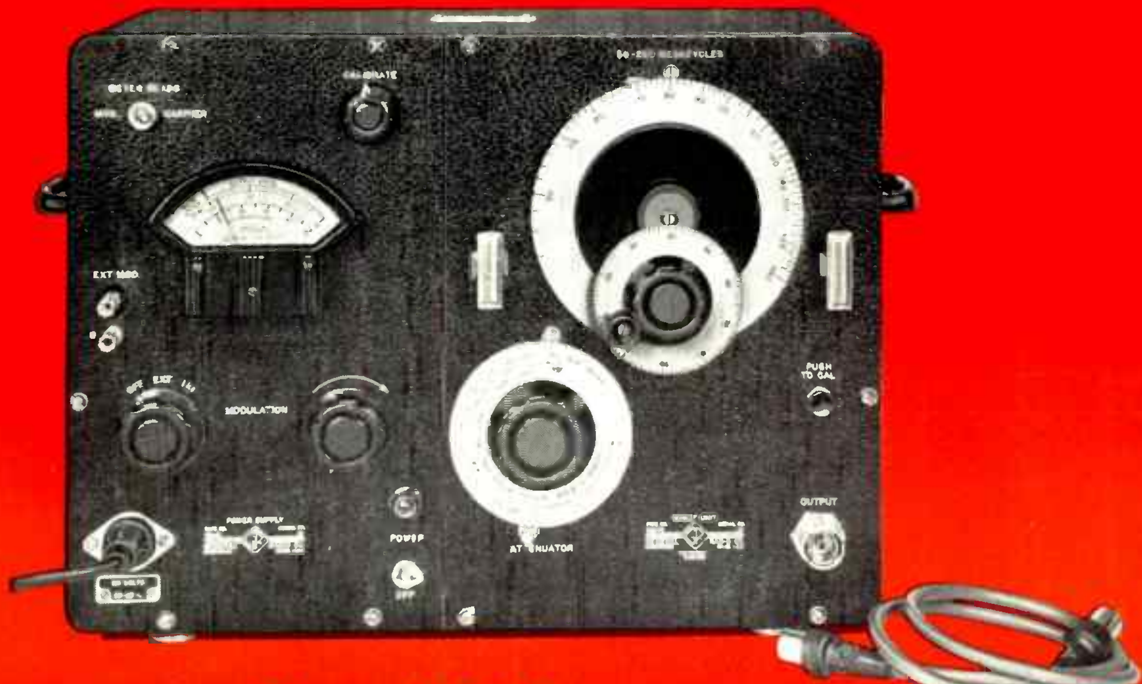
Price 25 Cents May '50

FM-TV RADIO COMMUNICATION

★ ★ Edited by ★ ★
Milton B. Sleeper

10th Year of Service to Management and Engineering

Announcing A New GR Standard Signal Generator



50 to 920 Mc

THE new General Radio Type 1021-A Standard-Signal Generator operates at frequencies between 50 and 920 Mc with the same convenience and reliability found in other G-R generators in the broadcast frequencies.

Its main use is the determination of radio receiver and circuit characteristics. With an inexpensive diode modulator, television picture modulation can be produced for overall testing of television receivers.

It is a convenient and well-shielded source of power for measurements with bridges, impedance comparators, and slotted lines. For these uses internal modulation is provided.

With the new G-R Type 874 line of Coaxial Elements, this generator provides a very complete and flexible system for measurements of voltage, power and standing-wave ratio from 50 to 920 Mc.

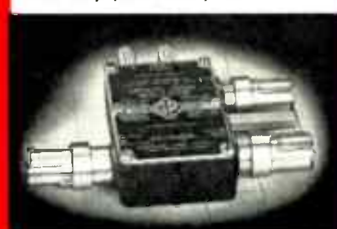
FEATURES

- **SIMPLICITY, RELIABILITY, CONVENIENCE** of a standard broadcast generator. **ACCURATE · COMPACT · LIGHTWEIGHT**
- **MODERATELY PRICED**
- **BUTTERFLY TUNING CIRCUIT** . . . no sliding contacts . . . no noise . . . perfectly smooth tuning . . . rugged design with good stability and very low drift
- **REGULATED POWER SUPPLY** assures good heterodyne beat note
- **OUTPUT FROM 0.5 MICROVOLT TO ONE VOLT** with overall accuracy better than ±20%
- **INTERNAL OUTPUT IMPEDANCE** 50 ohms
- **LEAKAGE AND RESIDUAL OUTPUT VOLTAGE** below sensitivity of most receivers
- **INTERNAL 1000-CYCLE AND EXTERNAL AMPLITUDE MODULATION** over audio range, adjustable from 0 to 50% . . . incidental fm under 100 parts per million over most of the ranges
- **T-V PICTURE MODULATION ON ALL CHANNELS** from 50 to 920 Mc with NO INCIDENTAL FM, when Type 1000-P6 Crystal-Diode Modulator and source of video signals are used. The power requirements for modulation are so low, video output from a standard T-V receiver can be used

TYPE 1021-AV V-H-F Standard-Signal Generator (50-250 Mc)...............	$595.00
TYPE 1021-AU U-H-F Standard-Signal Generator (250-920 Mc).............	615.00
TYPE 1000-P6 Crystal-Diode Modulator..................................	35.00

Type 1021-P2 Oscillator Unit (250-920 Mc)
Two separate oscillators are available. They are mechanically and electrically interchangeable, and are sold as separate units to convert the range of one standard-signal generator to that of the other.

TYPE 1021-P2 U-H-F Oscillator Unit only (250-920 Mc).... $420.00
TYPE 1021-P3 V-H-F Oscillator Unit only (50-250 Mc)..... $400.00

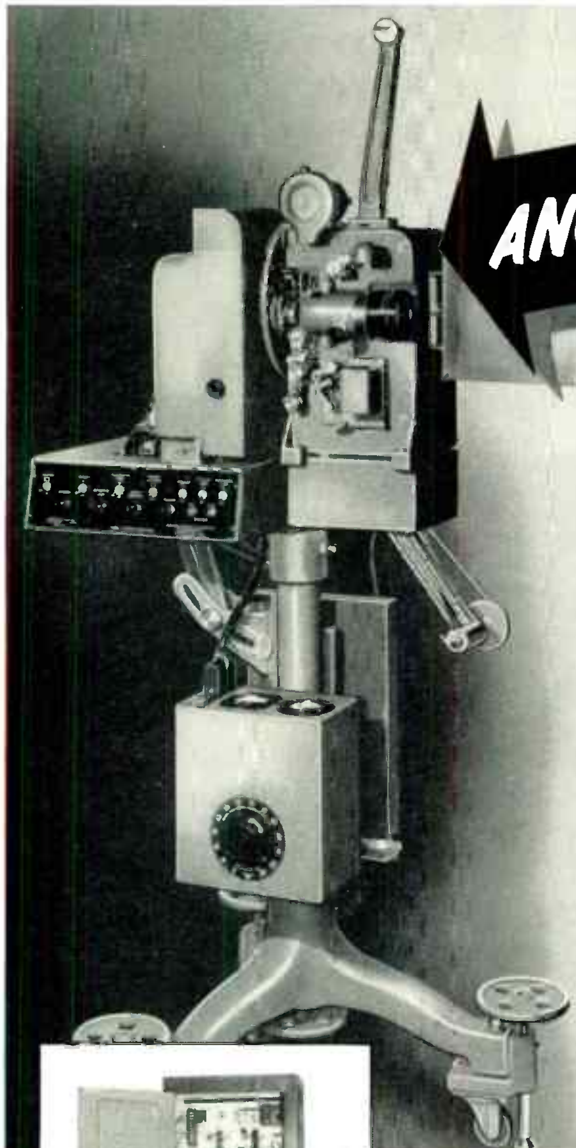


Type 1000-P6 Crystal Diode Modulator
An inexpensive, wide-band modulator for amplitude modulation of carrier frequencies between 20 and 1000 Mc. Modulation-frequency range is 0 to 5 Mc.
$35.00

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 · 920 S. Michigan Ave., Chicago 5 · 1000 N. Seward St., Los Angeles 38



ANOTHER DUMONT FIRST!

The New Du Mont-Holmes *SUPERSPEED* Projector

- Sets new standards of performance, utility and economy for TV station operation. Provides a means of film pickup that approaches the contrast and clarity characteristic of studio productions.

- **DIRECT FILM PROJECTOR**

Used with a Du Mont Special Image-Orthicon film pickup to give *studio clarity* to movies and teletranscriptions.

- **BACKGROUND PROJECTOR**

Brings dramatic moving sets and backgrounds into any studio. Eliminates costly and cumbersome sets and backdrops.

FLYING SPOT SCANNER

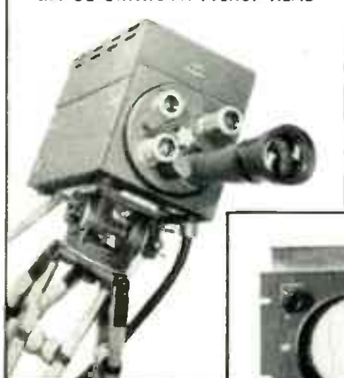


IMAGE ORTHICON PICKUP HEAD

For information on the Superspeed Projector or other Du Mont Telecasting Equipment write, phone, or visit.

RF WAVEFORM MONITOR

ACORN TRANSMITTER

DUMONT *First with the Finest in Television*

ALLEN B. DU MONT LABORATORIES, INC., TELEVISION TRANSMITTER DIVISION, CLIFTON, N. J.

ZENITH World's FOREMOST Radio Manufacturer Brings You the World's FOUR MOST Popular Portables

REG. U. S. PAT. OFF.

Dealers everywhere acclaim these the "SELLINGEST" sets in radio!

They're tops for turnover—these handsomely-styled, super-powered portables with the many sales-making features only Zenith can provide. Look them over. Compare them for stunning beauty, for demonstrable features, for honest quality, for built-in value—then note their down-to-earth price—and you'll easily see why Zenith dealers are looking forward to this summer as the biggest money-making season in portable radio history!

the sensational . . .

New Zenith "Universal"

with styling that stops them . . . performance that sells!

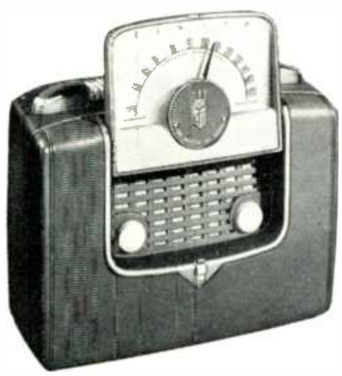
Even in remote locations where many portables fail, the Universal* comes through with amazing clarity and volume. The secret? An extra-powerful circuit with Tuned R.F. amplification . . . A new, more sensitive Alnico 5 Speaker and the exclusive Wavemagnet*. Plays instantly when lid is opened, turns off when closed. Luggage-type buffalo-grained case in black or brown. A natural for summer sales! AC/DC or Battery operation. **$49.95†** *Less Batteries*

Customer's Choice—Coast-to-Coast!

world's finest portable—with the world's finest reputation . . .

"Trans-Oceanic"

The world-famous portable that's extra-powered for long-range reception. Brings in Standard Broadcast plus international Short Wave on 5 separate bands. Plays anywhere—on boats, trains, planes and is Tropic-Treated for resistance to humidity. AC/DC or Battery operation. **$99.95†** *Less Batteries*



Tip-Top Holiday*

A streamlined beauty that catches everyone's eye! Lid swings up to reveal giant dial—give tip-top tuning ease. Set plays when lid is raised, shuts off when closed. Rugged cabinet in handsome ebony or two-tone blue-grey plastic! AC/DC or Battery operation. **$39.95†** *Less Batteries*

Zenith "Zenette"

Exactly what customers want in a personal radio! Only Zenith engineering skill could produce a tiny portable with such big-set performance. Has built-in Wavemagnet, plays on AC, DC, or battery. Black, maroon or white plastic case gives it maximum sales appeal. **$39.95†** *Less Batteries*

. . . if you want PROFITS—you want ZENITH PORTABLES!

*Reg. U. S. Pat. Off. †Suggested retail price. West coast and far South prices slightly higher. Prices subject to change without notice.

ZENITH LONG DISTANCE RADIO and TELEVISION — THE ROYALTY OF RADIO AND TELEVISION

ZENITH RADIO CORPORATION
6001 DICKENS AVENUE • CHICAGO 39, ILLINOIS

FM-TV

Formerly, *FM* MAGAZINE, and *FM* RADIO-ELECTRONICS

VOL. 10 MAY, 1950 NO. 5

CONTENTS

MILTON B. SLEEPER, *Editor and Publisher*

ROY F. ALLISON, *Associate Editor*
CHARLES FOWLER, *Business Manager*
LILLIAN BENDROSS, *Circulation Manager*
SOPHIE FORTY, *Production Manager*
Published by: FM COMPANY

Publication Office: 264 Main St., Gt. Barrington, Mass. Tel. Gt. Barrington 500

Chicago Office: Louis Reinig, 176 W. Adams St. Tel. Andover 3-5585

FM-TV Magazine is issued on the 10th of each month.

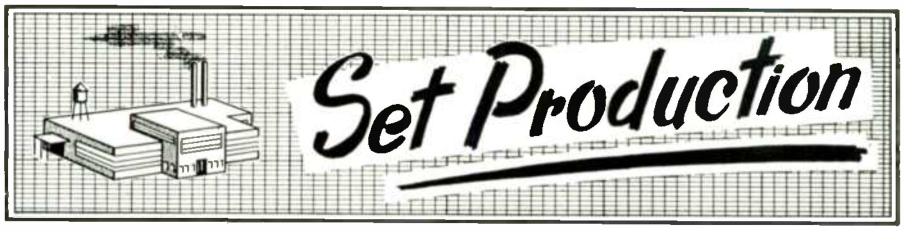
Subscriptions: Should be addressed to 264 Main St., Great Barrington, Mass.

Single copies 25c—Subscription rate: $6.00 for three years, $3.00 for one year in the U. S. A.—Canada, add 50c per year postage—foreign, add $1.00 per year postage.

Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will *FM-TV* Magazine be responsible for their safe handling in its office or in transit.

Entered as second-class matter August 22, 1946, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Boston, Mass. Printed in the U. S. A.

CPA AUDIT
CIRCULATION AUDITED BY HENRY R. SYKES, CERTIFIED PUBLIC ACCOUNTANT SYKES, GIDDINGS & JOHNSON PITTSFIELD, MASSACHUSETTS



Set Production

SET production reported by RMA members showed an increase of 31,477 TV units in February over January, while AM production went up 3,743, and FM dropped by 2,681.

If, as is generally anticipated, TV sales ease off a little this summer, a little slack will be welcomed because of the continued shortage of components. Parts manufacturers, however, will have no respite, for they will be hard put to meet industry estimates of 5½ to 6½ million TV sets to be produced this year.

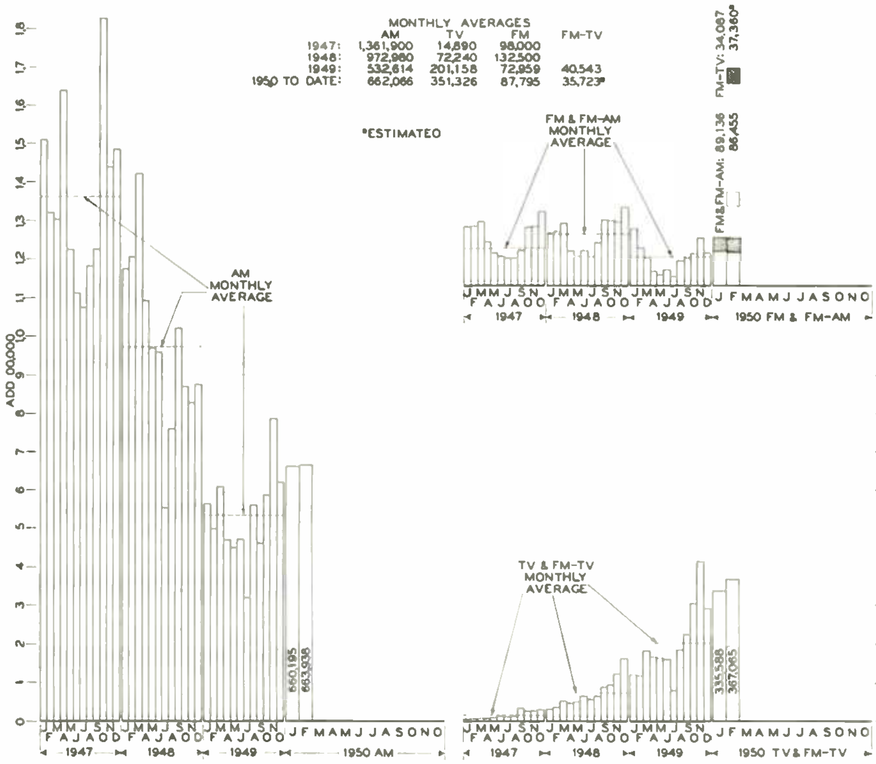
In the RMA bulletin dated March 20, it was stated that figures compiled by the Statistics Committee showed that "7,456,000 home type radios, other than those in TV sets, and 3,964,000 automobile radios" were produced by the entire industry in 1949. There must be an error somewhere in these figures, because the bulletin of January 22 gave a total figure of 7,266,876 for all AM and FM sets in 1949, including 2,291,884 auto models. That would leave 4,974,992 home type sets.

This shows a discrepancy of 2½ million home sets and over 1½ million automobile types. Of course, some manufacturers don't belong to RMA, but we doubt if they have enough production to account for this difference. Such an error is not necessarily important to the manufacturers, but it may well lead to misconceptions when broadcasters use the figures to gauge the status of audio receivers in use.

February receiving type tube sales were up 2½ million over January, and nearly double January 1949. Biggest jump was in the 20,073,094 tubes for new sets. Smaller increases were represented in 3,935,796 for replacements, 758,607 for export, and 98,049 for Government agencies.

Increased preference for large TV images was reflected in picture tube sales for February. Of the TV types for new sets, 96% were 12 ins. or larger, and 35% were 14 ins. or larger. This compares with 90% and 39% in January.

Sales to manufacturers amounted to 427,189 units valued at $10,685,295, slightly under January, and 16,783 units for replacement, valued at $389,719. All types of cathode-ray tubes, including oscilloscope and camera pickup types, aggregated 449,501 units at $11,294,417.



TV, FM, and AM Set Production Barometer, prepared from RMA figures

HAMMARLUND: *Perfected System of Selective Calling*

Approved—**Approved by manufacturers and users because it is technically sound and has been successfully field tested over a period of years.**

Specified—**Specified by leading manufacturers of two-way radio for all selective calling applications because of guaranteed customer satisfaction.**

Used—**Used in large and exacting installations because of its economy, versatility, and reliability.**

Available—**Available to fill your needs for privacy, speed, safety, and convenience. Add it to your existing system or specify it for your new systems.**

RCA—Business and Professional Telephone Exchange, Los Angeles, Cal. 2 Hammarlund SCPB Push Button Central Station Coders and 20 SCM-30 Mobile Control Unit, Audio Mute Type.

