radium, in a sealed capsule, disintegrates to form, among other things, alpha particles. These are doubly charged helium ions. These particules are emitted with a high velocity. Numerous collisions with the residual gas molecules are produced, and the latter are ionized at a rate proportional to their number. The ions formed are collected and measured as before.

¹The Philips Gauge.

Figure 7

Foreground, Philips vacuum gauge. Pressure is indicated on the instrument in background. (Courtesy Distillation Products, Inc.)



Wanted

- ★ PHYSICISTS
- ★ RADAR ENGINEERS
- ★ SYSTEMS ENGINEERS
- ★ ELECTRONIC ENGINEERS

To enable us to carry out our long-term engineering program on missiles, radar, communications, etc., we must add a considerable number of qualified graduate engineers with electronic, research design and/or development experience to our staff. Please furnish complete resume of education, experience and salary expected to: Personnel Manager

BENDIX RADIO DIVISION
Bendix Aviation Corporation
Baltimore 4, Maryland

Test Instruments

(Continued from page 21)

ured but not to as small a value as with positive pulses.

Since the resonant frequency of V_1 is something above 1000 mc, readings on r-f transmission lines can be obtained with good accuracy up to the 1000-mc point. For readings above 100 mc the manufacturer recommends that the small tip on the end of the diode be removed (this tip contains a built-in .00025-mfd blocking capacitor) and a button type capacitor of approximately 50 mmfd be tightly connected to the point to be measured. For frequencies below approximately 50 cycles, a capacity of .25 mfd should be substituted for the tip.

The vtvm can be used for:

- (1)—Measuring standing wave ratios on transmission lines.
- (2)—If exact *swr* is known, power can be measured at f-m frequencies as well as at lower frequencies.
- (3)—Neutralizing of transmitter r-f stages.
- (4)—Measuring any voltage within the range of the meter at critical points in circuits where a conventional voltmeter would upset circuit characteristics.
- (5)—Measuring of resistances from approximately .1 ohm to 500 megohms.
- (6)—D-c voltage measurements from .01 to 1,000 volts at a load of 100 megohms.

The Signal Generator

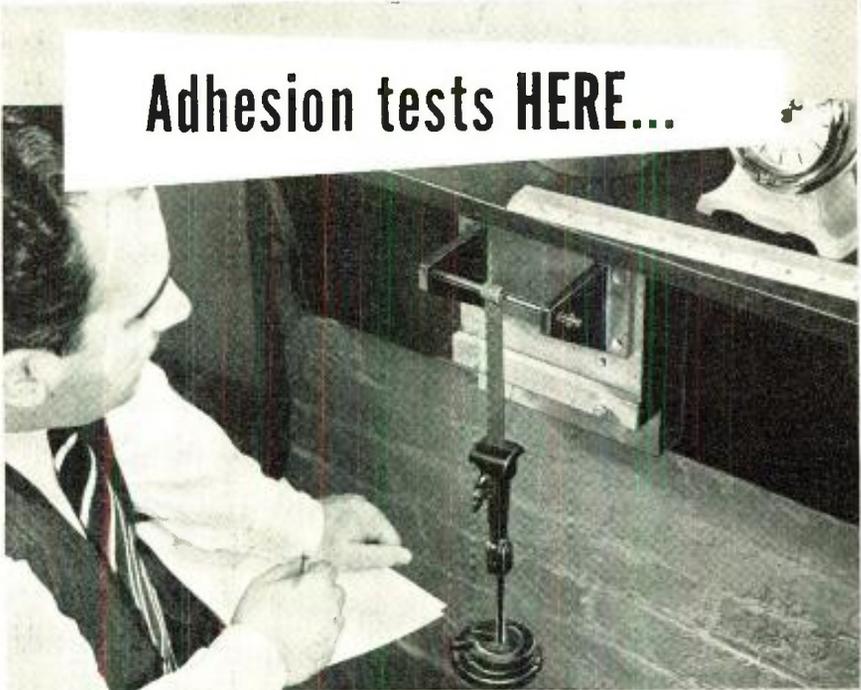
Two signal generators are used at our stations. One is a composite lab-built generator and the other a commercial model.⁴

While the commercial type can hardly be considered broadcast test equipment, since it was designed primarily for the servicing of receivers, it does come in handy when checking receiver monitors and shortwave pick-up equipment. This generator can also be used in conjunction with an r-f bridge, but it must be borne in mind that its output is too low to override much interference or static when measuring antenna characteristics.

The lab-built unit, which features a cathode-follower output stage, was designed with one main purpose in mind: to provide a steady, strong signal capable of being modulated up to 100 per cent with an output of at least 10 volts

⁴Hickok Model 288-X.

Adhesion tests HERE...



Your assurance for *Lasting splices*

The performance of PANTHER and DRAGON Friction Tapes is guaranteed by constant checks on adhesion made in accordance with ASTM specifications, as shown here. The extra adhesion built into them insures longer splices and complete user satisfaction.

PANTHER and DRAGON Friction Tapes work easily, and make splices stay put. Sold only through recognized independent wholesalers.

The Okonite Company, Passaic, New Jersey.



Panther and Dragon
friction and rubber tapes

6409

so that static and station interference could be overridden when using an r-f bridge to measure characteristics of antennas within the 550 to 1600-ke range. The oscillator has a much greater frequency range than this, and thus it can be used for receiver work also.

The output varies from 10 to 15 volts across the standard broadcast band and drops lower when other bands are switched in. The full frequency range of the unit is 380 kc to 7 mc in four bands. Harmonics can

be used if a higher frequency is needed for receiver test work.

The instrument is well shielded with filters in the 110-volt supply lead to prevent radiation of the signal.

The cathode-follower output stage affords a low impedance output for good regulation.

The modulating signal is set at 400 cycles and is generated by a Wein-bridge oscillator driving a modulator, which in turn excites an electron-coupled oscillator operating at a radio

(Continued on page 34)



HIGH EFFICIENCY—WIDE DYNAMIC RANGE

Extra TONAL REALISM

are yours with

Jim Lansing
SIGNATURE
Speakers

the result of a quarter of a century of experience in the loud speaker field.

Designed especially for music systems and public address use. This speaker has exceptionally high efficiency recommended for operation at frequencies from 60 to 6500 C.P.S. and a maximum useable range of 40 to 15,000 C.P.S. Extremely sensitive spherical metal diaphragm fastened directly to the voice coil support tube acts as a direct radiator at the higher frequencies. Heavy field case prevents stray magnetic fields which allows use near cathode ray or television tubes without image interference.

COMPARE Jim Lansing SIGNATURE SPEAKERS before you buy—it's easy to see and hear the difference. Available through your Jobber.

**MODEL
D130**



JAMES B. LANSING SOUND INC.

