



AND TELEVISION

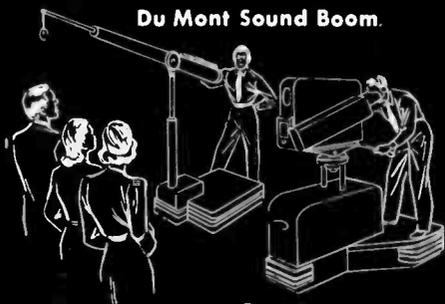


**FM SELECTIVE CALLING ON
161 MC. MEETS TOUGHEST TEST**

SEE PAGE 3 AND 4

Directory of Emergency Stations, Part 2

★ ★ *Edited by Milton B. Sleeper* ★ ★

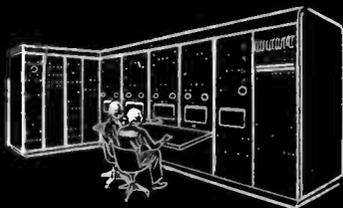


Du Mont Sound Boom.

Du Mont Iconoscope Camera



Producer's Control Desk

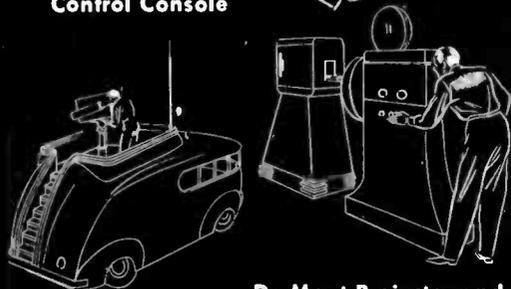


Master Control Board

Du Mont Video-Audio Transmitter



Du Mont Transmitter Control Console



Du Mont-equipped Television Truck

Du Mont Projector and Film Pickup Camera

NEW EQUIPMENT FOR A NEW INDUSTRY

by



DU MONT'S ADVANCED TELEVISION BROADCASTING EQUIPMENT ACHIEVES:

- 1—a new standard of exceptional video quality,
- 2—an amazingly increased flexibility and ease of control,
- 3—a record high in efficient, dependable, trouble-free performance,
- 4—an outstanding triumph in low-cost operation and maintenance.

These advances provide progressive station management with the technical set-up requisite to a sound commercial venture.

Du Mont-engineered design features (which delight the heart of engineers) include:

- 1—test oscillographs strategically mounted in all studio control units for instant and continuous checks on video information,
- 2—"wide open" accessibility for testing and for replacement of components, made possible by an ingenious arrangement of sliding doors and hinged panels,
- 3—rugged dependability that assures heavy-duty service, a virtue widely acclaimed by men who used Du Mont radar equipment in the Armed Services,
- 4—labor-saving ease of operation resulting from conveniently concentrated controls and monitors.

Du Mont television broadcasting equipment is distinguished by the combination of pioneering vision and 15 years of precision electronics know-how. Du Mont has built more television stations than any other company. Du Mont has operated its own station, WABD, for more than 4 years. The fruit of this experience is yours in Du Mont equipment...and in a new booklet, "The Economics of Du Mont Television." Please request the booklet on your firm letterhead.

Copyright 1946, Allen B. Du Mont Laboratories, Inc.

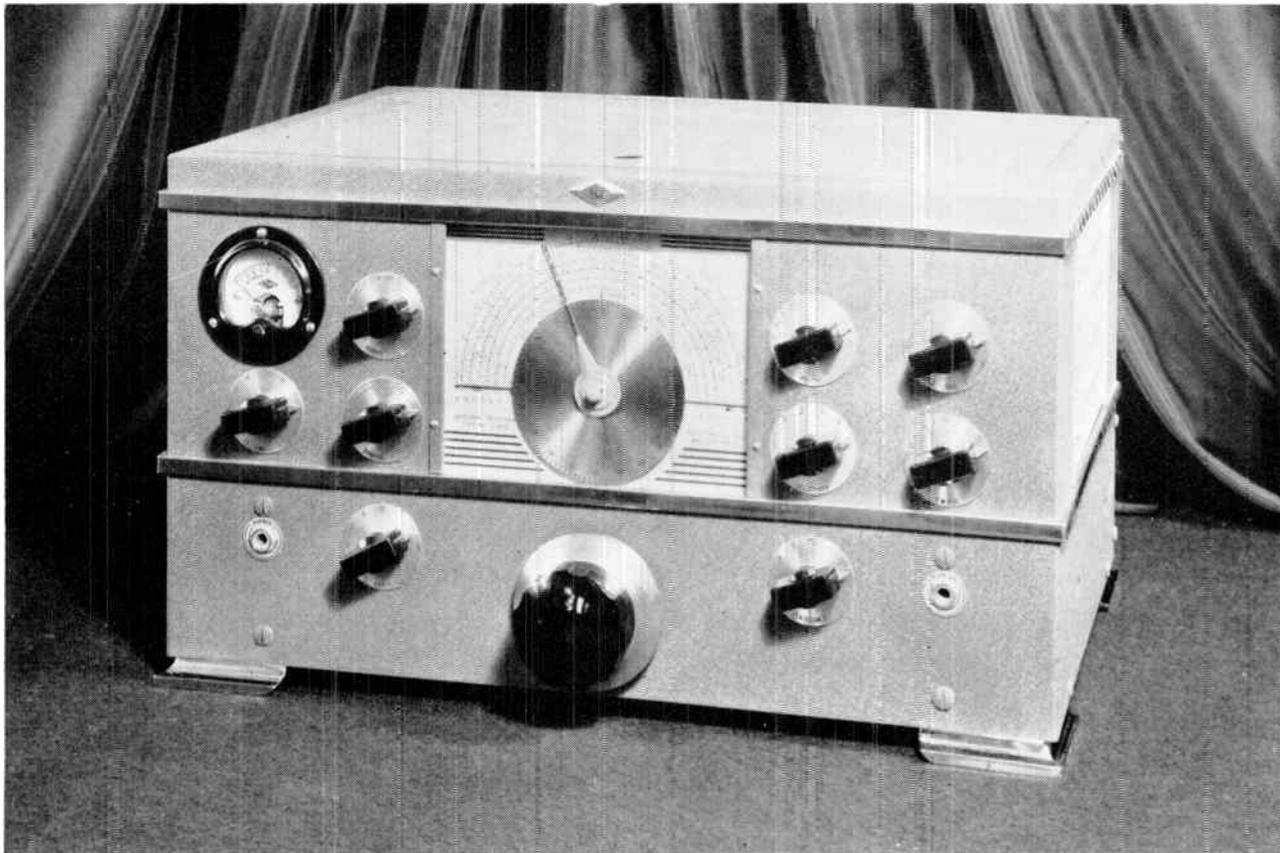
DU MONT



Precision Electronics and Television

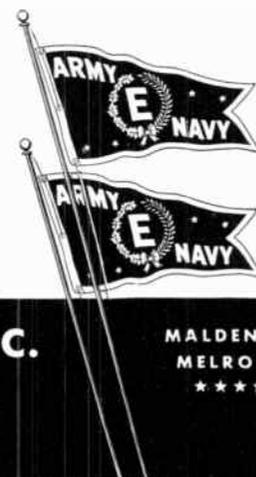
ALLEN B. DU MONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

hr 3



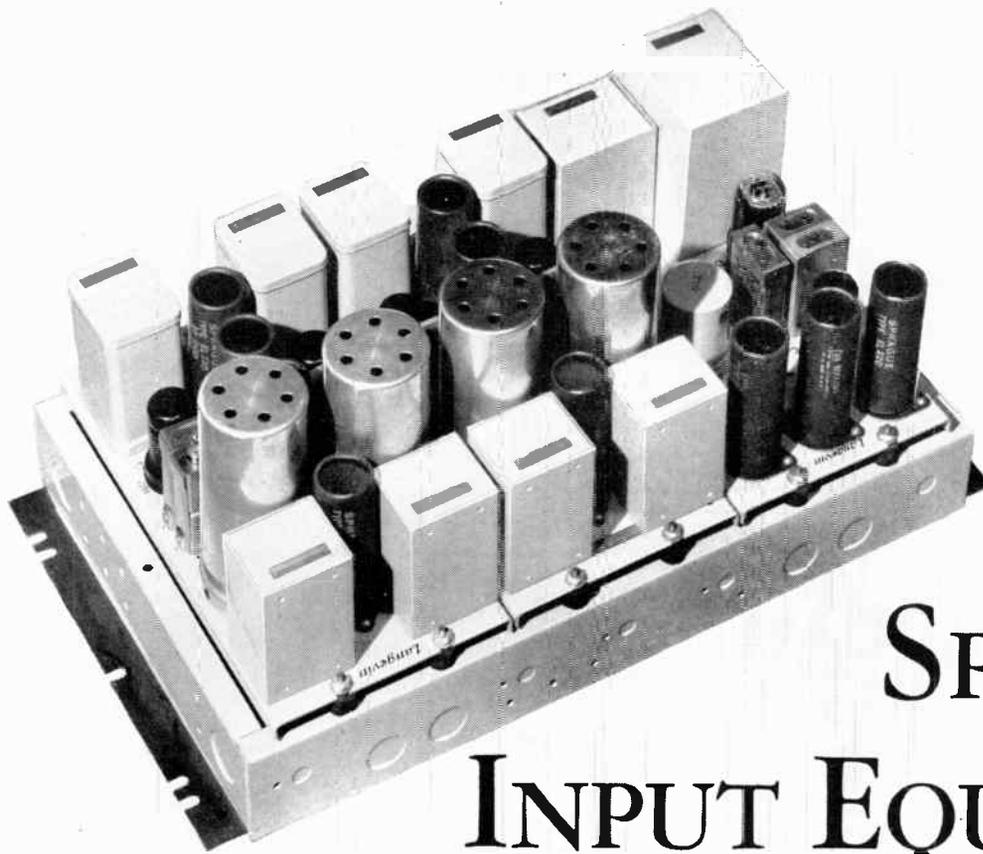
THE NC-2-40C

THIS superb new receiver reflects National's intensive receiver research during the war period. Many of the NC-2-40C's basic design features stem from the NC-200, but to them have been added circuit and construction details that set it apart as a performer. Stability and sensitivity are outstanding. A wide range crystal filter gives optimum selectivity under all conditions. The series-valve noise limiter, the AVC, beat oscillator, tone control and S-meter are among the many auxiliary circuits that contribute toward the all-around excellence of the NC-2-40C. See it at your dealer's.