LINK—Republic of Cuba National Police, Havana, Cuba. 1 Hammarlund SCPB Push Button Central Station Coder, 3 SCF-30-C Dial Central Station Coders and 50 SCM-30-T Mobile Control Units, Bell Ringer Telephone Type.

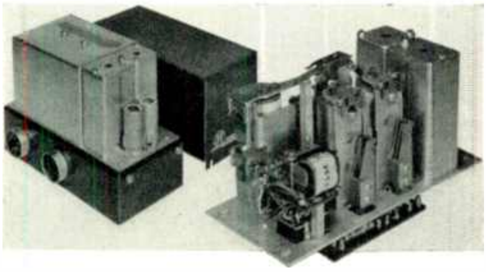
G. E.—Philadelphia Suburban Transit Company, Philadelphia, Pa. 1 Hammarlund SCF-30-C Dial Central Station Coder and 25 SCM-30-T, Bell Ringer Telephone Type.

PHILCO—Geneva Telephone Company, Geneva, Ohio. 1 Hammarlund SCF-30-C Dial Central Station Coder and 10 SCM-30-T, Bell Ringer Telephone Type.

MOTOROLA—Greenwood Telephone Company, Greenwood, N. Car. 1 Hammarlund SCF-30-C Dial Central Station and 25 SCM-30, Mobile Control Units, Audio Mute Type.

LINK—City of Saint Paul Police and Fire Departments. 2 Hammarlund SCPB Push Button Central Station Coders and 80 SCM-30-T Mobile Control Units, Bell Ringer Telephone Type.

RCA—State of Pennsylvania Flood Control. 1 Hammarlund SCF-30-C Dial Central Station Coder and 24 SCM-30-T Mobile Control Units, Bell Ringer Telephone Type.



Inquiries are invited on radio, carrier or land line control requirements. Systems for remote supervisory control, radio telemetering and fault alarms for microwave relays supplied to your specification needs.

HAMMARLUND MFG. COMPANY, INC.

460 West Thirty-fourth Street, New York 1, N. Y.

THIS MONTH'S COVER

We've had many inquiries as to which tuner and what kind of audio equipment our Editor uses in his home. Accordingly, we photographed it, and it turned out so well that we decided it would make a fine cover picture. The equipment itself is simple and straightforward; perhaps the secret of its superb performance lies therein. A 10-w. audio amplifier is included in the REL 646-B FM receiver, which is ample to drive the efficient Klipsch corner speaker for any program peaks. Duke and NuNu, warming themselves on the 646-B, contribute nothing but approval to the results.

SPOT NEWS NOTES

ITEMS AND COMMENTS, PERSONAL AND OTHERWISE, ABOUT PEOPLE AND COMPANIES CONCERNED WITH RADIO COMMUNICATIONS

WTAR-TV, Norfolk:

New station in Virginia began operation April 3, using 24.5 kw. for video and 12.25 kw. for audio on Channel 4.

Dr. Donald B. Sinclair:

Has been appointed chief engineer of General Radio Company, succeeding Melville Eastham, who retired last February. He received his degree of Doctor of Science in 1935 from M. I. T., where he continued as research assistant and later research associate until 1936, when he joined General Radio. For his wartime work on countermeasures and guided missiles, Dr. Sinclair received the President's Certificate of Merit.

More AM Co-Channel Trouble:

Now there's trouble on 1,550 kc. from a non-directional Mexican station that has been set up on the border of Nuevo Laredo.

Transitcasting in Trenton:

WTOA, owned by the *Trenton Times*, N. J., will provide service to five receivers in vehicles operated by the Trenton Transit Company for a period of 30 days. If tests prove successful, 150 vehicles will be equipped under terms of a 5-year agreement. This will be the 22nd affiliate of Transit Radio, Inc.

Richard R. Hayes:

Engineering firm of Richard R. Hayes & Associates has reopened its office at 1608 Mardell Avenue, San Antonio, Texas. Consulting practice covers communications, and audio and TV broadcasting.

Telemetering Conference:

A three-day discussion of telemetering equipment and techniques, sponsored by the A. I. E. E., will be held at the Benjamin Franklin Hotel, Philadelphia, May 24 to 26. Information can be obtained from S. E. Moore, Philadelphia Electric Company, 900 Sanson Avenue, Philadelphia.

Major General Frank E. Stoner:

Wartime chief of Army communications has joined Weldon & Carr, consulting radio engineers of Washington, D. C. General Stoner, a native of Vancouver, will be in charge of the firm's new branch office at Seattle.

Microphone Data:

A very interesting microphone catalog, illustrated with performance curves, has been issued by The Turner Company, Cedar Rapids, Iowa. Models listed are for studio use, mobile radio, and special applications.

Crystal-Gazing Department:

It's anyone's guess as to what he's thinking, but during the TV hearing on April 5, Chairman Coy suggested a 6-year period for amortizing VHF television, at the end of which time all service would be on UHF. Then the VHF channels could be "utilized by other services. They are needed for other services, and that would be in the public interest."

1840-Mile Microwave System:

Transcontinental Gas Pipe Line Corporation will spend $1 million on a microwave communications system between Mercedes, Tex., and New York City. Seven two-way channels will be provided for the use of district offices, intermediate compressor stations, and maintenance crews patrolling the pipe lines. There will be 30 unattended repeater stations. Entire system is scheduled for completion by March, 1951.

(Continued on page 8)

UNIVERSAL MODULATION MONITOR

Monitors the modulation of all FM communications transmitters on 30 to 162 mc.

THE BROWNING Universal FM Modulation Monitor provides a simple and inexpensive means for every communications supervisor to check his own fixed and mobile transmitters—and those of other systems—for compliance with FCC limitations on carrier swing due to modulation.

Maintenance of frequency swing within the plus-and-minus 15 kc. limit is more than a matter of complying with FCC rules. It is absolutely essential to the reduction of adjacent-channel interference! And, with the BROWNING Universal Modulation Monitor, you can check not only your own transmitters, but those of other systems on 30 to 50, 72 to 76, and 152 to 162 mc.

A single BROWNING Monitor can be used to check all transmitters.

There is no worry or expense of crystals, since the accuracy does not depend in any way on crystal control.

Operation of the BROWNING Monitor is so simple that it can be explained in a few words: The multi-range band-selector switch is set to the proper band, and the unmodulated transmitter carrier is tuned in precisely. Then the carrier is modulated by voice or an audio oscillator, and the frequency swing is read directly from a 4-in. panel meter calibrated to 20 kc. The meter shows sustained sinusoidal modulation or voice peaks of .3 seconds duration. An audio output jack, connected to an amplifier, permits aural monitoring.

Signals of 500 microvolts are adequate to operate the Monitor. If the instrument is mounted permanently at the headquarters station, cars can be checked while they are on the road.

The BROWNING Universal FM Modulation Monitor is carried on a 19-in. panel. It is supplied with a portable case 20½ ins. wide, 9 ins. high, and 12 ins. deep, or without the case for mounting on a rack at headquarters or in a test truck.

Further technical data on the MD-25, and information on price and delivery will be sent on request. Use the coupon below.

Browning Frequency Meters Have Been the Standard for Communications Since 1939

FREQUENCY METERS: Equally important to reducing adjacent-channel interference is the precision frequency adjustment of fixed and mobile transmitters. For this purpose BROWNING meters are preferred because they are so convenient to use. Moreover, any BROWNING meter can be checked in the field against WWV standard frequency transmissions. Every BROWNING meter used a 100-kc. crystal, which is a sub-multiple of WWV. Remember this when you buy a frequency meter, because if it has a crystal ground to a specific transmitter frequency, it cannot be checked against WWV without elaborated interpolating instruments.

BROWNING meters are available for all communications frequencies from 1 mc. to 500 mc. Use the coupon to get complete details on single-frequency and multiple frequency meters.

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.
ENGINEERED FOR ENGINEERS

IN CANADA, ADDRESS:
Measurement Engineering, Ltd., Arnprior, Ont.
EXPORT SALES
9 ROCKEFELLER PLAZA, Room 1422
NEW YORK 20, U. S. A.

BROWNING LABORATORIES, Inc.
750 Main St., Winchester, Mass.
Please send me technical details and prices on the following Browning precision products:
- ☐ Model MD-25 Universal Modulation Monitor
- ☐ Frequency Meters, calibrated at the following frequencies
..........mc..........mc..........mc..........mc

Name ....

Address ....

Company Connection ....

Professional Directory

SPOT NEWS NOTES

(Continued from page 6)

Walter E. Poor, 1886-1950:

Walter E. Poor, board chairman of Sylvania Electric Products, Inc., passed away at New York City on April 4. He was a native of Salem, Mass., a graduate of M. I. T., and a pioneer in the manufacture of incandescent lamps. His career in that field began in 1911, when he joined his brothers in the Hygrade Lamp Company, predecessor of Sylvania.

Radio Manual:

Fourth edition of this widely used book by FCC Commissioner George E. Sterling and Robert B. Monroe, CBS engineer, has been announced by D. Van Nostrand, 250 Fourth Avenue, New York 3. Covering theory, operation, installation, and maintenance of all types of equipment, this volume contains 820 pages, 742 illustrations. Price is $12.

Remote Transmitter Control:

An interesting installation of Hammarlund remote control units has just been completed for one of the public utilities. Previously, control of a distant transmitter from the dispatcher's office was accomplished by a DC pair, in addition to the voice circuit. Now the former is no longer needed, for audio tones, automatically sent over the voice circuit when the microphone switch is actuated, turn the remote transmitter on and off. To prevent false operation of the transmitter relay by voice impulses, two audio tones are used to actuate the relay, and two others to release it. Because the dispatcher's office is not within range of the mobile units, they are picked up by a receiver at the transmitter. The receiver output is connected to the voice circuit, so the dispatcher can hear all calls from the cars. The cost of the Hammarlund units will be returned quickly by eliminating charges for the DC pair.

WGHF New York:

Will transmit programs for Air Music, Inc. Receivers will be supplied by Functional Music, Inc. The arrangement provides that WGHF will acquire a library of some 6,500 selections, augmented by monthly additions. Air Music will sell background music service, and install and maintain the receivers. Present WGHF schedule of 9 hours per day will be increased eventually to 18 hours.

Projection TV Units:

Under a new merchandising plan, North American Philips Company will make its Protelgram projection units available to custom set builders through radio dealers

(Concluded on page 9)

Professional Directory

RATES FOR
PROFESSIONAL CARDS
IN THIS DIRECTORY
$12 Per Month for This Standard Space. Orders Are Accepted for 12 Insertions Only.

SPOT NEWS NOTES

(Continued from page 8)

and parts jobbers. These parts can be used to convert the many 10-in. sets into projection models. Details can be obtained by addressing the headquarters office at 100 E. 42nd Street, New York 17.

Excise Tax on Tuners:

An item in this column last February concerning the excise tax on tuners brought a number of requests for more specific information. To obtain an official answer, we wrote the Treasury Department, and received this reply from Deputy Commissioner Charles J. Valaer:

"It is held that an FM tuner which includes a power supply and which has an output sufficient so that signals may be received through the use of headphones is a taxable radio receiving set under section 3404 (a) of the Code. An FM tuner without a power supply is a radio receiving chassis under section 3404 (b) of the Code. Tax under section 3404 of the Code attaches to the sales of FM tuners by the manufacturer at the rate of 10% of the selling price.

Mobile Radio Equipment:

Newcomer is Chicago Radio Telephone Manufacturing Company, Inc., 361 W. Superior Street, Chicago 10. Vernon R. Carr is director of sales, J. B. Ferguson director of engineering, and Frank Stift production manager.

Picture-Size Ratings:

With rectangular tubes coming into use, we now have realistic and honest ratings for picture sizes, representing the standard 3-to-4 aspect ratio. For example, a given rectangular tube is rated as giving a 9- by 12-in. picture, whereas picture-sizes with round tubes have got so out of hand that they have no relation to tube diameter.

More FM Power:

Fort Industry's WJBK-FM has increased power from 1 kw. to 30 kw., providing solid coverage over a radius of 75 miles. This includes Detroit, Port Huron, and Toledo. Programs running from noon to 11:00 will carry Detroit Tiger's baseball games.

Mobile Radio Handbook:

We have almost cleaned up our backlog of orders for the paper-covered edition of the Mobile Radio Handbook. If you have been waiting for your copy and do not receive it within a few days, please let us know. Cloth-bound copies have not been received from the bindery yet, but they will be ready shortly, and will be mailed immediately on receipt.

BRIDGEPORT UHF-TV TEST RESULTS

FIRST TEST REPORT OF NBC EXPERIMENTAL UHF TELEVISION STATION GIVES RESULTS OBTAINED FROM 1,000 HOURS OF OPERATION — *By* RAYMOND F. GUY*

GREAT industry-wide interest is being shown in the RCA-NBC experimental UHF station at Bridgeport, Conn. This is the first extensive experiment on UHF propagation under actual operating conditions. Although tests are by no means complete, a preliminary NBC report to the FCC, accompanying a request for renewal of the station's STA, discloses some significant data. The report is presented in revised form in this paper, together with some additional, pertinent background facts.

UHF Transmitter:

Station KC2XAK is located just outside Bridgeport on Success Hill, one of the many 200-ft. hills which surround the City. The transmitter, designated the TTU-1A, is a modified version of the RCA TT-500B television transmitter, adjusted to operate in the lower part of the UHF band. Power outputs of 1 kw. peak visual and ½ kw. aural signals are obtained in a standard 6-mc. band, from 529 to 535 mc.

The station began operating at full power on Dec. 29, 1949. Regular test-pattern and picture transmission began on Jan. 11, 1950, on a five-day weekly schedule. During January the station was in operation 400 hours. In February, when a new vestigial side-band filter was installed, 268 hours of operation were logged. At this time of writing, more than 1,000 hours have been recorded.

Programs transmitted from KC2XAK are received from WNBT, New York, by radio link. Early in the experiments, the pictures were received on channel 4 and demodulated in a receiver at Bridgeport. They were then fed to the UHF transmitter. Thus, it was necessary to modulate and demodulate the signals twice before they could be shown on the experimental receivers.

It is well known that in the required vestigial sideband system, a slight amount of distortion is introduced at both the transmitter and receiver. Doubling this distortion caused noticeable degradation of the pictures. In addition, unidentified interference at Bridgeport on channel 4 caused occasional periods of very poor picture reception.

In order to evaluate the performance of a new system, such as KC2XAK's transmitter and experimental receivers, it is desirable that the input test pattern and pictures be of high definition, free of transients and noise. If mediocre program material is used, the received pictures will also be mediocre, regardless of how faithfully the UHF system performs. The inevitable result of using inferior input pictures is inaccurate reporting of the system performance.

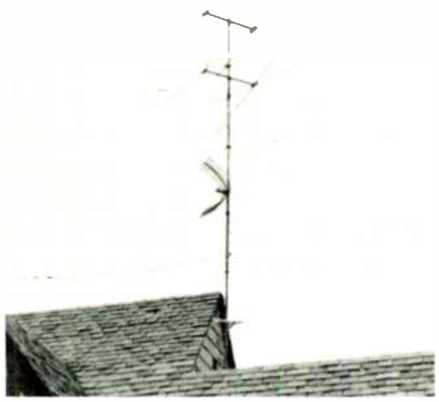


Fig. 1. UHF parabola is at mast center

Fig. 2. Stacked vee is simple, efficient

Such was the case at Bridgeport, using double modulation and demodulation. It was desirable, therefore, to take steps to obtain a more perfect input picture, uninterrupted by interference. Accordingly, experiments were made using a relay link operating on 2,000 mc. Pictures from WNBT's New York Studio were fed directly to the relay transmitter, on the 85th floor of the Empire State Building, without going through the WNBT vestigial sideband filter. The relay transmitter fed a parabolic antenna on the outside parapet. At KC2XAK, a parabolic receiving antenna is mounted on the tower at 180 ft., with a ⅞-in. coaxial transmission line to the transmitter.

It was found that the picture quality was excellent. The relay is reliable and practically free of external disturbances of any kind. It was put into operation on January 25, 1950, and has been in continuous use since then. Even though the airline distance is 55 miles, the input pictures at KC2XAK are as good at those leaving the WNBT studio, as nearly as can be observed. Signal-to-noise ratio of the relay system is 30 db.

The channel 4 receiving system has been kept intact as a program standby facility.

Performance of the TTU-1A transmitter has been excellent. The circuit adjustments were found to be at least equal, in case of handling and stability, to those of commercial VHF equipment. Because of the high operating frequency and the nature of the circuits, broadbanding is less of a problem than in VHF equipment.

Tube life has been quite satisfactory. During 1,000 hours of operation, there has been only one hour of shutdown time due to a defective tube.

Frequency stability has been checked daily during March by the RCA measuring station at Riverhead, Long Island. Measurements show that the transmitter is capable of maintaining a frequency stability of better than .001%, compared with standard stability of .002%.

Field Intensity Recording:

NBC has installed and is operating field intensity recording equipment in the RCA Building, New York. This consists of an RCA 9T246 receiver with a UHF converter, a DC amplifier, and an Esterline-Angus recorder. The receiver has been modified by removal of the automatic gain control on the video IF system, and slight changes in the video 2nd detector to drive the DC amplifier. The parabolic receiving antenna is mounted in a plastic radome on the roof of the building, at about 860 ft. above sea level.

Field intensity is approximately 2,700 microvolts per meter at the antenna. Recordings indicate no significant variations in field intensity to date. Occasional effects from airplanes are observed, and as much as 10% variation occurs during high winds. This is caused,

*Manager, Radio & Allocations Engineering, National Broadcasting Company, Inc., RCA Building, Rockefeller Plaza, N. Y. C.

it is believed, by slight mechanical movement of the transmitting antenna, which depresses or elevates the sharp main 2° radiation lobe.

A recording installation has been in operation since Feb. 17 at the RCA Laboratory at Riverhead, Long Island. Here a special laboratory receiver drives a Bristol recorder. In parallel with the recorder is a step analyzer, which totalizes the times during which the field intensity rises above 12 fixed levels. No daily trends in field intensity variation have been observed, but it is thought that they may develop during warmer weather.

ANTENNA TYPE	INSTALLATIONS NO.	%	AVERAGE DISTANCE IN MILES
Stacked Rhombic	2	5.0	3.5
Single Rhombic	1	2.5	5.0
Single Fan	15	37	6.3
Stacked Vee	19	46	11.4
Parabola	3	7.0	14.9
Stacked Fan	1	2.5	23.0
Single Vee	0	0	-
TOTAL	41	100	

Median distance of all antennas from transmitter......9.6 miles

Fig. 3. Stacked vees, fans were used most

A third recording installation has been made at Princeton RCA laboratories. Recording will continue at all three fixed points until sufficient information has been accumulated to prepare a detailed report.

Crews of technicians with mobile field-strength equipment have begun the long task of taking measurements of field strength and receiver input voltages at all receiver locations. A thorough measurement and analysis program is contemplated.