4221 SOUTH LINCOLN BLVD., VENICE, CALIF.

Test Instruments

(Continued from page 33)

frequency. This then drives the cathode-follower output tube.

Previous experience has shown that a null is most difficult to obtain on an r-f bridge under other than ideal conditions when the driving generator is incapable of producing more than .1 to 1.0 volt of r-f, especially when the antenna being measured is of low ohmage.

[To be continued]

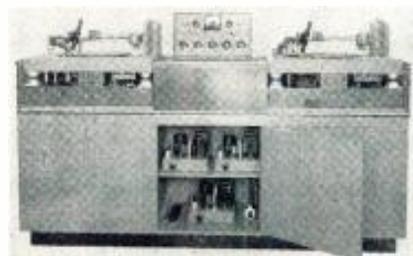
CAA Range

(Continued from page 11)

navigational program, since the basic policy adopted in this country provides for navigation information aboard aircraft to be obtained direct by a means not requiring communication between aircraft and ground, and to allow each aircraft to navigate a desired course independent of all other aircraft without help from ground personnel.

The next step in the long term navigational plan will be the addition of distance measuring equipment (DME) to the VOR system, which will provide almost unlimited navigational possibilities. For example, using DME-VOR equipment with a course computer of relatively simple design, the pilot will be able to pre-set any desired straight line or orbit course. This course need not pass over the VOR station and can be made good regardless of changing winds and without the need of dead-reckoning or numerous other methods of orientation. The pilot need only fly the vertical needle of the deviation indicator and may, if his aircraft is equipped with an automatic pilot and automatic flight coupler, merely flip a switch which will fly this course automatically; thus we may think of the VOR-DME system as satisfying the exact means of aircraft position control required by the increasing number of aircraft using our domestic airways.

AUDIO CONTROL EQUIPMENT



Professional recorder console and control turret which incorporates two recorders for simultaneous operation, recently installed at WKJG, Ft. Wayne, Indiana. Either one of the two program busses on the cutting units may be monitored during operation. (Courtesy RCA)

**FREE NEW ALLIED
CATALOG**



**Everything in
Radio &
Electronic
Supplies**

**Complete, Expert Service
for Radio Engineers**

You'll find everything you need in radio and electronic equipment for laboratory work, in the new 172-page ALLIED Catalog! World's largest stocks—thousands of parts, tubes, tools, books, test instruments, sound apparatus—ready for instant expert shipment at lowest market prices. Write today for your FREE copy of ALLIED'S newest Buying Guide!

ALLIED RADIO CORP., Dept. 31-D-8
833 W. Jackson Blvd., Chicago 7, Ill.
 Send FREE New ALLIED Catalog.

Name.....
Address.....

ALLIED RADIO

ANOTHER *New* BROWNING DEVICE

OSCILLOSYNCHROSCOPE

MODEL OL-15 A

Versatile laboratory instrument designed for observing phenomena requiring extended range amplifiers and a wide variety of time bases.

Frequency meters. WW standard frequency calibrator Oscilloscope. Power supply and square wave modulator Capacitance Relay. FM-AM Tuners. FM Tuner.

WRITE TO
DEPT. A
FOR
CATALOG

**KNOW THE ENTIRE
BROWNING LINE**
ENGINEERED for ENGINEERS



BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

The Industry Offers

BENDIX DYNAMOTOR

A regulated dynamotor, which is said to permit constant output voltage with as much as a 25% variation in input voltage, has been announced by Bendix Aviation Corporation, Red Bank, N. J. Unit is said to be designed for operation under extremes of temperature, humidity and altitude. Available in a variety of frame sizes and voltage ratings.



C-D TV CAPACITORS

A line of tv capacitors, DSTH, has been announced by Cornell-Dubilier. Capacitors, oil impregnated and wax filled, are made with a double seal consisting of one complete wax paper tubular, including a wax dip inserted in a second outer dip. The size range is from 1/2" diameter x 2 1/8" length up to 1 13/16" x 4 3/4". Voltage d-c, from 3,000 to 6,000.

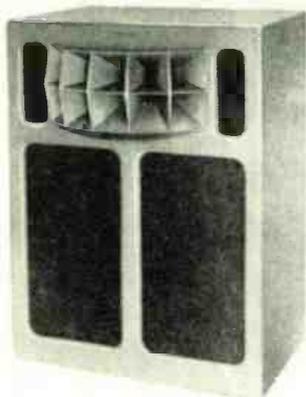
STEPHENS TWO-WAY SPEAKER

A 2-way speaker system, Tru-Sonic model P-63HF, has been developed by Stephens Manufacturing Corporation, 10416 National Boulevard, Los Angeles 34, California.

Rated at 30 watts. Has a 600-cycle crossover to relieve the two model P-52L, 15" 20-watt low-frequency drivers of high frequencies and consequent intermodulation and cone breakup. Horn loading down to 60 cycles. Chamber behind drivers reinforces bass to 30 cycles. 2 x 5, 10 cell, 100° x 40° h-f dispersing horn. A model P-30, 30-watt h-f driver is said to extend range beyond 15,000 cycles. Equipped with h-f attenuator.

Size, 25" deep x 36" wide x 45" high. Input: 16 ohms.

Bulletin 109 contains additional data.



RMC AMPLIFIERS

A series of amplifiers, type 115, for broadcast monitoring, recording studios, public address systems and wired music services, has been announced by Radio Music Corp., Port Chester, New York.

Equipped with aural and gain controls. Aural control on low end said to boost without high end attenuation. Three-stage push-pull.

Bulletin A1-4 upon request.

Proved in Millions
of Applications!



RELAYS
RESISTORS
RHEOSTATS

Vast Variety of Stock Units

ANSWERS EVERYDAY NEEDS ECONOMICALLY

Relays are available from stock in general-purpose, industrial, and radio amateur types for continuous or intermittent duty.

Vitrohm wire-wound Fixed Resistors are available in 8 stock sizes from 5 to 200 watts. Adjustohms in 7 stock sizes from 10 to 200 watts. Plaque Resistors in 3 sizes from 20 to 125 watts. Discohms in 18 watts. Stripohm in 5 stock sizes from 30 watts to 75 watts. Ring-type close control Rheostats in 4 stock sizes from 25 to 150 watts. (Plate Type Rheostats recommended for larger sizes.) Wide variety of Resistance Values.

AUTHORIZED DISTRIBUTORS EVERYWHERE

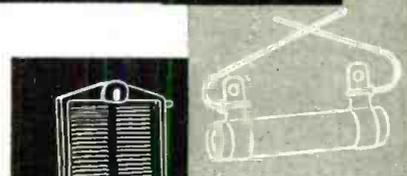
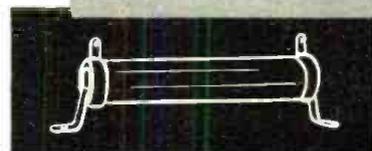
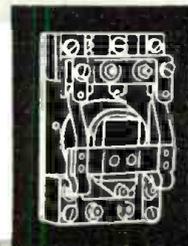
WARD LEONARD ELECTRIC COMPANY

Radio & Electronic Distributor Division

53-M West Jackson Blvd., Chicago 4, U. S. A.