NATIONAL COMPANY, INC.
MALDEN, MASSACHUSETTS, U.S.A.

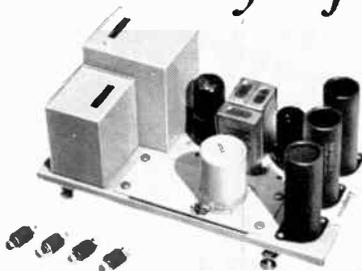
MALDEN
MELROSE



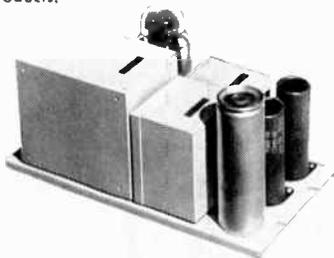
AT LEFT. Two Langevin Type 111-A Dual Pre-Amplifiers and one Langevin 102-A Line-Amplifier mounted on a 3-A Mounting Frame. This unit provides four pre-amplifiers and one line-amplifier, or three pre-amplifiers, one booster-amplifier and one line-amplifier, all in 10½" of rack mounting space. External power supply such as the Langevin 201-B Rectifier, as shown below, is required.

SPEECH INPUT EQUIPMENT

Worthy of an Engineer's Careful Consideration



TYPE 102A Amplifier is one of the 102 Series Line Amplifiers of which four different types are available. The "A" is mostly used to drive the line after the master gain control. It is quiet, has excellent frequency characteristic and ample power output with low distortion products.



The 201-B Rectifier is one of the 201 Series Rectifiers, of which two types are available, the "B" having additional filtering, thereby giving a slightly lower ripple content than the "A." This unit is capable of supplying power for one 102 Series Line Amplifier and three 111 Pre-Amplifiers (six pre-amplifiers).

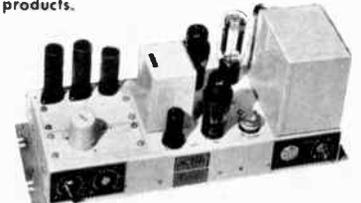
Every unit of Langevin speech input equipment is held to a rigid standard of performance. These units may be cascaded in accordance with good engineering practices and still be well within the allowable limits of FM requirements as to frequency response, noise and distortion products.

All Langevin speech input equipment units are mounted on standard 5¼" x 10¼" chassis. Three of these units can be mounted on a Langevin 3-A Mounting Frame, which occupies 10½" of space on any standard rack. Wall mounting steel cabinets for housing these units are also available.

We are proud of the products which bear the name *Langevin*. It will only appear on good apparatus.



The 111-A Amplifier consists of two individual pre-amplifiers on a single chassis for use in high quality speech input equipment. Its compact unitized construction saves rack space. Input impedances of 30, 250 and 600 ohms; output impedance 600 ohms. It is quiet and has excellent frequency characteristics and ample power output with low distortion products.



The 108-A Amplifier is one of the 108 Series Monitor Amplifiers, of which four different types are available. The "A" is ordinarily used to drive a monitor system from a 600 ohm or bridging source. Its distortion is low for this type of service. It is quiet and has ample power with excellent frequency characteristics.

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St., 3

LOS ANGELES
1000 N. Seward St., 38



AND TELEVISION

FORMERLY: FM MAGAZINE and FM RADIO-ELECTRONICS

VOL. 6

FEBRUARY, 1946

NO. 2

COPYRIGHT 1946, Milton B. Sleeper

CONTENTS

WHAT'S NEW THIS MONTH

FCC's FM Decision — An Apology — FCC — Pauley Situation 4

REPORT ON CBS TELEVISION

Arnold C. Nygren 21

FM PERFORMANCE OVER RUGGED TERRAIN

Fred Ebel 28

FEDERAL FM BROADCAST TRANSMITTER

Martin Silver 34

MANUFACTURE OF CONDENSER PAPER

William P. Schweitzer 37

SELECTIVE CALLING IN NEW YORK ON 157 MC.

Milton B. Sleeper 46

THE NAVY'S WARTIME FM EMERGENCY SYSTEM

Cmdr. H. J. Waters 50

SPECIAL DEPARTMENTS

What's New This Month 4

Engineering Sales 8

Spot News Notes 32

News Picture 33

Directory of Emergency Radio Stations — Part 2 46

THE COVER DESIGN AND CONTENTS OF FM AND TELEVISION MAGAZINE ARE FULLY PROTECTED BY U. S. COPYRIGHTS, AND MUST NOT BE REPRODUCED IN ANY MANNER OR IN ANY FORM WITHOUT WRITTEN PERMISSION

★ ★ ★ ★ ★

MILTON B. SLEEPER, Editor and Publisher

ARNOLD NYGREN, Associate Editor
WILLIAM T. MOHRMAN, Advertising Manager
ANDREW GLIER, Circulation Manager
STELLA DUGGAN, Production Manager
Published by: FM COMPANY

Publication Office: 261 Main St., Great Barrington, Mass. Tel. Great Barrington 1011

New York: 511 Fifth Avenue, New York 17, Tel. VA 6-2183

Chicago: MARIAN FLEISCHMAN, 360 N. Michigan Ave., Tel. STate 1822

Pasadena: MILO D. PUGH, 35 S. Raymond Ave., Pasadena 1, Calif. Tel. Madison 6272

FM Magazine is issued on the 20th of each month. Single copies 25c — Yearly subscription in the U. S. A. \$3.00; foreign \$4.00. Subscriptions should be sent to FM Company, Great Barrington, Mass., or 511 Fifth Avenue, New York 17, N. Y.

Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will FM Magazine be responsible for their safe handling in its office or in transit. Payments are made upon acceptance of final manuscripts.



THIS MONTH'S COVER

THIS month's cover shows, left, Francis P. Burns, Acting Superintendent, Telegraph Bureau, New York City Police Department, and Fred Budelman, chief engineer of Link Radio Corporation, checking the operation of the 157-mc. dial calling system described in this issue. Although the transmitter is remote-controlled, it can be operated directly by a handset installed for that purpose.

Superintendent Burns was characteristically non-committal about possible plans for new radio equipment for New York's Police Department. Once the finest system of its kind in any city, the present installation has paid high dividends to the Department and to the public. Measured against radio progress, however, its one-way AM operation is now outdated.

HIGHER PERFORMANCE

LOWER MAINTENANCE

Those are not claims, but facts — attested to by many hundreds of Blaw-Knox Vertical Radiators now boosting the coverage and clarity of America's major stations.

BLAW-KNOX DIVISION

of Blaw-Knox Company
2046 Farmers Bank Bldg.
Pittsburgh, Pa.

BLAW-KNOX VERTICAL RADIATORS

Entered as second-class matter, August 22, 1945, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Concord, N. H. Printed in the U. S. A.



The
SMALL
like the
LARGE...

in *Vertical* **FULLY MOUNTED TRANSFORMERS**

FIVE newly-developed vertical shields, accommodating core stacks with $\frac{1}{2}$ " to $\frac{7}{8}$ " center legs, now make it possible for Chicago Transformer to fully-mount both small and large transformers with uniformity.

Now, in radio chassis and similar applications, both small and large units can be vertically-mounted with standardized assembly techniques—with uniform appearance in the finished product.

Adaptable to many variations, Chicago Transformer's complete line of vertical shields allows for either screw or twist-lug mountings and for lead exits through either sides or bottoms of the shields.

CHICAGO TRANSFORMER
DIVISION OF ESSEX WIRE CORPORATION
3501 WEST ADDISON STREET
CHICAGO, 18

WHAT'S NEW THIS MONTH

1. FCC'S FM DECISION
2. AN APOLOGY
3. FCC-PAULEY SITUATION?

1 Following the January 18-19th hearing on Zenith Radio's petition that the 42- to 50-mc. band be assigned to FM broadcasting, the FCC let it be known that this service would be confined to 88 to 108 mc.

That was on January 23rd. Three weeks later, at this time of writing, the formal announcement and explanation of the decision had not been issued in accordance with customary practice.

As matters stand now, the Commission has reaffirmed its intention of limiting FM service to the public by holding the effective output of metropolitan FM stations to 20 kw., combined with an antenna height of only 500 ft. above the average terrain. This gives effect to the CBS-Kesten plan to limit FM to single-market coverage, and gives the lie to Chairman Porter's own fine promises to assure the rapid expansion of FM's superior service to radio listeners.

Perhaps the Commissioners are finding it difficult to formulate an explanation of their decision that even satisfies themselves. To satisfy the industry and the public, they will have to explain among other things:

1. If they are going to increase the power of metropolitan FM stations or reduce the power of AM stations so that FM and AM can compete on a basis of equal coverage, or whether FM will be held down to Commissioner Jett's estimate of 35 miles radius, while such an AM station as WOR is allowed to operate with sufficient power to support the claim that: "If a sponsor uses WOR, it's a sign that his program will be heard in 16 of America's greatest cities of more than 100,000 people in each. They include: New York City, Wilmington, Philadelphia, Trenton, Hartford, and 11 others."¹

2. Why the Commissioners support the CBS-Kesten plan of single-market coverage when they know that fewer FM stations of greater coverage will give listeners a wider choice of programs than a large number of limited-coverage stations.

3. Why, when the Commissioners know that the economics of public service ren-

¹From the text of an advertisement on the front cover of *Broadcasting*, February 4, 1946.

(CONTINUED ON PAGE 78)

RAYTHEON'S NEW STUDIO CONSOLE

For AM or FM



Easily Controls Two Studios, Announcer's Booth and Fourteen Permanently Wired Remote Lines

COMPLETE high-fidelity speech-input facilities for the modern station; this single compact unit contains all the control, amplifying and monitoring equipment. Any combination of studios, remote lines or turntables may be broadcast and auditioned simultaneously through the two high quality main amplifier channels. On-coming programs may be cued and the volume pre-set while on the air.

Its modern functional beauty in two-tone metallic tan will blend with other equipment and yet add a definite air of quality and distinction to your studio. Sloping front panel combines maximum visibility of controls with ease of operation. Sloping top panel gives operator an unobstructed view into the studio.

Engineered for dependability and built of finest quality components throughout. Telephone-type lever action, 3 position key switches assure trouble-free operation and *eliminate nineteen controls*. This simplified switching reduces operational errors. All controls are standard, simple and positive—easy to operate.