PICTURE QUALITY	RECEIVERS INSTALLED NO.	%	AVERAGE DISTANCE IN MILES
Excellent	17	39	5.4
Good	9	20.5	8.4
Fair	9	20.5	15.6
Poor	5	11	12.4
Unusable	4	9	18.5
TOTAL	44	100	

Median distance of all receivers from transmitter......10.1 miles

Fig. 4. Summary of reception ratings

NBC equipment has been developed and is being tested for measuring transmitting antenna vertical radiation patterns. A helium-filled balloon is utilized, carrying an omnidirectional receiving antenna and crystal rectifier which feeds DC to a microammeter on the ground.

Similar equipment is being developed to measure field intensity vs. altitude at receiver locations, and to study terrain effects. No other reasonably satisfactory means is available for measurements behind obstructions at the altitudes involved.

There are practical difficulties with balloons. Wind blows them about, and they are useful only on infrequent windless days. It is proposed to transport them on the NBC rigging truck which is equipped with variable power-driven winches and other convenient facilities.

UHF Receivers:

Receivers used for the Bridgeport tests are, for the most part, standard VHF television sets to which have been added tuner units designed especially for the project.

Since operation in the lower part of the UHF band is involved, standard VHF tubes give satisfactory performance. A 6J4 triode is used as a grounded-grid RF amplifier. Double superheterodyning is necessary, and a 6J6 serves as the first oscillator-mixer, using cathode injection of the oscillator voltage. Two 6AG5 stages follow as 132- to 138-mc. IF amplifiers. Another 6J6 is employed as the second oscillator-mixer, to obtain a second IF of 21 to 27 mc.

A high-pass filter at the tuner input is necessary to reduce image and direct IF responses. It cuts oscillator radiation also, since the first oscillator operates below the incoming signals.[1] The tuned filter circuits were printed by photo-engraving a 1.5-mil copper sheet bonded to a bakelite base.

Sensitivity of the tuner is 140 microvolts peak signal to give a 10-to-1 ratio with peak noise.

Receiver Installations:

Two RCA installation crews are working on receiver and converter installations. As of March 23, forty-four receivers were placed in homes throughout the area at a median distance of 10.1 miles.

In making all installations, except where extremely hazardous conditions were encountered, the procedure has been to start with a single fan antenna. If an unsatisfactory picture was obtained, successively higher-gain antennas were used. If no improvement was found, the fan was put back, unless the picture was practically non-existent, in which case the entire installation was removed. This occurred in three installations.

The parabola is the highest-gain antenna used, but because of its weight and scarcity its use has been limited. Stacked vee antennas are superior to the rhombic type and are less difficult to mount. Figs. 1 and 2 show typical parabola and stacked vee installations.

[1]A converted receiver was shown on the front cover of *FM-TV*, April, 1950. Detailed views are given of the tuner and the printed-circuit filter.

In Fig. 3 a table of antenna installations is given. The fans are satisfactory within a medium radius under line-of-sight conditions. Higher-gain antennas with low-loss lines, it seems, are desirable for longer distances. The antenna line used in all installations so far, with the exception of one, was RG59-U. Only 500 ft. of Amphenol tubular 280-ohm line has been shipped so far, although sufficient tubular line has been ordered to take care of all poor-reception locations.

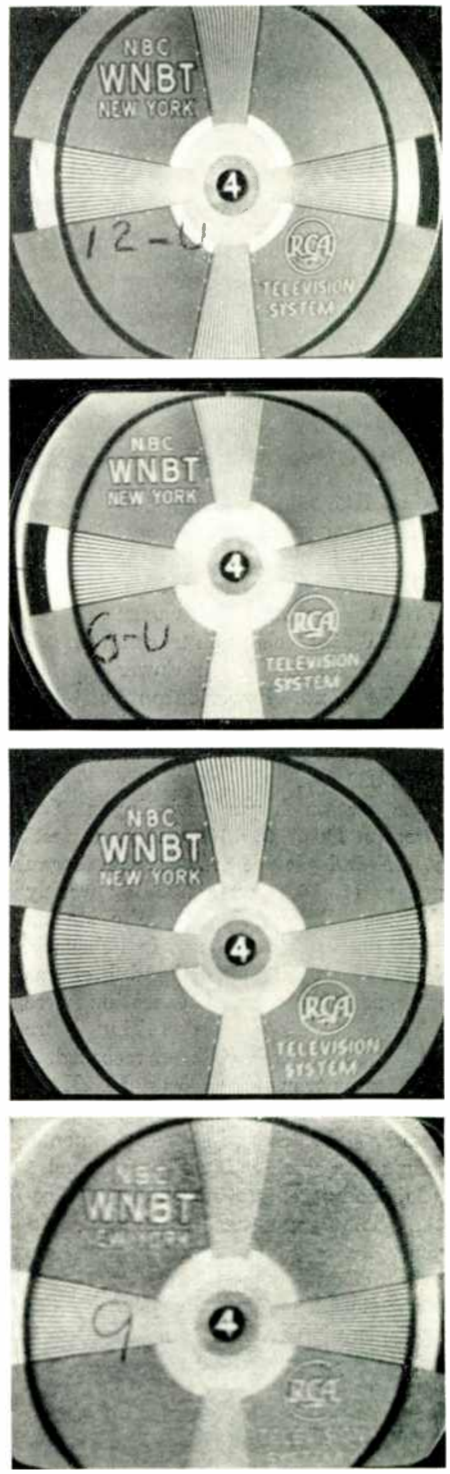


Fig. 5. Picture ratings: Top, excellent; 2nd, good; 3rd, fair; bottom, poor

Reception Ratings: As has been stated, measurement of signal strength at receiver locations has only begun. Therefore, reception ratings are, for the most part, based on visual judgments only. New and better UHF transmission lines, more carefully selected antenna locations, better antennas, and careful receiver adjustments will upgrade some ratings presented here, and others will probably be reduced.

Fig. 6. Signal inputs are as follows: Top, 3,310 uv.; center, 935 uv.; bottom, 182 uv.

Fig. 4 is a summary of present ratings, and includes three installations which were removed because of completely useless pictures. As can be seen, picture quality was good or better than good, even with inferior line, at 59% of all locations.

Pictures are rated as shown in Fig. 5. Sample pictures, obtained with measured levels of signal input, are presented in Fig. 6 for purposes of comparison.

Fig. 7 is a complete table of reception ratings, with antenna type, distance, antenna height, and terrain data included. Type C terrain, with the receiver situated on low ground behind a hill, seems to be the most unfavorable position. Most favorable, as would be expected, is type A terrain, which represents a hilltop location with no obstructions.

Finally, a table of service range vs. picture quality is given in Fig. 8. This is probably the most meaningful way to portray the actual service range of the station. Fair pictures which, incidentally, many living in extreme fringe areas of VHF transmitters would consider quite acceptable, are being obtained at 85% of locations out to a radius of 23 miles. Excellent reception is afforded 42.5% of locations in the same area, and 60% of locations within a 10-mile radius.

Good pictures are received at 65% of locations within a 23-mile radius, and at 84% of locations within a 10-mile radius. These figures become more significant when it is remembered that the median distance of all receivers is 9.6 miles. Also, many ratings will be raised with the installation of superior transmission line.

DISTANCE IN MILES	ANTENNA TYPE	ANTENNA HEIGHT (FT.)	TERRAIN AT RECEIVER	PICTURE QUALITY
1.1	Fan	70	D	Excellent
1.6	Fan	30	D	Excellent
2.0	Fan	35	D	Good
2.2	Fan	42	A	Excellent
2.8	Fan	80	F	Excellent
3.0	Stacked Vee	30	B	Good-Some reflections
3.0	Fan	47	A	Excellent
3.0	Stacked Rhombic	60	E	Excellent-Light ghost
4.0	Stacked Rhombic	70	F	Good
4.0	Stacked Vee	36	D (Trees)	Excellent
4.0	Fan	30	A	Excellent
4.0	Stacked Vee	50	F	Excellent
4.0	Stacked Vee	45	C	Poor
4.8	Fan	30	A	Excellent
5.0	Rhombic	40	D	Fair
5.0	Stacked Vee	45	D	Excellent
5.5	Fan	35	A	Good
5.7	Fan	33	D	Excellent
6.0	Stacked Vee	30	B	Good
6.0	Fan	60	D	Good
6.1	Fan	40	D	Excellent
7.5	Stacked Vee	40	D	Excellent
8.5	Stacked Vee	40	E	Excellent
8.8	Stacked Vee	30	C	Fair
10.0	Stacked Vee	35	D	Fair
11.4	Stacked Vee	55	B	Excellent
13.0	Parabola	30	D	Good
14.0	Fan	40	A	Poor-Very snowy
14.0	Stacked Vee	40	A	Poor-Snowy
14.0	Parabola	35	B	Good
14.0	Fan	50	B	Fair
15.0	Stacked Vee	30	E	Poor
15.0	Stacked Vee	50	A	Fair
15.0	Stacked Vee	35	B	Fair-Some snow
15.0	Stacked Vee	25	B	Poor
17.0	Stacked Vee	47	E	Excellent
17.6	Parabola	33	B	Fair-Usable
22.0	Stacked Vee	40	A	Good-Some snow
22.0	Fan	50	B	Unacceptable
23.0	Stacked Fan	65	B	Fair
32.0	Stacked Vee	55	C	Fair

TYPES OF TERRAIN

A - On hill, no obstructions
B - On side of hill away from KC2XAK
C - Low, in back of hill
D - Flat, no obstructions
E - Flat, in back of buildings
F - On hill in back of higher buildings

Fig. 7. Individual reception ratings, showing conditions for each receiver

RADIUS IN MILES	NUMBER OF LOCATIONS	EXCELLENT		GOOD OR BETTER		FAIR OR BETTER		POOR OR BETTER	
		NO.	%	NO.	%	NO.	%	NO.	%
0-2.5	4	3	75	4	100	-	-	-	-
0-5	16	11	68.75	14	87.5	15	93.8	16	100
0-10	25	15	60.0	21	84.0	24	96.1	25	100
0-23	40	17	42.5	26	65.0	34	85.0	39	97.5

Fig. 8. A summary of quality ratings for receivers within distances shown

TELEPHONE TAXES

Those tax items on your telephone and telegraph bills add up to staggering figures. Although they were to be imposed only for the period of the war, private and business subscribers paid $417.6 million in 1947, $466.8 million in 1948, and $535.9 million in 1949 up to June 30, the end of the Government's fiscal year. This tax is far greater than the postwar rate increases! All of which should remind us that we pick up the (tax) check every time Uncle Sam gets big-hearted and decides to give us something.

UHF COVERAGE IN PITTSBURGH

RESULTS OF RECENT UHF-VHF FIELD-STRENGTH SURVEY SHOW LITTLE AGREEMENT WITH FCC'S PROPOSED COVERAGE-CALCULATION PLAN—*By* R. N. HARMON*

VERY little is known of transmission characteristics of the UHF band from 470 to 890 mc. This is particularly true for rough-terrain areas.

The Notice of Further Proposed Rule Making for television broadcasting issued by the FCC on July 11, 1949, described certain methods for determining the coverage of UHF transmitters in extremely hilly areas. Because of the importance of adequate and accurate transmission information for making contemplated allocations on the frequencies concerned, the engineering department of Westinghouse Radio Stations, Inc. has, since then, made a detailed survey of a portion of the Pittsburgh area. Its purpose was to determine the suitability of the proposed method of coverage calculation.

Particular importance was attached in this survey to the following transmission characteristics:

1. Multipath reception or ghosts.
2. Signal scatter. That is, the maximum and minimum signal intensities received at locations equidistant from the transmitter.
3. Height-gain function. The amount of increase in signal strength with increasing antenna height.
4. Comparison of useful coverage areas for 92.9 mc. and 508 mc., with a given radiated transmitter power.

Because the time available to make the survey was short, no attempt was made to measure the tropospheric signal which might be expected well beyond the normal primary service area. This characteristic, of course, must be considered in any allocation plan because it will be necessary to duplicate the same channel at different locations.

For these tests a pulsed transmitter, operating at 508 mc. fed a directional antenna. The antenna was a parabolic reflector, 10 ft. in diameter, and illuminated by a half-wave dipole exciter with a half-wave reflector, spaced a quarter-wave from the dipole, at the approximate focus of the parabola. The pulsed transmitter, with the high-gain directive antenna, provided a peak effective radiated power of 165 kw. The horizontal and vertical beam widths of the antenna were equal, with approximately 15° between half-power points.

The transmitter and antenna were mounted in KDKA's FM tower at Herron Hill, just behind Pitt Stadium. The tower is 500 ft. above ground. This is equivalent to 640 ft. above average terrain, as established by the FCC's two-to-ten-mile rule.

Since it was desired to compare the 508-mc. transmission signal with that of a lower frequency, the 92.9-mc. signal radiated by KDKA-FM was measured at the same time. The effective radiated power of the 92.9-mc. signal was 9 kw. For purposes of comparison, the measured fields at 508 and 92.9 mc. were reduced to an equal basis of 1 kw. radiated power.

Measurement Plan:

Before the measurement plan was composed, a careful study was made of terrain on various radials drawn from the transmitting antenna. Because of the highly directional antenna used, a complete 360° field survey would necessitate orienting the antenna along 24 different radials, and taking corresponding measurements along each radial. Time was not available for this procedure, however. A choice had to be made between making complete measurements along one radial, or a few measurements on all radials. It was found that the terrain profiles along all radials were generally the same out to about 30 miles from the antenna site. Therefore, since information obtained from one radial would be representative of all, it was decided that better data could be obtained in the allotted time by concentrating all measurements in one direction.

The southeast radial was finally chosen. It was considered that this was the most desirable because the population density in that direction is relatively great, and because it best represents the general terrain around Pittsburgh out to a distance of 30 miles. At 30 miles, however, the average elevation rises steeply on the southeast radial.

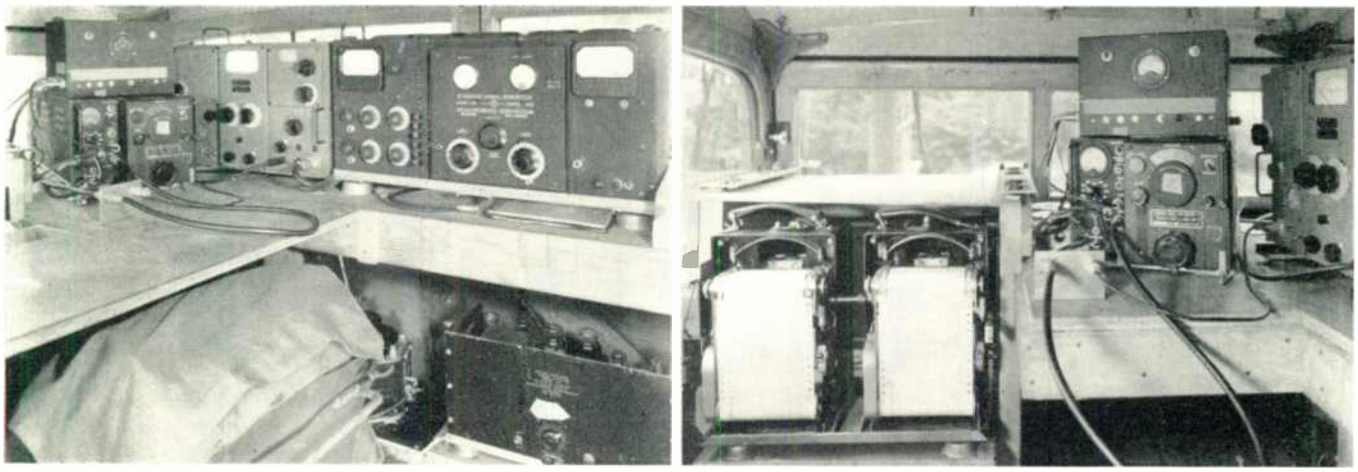
It should be noted that the area within 10 miles of the transmitting antenna is heavily built up, and is both industrial and residential in character. Between 10 and 30 miles, the area is more suburban, and beyond 30 miles it is mostly rural, with scattered small towns.

With the central direction of measurement determined, the angle included by the antenna half-power points was subdivided into eleven close radials. A ter-

*Engineering Manager, Westinghouse Radio Stations, 1625 K Street N. W., Washington 6, D. C.

Fig. 2. Setup for mobile measurements

Fig. 2. Setup for mobile measurements



Figs 3 and 4. Station-wagon contained complete measuring and recording equipment for 92.9- and 508-mc. field intensities

rain contour plot was made for each of these secondary radials in order to select measuring points which would give the most information. These points were laid out on a suitable map and used by the field-measuring crew for point location. A total of 289 fixed points was used.

Measuring Equipment:

At each of the 289 fixed points, measurements were made of both the 92.9- and 508-mc. field intensities, at 12- and 30-ft. heights. This provided information for height-gain calculations. Photographs of terrain in the direction of the transmitter were taken at each fixed measurement point.

Four receiving antennas were used. Fig. 1 illustrates the directional antennas, extended to 30 ft. An 8-element broadside array for 508 mc. is at the top of the mast. Just below it is the 3-element Yagi, used for 92.9-mc. reception.

The directional antennas were rotated through 360° at the 30-ft. levels to obtain information concerning signal direction and amplitudes of reflections, or ghosts. The half-power angle of the VHF Yagi array was 48°, and back pickup was about 6%. For the 508-mc. broadside array, half-power beam width was 24° and back pickup was 20%.

Since shadow effects are important at UHF, an attempt was made to determine the height of the highest hill between transmitting and receiving antennas at each fixed point.

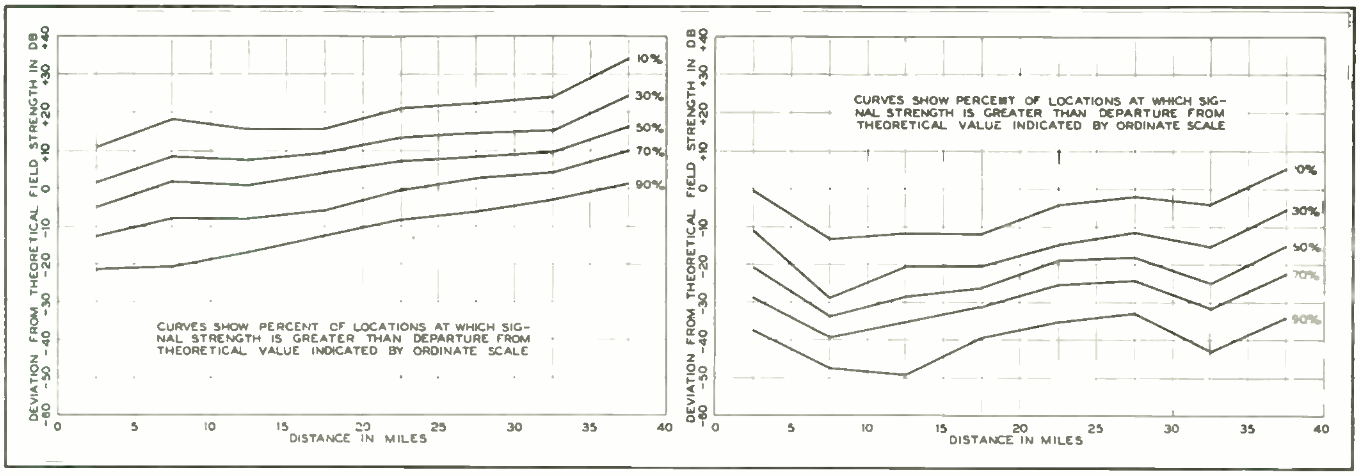
Measurements were recorded continuously while driving from point to point. For mobile measurements, omni-directional antennas, illustrated in Fig. 2, were employed. The use of non-directional antennas provided for continuous measurement, while the station wagon drove in various directions, without requiring corrections for antenna patterns. At the 11.3-ft. level, Fig. 2, is a horizontally-polarized circular antenna of modified donut design for 92.9 mc. Above it, at 12.7 ft., is a single-bay cloverleaf for 508 mc.