SEND FOR HELPFUL CATALOGS

Catalog D-30 gives complete data and listings on stock units available in Resistors, Rheostats and Radio Amateur Relays. Catalog D-20 lists Industrial and General-Purpose Relays. Write for them today!



WARD LEONARD

Basic 3R's in Current Control!

G.E. PANEL INSTRUMENTS

A new line of 3 1/2" panel instruments of internal-pivot design has been announced by the meter and instrument divisions of G. E.

The instruments, type DO-71, feature an Alnico magnet which is said to provide high torque for quick response and good damping. High torque is also said to allow the use of larger-radius pivots.

STACKPOLE DUAL CONCENTRIC SHAFT CONTROLS

Dual concentric volume and tone controls have been announced by the Stackpole Carbon Company, St. Marys, Pa.

Controls, 57/64" in diameter, available as a dual unit with single control at the panel, as a dual concentric with two separately controlled continuously variable resistance units mounted in tandem, or as dual concentric with one continuously variable unit, and one tone switch in tandem.

BRACH H-F WHIP ANTENNA

A high-frequency antenna, covering 152 to 162 mc. for auto communications systems, has been announced by the L. S. Brach Manufacturing Company, Newark, N. J.

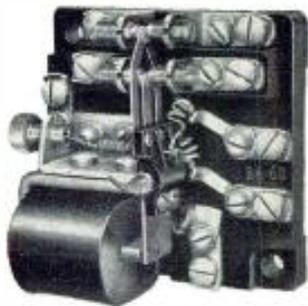
Antenna features a locking device, a single clamp which by pressure and biting into the metal roof, from above and below provides a mount and ground to coaxial shield. The antenna portion is of beryllium copper, pressure fitted into a locking nut.

RAYTHEON TV EQUIPMENT

A line of tv station equipment has been announced by Raytheon Manufacturing Co., Waltham, Mass.

Both 500 watt and 5-kw tv-transmitters will be in the line. Portable camera chain equipment will be produced for both pick-up and studio use.

(Continued on page 36)



A NEW SENSITIVE ALLIED RELAY

Where power supply is limited, or where precise operating characteristics are required, use this new sensitive Allied Relay. Insulating parts throughout are of molded bakelite. Adjustable contact screws enable precise adjustment and easy servicing. Standard screw-type terminals. Supplied in one- or two-pole, normally-open or normally-closed, or double-throw contact arrangements.

BK RELAY SPECIFICATIONS

- **COIL RATING:** Up to 32 volts at 24 milliwatts D.C. and 220 volts at .240 volt-amperes A.C.
- **CONTACT RATING:** 1 ampere at 48 volts D.C. and 5 amperes at 110 volts A.C. non-inductive.
- **DIMENSIONS:** Length 2 5/8", width 2 5/8", height 1 21/32".

Write us for detailed information on type BK relay and other Allied relays.

AL-125



ALLIED CONTROL COMPANY, Inc.

2 EAST END AVENUE • NEW YORK 21, N. Y.



STANDARDIZED METAL EQUIPMENT

ADAPTABLE FOR EVERY REQUIREMENT

Par-Metal Equipment offers many features, including functional streamlined design, rugged construction, beautiful finish . . . plus ADAPTABILITY. Eliminate need for special made-to-order units on many jobs.

Engineers and manufacturers will effect economies with Par-Metal Products, which are available for every type of job from a small receiver to a deluxe broadcast transmitter.

Professional techniques and years of specialization are reflected in the high quality of Par-Metal.

**CABINETS • CHASSIS
PANELS • RACKS**

Write for Catalog



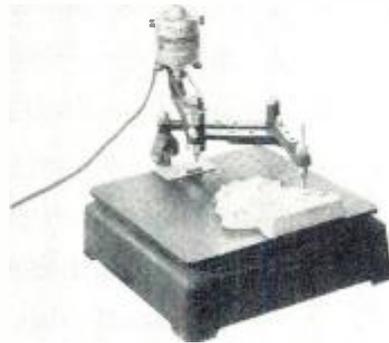
The Industry Offers

(Continued on page 35)

MICO ENGRAVER

A 2- and 3-dimensional portable pantograph engraving machine, type 252, has been announced by Mico Instrument Company, 80 Trowbridge St., Cambridge 38, Mass. Can be used to make small dies and molds for plastics, rubber, glass, die castings, templates, etc. Three-dimensional milling is accomplished by tracing the shape of an enlarged master with the stylus.

A spindle is mounted on pre-loaded ball bearings and equipped with a chuck that holds midget milling cutters, burrs or mounted points having 3/8" diameter shanks. A micrometer depth control, graduated in thousandths of an inch of feed, has a range of .250".



SORENSEN AUTOMATIC ELECTRONIC VOLTAGE REGULATOR

An automatic electronic voltage regulator, the Controller, which is said to permit selective stabilization of a-c, d-c or r-f outputs in any one circuit over wide ranges of line and load, has been announced by Sorensen and Co., Inc., Stamford, Conn. The a-c output is said to swing between 85 and 145 v, automatically adjusting the output of unit against line and load.

At least one watt of power must be made available to the Controller bridge circuit. In a d-c application at least 0.4 ampere must be made available from the rectifier filter circuit.

AUDAX TUNED-RIBBON PICKUP

A tuned-ribbon reproducer, Audax model 79-G, has been announced by Audax Co., 500 Fifth Ave. 18, N. Y. Linear 50 to 10,000 cycles; point-pressure about 24 grams; jewel-stylus; output about -30 db.



LENKURT 22-CHANNEL CARRIER SYSTEM

A carrier system which is said to provide 11 voice circuits in the 200 cps to 50 kc band has been announced by Lenkurt Electric Co., 1124 County Road, San Carlos, California. Where limited fidelity is acceptable, as many as 22 narrow-band channels can be provided.

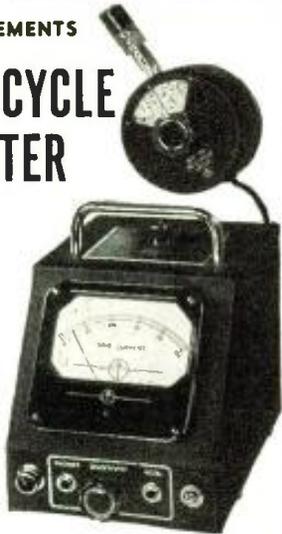
Particularly suited for application between communication control centers and associated radio transmitter and receiver stations.