Inquire! The low price of this Raytheon Console will amaze you. The first orders are now being delivered. Write to:

RAYTHEON MANUFACTURING COMPANY
Broadcast Equipment Division
7517 N. Clark Street, Chicago 26, Illinois

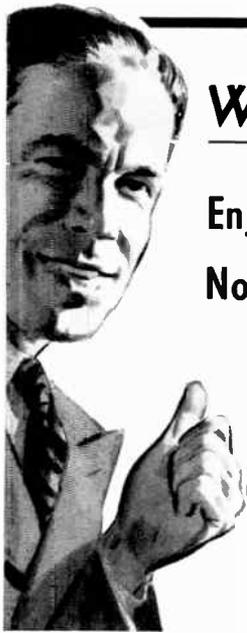
Devoted to Research and Manufacture for the Broadcasting Industry

Compare THESE OUTSTANDING FEATURES WITH ANY OTHER CONSOLE

1. **Seven** built-in pre-amplifiers—*more than any other console*—making possible 5 microphones and 2 turntables, or 7 microphones, on the air simultaneously.
2. **Nine** mixer positions—*more than any other console*—leading to 5 microphones, two turntables, one remote line and one network line.
3. **Fourteen** remote lines—*more than any other console*—may be wired in permanently.
4. **Telephone-Type** lever-action key switches used throughout—most dependable, trouble-free switches available. No push buttons.
5. **Frequency Response** 2 DB from 30 to 15,000 cycles. Ideal speech input system for either AM or FM.
6. **Distortion** less than 1%, from 50 to 10,000 cycles.
7. **Noise Level** minus 65 DB's or better. Airplane-type four-way rubber shock mounting eliminates outside noise and operational "clicks."
8. **All FCC Requirements** for FM transmission are met.
9. **Dual Power Supply** provides standby circuit instantly available for emergency use.
10. **Power Supply** designed for mounting on desk, wall or relay rack.
11. **Instant Access** to all wiring and components. Top hinged panel opens at a touch. Entire cabinet tilts back on sturdy full-length rear hinge.

RAYTHEON

Excellence in Electronics



Where Will YOU Be in 1950?

Enjoy Security and Good Pay! Prepare Now With CREI Modern Technical Training and Step Ahead of Competition into a Good Radio Job!

CREI Offers You a Proved Program of Self-Improvement to Keep Pace With Modern U.H.F. Advancements and Enables You to Go After — and Get a Secure Radio Job!



Yes, there are GOOD JOBS . . . for GOOD men! The easy jobs are gone and once again knowledge and ability are the requirements for the good-paying jobs. Competition is opening up. The fight to HOLD good jobs — to SECURE better ones is just starting. Employers once again can afford to be "choosy" . . . to select the best man for the best job. In the face of this show-down situation — **where do YOU stand?**

CREI home study training in Practical Radio-Electronics Engineering can equip you to meet the requirements to **hold** your job — or advance to a **better** one. No matter what your past radio electronics experience has been — no matter what your training — you must actually start anew to gain the confidence born of knowledge. By adding CREI training to your present radio experience you can safeguard your future and keep pace with such new developments as U.H.F. Circuits, Cavity Resonators, Pulse Generators, Wave Guides, Klystrons, Magnetrans and other tubes. Are you equipped to handle them? CREI is equipped to **help** you, by providing the know-how and ability that is required.

In our proved method of instruction, you learn not only **how**, but **why**! Easy-to-read-and-understand lessons are provided well in advance, and each student has the benefit of personal guidance and supervision from a trained instructor. This is the basis of the CREI method of training for which many thousand professional radiomen have enrolled since 1927.

It costs you nothing to read the interesting facts . . . to learn how CREI can help you enjoy the security you want . . . the better-paying job that can be yours. Write for particulars now!

CAPITOL RADIO ENGINEERING INSTITUTE

HOME STUDY COURSES IN PRACTICAL RADIO-ELECTRONICS
ENGINEERING FOR PROFESSIONAL SELF-IMPROVEMENT

Dept. F-2, 3224-16th Street, N. W., Washington 10, D. C.

Contractors to U. S. Navy — U. S. Coast Guard — Canadian Broadcasting Corp.
Producers of Well-trained Technical Radiomen for Industry

Member: NATIONAL COUNCIL OF TECHNICAL SCHOOLS

ADVERTISERS INDEX

Aerovox Corp.	78
American Phenolic Corporation	67
Amperite Company	76
Anderson, H. V., & Associates	19
Andrew Company	8, 19
Bell Telephone Labs.	10, 11
Blaw-Knox	3
Boonton Radio Corp.	73
Browning Laboratories, Inc.	59
Burstein-Applebee Co.	64
Capitol Radio Eng. Inst.	6
Centralab	61
Chicago Transformer Corp.	4
Commercial Radio Equip. Co.	19
Cornish Wire Co.	79
Drake Mfg. Corp.	78
Dumont Laboratories, Inc., Allen B.	

Inside Front Cover

Eitel-McCullough, Inc.	53
Electrical Reactance Corp.	74
Fed. Tel. & Radio Corp.	14, 66
Finch Telecommunications, Inc.	17
FM Company	71, 64, 75
Freeland & Olschner Products, Inc.	19
Galvin Mfg. Corp.	77
General Electric Company	40, 41
Hallicrafters Co.	20
Hammarlund Mfg. Co., Inc.	80
Hytron Radio & Electronics Corp.	70
Jansky & Bailey	19
Kaufman, Robert L.	19
Keel, John J.	19
Kluge Electronics Co.	19
Langevin Company	2
Link, F. M.	Back Cover
Mackintosh, Frank	19
May & Bond	19
McKey & Shaw	19
Measurements, Inc.	76
National Company, Inc.	1
National Union Radio Corp.	69
Newark Electric Co.	64
Ohmite Mfg. Co.	55
Presto Recording Corp.	13
Radio Corporation of America	65
Radio Dev. & Research Corp.	18
Radio Engineering Labs, Inc.	

Inside Back Cover

Radio Wire Television, Inc.	74
Ray, Garo W.	19
Raytheon Mfg. Co.	5, 15
RCA Communications, Inc.	19
Rogan Bros.	64
Sherron Electronics Co.	12
Shure Bros.	57
Standard Measuring & Equip. Co.	19
Swain Nelson Co.	63
Sylvania Electric Products, Inc.	9, 72
Transmitter Equipment Mfg. Co.	16
United Cinephone Corp.	7
U. S. Recording Co.	19
Western Electric Co.	10, 11
Westinghouse Electric Corp.	68
Wilмотte, Raymond M.	19
Wilson, Herbert L.	19
Wincharger Corp.	79
Zenith Optical Laboratory	73



**WRITE FOR
FREE 36-PAGE
BOOKLET**

**"Your Opportunity
in the New World
of Electronics"**

If you have had professional or amateur radio experience and want to make more money, let us prove to you we have something you need to qualify for a better radio job. To help us intelligently answer your inquiry — PLEASE STATE BRIEFLY YOUR BACKGROUND OF EXPERIENCE, EDUCATION AND PRESENT POSITION.

... it's New!



**FOR
TELEVISION
RADAR AND
FAC-SIMILE**

Wide Band **VIDEO AMPLIFIER**

Designed primarily for use in amplifying complex waves to be viewed on an oscilloscope, this instrument is also extremely useful in laboratory work as an audio amplifier for tracing and measuring small R. F. Voltages, (as in the early stages of radio receivers,) and many similar applications.

Specifications

BAND WIDTH: Frequency response is flat within 1.5 DB of the 10 KC response from 15 cycles, to 4 megacycles and 3 DB from 10 cycles to 4.5 megacycles. Phase shift is controlled to provide satisfactory reproduction of pulses on the order of one micro-second, and square waves at repetition rates as low as 100 per second.

GAIN: The gain is approximately 1000 when direct input is used. Use of probe input introduces an attenuation of approximately 10:1.

INPUT is normally through a probe (furnished with the equipment), which has an input circuit consisting of a 1.1 megohm resistance in parallel with approximately 18 mmfd. The amplifier direct input (without probe) is approximately 2.2 megohms of resistance in parallel with 40 mmfd.

OUTPUT voltage can be adjusted from zero to 50 volts R.M.S. with a sine wave signal.

LOAD IMPEDANCE: Designed to work into a load of not more than 22 mmfd.

RIPPLE OUTPUT is less than 0.5 volt for all operating conditions and all positions of gain control.

CIRCUIT FEATURES: A cathode follower input stage provides circuit isolation and is equipped with a 3-position attenuator.

Attenuator ratios are 1:1, 10:1 and 100:1 (This is in addition to probe attenuation). A gain control conveniently varies the video output. A "Signal Polarity" switch is provided which carries the cathode bias on the output stage in such a manner that the amplifier may be adjusted for optimum performance, regardless of the polarity of the input signal.

OPERATING VOLTAGE: 110 to 120 volts, 60 cycles.

POWER CONSUMPTION: 100 watts.

WEIGHT: 35 pounds (Complete with tubes and probe).

WIDTH: 7 $\frac{3}{4}$ " **HEIGHT:** 9" **LENGTH:** 20 $\frac{3}{4}$ "

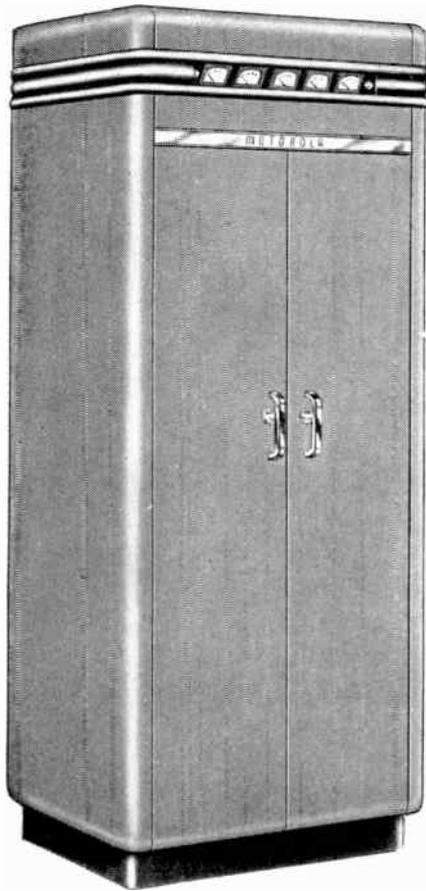
INQUIRE EARLY TO INSURE PROMPT DELIVERY

UNITED CINEPHONE CORPORATION

Designers, Engineers and Manufacturers of Electronic Products

18 NEW LITCHFIELD STREET

TORRINGTON, CONNECTICUT



Illustrated is Motorola's newest contribution to this field—the Model FSTRU-250-BR 250-watt Central Station Transmitter - Receiver Unit, designed for the newly-established 152-162 mc. band.