It was impossible to use a 30-ft. mast while the car was in motion, but about 360 miles of mobile measurements at 12 ft. were made during the course of the tests.

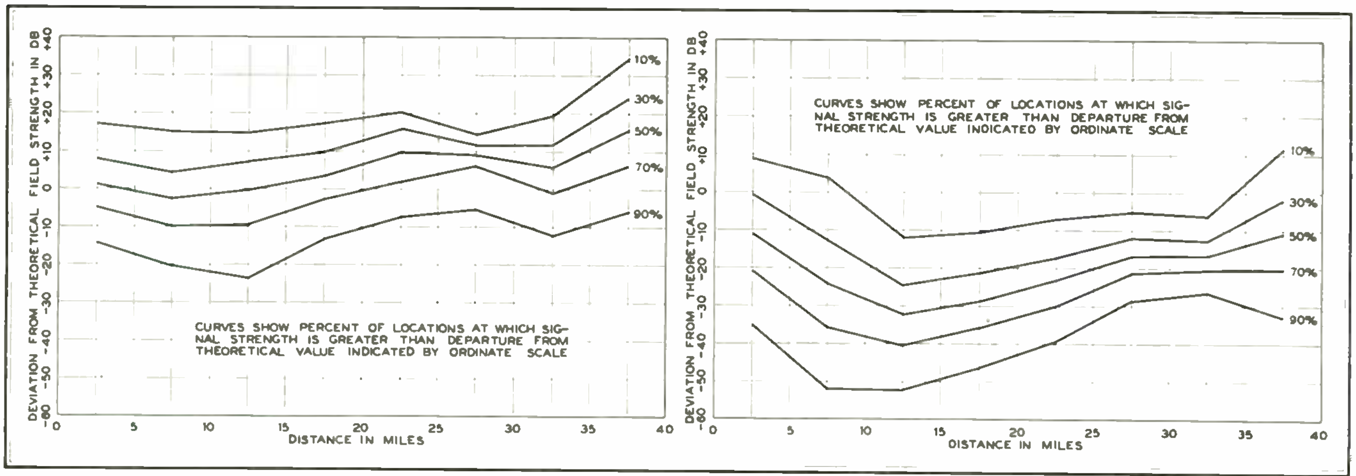
Measuring and recording equipment inside the station wagon is shown in Figs. 3 and 4. At the extreme right end of the shelf, Fig. 3, is a Measurements model 84 signal generator, used for calibration of the 508-mc. receiver. Next on the left is a Clarke model WX1A field-intensity meter for 92.9 mc. Facing at right angles to the other instruments is a modified AN/APR-4 receiver for measuring 508-mc. field intensity. Fig. 4 shows two Esterline Angus recording meters. These were fed by the WX1A and the AN/APR-4 to provide a continuous record of field intensities on both frequencies. Each recorder was geared to the car's speedometer cable, to provide a mileage base as abscissa rather than a time base.

Field Strength Measurements:

Figs. 5 through 8 are analyses of field strength measurements taken in the survey. Departure from theoretical values for 92.9 and 508 mc., plotted from mobile data, are given in Figs. 5 and 6. The same type of information, obtained from fixed-point data, is shown in Figs. 7 and 8. The most striking fact is that measured 508-mc. signal strength was always much lower than theoretical fields. The medium or 50%-of-locations field was between 11 and 34 db below theoretical values, the 10%-of-locations signal ranged between 12 db above and 14 db below theoretical values, and the



Figs. 5 and 6. Difference between measured and theoretical field-strength values. Mobile data on 92.9 mc., left; 508 mc., right



Figs. 7 and 8. Difference between measured and calculated field intensities. Fixed-point data on 92.9 mc., left; 508 mc., right

90%-of-locations signal varied between 52 db below and 26 db below theoretical values.

In general, all receiver locations close to the transmitting site, comprising heavily industrialized and built-up areas, departed further from theoretical smooth-earth predictions than the receiver locations at the end of the radial, 30 to 40 miles away, where the area is thinly industrialized and populated. This is shown clearly in Fig. 9. However, short-distance terrain irregularity is similar at the end of the radial to that close to the transmitting site.

The probable reason for the greater departure from theoretical smooth-earth fields close to the transmitter is that the *apparent* roughness of terrain is a function of the angle of signal-arrival to the ground. With a given roughness of ground, or for a hill of any given size, the shadow-effect is greater for large angles of signal-arrival than it is for small angles. Thus, rough terrain close to a transmitter seems to create deeper shadows than rough terrain at a distance.

An interesting fact is that the strongest signal received for the best 10% of receiver locations was approximately 40 db stronger than the weakest signal received at 90% of the receiver locations.

The 92.9-mc. measurements show that the signal was usually very little below the theoretical smooth-earth, predicted value and, in many cases, considerably above. The medium signal was found to lie between 5 db below and 17 db above theoretical values, the 10%-of-locations signal was between 11 db above and 34 db above, and the 90%-of-locations signal varied between 24 db below and 1 db above theoretical smooth earth fields.

The spread between the strongest signal received at the 10% best receiving locations and the weakest signal received at any one of 90% of the receiving locations was 38 db, which was almost the same as the spread for 508 mc.

Perhaps better figures to use in comparing the spread in signals received is the difference between the weakest signal received at 50% of the receiving locations to the weakest signal for 90% of the locations. This figure for 508 mc. was 20 db, and for 92.9 mc., 22 db.

If, instead of taking the maximum spread on any given radial between the medium and the 90%-of-locations signal, the spread over the entire length of all radials was averaged, a somewhat narrower spread resulted, namely, 16 db for mobile measurements on 508 mc. and 16 db for the 92.9 mc. signal.

From these figures, it can be concluded that there was very little difference in spread for 508 and 92.9 mc.

There was, however, one important difference between the 508- and 92.9.-mc. signals. This was the measured field strength for equal radiated powers. The 92.9-mc. signal was between 18 and 20 db higher for any given radiated power than the 508-mc. signal.

Height-Gain Relations:

The curve of height-gain at 92.9 mc., Fig. 10, shows that the theoretical height-gain function and measured height-gain were in close agreement. That is, the field strength at 30 ft. for the medium signal was about 2.5 times the 12-ft. field. However, agreement for 508 mc. was poor. The measured medium field for 508 mc. at 30 ft. was only about 15% greater than that at 12 ft. Failure to obtain the predicted height-gain relation at 508 mc. can be attributed, probably, to the confused nature of the field existing at any given spot. Thus, the vector sum of all possible angles varied considerably, and appeared to increase very little from 12 to 30 ft.

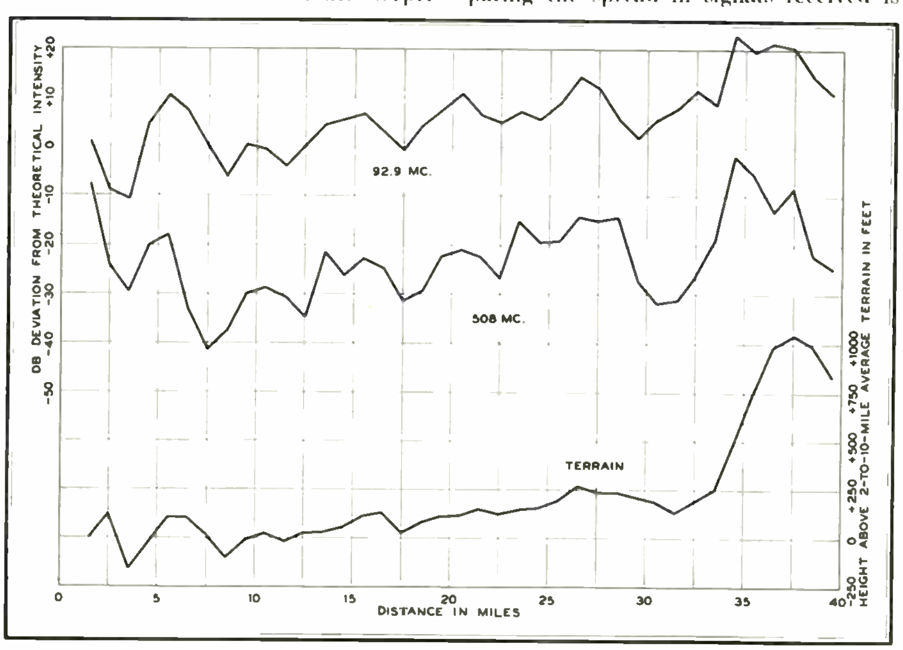


Fig. 9. Effects of distance and height on predicted- and measured-field agreement

Signal Reflections:

The problem of multipath transmission is of considerable importance in this study, because multiple signal paths cause TV signal ghosts. No measurements of path length or signal delay were made. However, the existence of multi-

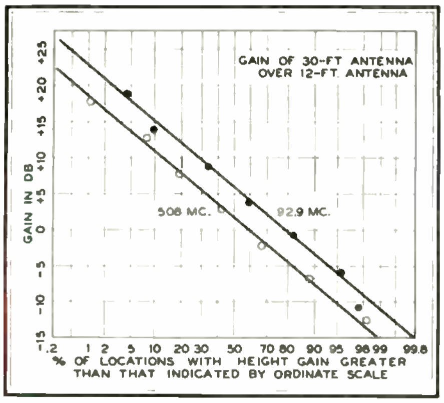


Fig. 10. Gain relations, 30 ft. over 12 ft.

paths was demonstrated by measuring the amplitude of signals from various directions. This was done by rotating the directional receiving antenna at 30 feet, and measuring the strongest ghost signal. Measurements were made on 508 and 92.9 mc. at each of the 289 fixed measuring points.

Results indicate clearly a greater probability of ghost signals on 508 mc. than on 92.9 mc. It was found that at 508 mc., Figs. 11 and 12, at least 10% of receiving locations had a ghost signal equal in amplitude to the direct signal, and at certain distances it reached 20%.

On the other hand, at 92.9 mc. a ghost signal this strong was rarely present. At only one receiving radius it was present at 14% of locations.

The data shows that on 508 mc., a ghost signal 10 db down, or one-third direct-signal amplitude, was present at half the receiving locations. In the worst type of terrain, it was apparent at 60 to 65% of the locations. However, the same ghost amplitude on 92.9 mc appeared at only about 10% of locations In the roughest terrain, it reached only 20 to 25%.

A relatively weak ghost signal of 10% direct-signal amplitude was found at 80 to 95% of all locations on 508 mc. At 92.9 mc., approximately 50% of locations received ghosts this strong. In the worst cases, it was present at 60 to 65% of receiving locations on a certain radius from the transmitter.

With such high vulnerability to ghosts on 508 mc., it is apparent that considerable directivity in the receiving antenna will be necessary to get ghost-free pictures. Fortunately, such antennas are not bulky and provide the added advantage of increased signal pickup. They must, however, be pointed accurately at the transmitting stations.

Transmitter Power:

FCC's proposed UHF allocations plan indicates that 90% of receiving locations in the primary area should receive a signal 65 db above one microvolt per meter. Also, the minimum signal-strength at 70% of receiving locations should be 68 db above one microvolt. The same proposal indicates that 200 kw. will be the maximum permissable radiated power.

On the same basis, the FCC allocations plan indicates that for rough terrain, a radius of 12 miles should be obtained for Class A signals, and Class B service should extend to 17 miles. Our fixed-point measurements indicate that with the conditions given, Class A service would be available at 6½ miles only, and Class B service at 12½ miles. If the mobile data is used for calculations, Class A service would extend to 9½ miles, and Class B to 11.75 miles. In making these calculations, a height gain of 1.7 db between 12 and 30 feet was used for the 508-mc. signal.

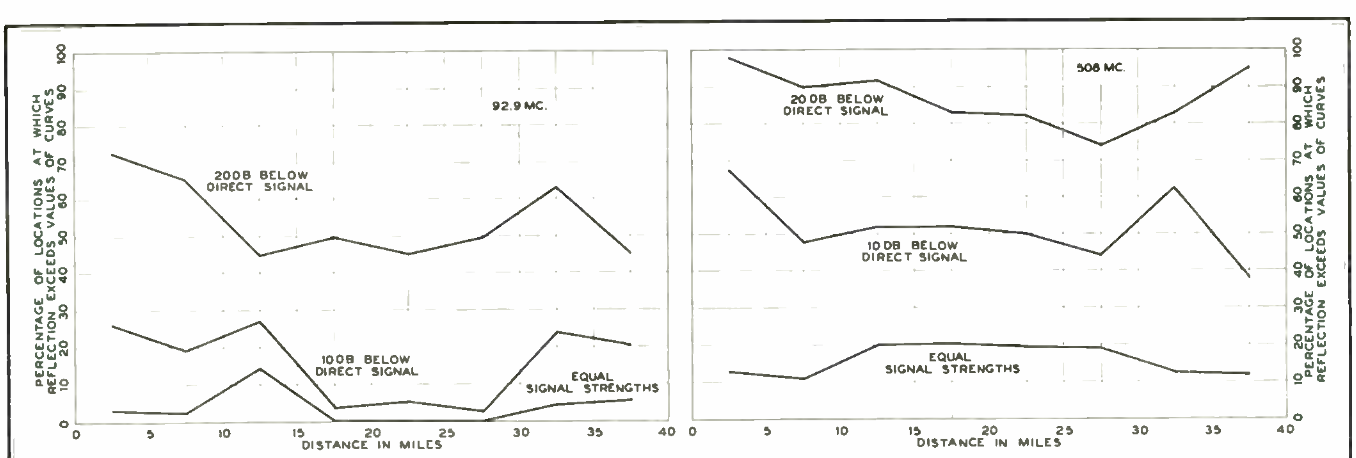
The data obtained indicates that increasing the transmitted power to 400 kw. would materially increase the B coverage. With 400 kw. radiated power, Class B coverage could be expected out to 28 miles.

It is noteworthy that 10 kw. radiated power on, say, Channel 3 would give Pittsburgh as good coverage as 200 to 400 kw. on 508 mc. In addition, the ghost problem on Channel 3 would be much less serious. Finally, variations in signal strength from line-of-sight locations to shadowed locations would be materially more on UHF than on VHF frequencies.

Radiating powers of 200-400 kw. at UHF frequencies presents a tremendous problem. Transmitter powers of 1 kw. or, perhaps after a year of intensive research and development, as high as 5 kw., can be considered practical at the low end of the UHF band. Assuming high-efficiency transmission lines, power transfer from the transmitter to the antenna might be as high as 85 to 90%. Thus, with 1 kw. of transmitter power, and an antenna gain of approximately 20, a maximum of 20 kw. radiated power could be anticipated. With a 5 kw. transmitter, a maximum of 100 kw. effective power is possible. At the present state of the art, transmitting antennas with gains of 10 to 13 db are possible and practical. Even higher gains are possible, but are hardly practical because of the extreme sharpness of the vertical beam with gains above 13 db.

It is apparent that large metropolitan areas, with terrain similar to that of Pittsburgh, cannot have adequate coverage at UHF frequencies until transmitter powers higher than are now available can be obtained. It is evident also that the capital investment and operating cost of a UHF transmitting station will be greater than that of a VHF station which would give equivalent coverage.

EDITOR'S NOTE: *Although the data presented by Mr. Harmon does not follow the pattern of the tests reported in the preceding paper by Raymond Guy, various interesting and significant comparisons can be made between UHF results obtained over very irregular and relatively smooth terrain. It is particularly interesting to note that higher frequencies and rougher terrain combine to increase the magnitude of errors in smooth-earth calculations.*



Figs. 11 and 12. Maximum reflection values. Higher reflections for 508 mc., right, indicate extreme vulnerability to ghosts

WHAT'S NEW THIS MONTH

COLOR TV MOVES FAST—DOT SEQUENTIAL SYSTEM FOR BETTER MONOCHROME IMAGES — CALL FOR CRYING TOWELS — THEY CAN SUCCEED IF THEY WANT TO

COLOR television developments are moving at a terrific pace. Never before in all radio history has so much been accomplished in so little time. Old hands in the industry will recognize David Sarnoff's personal drive behind this activity as certainly as if it bore his own trademark.

In February, RCA gave a perfect demonstration of 3-tube color reception. A month later, the single tri-color tube was shown, and acclaimed as equalling the performance of the 3-tube receiver. Meanwhile, it has been generally accepted that color signals fed into AT & T coaxial cable would come out in plain black-and-white images, but on April 6, Dr. C. B. Jolliffe said: "In order to make immediate use of existing cable routes, pending the planned increase in their frequency band width, RCA research engineers have devised special equipment which makes possible now the transmission of RCA color pictures over these routes. This equipment insures that, at the very start of color television service, all existing network facilities, whether they be coaxial cables or radio relays, are available for use with the RCA color television system."

NBC president Joseph McConnell testified at the FCC that, upon authorization from the Commission, color programs now being transmitted experimentally by WNBW, Washington, 8½ hours per week, will be sent to New York for transmission by WNBT. Also, equipment will be set up at WNBT for originating color programs, and an initial schedule of 12 hours per week will be stepped up to at least 18 hours within a year's time. Further, Mr. McConnell assured the FCC that NAB stations in Cleveland and Chicago will be supplied with color programs from New York, pending the installation of new equipment at those stations, and that color service will be made available at Boston, Providence, Philadelphia, Pittsburgh, Toledo, Davenport-Rock Island, Wilmington, Baltimore, Detroit, Milwaukee, Schenectady, Utica, and Syracuse.

As for the CBS system, there is no likelihood that any significant number of RCA licenses would build CBS sets even if the CBS system of broadcasting is authorized.

THE present FCC Commissioners will be long remembered as the men who decided on the transmission standards for UHF television. Presumably, they know that the studio equipment now in use is capable of giving much superior picture quality than is currently transmitted within the limitations of a 6-mc. channel. They have probably observed that home reception is decidedly inferior to the images on the studio monitors. And they are surely acquainted with the fact that present standards were adopted at a time when it appeared that 5-in. picture tubes would be the most popular size. Obviously, these standards do not represent the capabilities of present studio facilities or the 16- and 19-in. tubes for which the public is now showing a decided preference.

If we are informed correctly, there is one way to achieve a substantial improvement in picture quality within the present 6-mc. band. That is to use RCA's dot sequential system for monochrome transmission. It can be applied to UHF without any difficulty. It can be used on new VHF stations to be installed in areas where there is no present service. While it may not be practical to use dot sequential transmission for areas where there are large audiences already established, that should not limit new audiences to picture quality that is less than the best that the art can provide.