Up to 18 signaling sub-channels can be transmitted over each of the eleven voice channels. Wide-band signaling circuits for semi-automatic keying can be obtained with a maximum dotting rate of 20 per sec. Each voice channel can be divided into six such channels plus six normal signaling channels.

MEASUREMENTS

**MEGACYCLE
METER**

**MODEL
59**



Radio's newest, multi-purpose instrument consisting of a grid-dip oscillator connected to its power supply by a flexible cord.

A most versatile instrument for the engineer, service-man or amateur. Write for descriptive circular.

SPECIFICATIONS:
Power Unit: 5 1/2" wide;
6 1/2" high; 7 1/2" deep.
Oscillator Unit: 3 3/4"
diameter; 4" deep.

FREQUENCY:
2.2 mc. to 400 mc.;
seven plug-in coils.

MODULATION:
CW or 120 cycles; or
external.

POWER SUPPLY:
110-120 volts, 50-60
cycles; 20 watts.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

RCA D-C MICROAMMETER

An electronic microammeter, WV-84A, which is said to be capable of measuring d-c currents down to one-billionth of an ampere, has been announced by the RCA tube department.

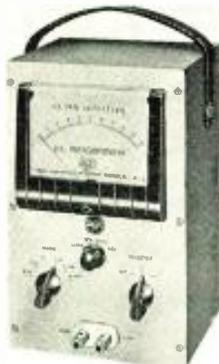
The microammeter is a portable, battery-operated, vacuum-tube meter.

May be used with multiplier photo tubes in measuring light intensities and the density of gases.

Current ranging from 0.001 microampere to 1,000 microamperes can be measured.

Can also be used as a high-range ohmmeter when connected to a suitable power supply. For example, when used with a 45-volt battery, the instrument will measure resistance up to 4,500 megohms.

The voltage drop for full-scale deflection of the meter is said to be 1/2 volt for all ranges.



HOFFMAN FREQUENCY METER

A heterodyne frequency meter and crystal calibrator, TS-323 U/R, with a frequency range of 20 to 480 mc. has been announced by Hoffman Radio Corp., Los Angeles, Calif.

The unit operates on two 6-volt A batteries and three 45-volt B's for portable operation. For fixed use an external connector is provided for operation through regulated power supply.

TRIPPLETT VOLT-OHM-MILLIAMMETER

A combination 20,000 ohms per volt d-c multi-range volt-ohm-milliammeter has been announced by The Tripplett Electrical Instrument Co., Bluffton, Ohio.

There are 35 ranges: Voltages to 1,000 d-c at 20,000 ohms/volt and a-c at 1,000 ohms/volt; d-c current ranges from 0-50 microamperes to 10 amps; a-c amps to 10; db -10 to +55.

ROWE V-H-F/U-H-F MILLI-WATTMETER

A v-h-f/u-h-f milli-wattmeter, type MW55, for measuring power output of h-f transmitters, oscillators, multiplier stages, has been announced by Rowe Engineering Corp., 2422 N. Pulaski Road, Chicago 39, Ill. Two methods of measurement are provided in the instrument, selection of which is made by a front panel switch. One is a the-mistor bridge arrangement for indicating powers from 2 to 60 milliwatts, and the other a p-m filament brilliance comparison method for higher powers from 20 to 1,000 milliwatts.

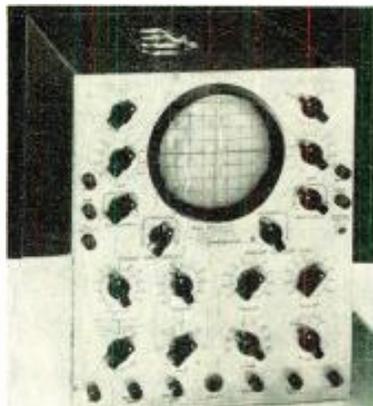
Accessory probes are available providing various methods of circuit coupling for obtaining maximum power measurements most satisfactorily.



HICKOK 5" SCOPE

A 5" scope, model 505, which uses the 5 U-P-1 has been announced by the Hickok Electrical Instrument Co., 10521 Dupont Avenue, Cleveland, Ohio.

Features include a wide and narrow band f-m oscillator, a wide-band, high-gain vertical amplifier (to 1 mc), a modulation circuit which permits the f-m oscillator to be either internally modulated or from an external source such as phonograph pick up, or microphones, demodulator which permits any modulated r-f signal to be viewed, self-contained mixer circuit, permitting f-m output with any good signal generator, sinusoidal sweep with phasing control, and a 3 range frequency compensated attenuator network in vertical amplifier.



CLARKSTAN SWEEP-FREQUENCY GENERATOR

A sweep-frequency generator model 125, has been announced by The Clarkstan Corp., 11927 West Pico Boulevard, Los Angeles 34, Calif.

Designed to operate in the audio range in conjunction with a scope. Complex signal is produced by scanning photoelectrically a synchronously rotating disc, modulated photographically from a precision pattern.

Output, 7 volts, open circuit, 50 milliwatts or 5 volts into 500 ohms; internal impedance, 200 ohms; frequency range, 40 cps to 10 kc with 40 cycle a-c; marker pulses at 1, 3, 5, 7, 9, and 10 kc. Sweep frequency governed by 20 synchronizing pulses per second.



"X" MARKS THE SPOT



... where the X-3-42 Receptacle (shown just above) unobtrusively reposes underneath the table top so that the intercommunication phone may be moved around the executive conference table. The Type "X" Series is particularly adapted to plug-in intercom systems such as shown above, and is also widely used in sound service, instruments, radio and public



X-3-11 Plug
\$1.75 List



X-3-12 Plug
\$1.25 List

address systems. Two plug and 3 receptacle types are available with 3 different insert arrangements (interchangeable): one 15-amp.; three 15-amp.; and three 10-amp. and one 15-amp. contacts. Shells are diecast zinc



X-3-13 Receptacle
\$1.75 List



X-3-14 Receptacle
\$1.25 List

with bright nickel finish, and have accommodation for 3/16" to 9/32" cable. Friction engagement. Available direct from more than 225 distributors over the U.S.A. or from factory.

Listed and priced in the RJC-2 and C-47 Condensed Catalogs. Engineering drawings of the "X" in P&O Bulletin. Specify bulletin desired. Address Dept. D-121.

SINCE 1915
CANNON
ELECTRIC

Development Company

3209 HUMBOLDT ST., LOS ANGELES 31, CALIF.

IN CANADA & BRITISH EMPIRE:
CANNON ELECTRIC CO., LTD., TORONTO 13, ONT.

WORLD EXPORT (Excepting British Empire):
FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO

ANOTHER *New* BROWNING DEVICE

FREQUENCY METER

MODEL S-6

Measures any radio frequency signal between 100 KC and 50 MC. Accurate to $\pm .025\%$.