That all Motorola Police and Public Utility equipment uses ANDREW Coaxial Cable is indicative of Motorola's confidence in ANDREW engineering and manufacturing skill. The ANDREW Company is a pioneer in the manufacture of coaxial cable and accessories.

POLICE USE *Motorola*

Eighty percent of all FM Police radio equipment in use today is Motorola. This includes a roster of 35 state police systems and many thousands of city and county systems throughout the United States.



WRITE FOR
ANDREW CATALOGUE
TODAY

ENGINEERING SALES

Raytheon: New representatives of the broadcast equipment division are Clair Miller for the midwest territory; W. B. Taylor for the southern territory, working out of Chattanooga; and E. J. Rome, working from the Raytheon office at 215 W. 7th Street, Los Angeles.

Aireon: R. C. Welsh, formerly vice president and treasurer of Aireon, has been appointed to the newly created post of vice president in charge of sales.

Madison: A new retail organization, to handle sales of household appliances and radios at Madison, N. J., has been set up by Madison Electrical Products Corporation, manufacturers of precision resistors. J. G. Ruckelshaus is in charge.

Machlett: Harold W. Rohar, formerly manager of Westinghouse transmitter tube sales, is now in charge of Machlett's renewal sales department.

Shure: Back in Chicago after two and one-half years overseas with the 3rd Infantry Division, Howard T. Horwich has been appointed advertising manager of Shure Brothers.

Electronic Laboratories: New sales manager of the E-L distributor division is F. Theodore Hegeman. He will make his headquarters at the plant in Indianapolis.

Sylvania: Lt. Henry C. L. Johnson is back at Sylvania as advertising manager of Sylvania's radio division. He will also direct advertising and sales promotion of the industrial electronics and international divisions. He took part in nine major South Pacific battles, and wound up as commanding the U.S.S. Thuban.

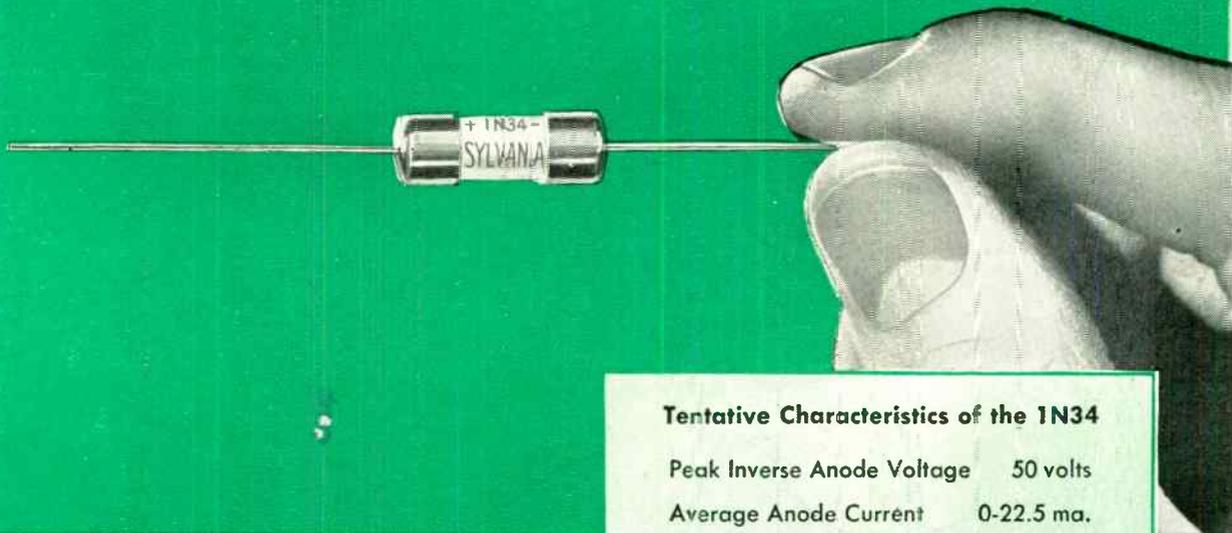
RCA: Six regional communications engineers have been appointed by RCA Service Company, Inc. They are: K. C. Heddens for New York; H. M. Leighley, Atlanta; E. E. Whitaker, Cleveland; J. S. Gremillion, Dallas; M. S. Reutter, Chicago; and F. C. Hartwick, Los Angeles. In addition, T. Griffin has been appointed national field supervisor.

REL: Edward F. Classen, Jr. has joined REL Equipment Sales, Inc., 612 N. Michigan Avenue, Chicago, as FM sales engineer. For the past 10 years he was with Zenith Radio, where he was program di-

(CONCLUDED ON PAGE 76)

FM AND TELEVISION

HERE'S A NEW CIRCUIT ELEMENT that displays non-ohmic characteristics



IMAGINE a circuit element that *violates* Ohm's Law. One that exhibits *polarized* non-linear current-voltage characteristics.

Such an element has now been made commercially available for the first time . . . Sylvania Electric's 1N34 G_x metal Crystal Diode. This tiny unit (shown full size in illustration) opens up many interesting potentialities in circuit design. Withstanding relatively high voltages, it is extremely useful as a circuit element.

Light in weight and equipped with pigtail leads, it is conveniently soldered into place . . . no sockets required. No heater supplies are needed — eliminating hum and noise, permitting both terminals to be connected far above ground potential.

The 1N34 Diode gives superior performance at high frequencies and with low values of load resistance.

Tentative Characteristics of the 1N34

Peak Inverse Anode Voltage	50 volts
Average Anode Current	0-22.5 ma.
Peak Anode Current	60 ma. max.
Surge Current	200 ma. max.
Back Conduction at 50 volts	2 ma. max.

(Surge current refers to transient values; peak current refers to the maximum value of an applied AC signal.)

Where Can You Use an Element Like This?

Among the expected applications of the 1N34 Diode are: DC restorers in television receivers; frequency discriminators in FM sets; peak limiters; video detectors; meter rectifiers; bias rectifiers; modulators and demodulators.

Perhaps *you* can see many other ways in which you can put this revolutionary circuit element to work. We'll be glad to send you further technical information to assist you in planning applications, and to discuss specific uses with you.

SYLVANIA ELECTRIC

Electronics . . . 500 Fifth Avenue, New York 18, N. Y.

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

February 1946—formerly FM RADIO ELECTRONICS

WOW

this team could do

There are three reasons why the team of Bell Telephone Laboratories and Western Electric was able to handle big war jobs fast and well.

(1) It had the men—an integrated organization of scientists, engineers and shop workers, long trained to work together in designing and producing complex electronic equipment.

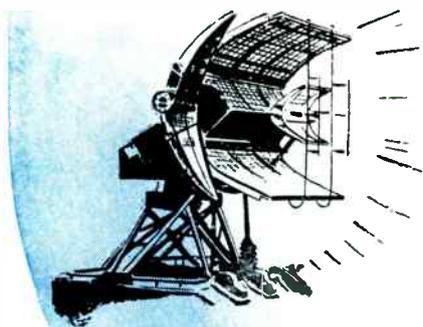
(2) It had unequalled physical facilities.

(3) Perhaps most important of all, it had a long-established and thoroughly tested method of attack on new problems.

What is this method of attack?

In simple terms, it is this. Observe some phenomenon for which no explanation is known—wonder about its relationship to known phenomena—measure everything you can—fit the data together—and find in the answer how to make new and better equipment.

In the realm of *pure research*, Bell Laboratories have carried on continuing studies in all branches of science, with particular emphasis on physics, chemistry and mathematics. Often they have set out to gain new knowledge



Bell Laboratories and Western Electric teamed up to supply more than 56,000 radars of 64 types—approximately 50% of the nation's radar production on a dollar volume basis.



Bell Laboratories designed and Western Electric produced more than 1600 electronic gun directors and gun data computers which greatly increased the accuracy of anti-aircraft and coast defense guns.



More than 1,000,000 airborne radio receivers and transmitters were furnished by Western Electric to help coordinate attack and defense in the air.



Bell Laboratories designed and Western Electric furnished more than 139,000 multi-channel FM receivers and 74,000 multi-channel FM transmitters for use by the Armored Forces and Artillery.



Bell Laboratories and Western Electric furnished revolutionary carrier telephone terminal equipment in great quantities—all "packaged" for quick installation in the field.

war jobs like these

with no immediate prospect of an application in the communications field. Time after time, their discoveries have eventually brought about fundamental scientific advances.

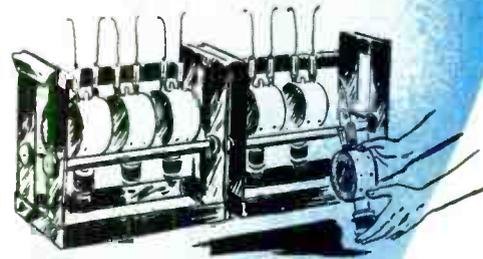
Applying new discoveries

As new discoveries have reached the stage of application, Western Electric manufacturing engineers have always worked closely with Bell Laboratories men to assure a final design suited to quantity production of highest quality equipment.

During the war, the capabilities of this unique research-production team expanded rapidly. New techniques were explored—new methods were developed—new ideas were born, rich with possibilities for the future.

What this means to YOU

Today Bell Laboratories and Western Electric are once more applying their facilities and their philosophy to the development and production of electronic and communications equipment for a world at peace. Depend on this team for continued leadership in AM, FM and Television broadcasting equipment.



Bell Laboratories and Western Electric played outstanding roles in the design and production of magnetrons and other essential vacuum tubes for use in radar and communications.



BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communication.

Western Electric

Manufacturing unit of the Bell System and nation's largest producer of communications and electronic equipment.



Sherron

STUDIO CONTROL

DESK MODEL SE-300 **FOR VIDEO**

This unit is especially designed to afford exclusive control to the program or technical director in charge of telecasting.

Three video pictures are included for ease in selection of camera pick-ups and in viewing the final transmitted picture. In addition, this Model SE-300 is equipped with inter-communication for contact with master control and studio camera men.

A loudspeaker in the end-unit gives the director his aural pick-up. . . .

The kinescopes are 7" direct viewing tubes, which facilitate the duties of the individual in charge of detail and contrast.

Should more camera pick-ups be needed, the Sherron Studio Control Desk can be enlarged by increasing the number of kinescope panels. Furthermore, a turntable can be included in one of the end-units.