Individual allocations can be changed if experience shows that the initial plan is subject to improvement, but the transmission standards, once established, must stand for as long as we can now project the future of television. As we see it, the new standards must be the very highest that can be set within the channel width that is finally adopted.

THE news that *The Milwaukee Journal* has closed down WTMJ-FM is not surprising to those who have had an active part in FM broadcasting.

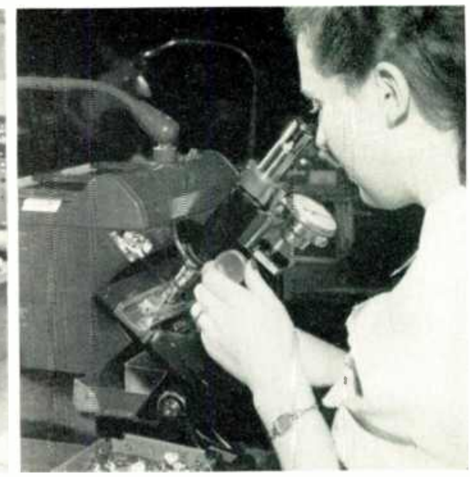
The demise of WTMJ-FM, announced in *The Journal* of March 26, quoted a letter to the FCC which followed the WMCA pattern of blaming FM: "Much to our regret, FM has not lived up to the bright promise of ten years ago. The radio listeners in Wisconsin have not seen fit to invest in a sufficient number of FM receivers to make the continued operation of WTMJ-FM and WSAU-FM a worthwhile undertaking." There was no explanation of the fact that *The Journal* has made no effort to sell time on the FM stations.

From Winston-Salem, we received an announcement that Gordon Gray has closed down WMIT. This mountain-top installation was a very expensive setup to operate and, as far as we know, the time was not sold. Gordon Gray told the Commission: "I had hoped that we might be able to find a purchaser who would take over the operation, but we have not been successful along that line. . . . I still feel that the frequency-modulation system is the superior form of sound broadcasting, and sincerely hope that some day this feeling, which is shared by quite a few other broadcasters, will prove to be right from a financial as well as a technical standpoint."

BY way of contrast, we have a report from Lee Gordon, general manager of KAYL and KAYL-FM, Storm Lake, Iowa: "KAYL, a day-timer, supplemented its operation by inaugurating KAYL-FM in early January of this year, when adverse FM publicity was appearing in the nation's press. Listener interest was aroused immediately by a full schedule of local basketball games carried on FM only, and under full sponsorship. As state tournament time neared, the KAYL-FM sportscaster asked his audience to write him advising if they would like to hear the state tournaments direct from Iowa City. These requests were confined strictly to FM broadcasting. As a result, 662 people said they could and would be listening to the state tournaments via FM. On the basis of this mail, the tournament was 100 per cent sponsored, well in advance.

"Sales of all kinds of radios had dropped to almost nil in the area served by this station. As soon as KAYL-FM went on the air with the basketball games, this situation was completely reversed. The supply could not possibly meet the demand. We are thoroughly convinced that FM is commercially practical, though we recognize that many obstacles must be removed, such as slow set deliveries, lack of dealer interest, adverse press publicity, and receiver defects. However, these are not insurmountable. KAYL-FM is now plunging ahead with plans to carry the local semi-pro, night-time baseball schedule."

When FM stations managed by men of such outstanding ability as E. K. Jett, Walter Damm, and Gordon Gray operate at a loss, there can be only one conclusion: It is not their intention to operate FM at a profit.



NEWS PICTURES

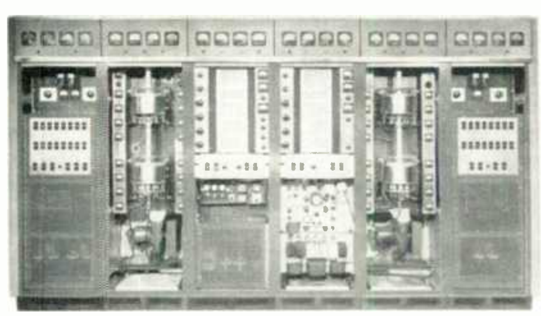
TOP: Scenes at the new DuMont plant at Allwood, N. J., devoted exclusively to manufacturing television picture tubes. At left is shown part of the bent-gun assembly department. Jig permits assembly and welding in a matter of seconds.

Center picture shows a circular railroad exhaust system. Tubes are almost perfectly evacuated by the time they return to starting point.

At right is a closeup of a calibrated microscope, used for inspection of cathode and grid assemblies. Critical spacing between cathode and grid can be measured accurately.

CENTER: Here is some new RCA equipment for broadcasters. At left is the KB-3A anti-noise microphone, designed to eliminate acoustic feedback, side comments, and background noise. High fidelity, high output level, and exceptional discrimination are claimed for the close-talking mike.

At top center is a light-weight tone arm, MI-11885, for use with magnetic



pickups. Maximum tracking error is 4°.

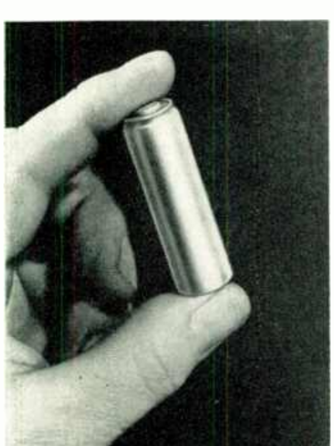
Below this is pictured the first UHF-TV transmitter commercially available. Type TTU-1A gives 1,000 w. peak visual power.

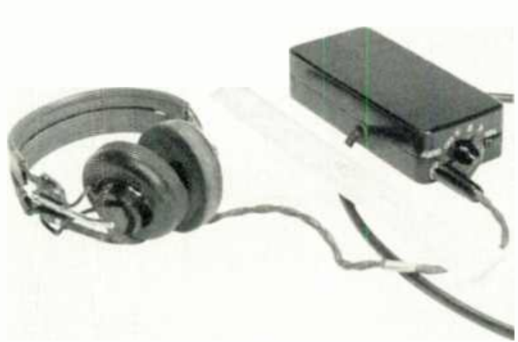
At right is the Flying Spot television camera, which produces video from photographic transparencies. Two optical channels permit fading and lap-dissolve operations.

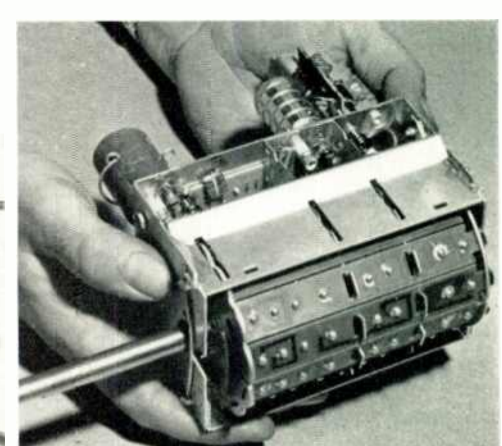
BOTTOM: Left picture shows Mallory's new mercury A-battery for miniature applications. It's service life is 10 hours at a current drain of .25 a.

Center, Polarad Electronics Corp. has developed a compact radio cue system, eliminating trailing communication wires. Receiving equipment is shown.

Right, another RCA development is this VHF-TV turret-tuner. All tuned circuits are printed by the photo-etch process, with the exception of channels 2 to 6 oscillator coils. Performance on all counts is said to be excellent.







ON its own motion, the Federal Communications Commission has issued a significant proposal to amend the industrial radio service Rules so as to permit the use of the 456- to 458-mc. band for fixed stations to extend the range of communications of mobile radio systems on the lower frequency bands.

UHF for Point-to-Point:

The proposal is designed to relax the present restrictions on the use of frequencies below 500 mc. for point-to-point communication purposes. The only band that may be used now for that purpose is the 72- to 76-mc. band. However, that band may only be used for point-to-point communications purposes when it does not cause interference to adjacent television channels 4 and 5. This condition has practically eliminated the use of 72 to 76 mc. in populous areas where television stations on channels 4 or 5 are likely to be operating.

In issuing its proposal to permit the use of 456 to 458 mc. for fixed stations, the FCC made it clear that it had not relaxed its general policy that long-haul, fixed-station radio circuits should be located in the microwave bands assigned above 500 mc. solely for point-to-point purposes. The proposal, therefore, does not look to the establishment of a long string of fixed stations operating on 456 to 458 mc.

Examples of Use:

A few examples will indicate the extent of the relaxation proposed. Let us assume, as in Fig. 1, that a company's main office is located at city A, with a branch office at city B; that the industrial station involved, using either 25- to 50-mc. or 152- to 174-mc. frequencies, is located on a mountain-top outside of city A at point X; and that the mobile unit C, using the same frequencies as the base station, is within range of X but out of range of A. Under the FCC proposal, an operational fixed control station may be constructed at A using a 456-mc. frequency which will operate the X base station automatically. An operational fixed repeater station may also be erected on 456 mc. to relay mobile unit calls.

However, only one operational fixed relay station may be utilized in any circuit. Suppose, for example, that the city office at A is out of range of the base station at X. One 456-mc. operational fixed relay station may then be erected between points A and X, but no more than one. This limitation prevents the long string of 456-mc. fixed stations that might be desired by some companies.

The relaxation is not intended to permit a number of company offices to be

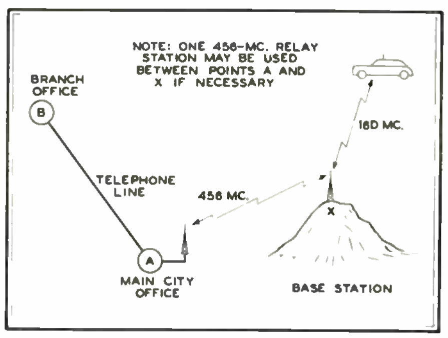


Fig. 1. Point-to-point 456-mc. system

tied together by a 456-mc. radio system for the purpose of circulating information to be manually relayed from a particular office. In the example given above, branch office B may not use a 456-mc. frequency to relay messages to main office A for manual retransmission at point A to mobile unit C. A telephone line between offices B and A, for remote control of the A 456-mc. transmitter by office B, would be necessary under the FCC proposal.

The proposed Rule amendments should give a distinct lift to development of 450-mc. equipment by mobile communications systems radio manufacturers. It is expected, furthermore, that similar proposals will be issued for the land transportation radio service as well.

Common Carrier Reorganization:

Following a management study of several months, the FCC has reorganized its common carrier staff along functional instead of professional lines. The head of the new common carrier bureau is Harold J. Cohen, formerly an Assistant General Counsel. Reporting to the new common carrier bureau chief will be the heads of four new divisions: telegraph, telephone, international, and common carrier statistics. The telephone division, of which Curtis M. Bushnell is chief, includes six branches. One of these, the domestic radio service branch, will handle mobile radio matters for both the telephone company and non-telephone company common carriers. This branch will be directed by Arthur A. Gladstone, who has been active in mobile radio matters in various posts within the Commission for a number of years. Most encouraging aspect of common carrier reorganization was that, for the most part, merit appointments were made without usual regard to seniority, and accompanying salary increases for hard-working staff members up-graded.

The industrial radio section of the Commission's Engineering Department has also taken some independent steps to clear up its application processing backlog, which recently reached an all-time high. Two application-processing lines were established on a trial basis. Line No. 1 will handle all properly-prepared applications which do not present any policy questions or other complications. It is expected that applications in this line will be very promptly processed. In line No. 2 will be placed all defective applications, all complicated applications which, although properly prepared, require one or more top-level staff reviews, and those applications which present policy questions for Commission consideration.

The Lost Footnote:

Our favorite department in *The New Yorker* is entitled, "The Legal Mind at Work." Under that heading are collected various erudite and lengthy proofs of what one poet compressed within the couplet:

"It wa'n't so much as wot 'e said
As the narsty w'y 'e said it."

The FCC has come up with its own candidate for honors in a recent order on industrial devices transmitting radio frequency energy, the decretal paragraph of which is quoted below in unexpurgated form:

"IT IS ORDERED, That effective January 31, 1950, the footnote to Section 18.1 (a) be amended as follows:

"The effective date of Part 18, with respect to electric welding devices using radio frequency energy, is January 31, 1951, PROVIDED, HOWEVER, that from and after January 31, 1950, the operation of such devices shall be subject to the condition that if such operation causes interference to any authorized radio service, steps to remedy such interference conditions, shall be taken promptly by the person responsible for the operation of the electric welding devices involved.

(Concluded on page 30)

*1707 H Street N. W., Washington, D. C.

CHECKING FREQUENCY & DEVIATION

EXPLAINING HOW TO MAKE FAST, ACCURATE CHECKS OF CENTER-FREQUENCY AND MODULATION SWING ON MOBILE FM TRANSMITTERS—*By* FRANK D. LEWIS*

To insure compliance with FCC regulations concerning mobile FM transmitters, measurement and adjustment of both center frequency and frequency swing under modulation must be made at frequent intervals. In particular, center frequency must be held within ±0.005% for transmitters operating above 50 mc. and within 0.01% for lower frequencies, and the modulation system must be so adjusted that frequency swing cannot exceed 15 kc.[1]

Methods of center-frequency measurement employ techniques similar to those used for AM, but the measurement of deviation calls for techniques not so commonly used in other branches of radio maintenance. Both types of measurement, however, can be made with the General Radio 1110-A interpolating frequency standard[2] and the 720-A heterodyne frequency meter.[3]

Center-Frequency Measurement:

It is generally agreed that frequency-measuring equipment should be at least twice as stable as the equipment being measured. Therefore, measuring equipment should contribute errors of ±0.0025 or less. Accuracy of this order is provided in the 1110-A interpolating frequency standard in the frequency range concerned. Since operation of the interpolating frequency standard depends on the production of many harmonics of an accurately-known reference frequency, some means must be provided for identification of the actual transmitter carrier frequency, and for detection of the beat notes produced during the measuring process. The 720-A heterodyne frequency meter serves this purpose.

The heterodyne frequency meter consists of a calibrated oscillator operating in the range from 100 to 200 mc., a detector, and an amplifier for use with headphones in detecting beats. The oscillator is tuned to zero-beat with the carrier to be measured, and the main and vernier dial scales are read to determine the frequency. The zero-beat point is determined by listening with headphones, or by watching the beat-indicating meter on the panel. When servicing FM mobile equipment, it is sometimes necessary to use a harmonic of the transmitter under test to obtain a zero beat. If any doubt exists as to the approximate operating frequency of the transmitter, it should be removed at the start of the measuring procedure by the use of a wavemeter.

Precision measurement of the transmitter frequency is accomplished by tuning a harmonic of the interpolating frequency standard to zero-beat with the transmitter carrier and the heterodyne frequency meter, and listening as before with headphones plugged into the frequency meter. With reasonable care, the overall accuracy of this precision frequency check will be ± 0.0025% or better. Accuracy can be increased still further by comparing the frequency of the interpolating frequency standard with standard-frequency transmissions from WWV.

Measurement in the 152- to 162-mc. band is simple, since the dial of the heterodyne frequency meter covers this range directly. Frequencies of transmitters operating in frequency bands below the directly-calibrated range can be measured by using harmonics of the transmitter. Even though the harmonic output of the transmitter may be relatively low, measurement is still possible since the crystal rectifier used in the mixer of the frequency meter will generate the required harmonics. Mobile equipment in the 30- to 50-mc. and 72- to 76-mc. bands can, therefore, be checked without additional equipment.

Deviation Measurements:

Measurements of modulation deviation can be made using the heterodyne frequency meter, an audio oscillator with a calibrated frequency scale, and a volume indicator or audio voltmeter to check the level of the modulating voltage at the microphone input. This measurement depends on certain fundamental phenomena involved in frequency-modulated waves. Since these phenomena may not be familiar to all, they will be reviewed here briefly.

A frequency-modulated signal, in the absence of any applied modulation, consists of a carrier wave with no side bands provided no amplitude modulation is present. Under such conditions, the modulation index of the wave is zero. The modulation index is defined as the ratio of the frequency deviation of the carrier to the audio modulating frequency. Expressed mathematically,

$$M = \frac{\Delta f}{f m}, \text{ where}$$

M = modulation index
Δf = modulation swing in cycles
fm = audio modulation frequency in cycles.

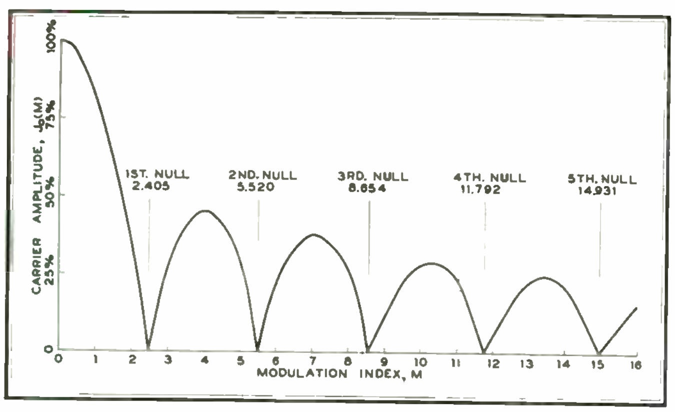
When a pure sine wave is used as the audio modulation, the amplitude of the

*Engineer, General Radio Company, 275 Massachusetts Ave., Cambridge 34, Mass.

[1]Effective July 1, 1950.

[2]J. K. Clapp, "The Interpolating Frequency Standard," *General Radio Experimenter,* Volume XXIII, No. 7, December 1948.

[3]Eduard Karplus, "A Heterodyne Frequency Meter for 10 to 3,000 Megacycles," *General Radio Experimenter,* Volume XX, Nos. 2 & 3, July and August, 1945.



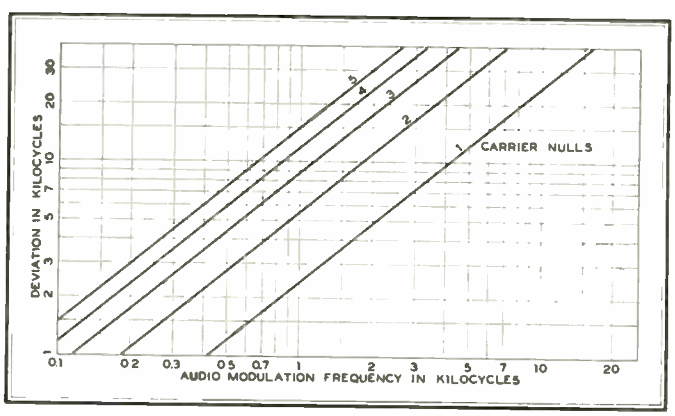


Fig. 1. Center-carrier amplitude varies as modulation index increases. Fig. 2. Null points increase with modulation frequency

center-frequency carrier will vary, depending on both the amplitude and frequency of the audio modulating voltage. The mathematical expression for this variation is:

$E = Jo(M)$, where
E = amplitude of center-carrier
M = modulation index
$Jo(M)$ = Bessel function of the first kind, zeroth order, of the modulation index as argument.

In Fig. 1. the magnitude[1] of the Bessel function is plotted. It will be seen that the magnitude of this function, which represents the center-frequency carrier amplitude, goes to zero when the modulation index, M, is 2.405, 5.520, 8.654, 11.792, 14.931, and certain higher values. For measurement purposes it is permissible to consider the given values and to neglect the higher null points.