Frequency meters. WWV standard frequency calibrator. Oscilloscope. Power supply and square wave modulator. Capacitance Relay. FM-AM Tuners. FM Tuner.

WRITE TO DEPT. A FOR CATALOG

KNOW THE ENTIRE BROWNING LINE ENGINEERED for ENGINEERS



Saves Space

THE JOHNSON N250 CONDENSER

Extremely High Voltage Rating In Proportion To Size

When space is limited, yet you need extremely high voltage rating, fine adjustment with uniform voltage breakdown rating throughout the full capacity range, the JOHNSON Type N Neutralizing Condenser is the perfect answer.

Because of their design, these condensers will withstand much higher voltage than conventional flat plate condensers of the same spacing.

High in quality—low in cost. JOHNSON condensers are always a wise choice.

For Complete Details Write For Latest JOHNSON Catalog



E. F. JOHNSON CO.
WASECA, MINNESOTA

News Briefs

INDUSTRY ACTIVITIES

The 14th annual meeting of the Associated Police Communication Officers, Inc., will be held at the Rice Hotel, Houston, Texas, Sept. 20 to 23, 1948.

Paul Franklin of the Houston Police Department is chairman of information for the meeting.

The U-Dryvit Auto Rental Co., Inc., Cambridge, Mass., will establish fixed station and mobile radiotelephone facilities in 21 cities throughout New England and New York State.

The U-Dryvit Co., which rents automobiles and trucks, plans to rent mobile radio-equipped vehicles. In addition, limited common carrier systems will be set up as a separate service to customers. Installations in privately owned vehicles will also be made.

Ultimate use of 1915 Philco mobile units is planned.

Gordon Huggins is general manager of the radiotelephone division of U-Dryvit.

At present, U-Dryvit operates a 100-unit system in the Boston area.

WDTV, Pittsburgh outlet of the DuMont television network, is expected to be on the air with test patterns by the middle of September, and with a full program schedule by December 1.

WDTV is being constructed in the Braslear Reservoir district, with transmitting antenna 1,140' above river level in Pittsburgh.

The transmitter will equal WABD's in signal strength, with an effective radiated power of 14.25 kw for video and 9.45 kw for audio.

Andrew Corporation, Chicago, recently received a citation from the Illinois department of the Disabled American Veterans for hiring a greater percentage of veterans than any other concern in Chicago.

WGHP, the 20,000-watt f-m station owned by Capt. W. G. H. Finch, New York City, has become affiliated with the Rural Radio Network, Inc., of Ithaca, N. Y.

The network, owned and operated by the ten statewide farm organizations of New York, has under construction six f-m stations on mountain tops across upper New York State.

A Canadian IRE Convention will be held in the Roof Garden of the Royal York Hotel, Toronto, on April 30 and May 1.

Papers to be presented include: *Narrow Beam Radar Recording Altimeter*, B. J. McCaffrey, National Research Council; *Frequency Allocations*, L. E. Coffey and C. J. Acton, Department of Transport; *Industrial Electronics*, J. T. Thwaites, Canadian Westinghouse Co., Ltd.; *A Direct Reading Phase Monitor*, D. F. Wright, Canadian Marconi Company; *F-M Field Intensity Measurement*, J. E. Hayes, Canadian Broadcasting Corp.; *Recent Developments in Facsimile*, F. A. Hester, Radio Inventions; *The Reproduction of Sound*, E. O. Swan, CKEY; *New Measuring Equipment in the Radio Industry*, Col. B. DeF. Bayly Engineering, Ltd.; *25 Cycle Operation of Television Receivers*, Orin Dakin, Canadian General Electric Co., Ltd.; and *Theatre Television Systems*, H. Goldin, Gaumont-Kalee, Ltd.

B. E. Shackelford, IRE president, will be the guest speaker at the banquet which will be held on Friday, April 30.

PERSONALS

Henry G. Randolph has been appointed district manager at Dallas, Texas.

He succeeds Walter M. Skillman who was recently appointed sales manager of standard line radios in the G. E. receiver division.

R. E. Mathes, recently chief engineer of Finch Telecommunications, has been named chief engineer of the Gray Research & Development Company, Inc., Elmsford, N. Y.

Edgar Kobak, president of Mutual, has been elected president of the Radio Pioneers, a 20-year club, succeeding Mark Woods, president of ABC.

Otis S. Freeman has joined the engineering staff of WPIX as assistant for operations. Freeman was with WABD for four years as chief operating engineer.



O. S. Freeman

Dr. John A. Hutcheson has been appointed director of the Westinghouse Research Laboratories, succeeding Dr. L. Warrington Chubb.

David Ferrier is now assistant to the president of the Servo Corporation of America, Lindenhurst, N. Y.

Ferrier was formerly with Harvey Radio Labs.

Ray S. Groenier has been appointed RCA sales engineer in charge of communications sales for the southwest region.

Groenier will headquarter at 1907-11 McKinney Avenue, Dallas, Texas.

Groenier was formerly chief radio engineer for the Madison, Wis., Police Department.

Anthony Wright, formerly chief RCA tv receiver engineer, has been appointed chief engineer of The Magnavox Company.

Free

Concord RADIO CATALOG

23 pgs. Radio & Television Sets - 62 pgs. Radio Parts
18 pgs. Sound Amplifiers & Accessories - 23 pgs. New Gear
8 pgs. Electronic Test Equipment

160 VALUE-PACKED PAGES

Write for FREE copy of this great, new Concord Catalog—a vast, complete selection of everything in Radio, Television and Test Equipment. Thousands of items... new, latest 1948 prices. See new LOWER prices on finest-quality RADIO SETS, PHONO-RADIOS, RECORD CHANGERS, RECORD PLAYERS, RECORDERS—wire and disc, PORTABLES, AMPLIFIERS, COMPLETE SOUND SYSTEMS, TESTERS. Complete latest listings of all well-known standard, dependable lines of radio parts and equipment. 4,212,014 SATISFIED CUSTOMERS CANNOT BE WRONG! For more than a quarter century at CONCORD the customer has been the Most Important Person in the world. This established reputation for Customer Satisfaction is the reason Radio Men (the Experts Who Know) keep coming back to CONCORD for every radio and electronic need. At CONCORD, YOU MUST BE COMPLETELY SATISFIED or your money will be cheerfully refunded. Write for Catalog Now—Please address Dept. 224

CONCORD RADIO CORP.

CHICAGO 7 265 Peachtree Street
901 W. Jackson Boulevard
Downtown Chicago Branch: 229 W. Madison Street
LAFAYETTE RADIO CORP.

PRECISION SERVICING

and Testing of
Communications Equipment
(Receivers and Transmitters)

According to exacting factory specifications for:
Sensitivity . . . A-F Response
Image Rejection Ratios
Bandwidths, etc.