As is characteristic of all Sherron broadcast equipment, maintenance and safety are primary considerations. Each chassis is removable without soldering of wires.

Plugs offer ease of removal and quickness of change.



SHERRON ELECTRONICS CO.

Subsidiary of Sherron Metallic Corp.

1201 Flushing Avenue • Brooklyn 6, N. Y.

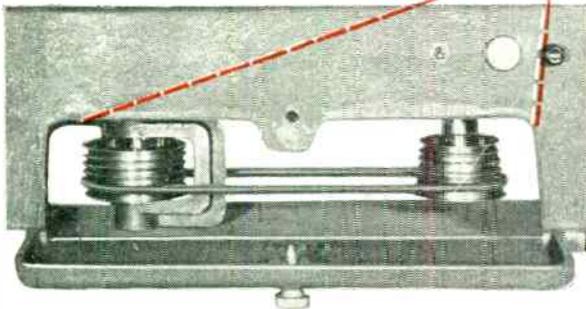
"Where the Ideal is the Standard, Sherron Units are Standard Equipment."

Not jet propelled...



PRESTO 8-D

but just as **NEW!**



The belt on step pulleys slips instantly to any position to set cutting pitch at 96-104-112-120-128 or 136 lines per inch. Other pitches available on special order.

PRESTO'S newest *turntable*... for highest quality master or instantaneous recordings. The 8-D features instantaneous change of cutting pitch. An improved cutting head provides higher modulation level, more uniform frequency response and retains its calibration under all normal temperature conditions.

The heavy cast-iron turntable and mounting base insure exceptionally low background noise. Adjustable feet permit accurate leveling on bench or stand at a height to suit the operator.

PRESTO



RECORDING CORPORATION

242 West 55th Street, New York 19, N. Y.

Walter P. Downs, Ltd., in Canada

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

February 1946—formerly FM RADIO ELECTRONICS

13

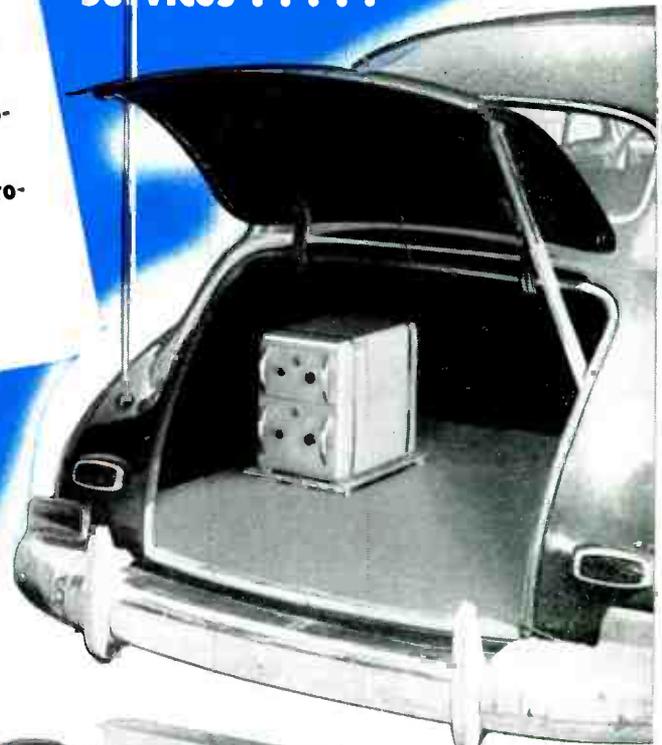
6 POINT

Superiority

DISTINGUISHES

Federal's Complete FM Radio Telephone System for Police, Fire and All Emergency Services

- "SELECTO-CALL" SYSTEM—receiver output muted until called by associated station.
- LOWEST CURRENT DRAIN—receiver standby 4.8 amperes; transmitter standby 1.6 amperes.
- SMALLEST SIZE—housing approximately 8³/₄" wide; 11³/₄" high; 13³/₈" long.
- EASE OF INSTALLATION AND SERVICING—both transmitter and receiver may be removed and standby units replaced in less than one minute.
- FEWEST TUBES—only five types assuring economy and low maintenance.
- HIGH SENSITIVITY—three-tenths of one micro-volt to operate "Selecto Call" System.



Here is mobile radio equipment built to "specifications" provided by the field, fundamentally different in design to meet the particular demands and solve the difficult problems of users of this type of installation. Backed by Federal's long experience and leadership in radio, this equipment incorporates

rugged compactness, greater ease of operation, real economy, unrivalled dependability and total satisfaction. Its exclusive "Selecto-Call" and its many other unique features, makes it the outstanding equipment for police, fire, forestry, conservation, taxi and bus dispatching and all other emergency services. Write for information.



Federal Telephone and Radio Corporation



Newark 1, N. J.



A "STAR SALESMAN" FOR YOU!

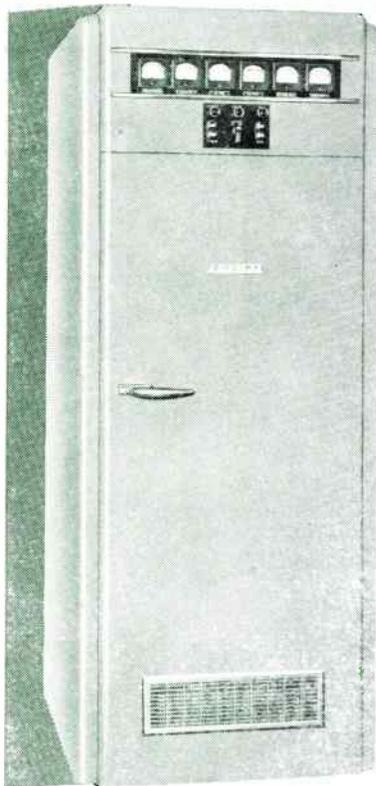
Every customer who comes to your counter will see this effective wall banner. It tells them you're a dependable, square-dealing Raytheon Bonded Electronic Technician — and brings them back to spend money with you.

This selling wall banner is only one of many carefully designed sales-aids — displays, decals, mailing pieces, job record cards — for you to use in building a lasting, money-making radio service business. Bonded service means better customer relations. See your Raytheon distributor today.

Another reason why it pays to qualify as a Raytheon Bonded Electronic Technician.



Need Communication Equipment?

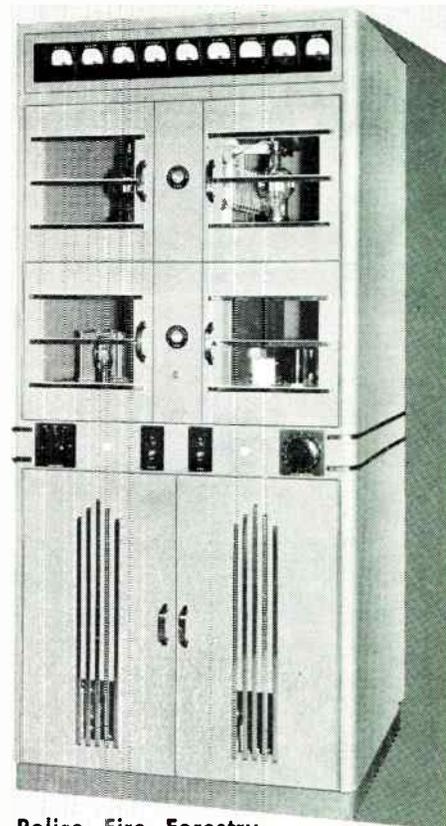


FM and AM Broadcasting

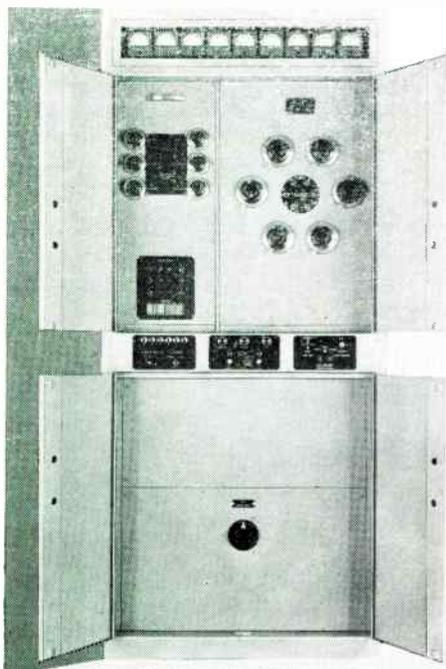
TEMCO will deliver within 30 to 60 days equipment for any of the following services:

- FM and AM BROADCASTING
- AVIATION and MARINE
- POLICE - FIRE - FORESTRY and PUBLIC UTILITY
- POINT - TO - POINT COMMERCIAL
- AMATEUR and CITIZEN

Send us your requirements for IMMEDIATE action



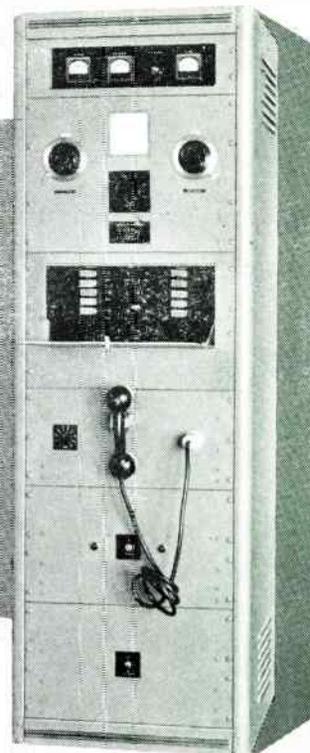
Police - Fire - Forestry and Public Utility



Point - to - Point Commercial



Amateur and Citizen



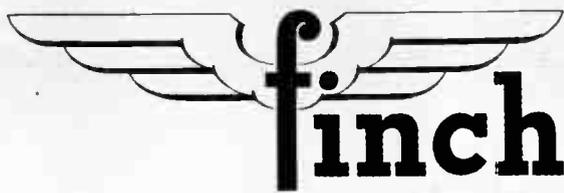
Aviation and Marine

TEMCO

RADIO COMMUNICATION EQUIPMENT

TRANSMITTER EQUIPMENT MFG. CO., INC.