Interpreted in terms of physical phenomena, the equation and graph show that as the sine-wave audio modulating voltage of fixed frequency is increased, the center-frequency carrier amplitude will change in accordance with the variation of the Bessel function, going periodically through null points. This change in the carrier amplitude is sometimes difficult to measure, since it can be obscured by sidebands produced in the modulation process. However, if interest is confined solely to detection of the points where the carrier component disappears, the problem is easily handled. The null points can be detected by listening for the disappearance of the beat note which is produced by beating an external oscillator against the carrier. A chart of carrier nulls as a function of modulation frequency and swing is given in Fig. 2.

The steps for measuring the modulation swing of an FM transmitter have been outlined. In order to clarify the application of this procedure, consider a typical example of deviation measurement.

The instruments used and their connections are indicated in Fig. 3. The audio oscillator feeds into the microphone input terminals. Any DC supply which may be present for a carbon microphone must be disconnected. An alternative arrangement, indicated on the diagram, makes use of a blocking condenser to isolate the DC from the output control of the audio oscillator or the attenuator. It is possible also to make a connection to the grid of the input audio amplifier, or to the input potentiometer if one is used. This will make practical the use of a smaller blocking condenser or, perhaps, eliminate the need for one at all.

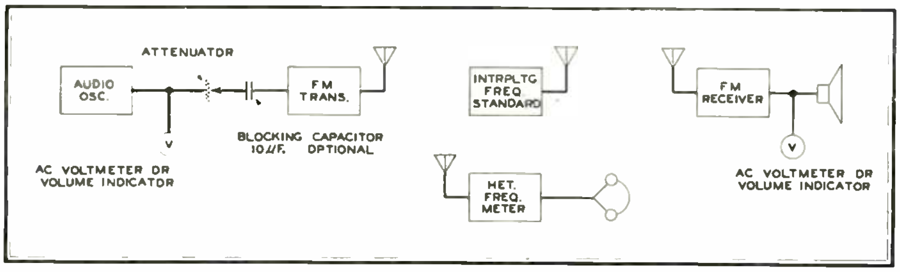


Fig. 3. Instruments used to check center-frequency and deviation due to modulation

The voltmeter shown at the output of the audio oscillator is unnecessary for the adjustment of the transmitter to a given modulation swing, but it is essential if results are desired in terms of audio input voltage for a given swing. This is required for limiter or compressor circuit calibration, and adjustment of de-emphasis and pre-emphasis circuits.

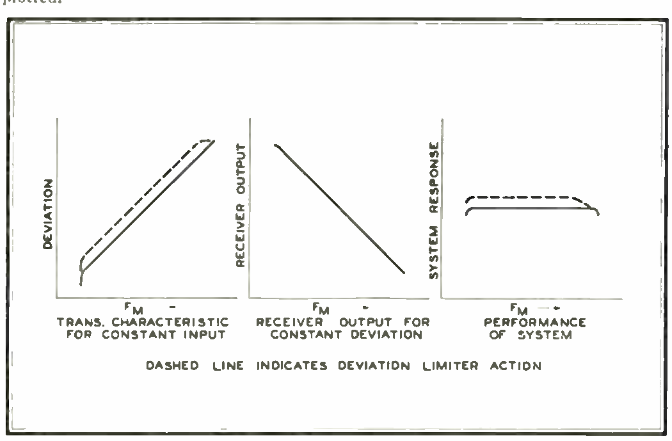
For convenience in recognizing the carrier null points, it is desirable to select a beat note which will not be confused by the appearance of modulation sidebands. This is made easier if a relatively high modulating frequency is chosen, since the sideband nearest the carrier will be spaced from the carrier by the modulating frequency. A modulating frequency of 2500 cycles will produce the first null at a swing of approximately 6.0 kc., and the second null at a swing of approximately 13.75 kc. This can be seen in Fig. 2. Assume that the transmitter operates in the 152- to 162-mc. band. The heterodyne frequency meter can be tuned to an audible beat with the carrier frequency by referring to the dial calibration of the frequency meter, and the assigned frequency of the transmitter.

The beat note is set to a frequency of approximately 600 cycles. The input audio voltage is increased slowly. When the transmitter swing reaches 6.0 kc., a null will be heard in the beat note. As the modulating voltage is increased further, a second null will be noticed, occurring when the swing reaches 13.75 kc. A convenient way to check these null points is by rocking the audio voltage control slightly to each side of the null point, and noting the disappearance of the beat note in the center of this range. There will be a family of beat notes in the background, which may at first mask the true null. But with experience, the proper beat note can be recognized easily in the presence of the additional beats. Caution is advisable, since it is relatively easy to mistake a null in one of the sideband beats for the desired carrier null. A quick check can be made by removing the audio modulating voltage and noting if the desired beat note is still present.

By choosing several modulation frequencies and measuring the swing for a given input voltage, or the input voltage for a given swing, a calibration curve of modulation deviation vs. input voltage for different audio input frequencies can be plotted, such as those shown in Fig. 5. It is possible also to check the

(Continued on page 33)

[1]The sign is neglected, only magnitude being plotted.



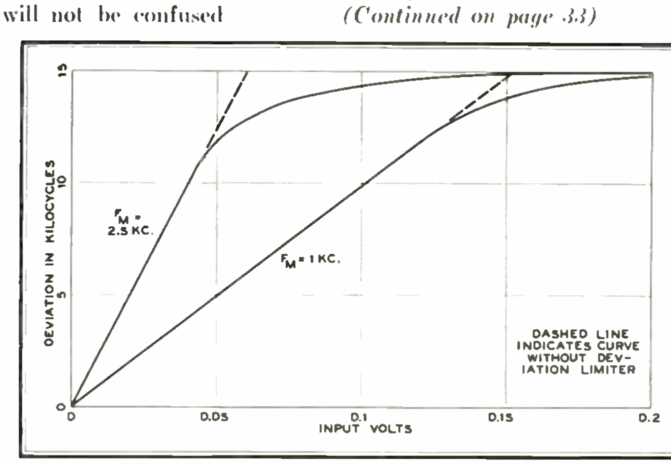


Fig. 4. Performance curves for a mobile system using phase-modulation. Fig. 5. Deviation curves for a typical transmitter

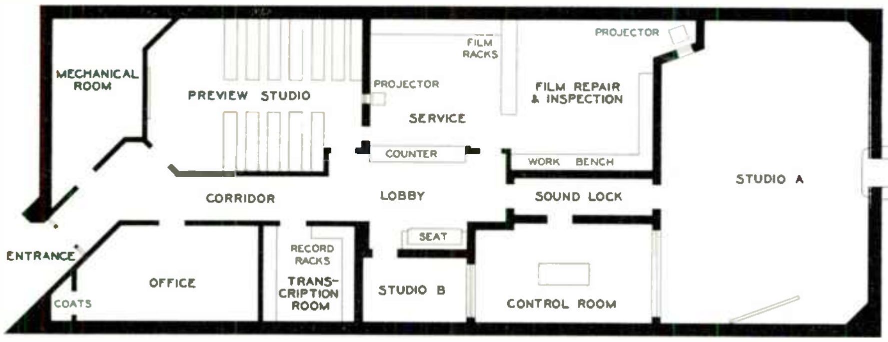


Fig. 1. Layout of Audio-Visual Department provides for educational FM station

MUNICIPAL FM STATION

HOW A 10-WATT EDUCATIONAL FM TRANSMITTER IS SERVING LOUISVILLE—*By* JOSEPHINE R. JOHNSON*

WFPL is the first radio station in the world to be owned and operated by a public library. Librarian C. R. Graham, along with Mayor Charles P. Farnsley and H. Ellison Salley, head of the recently organized Audio-Visual Department of the Louisville Free Public Library, has long been aware of the tremendous opportunities presented by this medium. At the inaugural broadcast of the radio station on February 18, 1950, Mr. Graham said: "A free people have to have most prompt access to broad areas of knowledge. Some of the old ways of imparting knowledge are too slow." This condenses the thinking which has motivated the entire project.

FCC Chairman Wayne Coy had pointed out previously that several FM broadcast channels were being reserved for educational use and, in his opinion, educators should make more of an effort to incorporate the new medium in their programs. We found that a ten-watt FM station, costing about $2,500, would offer vast new, and in most cases completely untried, fields for educational experiment at all age levels.

Work began in May, 1948, to convert a portion of the east wing of the main library building, Fig. 1, into headquarters for our Audio Visual Department, of which the radio station is now a functioning unit. With our construction permit issued, the studios and control room were completed early last February, and all the necessary equipment installed. These facilities include two acoustically-treated studios, a control room set up to play four programs from tape recorders and four programs from disc recorders simultaneously, and a transcription library made up of the best in educational and documentary material, and serious music of all types. Figs. 2 and 3 show studio and control room facilities.

WFPL uses a General Electric single-bay halo-type antenna, and G. E. 10-watt transmitter located at Police Station KIB-695. Our FM antenna is mounted on the mast which carries the police radio antenna. Since they operate on widely different frequencies there is no mutual interference.

The library radio station is run almost entirely by volunteers. Several civic groups, including the Junior League and the local organization of ham radio operators, are contributing their services as program monitors and technicians in the control room. All departments of the Louisville Public Library system are being encouraged to publicize their services by means of short skits and spot announcements over station WFPL.

The use of our installation has been made available to the Louisville Board of Education. From 9:00 A. M. to 3:00 P. M., it is employed primarily to meet the requirements of school programs. The possibilities of the plan are such that the Board proposes to release some teachers from their regular duties, to work on radio programs correlated with the regular school curriculum. Also, these programs will be made available to all city agencies as they are made accessible to the schools. This is still mainly in the planning stage, but our initial efforts are proving very successful.

At this time, the radio station is on the air six hours daily from 12:00 noon to 3:00 and from 8:00 to 11:00 P. M., seven days a week. The major part of the nightly broadcasts is made up of serious music. A plan is being tested that has never been tried before on any radio channel. That is, we are repeating the same musical program seven nights in succession. The purpose is to tie in directly with the regular and the adult educational curricula of the University of Louisville School of Music. The casual listener also will have the opportunity to hear any complete work by planning his

(Continued on page 30)

*(Mrs. N. L. Johnson) Assistant, Reference Department, Louisville Free Public Library, Louisville 3, Kentucky.

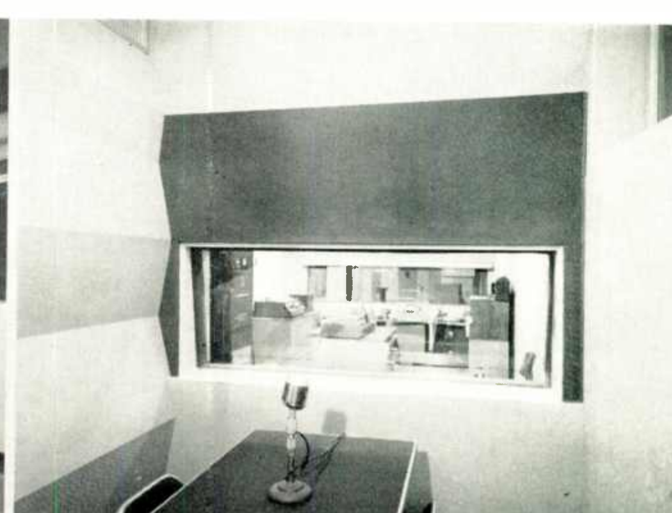
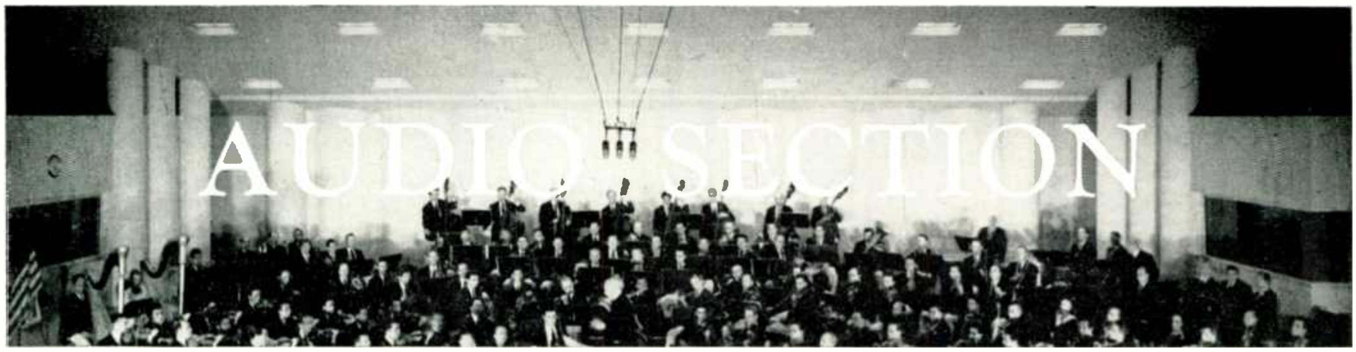


Fig. 2. Size of Studio A permits wide variety in live programming. Fig. 3. Studio B, with control room seen through window



DEVELOPMENTS IN ENGLAND

COMMENTS ON THE RADIO SITUATION IN ENGLAND, INTRODUCING A SERIES OF ARTICLES ON ENGLISH EQUIPMENT AND TECHNIQUES — *By* JAMES MOIR*

THE pleasant task of keeping *FM-TV* readers au fait with developments in England having been undertaken by "yours faithfully", you can expect to hear from me at intervals on any subject that seems technically interesting. I would like that feeling to be reciprocated, and I would like to hear from readers of *FM-TV*. If there is anything over here on which you would like further information, don't hesitate to drop me a line and I will endeavour to satisfy your thirst for information whether it is concerned with something hot in the microphone line, or merely the arrangement for the Shakespeare Festival at Stratford-on-Avon this year. It may not be possible to deal in detail with everything that is cooking up over here, partly because space is limited and partly because I may not know the particular job in such detail that I can tell you the value of R4 or C16. Generally, if I do not know the detail, I do know the next best thing, the man who does, and I can find the answer, or put you in touch if that seems more appropriate.

With this preliminary canter, it is perhaps best to give you something of the overall picture of the communication field in Great Britain in order to help you appreciate the detail that should follow.

In the Welfare State, an undue proportion of the field tends to be concentrated in a few hands. It may help to keep this in mind, as well as the difference in total population and area[1] of the U. S. and Great Britain, when comparing technical developments.

First of all, the general picture of the broadcasting setup: This is probably vaguely familiar to many of you. Certainly the results seem familiar to many of the gagsters in the U. S.

Broadcasting in Great Britain (England, Scotland, Wales and Northern Ireland) is a monopoly in the hands of the British Broadcasting Corporation, a government-sponsored organization financed by a yearly license fee of £1 ($3) for sound or £2 for sound and television, collected by the Post Office from every listener or looker. As it is an offense to operate radio receiving equipment without such a license, the Post Office maintains an organization for detecting and prosecuting unlicensed listeners. The license is collected over the counter at any Post Office. Incidentally, our Post Office architects don't appear to be such introverts as yours. Our Post Offices are easier to find and a bit more imposing architecturally. At least, it seemed that way to me.

With about 45,000,000 people in these isles there are roughly 12,000,000 licenses and probably a half million receivers with indoor aerials and no license. This produces £12,000,000 a year, from which the Post Office makes a deduction to cover the costs of collection, chasing the unlicensed half million, and operating the radio anti-interference service (of which more later).

The Chancellor of the Exchequer reduces it still further to help provide free teeth and all the other benefits, leaving the B. B. C. with an income of roughly $25,000,000 a year, at the present rate of exchange, to provide domestic entertainment.

Free broadcasting must seem to you one of the inalienable rights of democracy, but we have got used to spending $3 a year on a license, and many people consider it a cheap way of keeping the blatant commercials out of the domestic loudspeaker.

(Concluded on page 30)

INTRODUCING JAMES MOIR

Last fall, I wrote my very good friend Hugh Pocock, Editor of **Wireless World**, to ask whom, among the top English audio experts, I might persuade to write a series of articles for **FM-TV**. In reply, he suggested James Moir as an engineer whose knowledge and experience made him eminently suited to such an undertaking.

Persuading Mr. Moir to commit himself to such a task proved quite an undertaking in itself. It was not until the end of March that we received word he had consented, and that his first contribution was en route by sea mail.

Efforts to get specific information from James Moir that would serve as a personal introduction were less successful. With the typical Englishman's evasiveness about himself, he wrote: "I was born in 1907 in a small town in the industrial northwest of England. From the age of twelve, I spent a large part of my spare time fiddling with spark coils, Geissler tubes, small motors, and other gadgets. After the usual formal education, I joined the electrical side of a steel works. Five years later, I decided that communication engineering was really my prime interest. From the electronic test department of a large Midland manufacturer, I progressed to the stage of being responsible for the design and development section engaged in sound reproduction problems."

He is a member of a number of technical societies, including the Institution of Electrical Engineers, Institute of Radio Engineers, American Acoustical Society, and the British Physical Society. Among his published papers are those on acoustical problems of theatres and small rooms, and on high-quality sound reproduction. Last summer, he was the principal speaker at the New York forum on motion picture theatre acoustics sponsored by the Society of Motion Picture Engineers and the American Acoustical Society. Mr. Moir explained: "Privately, I am a high-fidelity enthusiast, which accounts in part for my interest in the acoustics of small rooms."

I am sure that Mr. Moir's series of papers, to be published in **FM-TV** every other month, will prove most interesting to radio engineers and executives as well in the United States.

MILTON B. SLEEPER

*87 Catesby Road Rugby, England.

[1] Continental United States, 150,000,000 population, 3,022,000 square miles: England, Scotland, Wales, and northern Ireland 45,000,000 population, 103,000 square miles.

VIDEO SOUND PICKUP TECHNIQUES

AN ANALYSIS OF PROBLEMS ASSOCIATED WITH TELEVISION AUDIO PICKUP, AND EQUIPMENT AND TECHNIQUES USED TO SOLVE THEM—*By* JOHN B. LEDBETTER*

SOUND pickup for television programs presents all the problems commonly encountered in FM and AM broadcast work. In addition, there are many special problems peculiar to video broadcasting, which require new, unfamiliar techniques, and which test severely the ingenuity of those who must solve them. This paper presents some of the difficulties most frequently met, and suggestions on how to overcome them.

The major differences in studio and control room arrangements for typical video and audio stations are shown in simplified block diagrams, Fig. 1. An audio broadcasting station might have as a minimum two turntables, an audio control console, racks for local and remote audio facilities, and the necessary microphones. A video station must have this equipment, plus microphone booms or dollies, provisions for sound pickup from two or more film projectors, and an audio-video intercommunications system. As can be seen in Fig. 2, the intercom system provides for direct communication between program director, audio control engineer, microphone boom operator, cameramen, camera control operators, video switcher, projectionist, announcer, and other personnel who need direction in studio activities while the program is on the air.