Test Equipment

("Scopes, Signal Generators, etc.)

Also serviced and tested carefully according to laboratory standards.

Hallcrafters

Authorized Service Center

Design and Construction of Special Electronic Equipment

All Service Work Guaranteed

WINTERS RADIO LABORATORY

11 Warren Street (Room 317)

N. Y. 7, N. Y. Tel.: COrtlandt 7-1361

INCREASED INSULATION BETTER CONNECTIONS JONES BARRIER Terminal Strips

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder head screws and terminals brass, nickel plated. Insulation, molded bakelite.



No. 2-142



No. 2-142-3/4 W



No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, 1/4-28 screws.

Catalog No. 16 lists complete line. Send for your copy.

HOWARD B. JONES DIVISION

Cinch Mfg. Corp.

2460 W. GEORGE ST. CHICAGO 18, ILL.

W. Hamilton Walter is now coordinator of sales for the Raytheon Manufacturing Co., Waltham, Mass. He will supervise Raytheon's marketing, advertising and public relations programs.

Ben Adler has opened a consulting engineering office at 15 Gedney Circle, White Plains, N. Y. He will specialize in broadcast facilities design, construction supervision and tv installation.

Dr. B. S. Ellefson, director of Central Research Laboratories, Sylvania Electric Products, Inc., will discuss **Ceramic Developments in the Electronic Field** at the May 19 meeting of the Metropolitan New York Section of the American Ceramic Society. As a part of the same program A. J. Monack, consulting engineer, will discuss **The Chemistry of Glass-Metal Seals**. Meeting will be held at Trammer's Restaurant, 1 West 52nd St., and begin at 5 p.m.

Rear Admiral Walter Albert Buck, U. S. Navy (Ret.), former Paymaster General and Chief of the Bureau of Supplies and Accounts in the Department of the Navy, has been elected president of Radiomarine Corporation of America.



Admiral Buck

J. E. Mossman, Phillips Control Corp., has been named chairman of the National Association of Relay Manufacturers' Committee on Standards and Nomenclature for 1948.

Other members of the committee include E. H. Gillette, Allied Control Corp., Inc., Fred W. Falck, Jr., Advance Electric & Relay Co., R. M. Brumfield, Potter & Brumfield Mfg. Co., Inc., and F. F. Rowel, Sr., Guardian Electric Mfg. Co.

LITERATURE

RCA Engineering Products, Camden, N. J., have released a 16-page brochure describing a 10-kw f-m broadcast transmitter, type BTF-10B.

Topics discussed in booklet include direct f-m, automatic frequency stability, grounded-grid amplifiers, power stage, power supply and control circuits, and general performance specifications.

The Standard Piezo Co., P. O. Box 164, Carlisle, Pa., have published a 4-page bulletin describing 11 types of mounted crystals. Crystal ranges include 1 to 20 mc, 100 to 10,000 kc, 3,000 to 10,000 kc, 12 to 75 mc and 400 to 10,000 kc.

The Broadcast Operators Handbook described in the March issue of COMMUNICATIONS is priced at \$3.30 and not \$3.00.

The Chemical Publishing Co., Inc., 26 Court Street, Brooklyn 2, N. Y., have published a 1948 catalog of technical books.

Catalog includes books on chemistry, physics, science, technology, engineering, metals, technical dictionaries, etc.

John F. Rider, Publisher, Inc., 404 Fourth Avenue, New York 16, N. Y., has published a 416-page book on **F-M Transmission And Reception**, by John F. Rider and Seymour D. Uslan.

One section covers narrow-band and wide-band transmitters. Both direct and indirect f-m transmitter theory is explained. Transmitting and receiving antennas are also described.

Receivers are analyzed in another portion of the book. There is also a chapter on alignment of receivers, with both the meter and visual method discussed. Such servicing problems as relocation of antennas, image response, noise and oscillator troubles, cathode lead inductances, etc., are contained in last chapter.

The RCA Tube Department has published a revised edition of the reference booklet, **RCA Receiving Tubes for Television, FM, and Standard Broadcast**.

The new edition contains 24 pages and includes data on tv picture tubes.

Booklet (form 1275-D) can be obtained from RCA tube distributors, or by sending 10 cents to Commercial Engineering RCA Tube Department, Harrison, N. J.

Practical help
with your problems in

ULTRAHIGH FREQUENCY TRANSMISSION & RADIATION

By NATHAN MARCHAND

A book for practicing engineers who have to use UHF in systems of mobile and relay communications; frequency modulation; relay and color television; pulse time modulation; and in many other specialized applications. The basic principles of UHF are presented so that you can readily apply them to your particular problems. All derivations and developments in the text lead to results that you can use on the job. M.K.S. units have been used throughout.

"This book is extremely well written, covers those topics of major interest . . . and presents the material with clarity and precision."

—Thomas J. Higgins, Illinois Institute of Technology

CONTENTS:

Transmission Lines; Elements of Vector Analysis; Fundamental Electromagnetic Equations; Plane Electromagnetic Waves; Radiation; Antenna Arrays; Wave Guides; Complex Transmission Line Network Analysis.



1947, 322 Pages; \$4.50

ON APPROVAL COUPON

JOHN WILEY & SONS, INC.

440 Fourth Ave., New York 16, N. Y.

Please send me, on ten days' approval, a copy of Marchand's **ULTRAHIGH FREQUENCY TRANSMISSION & RADIATION**. If I decide to keep the book, I will remit \$4.50 plus postage; otherwise I will return the book postpaid.

Name

Address

City State

Employed by
(Offer not valid outside U. S.)

C-4-48



COSMALITE* TUBES FOR *Television* DEFLECTION YOKES

These spirally laminated paper base, Phenolic Tubes are obtainable in sizes and with punching and notching that meet each customer's individual needs.

Quality performance at prices that appeal.

OTHER COSMALITE TYPES INCLUDE . . .

≠96 Cosmalite for coil forms in all standard broadcast receiving sets.

SLF Cosmalite for Permeability Tuners.

Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

Partial List of Radio & Television Receivers in which COSMALITE is used:	
STEWART WARNER	HOWARD
MOTOROLA	BELMONT
ZENITH	ADMIRAL
FARNSWORTH	SENTINEL
MAGNAVOX	WELLS GARDNER
BENDIX RADIO	WARWICK

Inquiries given specialized attention.