345 Hudson Street, New York 14, N. Y.



self-synchronizing

finch facsimile

POINT TO POINT (Mobile or Stationary)

faxogram



World's Fastest and Most Accurate Communications Equipment

TELEFAX

the "Instant Courier"

With Finch Facsimile equipment ("Telefax"), illustrated and written messages called Faxograms can be sent at great speed between any two points that can be connected by radio or wire. These points may be stationary (as between factory and office) or mobile (as between ship to airplane or station to patrol car). Anything or everything that can be printed, drawn or written on a sheet 8½" x 11" can be transmitted by radio in two minutes or by wire in four minutes.

BROADCAST



AIR PRESS

TELEFAX ILLUSTRATED NEWS

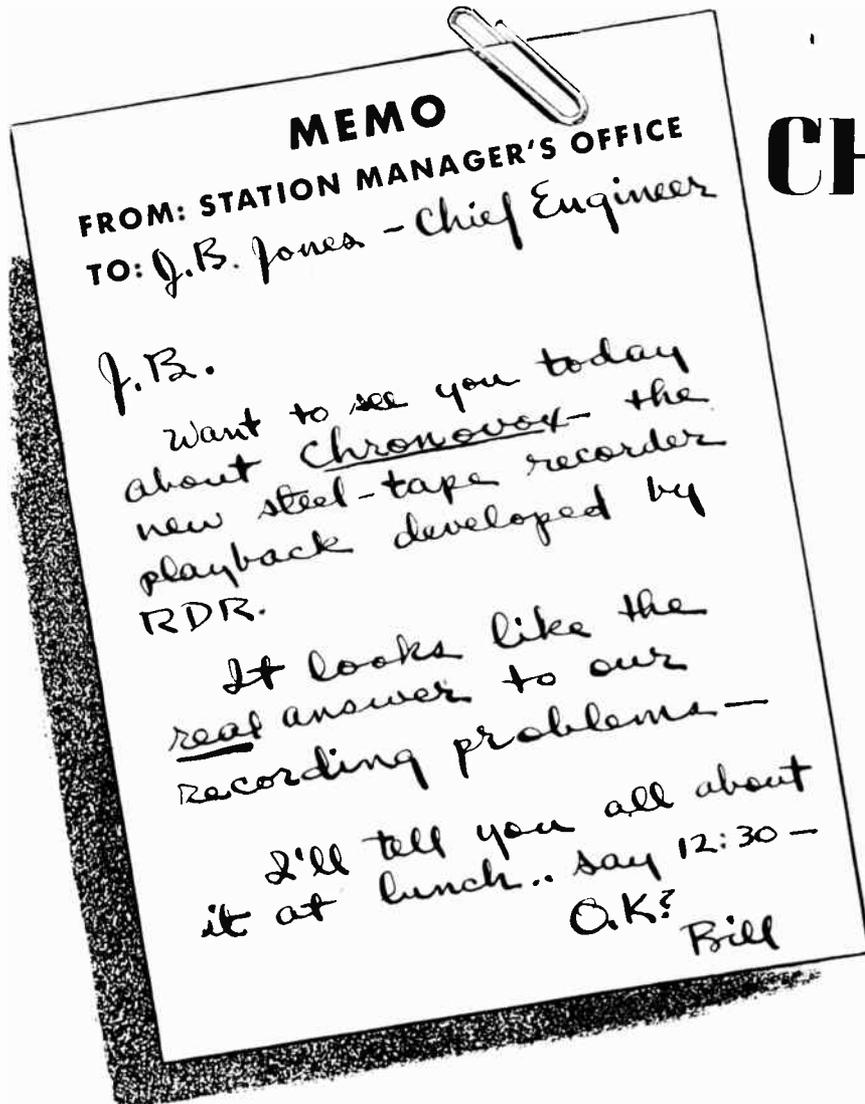
*Pictures and printing
broadcast to homes*

With Finch Facsimile equipment, illustrated printed matter such as newspapers or magazines can be sent by radio to homes. Stations are now being licensed to render this service. Home recorders and recording paper will be moderately priced. Broadcasts will include all news and features such as cartoons, market reports, photographs, and maps besides illustrated and printed advertisements. In one hour, the equivalent of more than twenty pages of tabloid size can be transmitted and received.

**For Full Information
write to:**

**FINCH
TELECOMMUNICATIONS, Inc.**
Passaic, N. J., U. S. A.
(N. Y. Office, 10 East 40 St.)

Making Steel Talk



with **CHRONOVOX**

Know these Facts about Chronovox!

- The cost of discs is eliminated!
- The steel tape is permanent ... indestructible!
- Recordings are erased at will!
- Surface noise lower than any other method of recording!
- Recordings reproduce indefinitely with less than 3DB attenuation!
- It's a complete, self-contained unit!
- Plugs in any 110 volt AC source!
- For a permanent record, "dub" from the final—perfect—Chronovox impression to your disc recorder!

Yes, memos like this one are being written daily. Radio executives KNOW that Chronovox will solve many of their recording problems. The RDR Chronovox is a precision instrument employing an improved method of recording sound on an indestructible steel tape. Recordings are made magnetically not physically—and the Chronovox will repeat the last recording indefinitely or until a new one is made.

FOR MORE INFORMATION - CONTACT:

RADIO DEVELOPMENT & RESEARCH CORP.

26 CORNELISON AVENUE

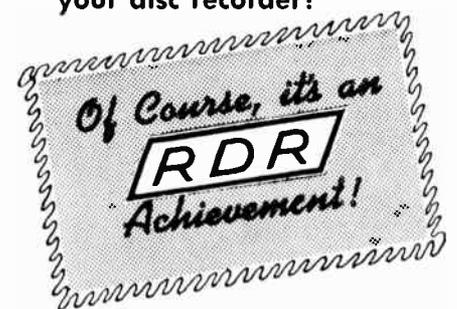
JERSEY CITY 4, N. J.

AFFILIATE: TRANSFORMER PRODUCTS, INC.

MIAMI: SALES—SERVICE

26 Cornelison Avenue, Jersey City 4, N. J.

1415 N. E. 2nd Ave., Miami, Fla.



Professional Service Directory

Jansky & Bailey

AN ORGANIZATION OF
Qualified Radio Engineers
DEDICATED TO THE
SERVICE OF BROADCASTING
National Press Bldg., Washington, D. C.

RAYMOND M. WILMOTTE
Consulting Radio Engineer

PAUL A. DEMARS
Associate

1469 Church St., N.W., Washington 5, D. C.
Decatur 1234

FRANK H.
McINTOSH

Consulting Radio Engineers
710 14th St. N.W., Wash. 5, D. C.
MEtropolitan 4477



ANDREW CO.

Consulting Radio Engineers
363 EAST 75th STREET, CHICAGO 19
Triangle 4400

MAY & BOND
CONSULTING RADIO ENGINEERS

★ ★ ★

1422 F Street, N. W. Wash. 4, D. C.
Kellogg Building Republic 3984

JOHN J. KEEL

Consulting Radio Engineers

Earle Building
NATIONAL 6513
Washington 4, D. C.

• TELEPHONE BRIDGEPORT 5-2055 •

GARO W. RAY

Consulting Radio Engineers

For Standard and FM Services
991 Broad Street, Suite 9-11
Bridgeport 3, Conn.

LABORATORY: Hilltop Drive
Stratford, Conn.—Phone 7-2465

Herbert L. Wilson
and Associates

CONSULTING RADIO ENGINEERS
AM-FM Television Facsimile

1018 Vermont Avenue, N.W.
Washington 5, D. C.
NAtional 7161

H. V. Anderson

—AND ASSOCIATES—

• Consulting Radio Engineers

715 American Bank Bldg. Tel. RAYmond 0111
New Orleans 12, Louisiana

The

ROBERT L. KAUFMAN
ORGANIZATION

• Construction Supervision (FM-AM),
Technical Maintenance, and Business Ser-
vices for Radio Broadcast Stations.

Munsey Building Washington 4, D. C.
District 2292

DIXIE B. MCKEY
ROBERT C. SHAW

CONSULTING
RADIO ENGINEERS

1108 16th Street, N. W. Suite 405
Washington, D. C. NAtional 6982

Frequency Measurements

Highest Accuracy — Anytime

One of the best equipped monitoring stations
in the nation

STANDARD

MEASURING & EQUIPMENT CO.

Phones 877-2652 EnId, Oklahoma
Since 1939

MORE RF KILOWATT HOURS
PER DOLLAR WITH
F & O TRANSMITTING TUBES

Freeland & Olschner Products, Inc.

611 Baronne Street, New Orleans 13, La.
Raymond 4756

High Power Tube Specialists Exclusively

**FREQUENCY MEASURING
SERVICE**

Exact Measurements - at any time



RCA COMMUNICATIONS, INC.
64 Broad Street New York 4, N. Y.



Radio Engineering Consultants,
Frequency Monitoring

Commercial Radio Equip. Co.

International Building • Washington, D. C.
321 E. Gregory Boulevard • Kansas City, Mo.
Cross Roads of the World • Hollywood, Calif.

RATES FOR
PROFESSIONAL CARDS
IN THIS DIRECTORY

•
\$10 Per Month for This Standard
Space. Orders Are Accepted
for 12 Insertions Only



1031 N. ALVARADO • LOS ANGELES 26, CALIF.

Custom-Built

SPEECH INPUT EQUIPMENT

U. S. Recording Co.

1121 Vermont Avenue
Washington 5, D. C.
District 1640

hallicrafters *new Model* S-40

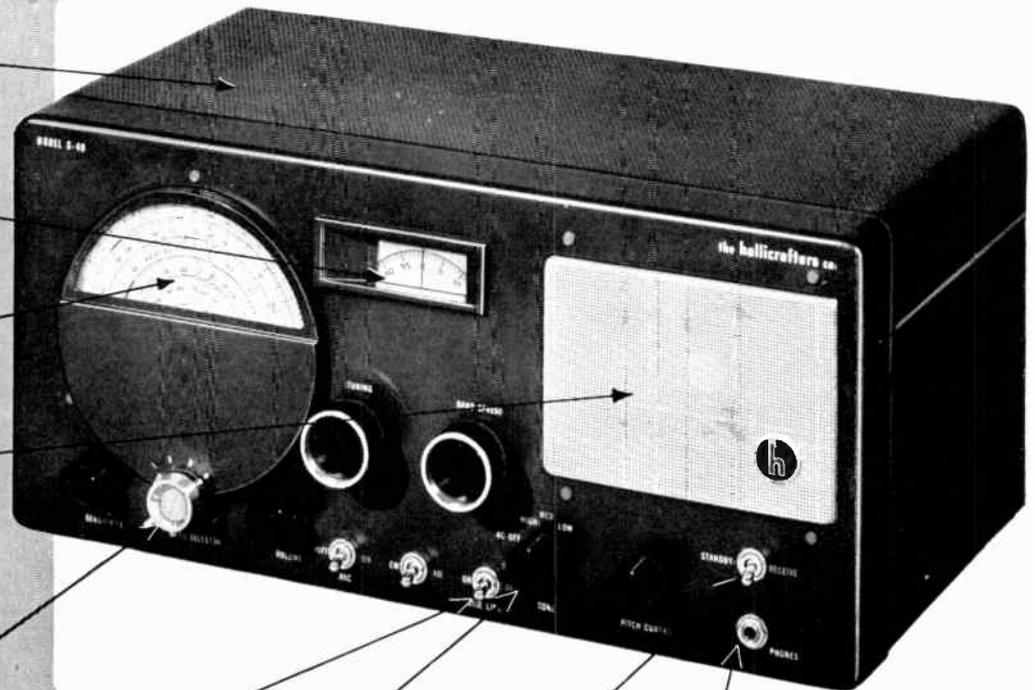
New beauty and perfect ventilation in the perforated steel top

Separate electrical bandspread with inertia flywheel tuning.