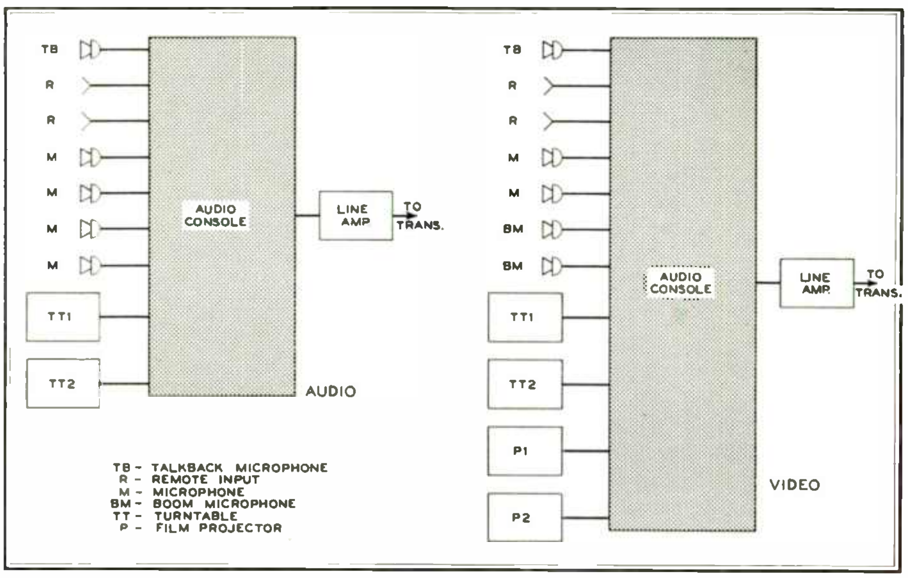


Fig. 1. Audio broadcasting sound equipment, left, and video sound facilities

Live Programs:

The primary source of difficulty in video sound pickup is the necessity for making the microphone invisible or as inconspicuous as possible. In live audio broadcasting, the orchestra or talent is arranged for best possible acoustical balance. Microphones are placed for optimum pickup, without regard to symmetry, appearance, or convenience to actors. In live video presentations, quite the opposite is true. Emphasis is placed on the video picture, with extensive rehearsal time allotted to perfection of backdrops, stage settings, lighting, special effects, trick camera superimpositions, and montages. These have first place, with audio pickup considerations trailing a poor second. It is extremely important, so far as most directors are concerned, that all microphones, booms, and even boom shadows be kept out of camera range. Awkwardness in handling the boom is considered a grave offense, and the boom operator who allows his microphone to dip into a picture is placed in the same category as cameramen who focus or change a camera turret on the air, or those who dolly in front of a live camera.

Since the microphone must be placed high enough to clear the studio cameras, both on closeups and long-range, wide-angle shots, there are many video programs in which the audio quality is far from optimum. This is especially noticeable in presentations such as an instrumental trio, for example, which includes a bass viol, piano, and guitar, and which features a feminine vocalist. The vocalist is usually incapable of holding her own with the instruments, and could easily be lost far off in the background. Sometimes, balance can be obtained by using a cardioid or selective-pickup microphone, and having the instrumental trio hold down behind vocal renditions. However, this practice represses the style or individualism of the group, and has an adverse effect on its performance.

To carry this example further, suppose that an intimate chat or even normal conversation is carried on between numbers, while the band or trio keeps up a background of bridge music. This is done on many programs to provide an informal touch. The voice pick-up under these conditions can be distressing, unless certain factors are combined successfully. First in importance is a well-designed studio, providing excellent acoustic properties. A second requirement is a wide-angle microphone, placed for optimum balance.

The first condition is seldom met in practice. In fact, there are some television studios now in use which resemble barns or huge storage closets more than broadcasting studios, with acoustics just as poor. In many cases, two or three walls are covered with celotex or similar material, with the ceiling and floor completely untreated. The floor, under normal conditions, must be covered with hard-surfaced, smooth material to facilitate movement of the cameras and studio dollies, but this should not prevent proper preparation of the walls and ceiling. The arrangement of flat surfaces into the angled or polycylindrical diffraction elements so common in AM and FM studios seems to be a forgotten art in some video studios. The natural result is that the audio quality is poor.

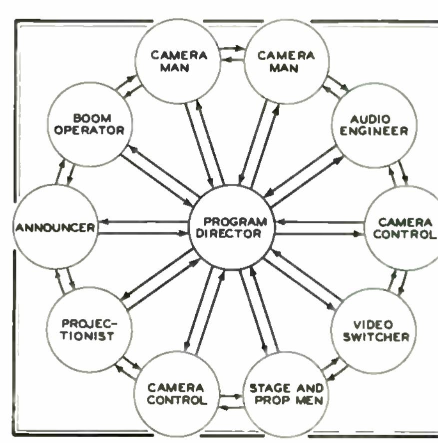


Fig. 2. Intercom system links these men

*Engineer, WKRC-TV, Cincinnati, Ohio.

Fig. 3. Microphones placed as indicated are inconspicuous, yet give good pickup

even with the best microphones and the most serious attempts at optimum placement.

Fig. 3 is an example of microphone placement for best performance under adverse acoustic conditions. A group pickup, such as the RCA 44-BX or 88-A, or a Western Electric 639-B, is placed above point A. At point B should be a small floor stand microphone, such as a W. E. 633-A. The vocalist can be assisted with a small hand pickup, possibly an RCA KB-2C, or could have an Altec Lansing 21B lapel microphone at point C.

For cases such as that described, and for those in which a good deal of action is encountered, a dolly or microphone boom can be employed ideally if acoustics are good. Booms used in television work range from light-weight, manually-operated types in small and medium-size studios to heavy-duty dollies for large-studio operations. A popular type of microphone boom can be seen in Fig. 4. In some live studio presentations, where no appreciable movement is involved, the microphone can be set in its optimum position during rehearsal and left there. However, in stage shows, amateur shows, audience participation, or similar presentations where any amount of action or moving about is anticipated, a boom operator must be assigned to keep the microphone at its best pickup distance at all times. The boom operator is equipped with a headset to monitor the program, and to receive operating instructions from the program director and audio control engineer.

Positions for operators and engineers are shown in Figs. 4 and 5. In Fig. 4, the floor manager is at A. Cameramen are at B, boom operators at C, sound-effects operators at D, and a lighting operator at E. This group is in constant touch with those in Fig. 5, identified as camera controllers and film camera operators at F, the video switcher at G, and the audio control engineer at H. The program director is at point I.

For some video programs, such as lectures, demonstrations, and newscasts, where essentially the same microphone setup is used at each performance, the microphone can be attached permanently to the ceiling. One method of attachment, which permits easy placement or changing of microphones, involves the installation of several sections of heavy wire grille on the studio ceiling. The microphones are mounted on adjustable lengths of regular microphone stands whose bases have been removed and an inverted J-hook substituted. The stands can be hooked into the grille mesh at the point desired. If steel beams or curtain-supports run laterally across the ceiling, a C-clamp or similar device can be attached to the microphone extension and screwed or clamped in place at any point along the beam.

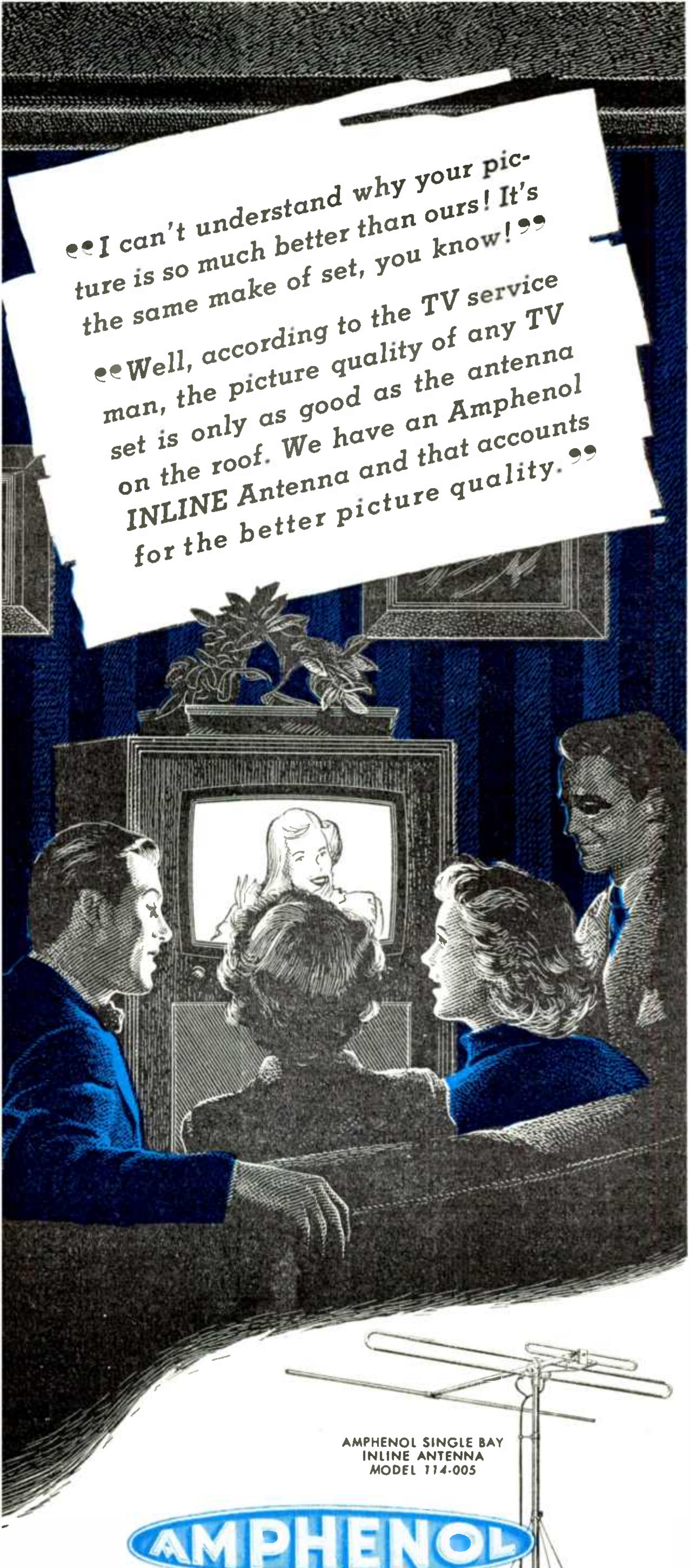
Many unpleasant effects, such as off-mike or shallow pickup, can be reduced by employing a microphone boom and using high-quality, wide-angle microphones. Other problems, however, cannot be solved efficiently by merely employing a special type of microphone, if the studio itself is not properly designed.

Film Presentations:

For the most part, sound reproduction troubles in film video programs have been minimized greatly during the past year. In earlier film recorders and projectors, the sound was unsatisfactory because of poor low-frequency response, flutter, excessive distortion, and wow. These have been partly corrected by de-

(Continued on page 29)

Fig. 4. These floor operators are under constant direction by control operators and engineers, shown at right in Fig. 5

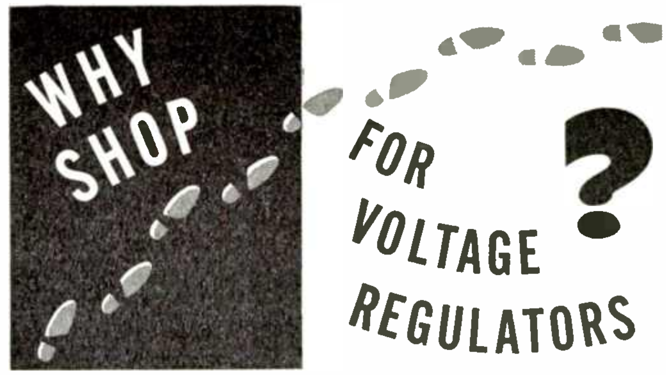


AMPHENOL **INLINE*** TV ANTENNAS

*U. S. Patent No. 2,474,480

AMERICAN PHENOLIC CORPORATION

1830 SO. 54TH AVENUE • CHICAGO 50, ILLINOIS



THE SUPERIOR ELECTRIC COMPANY HAS A STABILINE FOR YOUR NEEDS

If you're looking for dependable automatic voltage regulation, investigate STABILINE first. You'll save time and money — you'll get longer service through better design and construction — you'll get performance and operating characteristics as advertised.

AVAILABLE IN 2 TYPES

STABILINE Type IE is instantaneous and completely electronic in action. Keeps output voltage to within ±0.1% of preset value regardless of wide line variations; to within ±0.15% regardless of load current or power factor changes. Waveform distortion *never* exceeds 3%. STABILINE Type IE is available in cabinet or rack mounting models — in numerous ratings.


TYPE IE PORTABLE


TYPE EM4102

STABILINE Type EM (Electromechanical) features zero waveform distortion, insensitivity to magnitude and power factor of load, no effect on system power factor; no critical adjustments. It is available in output ratings up to 100 KVA — for single and for 3 phase operation.

STABILINE Types IE and EM perform "as advertised". Each and every STABILINE Automatic Voltage Regulator is inspected and tested to the most rigid specifications. If — after you purchase a model of either type — you would like a copy of the inspection and test report, write us and a full report will be sent promptly.

WRITE US TODAY FOR FURTHER DETAILS ON THE STABILINES

905 MEADOW STREET, BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLIES • STABILINE VOLTAGE REGULATORS

TV SOUND PICKUP

(Continued from page 26)

signing both recording and projection machines with heavy flywheels, or rotary stabilizers, to reduce speed variation. Precision gears and synchronous-drive mechanisms reduce flutter, lateral distortion, and pull-down troubles. New, high-fidelity sound pickup-heads and pre-amplifiers improve frequency response. Some film presentations, it is true, still fall short of acceptable quality, but these in most cases are stock releases of old films, or are recorded on faulty or inferior equipment.

A simplified diagram, showing the usual method of sound pickup, is given in Fig. 6. The film, incorporating either a variable-area sound track, Fig. 7 left, or a variable density sound track, Fig. 7 right, passes over a rotary-stabilized drum. As it does so, light from the exciter lamp, E, passes through the lens L1, which focuses it on a miniscule slit, S. The concentrated light passes through the slit to another lens, L2, and to the film sound track. Here it is modulated by the area or density variations on the sound track, and passed through a third lens, L3, to the plate of the phototube. The resultant audio voltage is fed to a pre-amplifier, then to one of the audio control console inputs.

Output impedances of 600 ohms, to match existing line inputs, and 125 ohms, for equipment using the new RMA standard, are furnished in most modern pre-amplifiers. The exciter lamp is usually supplied from a DC source, although for special circuits, such as that used in the G. E. Synchrolite system, this power is obtained from a 30-kc. oscillator.

Troubles affecting sound reproduction with present-day film are few. Failure due to exciter lamp burnout, pre-amplifier defects, flutter due to incorrect threading on the sound drum, and poor recordings are the most common defects. Unsatisfactory recording can be caused by overexposure or underexposure during processing, or by using inferior or badly-adjusted equipment.

Although tele-transcriptions, or kinescope films, which are photographed directly from the screen of a video monitor are used widely in TV stations, there persists a wide inconsistency of quality in both sound and picture material. This is attributed to a number of factors which vary at the time of each recording, and it cannot be remedied until experience, research, and new developments in this field bring these factors under close control. Meanwhile, frequency response of poor film recordings can sometimes be improved by installing variable equalizers in the output circuit of the projector pre-amplifiers. Simple, easily adjusted equalizers are most desirable, since individual films differ widely and must be compensated for according to individual characteristics.

It must be remembered, however, that simple passive equalizers have unavoidable insertion losses. The projector pre-amplifier or the audio console may not have gain enough to offset the attenuation between zero and maximum values of equalization. This loss usually encompasses approximately 30 to 35 db. In some cases the audio console will be able to overcome the insertion loss, but in

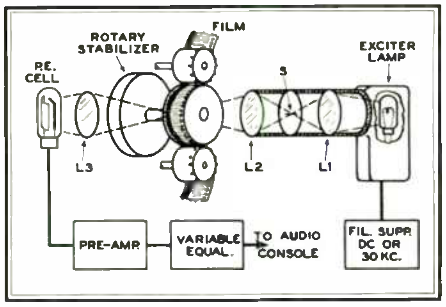


Fig. 6. How film sound pickup is achieved

others a small booster amplifier will be necessary.

The practical limits to which equalization can be carried depend largely on sound track noise and distortion. It is sometimes necessary to discriminate against certain frequencies in order to mask these disturbances.

Projector Maintenance:

Amplitude and frequency distortion, or low output level from the sound system of a film projector, can be due to any one of many possible maladjustments as well as to defective components. The exciter lamp, the focusing lenses, and the

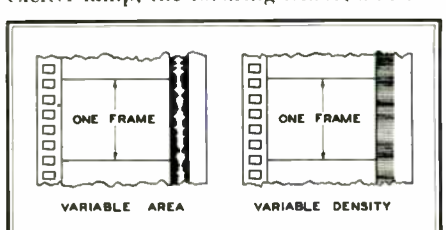


Fig. 7. Two common types of sound track

optical slit have several critical adjustments which must be made by competent engineers. Special instruments are available for this purpose. Test films, also, are invaluable aids to proper service and adjustment.

One type of test film is helpful for audio output measurement, and adjustment of the sound optical slit for uniform scanning across the sound track. Another film incorporates a 3,000-cycle tone in center position and a 1,000-cycle tone on either side of center. This facilitates the centering adjustment for the slit. Still another type of test film provides for adjustment of the optical sound focus system.

Actual maintenance of the projector sound system entails the usual amplifier tube testing, in addition to keeping the lenses and mirrors polished and free of dirt, lint, and foreign matter. The mechanical parts of the system must be checked, cleaned, and lubricated periodically.

The Sound Engineer:

One of the most noticeable differences between the TV sound-control organization and that of audio broadcasting is the degree of interdependence between the sound engineer and the other departments. In FM or AM broadcasting, the studio engineer cooperates with the announcer or producer and shares the responsibility for getting programs on and off the air on time. Usually, he alone is responsible for proper studio microphone placement, riding gain on programs, and mixing. Since the experienced engineer has developed a keen sense of timing, he is often given the responsibility for cutting in and out of programs at the proper time and inserting local cut-ins to conform with network or commercial scheduling. In video broadcasting, the sound control engineer is limited in making such decisions. They are normally made or authorized by the program director.

While the FM sound engineer must work with only one or two other persons, such as the announcer or producer, the video sound engineer must work in close harmony with announcer, cameramen, boom operator, video switcher, projectionist, and program director. He must know in advance exactly what should happen, and be prepared to operate smoothly and efficiently if it does not. A typical video program will be broken down to show the complex sound operations involved. Take, for example, a popular quiz show, in which audience participation is a regular feature. At least two studio cameras, often more, are required to cover the announcer, master of ceremonies, audience, and the commercial cards or announcements used during the program. These can be mixed with a slide projector, a Balopticon, or from the studio cameras. In addition, a short commercial film may be used during the show. An 11-piece orchestra furnishes musical accompaniment. This gives the following requirements: 1. A boom microphone for the announcer and master-of-ceremonies. 2. Two or more microphones for the orchestra. 3. A second boom for the contestants. 4. The audience or applause microphone, which will follow no action and can be suspended from the ceiling.