*Trade Mark Registered

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

- All-Fibre Cans • Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

PRODUCTION PLANTS also at Plymouth, Wisc., Ogdenburg, N.Y., Chicago, Ill., Detroit, Mich., Jamesburg, N.J.,
 PLASTICS DIVISION at Plymouth, Wisc. • ABRASIVE DIVISION at Cleveland, Ohio
 *SLES OFFICES: Room 5632, Grand Central Term. Bldg., New York 17, N.Y., also 647 Main St., Hartford, Conn.
 CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario



ADVERTISERS IN THIS ISSUE COMMUNICATIONS INDEX APRIL, 1948

ALLIED CONTROL CO., INC. Agency: Michel-Cather, Inc.	36
ALLIED RADIO CORP. Agency: George Brodsky, Advertising	34
AMERICAN TELEPHONE & TELEGRAPH CO. Agency: N. W. Aver & Son, Inc.	7
ANDREW CO. Agency: Burton Browne, Advertising	31
BENDIX RADIO DIV. BENDIX AVIATION CORP. Agency: MacManus, John & Adams, Inc.	32
BROWNING LABORATORIES, INC.	30, 34, 38
CANNON ELECTRIC DEVELOPMENT CO. Agency: Dana Jones Co.	37
THE CLEVELAND CONTAINER CO. Agency: The Nesbitt Service Co.	40
CONCORD RADIO CORP. Agency: E. H. Brown Adv. Agency	38
FEDERAL TELEPHONE & RADIO CORP. Agency: Rickard & Co.	Back Cover
GENERAL RADIO CO.	Inside Back Cover
HEWLETT-PACKARD CO. Agency: L. C. Cole, Advertising	24
E. F. JOHNSON CO. Agency: Rudolph Bariz, Advertising	38
HOWARD B. JONES DIV. CINCH MFG. CORP. Agency: Merrill Symonds, Advertising	39
KELLOGG SWITCHBOARD & SUPPLY CO. Agency: Evans Associates, Inc.	5
JAMES B. LANSING SOUND, INC. Agency: Julian H. Besel & Associates	34
LENZ ELECTRIC MFG. CO. Agency: Triangle Adv. Agency, Inc.	6
MEASUREMENTS CORPORATION Agency: Frederick Smith	37
JAMES MILLEN MFG. CO.	30
THE OKONITE CO. Agency: Doyle, Kitchen & McCormick, Inc.	33
PAR-METAL PRODUCTS CORP. Agency: H. J. Gold Co.	34
PHILCO CORPORATION Agency: Julian G. Pollock Co.	17
PREMAX PRODUCTS DIV. CHISHOLM-RYDER CO. Agency: Norton Adv. Service	30
PRESTO RECORDING CORP. Agency: Roy S. Durrstine, Inc.	1
RADIO CORPORATION OF AMERICA Agency: J. Walter Thompson Co.	18, 19
SHALLCROSS MFG. CO. Agency: The Harry P. Bridge Co.	29
SORENSEN & CO., INC. Agency: Henry A. Stephens, Inc.	Inside Front Cover
SYLVANIA ELECTRIC PRODUCTS INC. Agency: Newell-Emmett Co.	3
TECH LABORATORIES, INC. Agency: Lewis Adv. Agency	32
U. S. TREASURY DEPT.	6
WARD LEONARD ELECTRIC CO. Agency: Henry H. Teplitz, Advertising	35
WILCOX ELECTRIC CO. Agency: Arthur G. Rippey & Co.	4
JOHN WILEY & SONS, INC. Agency: The Waterston Co.	39
WINTERS RADIO LAB.	39

METERS—by



**TYPE 727-A
VACUUM-TUBE VOLTMETER**

This general-purpose, battery-operated vt voltmeter is for use at frequencies up to about 100 megacycles.

RANGE — 0.05 volt to 300 volts ac, in seven ranges (0.3, 1, 3, 10, 30, 100, 300 volts, full scale)

ACCURACY — With sinusoidal voltages applied, the accuracy is $\pm 3\%$ of full scale on the 0.3-volt range and $\pm 2\%$ of full scale on all other ranges. Periodic checking of the full-scale sensitivity will give corrections to be made to eliminate effects of aging on the higher voltage ranges.

WAVEFORM ERROR — On lowest ranges the instrument approximates a true square-law device. It is calibrated to read the r-m-s value of a sinusoidal voltage. On the higher voltage ranges it is essentially a peak-reading instrument calibrated to read 0.707 of the peak values and on distorted waveforms the percentage deviation from r-m-s values may be as large as the percentage of harmonics present.

FREQUENCY ERROR — Less than 1% between 20 cycles and 30 Mc. At 65 Mc the error is about +5% and at 100 Mc about +10%.

INPUT IMPEDANCE — The input capacitance is about 16 micromicrofarads. Parallel input resistance (at low frequencies) is about 5 megohms on the lower ranges and about 3 megohms on the upper.

PRICE: \$180



**TYPE 728-A
D-C VACUUM-TUBE VOLTMETER**

This battery-operated vt voltmeter is designed for measuring d-c voltages in low-power circuits where no appreciable power can be taken by the meter.

RANGE — 0.05 to 3000 volts in seven ranges (3, 10, 30, 100, 300, 1000, 3000 volts, full scale)

ACCURACY — Within $\pm 3\%$ of full scale on all ranges. If the full-scale sensitivity is checked occasionally the effect of aging, on the higher voltage ranges, can be eliminated.

INPUT RESISTANCE — 1000 megohms on the ranges above 100 volts; greater than 5000 megohms on the lower.

TERMINALS — Two sets of input terminals are provided; one for measurements at the 0 to 30 volts end of the range and the other for higher voltages.

POLARITY — A reversing switch on the panel permits measurements with either the positive or the negative of the source grounded to the panel of the instrument.

EFFECT OF A-C — A superimposed a-c voltage of as high as 200 volts has negligible effect on meter indication.

PRICE: \$155



**TYPE 729-A
MEG OHMMETER**

This battery-operated megohmmeter is particularly useful where portability is required. It is well suited to field measurements of leakage resistance of cables and insulation.

RANGE — 2000 ohms to 50,000 megohms in five overlapping ranges.

SCALE — Standard direct-reading ohmmeter calibration is used; center scale values are .1, 1, 10, 100 and 1000 megohms.

ACCURACY — Within $\pm 5\%$ of the indicated value between 30,000 ohms and 3 megohms when the center decade of the scale is used; otherwise the error is increased because of the compressed scale.

TEMPERATURE AND HUMIDITY — Effects of these are negligible over normal range of room conditions (65 to 95 deg. F.; 0 to 95% relative humidity).

VOLTAGE ON UNKNOWN — Voltage applied to the unknown does not exceed $2\frac{1}{2}$ volts and varies with meter indication.

PRICE: \$105

THESE three accurate, highly stable and portable meters are all battery-operated and completely self-contained. They are housed in identical walnut cabinets 11 inches by 6 $\frac{5}{8}$ inches by 5 $\frac{3}{8}$ inches in size. Their accuracy is sufficient for a wide variety of measurements both in the laboratory and in the field.