Tuning range from 540 kc to 42 Mc continuous in four bands

Self-contained, shock mounted, permanent magnet dynamic speaker

All controls logically grouped for easiest operation. Normal position for broadcast reception marked in red, making possible general use by whole family.



Automatic noise limiter

3-position tone control

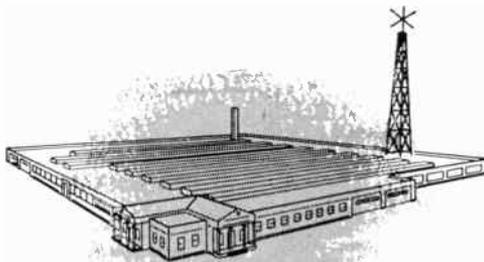
Standby receive switch

Phone jack

(APPROXIMATELY)

**New design, new utility in a great \$79⁵⁰
new communications receiver . . .**

Here is Hallicrafters new Model S-40. With this great communications receiver, handsomely designed, expertly engineered, Hallicrafters points the way to exciting new developments in amateur radio. Read those specifications . . . it's tailor-made for hams. Look at the sheer beauty of the S-40 . . . nothing like it to be seen in the communications field. Listen to the amazing performance . . . excels anything in its price class. See your local distributor about when you can get an S-40.



COPYRIGHT 1945 THE HALLICRAFTERS CO.

INSIDE STUFF: Beneath the sleek exterior of the S-40 is a beautifully engineered chassis. One stage of tuned radio frequency amplification, the S-40 uses a type 6SA7 tube as converter mixer for best signal to noise ratio. RF coils are of the permeability adjusted "micro-set" type identical with those used in the most expensive Hallicrafters receivers. The high frequency oscillator is temperature compensated for maximum stability.

From every angle the S-40 is an ideal receiver for all high frequency applications.

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

Sole Hallicrafters Representatives in Canada: Rogers Majestic Limited, Toronto - Montreal



FM AND TELEVISION

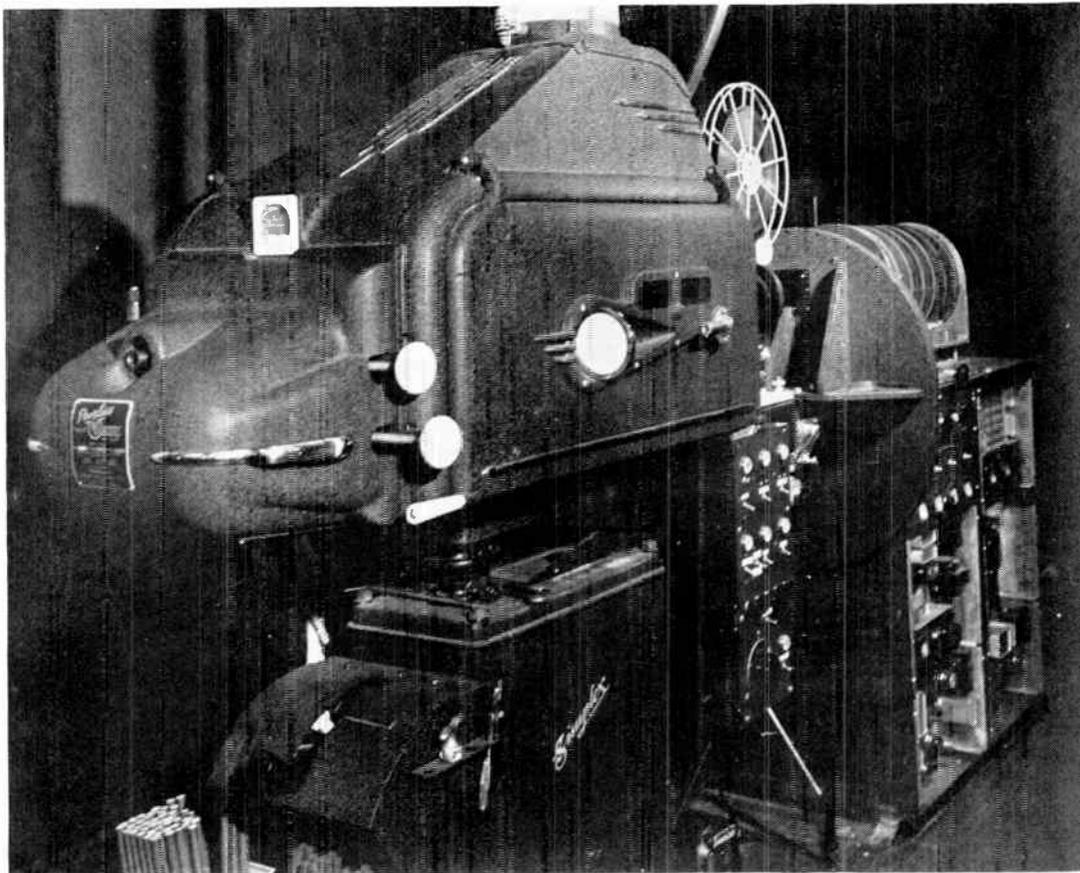


FIG. 1. MACHINE USED BY CBS TO SCAN COLORED MOTION PICTURE FILM FOR THE NEW TRANSMITTER

REPORT ON CBS 490-MC. COLOR TELEVISION

A Detailed Account of the 1-Kw. Transmitter and Receiver Put into Operation by CBS on January 30th

BY ARNOLD C. NYGREN

COLUMBIA Broadcasting System's new ultra-high-frequency color system was shown to representatives of the press and industry at a series of demonstrations beginning January 30. By offering wide-band color on 490 mc., with an effective power of 20 kilowatts, CBS contends it is now ready to demonstrate that "upstairs color" is a commercially practical system and, with the wholehearted support of the industry, equipment could be produced in the fall of 1946 for a full-fledged commercial television inaugural early in 1947.

The demonstrations originally scheduled for early January and suddenly canceled, were to have been made with exceedingly low power and on a point-to-point basis only. Since then, CBS has completed the installation of a 1-kw. transmitter, manufactured by Federal Telephone and Radio Corporation, on the 71st floor of the Chrysler Building, New York City. A new antenna, specifically designed for low-angle radiation and circular coverage, was also completed and in operation on February 1st. According to

figures released by CBS engineers, this new antenna gives an effective power of 20 kw., 4 times greater than any other television station operating in the New York area. This power is based on the antenna design plus the inherently better efficiency of the ultra-high frequencies over the lower frequencies now in use.

For the demonstrations, a receiving antenna on the 9th floor of the CBS Building, 485 Madison Avenue, was connected to a receiver, located in a small room on the 6th floor, by means of a coaxial line. The antenna could be rotated through 360°, and was remotely controlled from the receiver. The receiver itself was designed and built by CBS engineers and, with the exception of the color scanner and the electronic circuits for synchronizing the receiver to the transmitter, it is essentially the same as any receiver designed for black-and-white reception.

For the time being, demonstrations will include only the transmission of colored film and slides. A new type of film scanner has been designed and built by CBS for

this purpose. A wide-band camera for color pick-ups is scheduled to be in operation some time in May.

Early CBS Color Transmissions ★ In September, 1940, CBS demonstrated the transmission of color with equipment designed for use on a 6-mc. band. The following month, a 25-watt transmitter was installed in the Chrysler Building, and experiments were conducted in the VHF region with a 4.5-mc. video band. A 375-line picture was produced which, admittedly, contained a noticeable flicker. Experiments were continued for over a year until the advent of war. Because of the low power involved, transmission was conducted on a point-to-point basis from the Chrysler tower to the Madison Avenue television laboratories. While conducting electronic research for the Armed Forces during the war, Dr. Peter C. Goldmark,¹ Director of

¹ Dr. Goldmark was awarded the Morris Liebmann Memorial Prize in recognition of "his contribution to the development of television systems, particularly in the field of color" at the winter meeting of the Institute of Radio Engineers, January 24, 1946.

Engineering Research and Development for CBS, became convinced that the future home for wide-band color television lay in the ultra-high frequencies. Work in this direction was begun immediately after V-J Day and the present accomplishments in UHF have all been made since then.

Progress in Color Transmission ★ During the demonstration which started February 1, 1946, Worthington Miner, manager of the CBS Television Department, pointed out the progress made in the field of color television since V-J Day. A new transmitter utilizing high power and water-cooled tubes of a new design had been developed and put in operation. The effective radiated power obtained with the new antenna assures adequate coverage for commercial broadcasting. CBS is successfully modulating a 10-mc. band, scanning each of the three primary colors at 525 lines at a rate of 20 complete pictures per second. The end result is a greatly improved picture image. Further, the use of UHF, practically eliminating the problem of ghost images, provides more solid coverage, par-



FIG. 3. TYPE 6C22 AMPLIFIER TUBE

ticularly in built-up metropolitan areas. Early objections made to CBS plans had not been directed at the use of color, but only at the length of time it would take to develop and use the higher frequencies, necessary for good color, with power comparable to that used in the lower television channels.

The scanning disc, Mr. Miner explained, was utilized because it represented the simplest and most economical means of providing color. Contrary to some beliefs, the mechanical scanner is simple in operation and, because of its sealed construction, does not present a maintenance problem.