(Concluded on page 30)

DEVELOPMENTS

(Continued from page 24)

Now what do the B. B. C. do with the $25,000,000 a year they are free to spend on domestic broadcasting? Approximately thirty stations are operated, one station of 150 kw. in the long-wave band on 200 kc., (1500 metres) to cover the whole country, six stations of 100 kw., seven of 60 kw., and about fifteen of 20 kw. or below, all in the band between 583 and 1500 kc. There are no FM stations officially on programme, but one high-power station is operating on 90 mc. for test purposes. It is the B. B. C.'s declared intention to extend the FM network to cover the whole country, a policy receiving a good deal of opposition from many receiver manufacturers here.

On the programme side, the six 100-kw. stations form the backbone of the regional system, the other big station re-enforcing them in difficult areas. Operating from 7 A. M. to 11 P. M., they generally radiate the same programme until 6:15, after which they separate and the programmes take on a more regional flavour, though any item of general interest might be radiated by some or all of the stations. As the B. B. C. does not need to worry whether the public likes it or not, they tend to keep the programme material just a little above the heads of John Public. Straddling the basic regional programme in intellectual level are the Light and Third programmes. The Light is mainly dance music, light orchestral works, and variety, while listeners to the Third take a diet of chamber music, Goethe, T. S. Eliot, and Greek plays. Always the butt of the Light comedian, the Third never registers more than 5 per cent in the B. B. C. polls.

Of the $25,000,000 available to the B. B. C. about half goes on programme material, artists, speakers, orchestras, news material, and royalties, about one-quarter on the Engineering Department, and the remaining quarter on rent, rates, taxation, and the central management organization.

It is perhaps natural that a purchasing organization should tend to concentrate on the products of one or two manufacturers, a policy that has obvious dangers when there is no alternative outlet. Whatever the reason, the technical equipment used by the B. B. C. is largely the product of two companies. These are Marconi Wireless Telegraph Company of Chelmsford, an associate of the English Electric Company, and Standard Telephones and Cables, an IT & T associate. Other manufacturers, notably General Electric Company (no relation of yours), Siemens, Decca, Metropolitan Vickers, and Rediffusion, do considerable business in the transmitter line for the specialised demands of the Post Office, aircraft, marine, and allied services, but this aspect and an outline of their activities in the recording and high-fidelity fields will have to wait for later review.

Earlier in these notes, the Post Office anti-interference service was mentioned as absorbing some of the listeners' license fees. As you may have no equivalent service, a few words of explanation are in order. Over here, when the radio emits a series of nasty bangs, crackles, and other noises, and you are certain that this is not the latest in hot jazz, you write to the local post office. In the fullness of time, two P. O. engineers appear with a light van full of equipment. Human nature being what it is, there is generally a rush for listeners' licenses from that section of the "great unlicensed" living on the same street.

The engineers commence a search for the noise, if it's still there. Statistics seem to indicate that 90 per cent of all interference originates in the complainant's own home. If the engineers find it on the premises or in the neighbourhood, they provide advice on how to cure the trouble, but at present they have no power to compel the owner to silence the offending equipment. However, the Welfare State is taking care of this, and it will shortly become an offence to create electrical disturbances.

Well, this has perhaps been a resumé of differences in the basic layout in England and the United States. In the next note I want to deal in more technical detail with the work that has been going on over here. Among other things, I want to discuss efforts being made to obtain some instrumental indication of the quality differences that exist in loudspeakers with similar frequency response curves.

MOBILE RADIO NEWS

(Continued from page 20)

Provided Further, However, that in any case where a proper showing is made to the Commission that the welding devices involved in fact meet the conditions set forth in Part 18 for type approval or certification of such devices by the Commission and are being operated in a manner that in fact complies with the provisions set forth in Part 18 as applicable to such devices, the person responsible for the operation of such devices may have the benefit of the provisions of footnote 5 to Section 18.32 as set forth in Part 18 notwithstanding the fact that such footnote, as part of Part 18, shall not be in effect generally with respect to such welding devices prior to January 31, 1951."

Any questions?

TV SOUND PICKUP

(Continued from page 29)

For smooth studio operation, the audio engineer must play transcribed fanfare, musical themes, and background effects in exact synchronization with the video presentation.

Conclusion:

As in all new fields, experience with television audio problems is the best teacher. Complicating the issue is the fact that acoustics and programming at different studios vary over a wide range, so that a treatment which solves a problem at one studio will fail miserably at another. Only general principles can be drawn from the successes of others, and even then they cannot be guaranteed.

On network shows, however, where the best in engineering skill, equipment, and facilities are available, it seems that good sound quality could be expected. Yet on many network programs, low frequencies are lacking and off-mike effects are noticeable. It appears that the television field generally would benefit by a more careful study of audio problems.

MUNICIPAL FM STATION

(Continued from page 23)

evening programs in advance. The amateur music lover can familiarize himself with works of serious music through an intensive listening program.

The policy makers of the library expect that this and other program innovations will afford benefits to radio audiences that are not available on regular commercial stations. Since WFPL is not competing with commercial broadcasting, it can play directly to its public, whether that public is one person, a class, a civic group, or all of the potential listening audience of 45,000 known owners of FM receivers. These radical changes in program policies will be a challenge to the casual listener. The Library believes an alert public will find this challenge stimulating, and that the response will be ample justification for its faith.

A 10-watt FM station is expected to cover only a 3-mile radius, but we find that WFPL is being received at distances up to 7 miles. This is a coverage area of approximately 150 square miles, compared to the City area of 35 square miles. The department is testing various standard receiving sets to determine the distance at which they can pick us up.

The audio equipment in our studio control room provides for the use of tape, as well as 78-RPM standard and 33 1/3-RPM microgroove recordings.

(Concluded on page 32)

MUNICIPAL FM STATION

(Continued from page 30)

and 16-in. transcription discs. Magnecord, Brush, and Point of Sale tape recorders are used. Turntables by Rek-O-Cut, cutting heads by Fairchild, and RCA lathes complete our extremely versatile recording and playback facilities. Program material includes everything of educational value recorded by permission from other radio sources, as well as transcriptions made at events worthy of preservation and repetition which take place anywhere in the City.

In addition to radio broadcasting the LFPL operates a wire network with 22 outlets. Using telephone wires, leased at the rate of $1.25 per one-fourth air mile per month, this service brings educational programs and worthwhile music to the following agencies: the Children's Center, a detention home for delinquent and dependent children, the Children's ward of the General Hospital, the psychopathic ward of General Hospital, Kentucky School of the Blind, the Y. W. C. A., two recreational centers, two parochial schools, three public schools, and ten branch libraries. Thus, our service is extended to the indigent, delinquent, dependent, physically handicapped, and the mentally ill.

There are important uses for leased wires which cannot be provided for by radio broadcasting. As an example, class schedules often demand that secondary school programs be repeated as often as seven times in one day. This can be done over the wire network without boring the casual community listener who might be tuned in for FM reception.

Again, a program carried on the wire network can be started at the exact instant a teacher requests it, and can be run the exact duration of the class period. This affords greater flexibility than radio broadcasting can provide.

The entire school system in Louisville, numbering 72 school plants, could be hooked up to use this type of service at a cost of approximately $500 per month for telephone charges.

Plans are already under discussion by the forward-looking policy makers of the LFPL to record television programs for retransmission as soon as such equipment is available and the needs of the community justify its use.

The head of our Audio-Visual Department calls this installation our Cultural Communications Center, using the term in all its positive and active connotations. "That is why," Mr. Graham said in his inaugural broadcast, "the Library is proud to add our new radio unit to its means of building mass information. We feel it can become a vital community agency for social culture and strength."

FREQUENCY CHECKING

(Continued from page 22)

operation of limiters or compressors by this overall measurement, since modulation swing can be observed to see if it flattens off as the audio input voltage is increased.

Since single-frequency sine-wave modulation only can be used to carry out the calibration procedure described above, it is desirable to have some way of converting the results to apply to voice modulation. If the audio voltmeter used is sensitive enough, it can be connected to show the modulating voltage, and the readings noted while talking into the microphone. When this method is used, the previous sine-wave calibration should be carried out with the voltmeter so connected. An alternative arrangement is shown in Fig. 3. A receiver is tuned to the transmitter frequency. The receiver output is fed to a volume indicator, and the readings compared between the calibrated sine-wave audio modulation and the subsequent voice modulation.

The use of the swing-measurement procedure to calibrate the receiver provides a rapid means for checking the operation of modulation limiters or compressors, and for observation of the preemphasis and de-emphasis characteristics of the system. Stated another way, the use of the Bessel function method of swing calibration provides points which can be used to calibrate a receiver, employing an output meter as a modulation-measuring device. If the receiver is to be used as a swing or modulation monitor, the de-emphasis circuit should be cut out, or the audio voltmeter connected ahead of the de-emphasis network. The receiver is then suitable for use as a continuous modulation-swing indicator, this indication being subject to an occasional check by the calibration method described. It is then a relatively simple matter to adjust pre-emphasis and de-emphasis for flat overall response, and to check the operation of the modulation limiter.

In order to clarify further the application of this calibration procedure, a hypothetical set of calibration curves are shown, Fig. 5. Many mobile FM systems employ phase-modulated transmitters, which give about 6 db per octave of pre-emphasis unless modified, and complementary de-emphasis in the receiver to provide a flat system response. The characteristics of such a system are shown in Fig. 4. It should be noted that the operation of a modulation limiter restricts the transmission of the high-frequency audio signals before it affects the lower tones. Thus, the dashed curve

(Concluded on page 34)

FREQUENCY CHECKING

(Continued from page 33)

shows the highs dropping off for a constant input level.

The method of measurement outlined here is suitable for transmitters operating on frequencies higher or lower than the calibrated range of the heterodyne frequency meter, providing certain precautions are observed. If the transmitter operates on a lower frequency, such as in the 30- to 50-mc. band, it will be necessary to beat a harmonic of the transmitter with the frequency-meter oscillator. The apparent modulation index of the transmitter will be increased in this way. If the fourth harmonic of a 30-mc. signal is used, the apparent modulation index will be four times that of the fundamental frequency of the transmitter. Therefore, the value measured at the harmonic frequency must be divided by four to obtain the actual modulation index of the transmitter. In other words, the frequency swing of the fourth harmonic is four times the swing of the fundamental, and the results must be interpreted accordingly.

Under opposite conditions, when a transmitter operates above the frequency-meter range, and a harmonic of the frequency meter beats with the transmitter fundamental, the modulation index observed is that of the actual fundamental frequency of the transmitter. This presents no problem.

The procedures outlined are not new[5]. They have been used for some time in the VHF range, with good results.

Measurements made using this method are accurate enough for routine calibration of modulation swing. Under some unusual circumstances, however, the method is subject to considerable error. In particular, the modulation index observed by the carrier-null method is in error by approximately 2.7 times the third-harmonic distortion contributed by the modulator[6]. The distortion involved is that contributed by the modulator only. The null points are independent of distortion in the audio modulation. Since distortion in a phase modulator is minor for small phase displacements, it is probable that the error in the audio frequency range, over which it is feasible to use the measurement method, will be negligible.

From the outline given, it is apparent that center-frequency and deviation measurements can be made with required accuracy using simple methods and readily available equipment.

[5] Murray G. Crosby, "A Method of Measuring Frequency Deviation," *RCA Review*, p. 473, April 1940.

[6] F. L. H. M. Stumpers and W. W. Boelens, "The Determination of Distortion in a Frequency Modulator," *Communication News (Philips)*, August, 1948, p. 107.

Advertisers' Index

Now available . . . a UHF, tube and socket package to solve your UHF tube and tube-cooling problems.

The combined use of the Eimac 4X150A tetrode and the new Eimac 4X150A socket makes possible improved circuit arrangement especially at frequencies between 100 and 500 Mc. and also simplifies mechanical design of the tube cooling system.

The tube . . . type 4X150A is a highly efficient beam-power Eimac tetrode capable of handling 150 watts of plate dissipation and delivering as high as 140 watts of useful output power per tube in conventional coaxial amplifier circuits. Its high degree of stability, high power-gain, and high ratio of transconductance to capacitance make it ideally suited for service as a video amplifier, TV sound amplifier, FM & TV r-f amplifier, or in UHF communications, and in STL and dielectric heating applications.

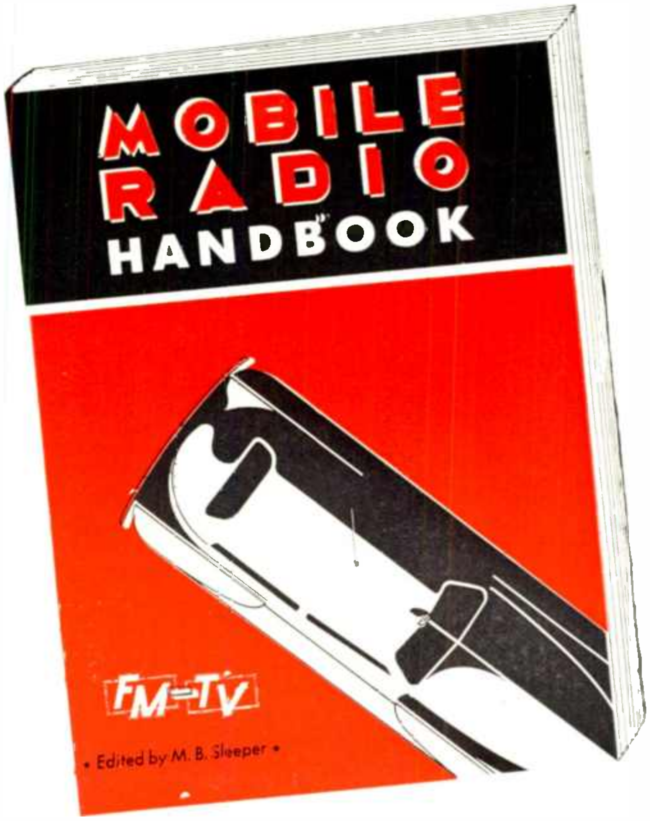
The socket . . . type 4X150A/4000, in addition to insuring adequate cooling of the 4X150A, simplifies circuit construction. It incorporates a 3750 $\mu\mu f$ screen bypass capacitor and its terminal design reduces lead inductance to a minimum. The 4X150A/4000 socket is engineered for service in either coaxial line or chassis construction.

Take advantage of the tetrode engineering experience of America's foremost manufacturer . . . Eimac. Write today for complete data on the 4X150A, 4X150A/4000 socket and other high performance tubes contained in the new Eimac tube catalogue.

255

Follow the Leaders to Eimac TUBES The Power for R-F

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California



OFF THE PRESS AT LAST!

A COMPLETE AUTHORITATIVE UP-TO-DATE HANDBOOK ON

MOBILE RADIO & POINT-TO-POINT COMMUNICATIONS

COVERS ALL THE NEW SERVICES

OF all the radio books that have been published, here is the first complete handbook on mobile and point-to-point communications. Based on the new rules and allocations made effective by the FCC last July, the Mobile Radio Handbook covers this field from cost figures, system planning, and license applications, to installation, maintenance, operation, and theory. Complete information is given for all common carrier, public safety, industrial, and transportation services.

It is a big book, 8¾ by 11½ inches, of 184 pages, profusely illustrated with diagrams and detailed photographs of the latest types of equipment and installations.

This book has been planned to present practical, working information for company executives and public officials responsible for communication systems, as well as for radio engineers, supervisors, and operators. The chapters were written by men who are recognized authorities on the subjects treated. Milton B. Sleeper, publisher of FM-TV Magazine and one of the pioneers in mobile radio, is the Editor. Jeremiah Courtney, former FCC assistant general counsel and now a specialist in the mobile radio field, is Assistant Editor.

CONTENTS

1. SYSTEM PLANNING: Information necessary for planning 2-way communications systems to cover present and future requirements.

2. RULES & ALLOCATIONS: Frequencies, requirements, and Rules for each service.

3. LICENSE APPLICATION: Step-by-step instructions for selecting and filling out necessary FCC forms. All FCC field offices are listed, with area covered by each.

4. EQUIPMENT SPECIFICATIONS: Latest data on all manufacturers' fixed and mobile equipment, with tube lists, battery drain information, and illustrations.

5. SELECTIVE CALLING: Instantaneous and dial methods of selective calling and fleet control. Applications to various kinds of mobile radio systems.

6 to 12. IN ADDITION, there are complete chapters on adjacent-channel operation, communications and point-to-point antennas, antenna tower erection, radio relay systems, maintenance routines and methods, operator license requirements and examinations, and a section on FM theory considered to be the finest ever written. Each chapter is packed with useful information. The coupon below will bring this volume by return mail.

FM-TV
Box 600, Great Barrington, Mass.

Please enter my order for a copy of the MOBILE RADIO HANDBOOK, for which my remittance is enclosed:

$2.00 Paper Bound Volume
$4.00 Cloth Bound Volume
(Add 25c postage outside U. S.)

Name ....

Street ....

City .... State ....

2-WAY RADIO'S **Greatest VALUE!!** **TODAY and TOMORROW**

with exclusive SENSICON RECEIVER - NOW AVAILABLE in the Dispatcher.

PERMANENT VALUE of ADVANCED DESIGN

The Sensicon Circuit with the Permakay Wave Filter, Statomic Oscillator, Differential Squelch, Capacitance Discriminator, and Thermally Balanced Crystal Oven, all exclusive Motorola developments, has advanced the art to permit practicable adjacent channel operation. Further, it provides the only uncompromised design capable of accepting full modulation on the desired channel, and adaptable to "split-channel" frequency assignments. With *"Instantaneous Deviation Control"* of the transmitter carrier plus the broad nose, steep skirt characteristic of the Sensicon Receiver, you have an advanced design combination which will give superior performance *now and tomorrow!*

RELIABILITY

Put it in and forget about it! It breezes along with peak performance always. With fixed-tuned, sealed circuits, precision compensated elements, quality components and workmanship—the day of radio tinkering is over! Remember! the Sensicon System is *coasting* while ordinary systems using fewer tubes are taxed to the false-economy limit!

UNIVERSAL PACKAGING

Built for quick and easy installation—with full accessibility, *here is the solution* to any mounting problem in any type of vehicle. Choice of new all-in-one front model, or trunk mount unit—both are drawer-type with quick lift cover. Both units provide for complete metering and antenna alignment through the covered ports on front—yet the complete housing is closed against dust or other foreign particles.

ENDURING ECONOMY

A quality communications unit designed to deliver longer sustained service at the lowest operating cost. New single vibrator power supply provides for minimum tube and vibrator replacement.

FREEDOM FROM OBSOLESCENCE

The growth of land mobile services licensees from 5,000 in 1945 to over 17,000 (over 160,000 transmitters) today indicates that channel-splitting is imminent. With adjustable modulation control, I.D.C., and exclusive exchangeable Permakay filter you have every factor in hand for your future protection.

Motorola

4545 Augusta Blvd., Chicago 51 · in Canada: Rogers Majestic, Ltd., Toronto

MADE BY THE WORLD LEADERS IN 2-WAY MOBILE RADIO BACKED BY 20 YEARS RESEARCH, EXPERIENCE, AND SPECIALIZATION IN MOBILE RADIO