Other G-R meters include a portable a-c operated vacuum-tube voltmeter for audio and radio frequency measurements up to several hundred megacycles, a crystal galvanometer direct-reading in voltage between 30 and 1,000 megacycles, an a-c operated megohmmeter with a range of 2,000 ohms to 50,000 megohms, a counting rate meter for measuring random emanations from radio-active materials, three models of output-power meters, and an audio-frequency microvoltage with an output voltage range of 0.1 microvolt to 1 volt.

G-R meters are carefully designed, correctly engineered, ruggedly constructed and accurately calibrated to insure many years of useful life.

A FEW OF EACH IN STOCK FOR PROMPT SHIPMENT

GENERAL RADIO COMPANY

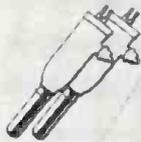
**Cambridge 39,
Massachusetts**

90 West St., New York 6

920 S. Michigan Ave., Chicago 5

950 N. Highland Ave., Los Angeles 38

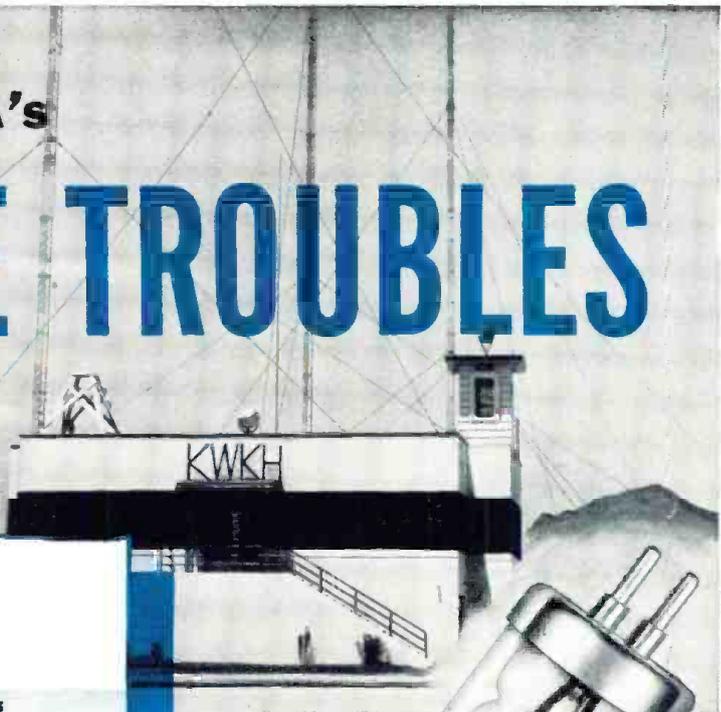
Federal's



342-A's

END TUBE TROUBLES

at



RADIO STATION

KWKH

JOHN D. BOWEN, President

30,000 WATTS → CBS

SHREVEPORT, LOUISIANA

FEBRUARY 14, 1948

Mr. C. J. HARRISON, SALES MANAGER
VACUUM TUBE DIVISION
FEDERAL TELEPHONE AND RADIO CORPORATION
CLIFTON, NEW JERSEY

DEAR MR. HARRISON:

YOU WILL DOUBTLESS BE PLEASED TO KNOW THAT, SINCE WE REPLACED THE DRIVER-STAGE TUBES IN OUR 50KW TRANSMITTER WITH TWO OF YOUR FTR 342-A TUBES, WE'VE HAD NO MORE TUBE TROUBLE.

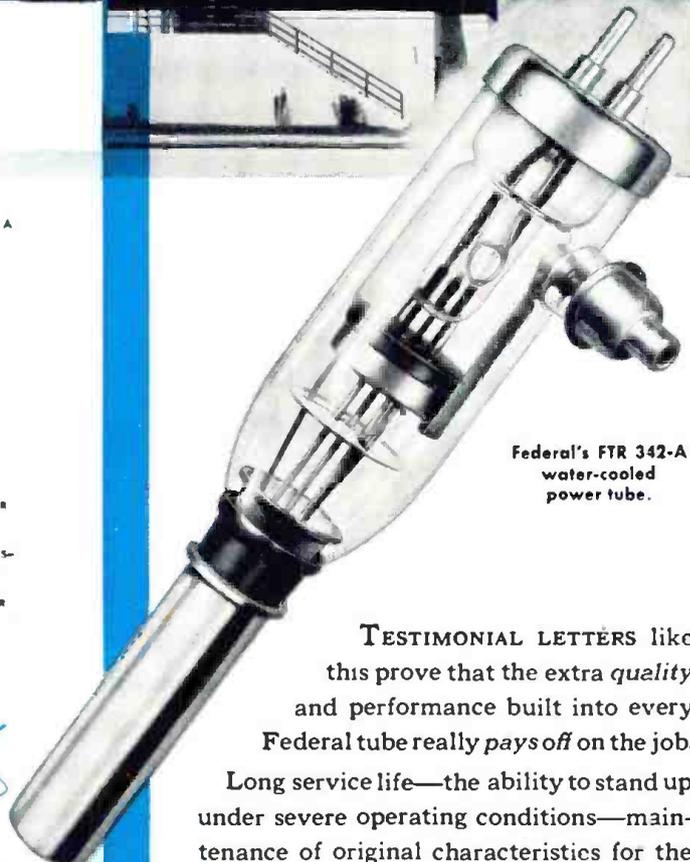
THIS IS A REAL RELIEF AS FREQUENT INTERNAL ARCING HAD BEEN CAUSING US PLENTY OF "HEADACHES". MR. CHATFIELD HAS PROBABLY TOLD YOU ABOUT THIS SITUATION, BUT WE THOUGHT YOU'D LIKE TO HEAR, FIRST-HAND, THAT YOUR TUBES ARE DOING SUCH AN EXCELLENT JOB FOR US. FROM NOW ON FEDERAL IS THE TUBE FOR US.

VERY TRULY YOURS,

RADIO STATION KWKH

W. E. Antony
W. E. ANTONY
CHIEF ENGINEER

OWNED AND OPERATED BY THE SHREVEPORT TIMES



Federal's FTR 342-A water-cooled power tube.

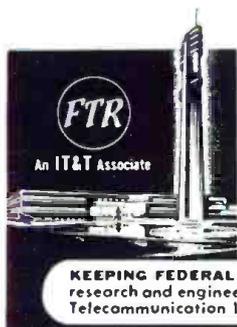
TESTIMONIAL LETTERS like this prove that the extra *quality* and performance built into every Federal tube really *pays off* on the job.

Long service life—the ability to stand up under severe operating conditions—maintenance of original characteristics for the life of the tube. These are the result of Federal's 37 years of research and experience in designing and manufacturing better broadcast tubes. The result of careful attention to every *detail*, and vigorous testing all along the line.

Write Federal today for information on broadcast tubes for your requirements. Dept. K910.

Federal Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY



KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N. Y.