CBS engineers are currently conducting research on an all-electronic system, but they feel that such a system is a number of years off. Even if perfected, it will not improve the transmission of color; it will only eliminate the mechanical system. Further, the mechanical system now used will not be made obsolete in such an event. CBS engineers are of the opinion that a number of improvements in the mechanical scanning system will be made in the next six months, so that even better color pictures will be available for full scale

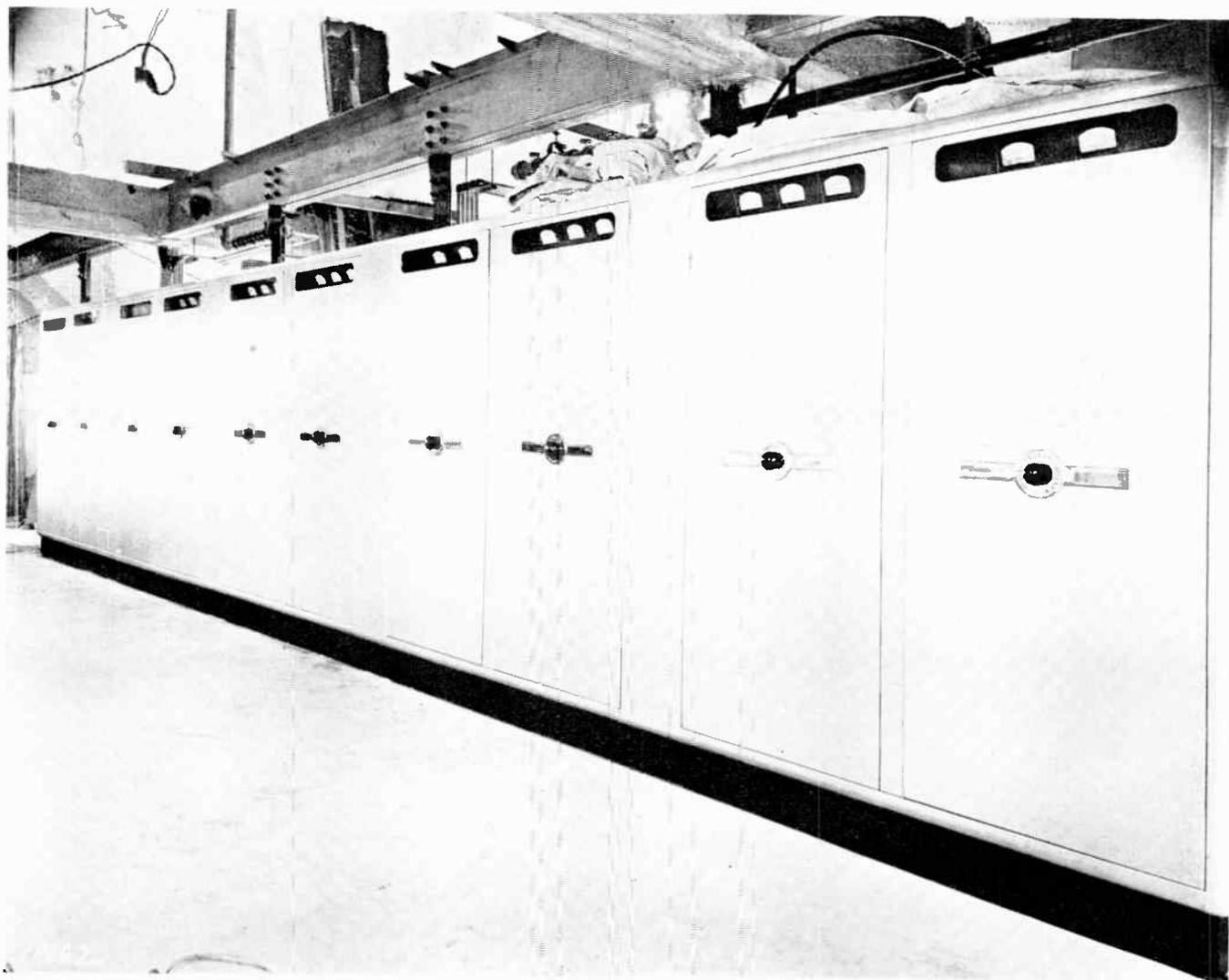


FIG. 2. 10-BAY 1-KW. COLOR TELEVISION TRANSMITTER INSTALLED BY COLUMBIA IN THE CHRYSLER TOWER USED WITH THE NEW ANTENNA SHOWN IN FIG. 9, THE EFFECTIVE POWER IS 20 KW. THIS TRANSMITTER WAS BUILT BY FEDERAL TELEPHONE & RADIO

commercial use in 1947.

The ultra-high frequency image presented by CBS is composed of 525 lines of red, 525 lines of blue, and 525 lines of green. Each color is transmitted successively but at such rapid speed that the persistence of vision in the human eye re-assembles them in precise proportion to their original values. These three basic colors are transmitted with red first, blue second, and green third. The speed and sequence of their transmission are as follows: Red, 1st field (odd lines) $1/120$ th of a second; and blue, 1st field (even lines) $1/120$ th of a second. First frame equals $1/60$ th of a second. Then green, 1st field (odd lines) $1/120$ th of a second; and red, 2nd field (even lines) $1/120$ th of a second. First two frames equal $1/30$ th of a second. Finally, blue, 2nd field (odd lines) $1/120$ th of a second; and green, 2nd field (even lines) $1/120$ th of a second. Complete 3-color frame requires $1/20$ th of a second.

Other improvements have been made in using the same signal to carry both sight and sound. The CBS system provides for the sound channel to be carried in the time occupied by the blanking pulse on the line retrace.

Film Scanner ★ Fig. 1 shows the film scanner installed on the tenth floor of the CBS building. Immediately in the foreground is the arc lamp with its control mechanism. The center section contains the scanning mechanism, while directly behind the film reel is the cylindrical unit that houses the electronic dissector tube. The electrical impulses are fed by means of a special wide-band coaxial cable to the transmitter in the Chrysler Building.

Transmitter ★ The color transmitter was built by the Federal Telephone and Radio Corporation for CBS. It is essentially a wide-band transmitter operating on a carrier frequency of 490 mc, with a power output of 1 kw. peak. The output can be modulated uniformly with all frequencies from direct current to 10 mc. Complete with all power units and water cooling equipment, the transmitter occupies ten bays each 30 ins. wide, and weighs approximately 12,000 pounds. Fig. 2 shows the transmitter as it is installed at the Chrysler Building.

Radio-Frequency Problems ★ The radio-frequency portion of the transmitter consists

of a conventional chain of amplifiers and frequency multipliers following a crystal oscillator. The oscillator stage uses a type 6V6/GT tube in a triode circuit, with a crystal frequency of 6,805 mc. The oscillator stage is arranged to double the crystal frequency in the plate circuit, so the output of this stage is approximately 3 watts at 13,611 megacycles.

The following stage uses a type 815 tube in a push-pull frequency tripler circuit. This tube, which is a dual beam tetrode, delivers approximately 10 watts at 40,833 mc. The following stage is another type 815 in a tripler circuit, delivering approximately 10 watts at 122.5 mc.

This is followed by an amplifier stage using a type 4-125 power tetrode, operating without neutralization, but with the reactance of the screen lead series-resonated to bring the screen to ground potential more effectively. This arrangement has proved entirely stable, and the stage delivers approximately 120 watts at 122.5 mc.

The remaining stages of the radio-frequency chain make use of the type 6C22 tube, Fig. 3, designed by the Federal Telecommunication Laboratories. This

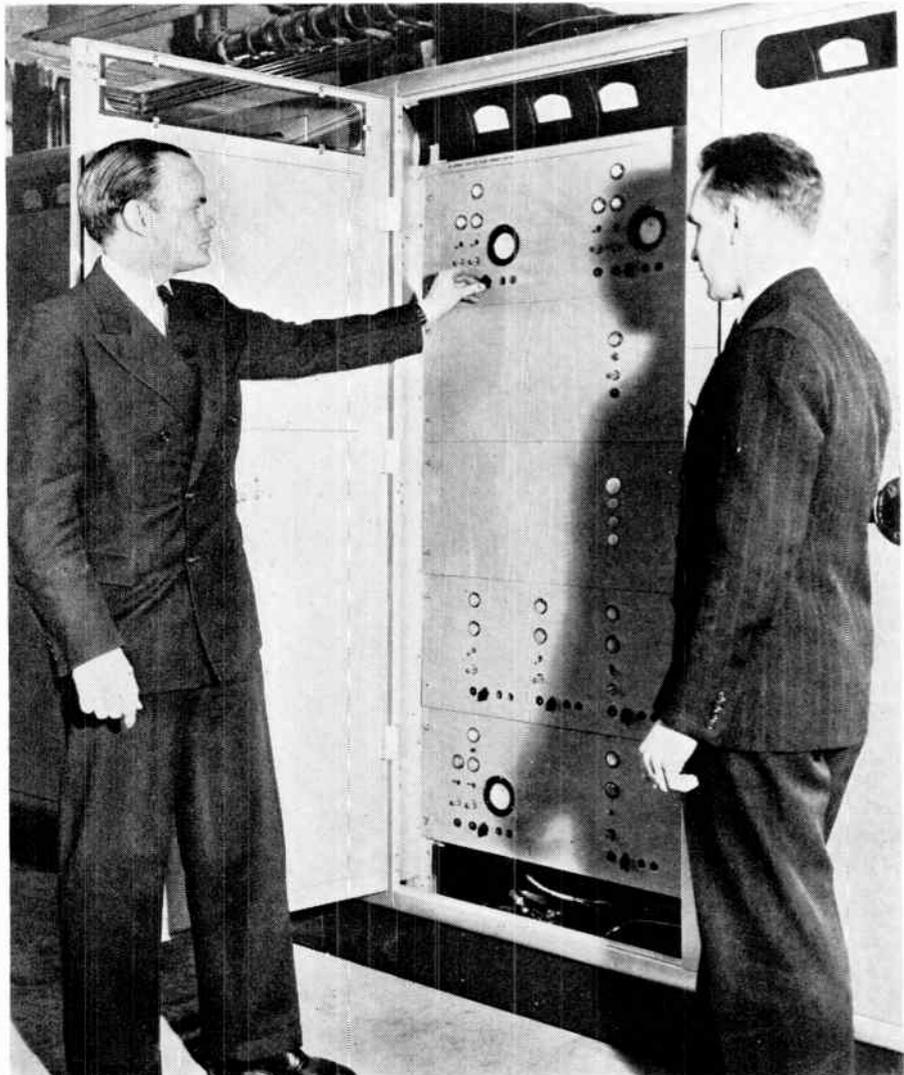
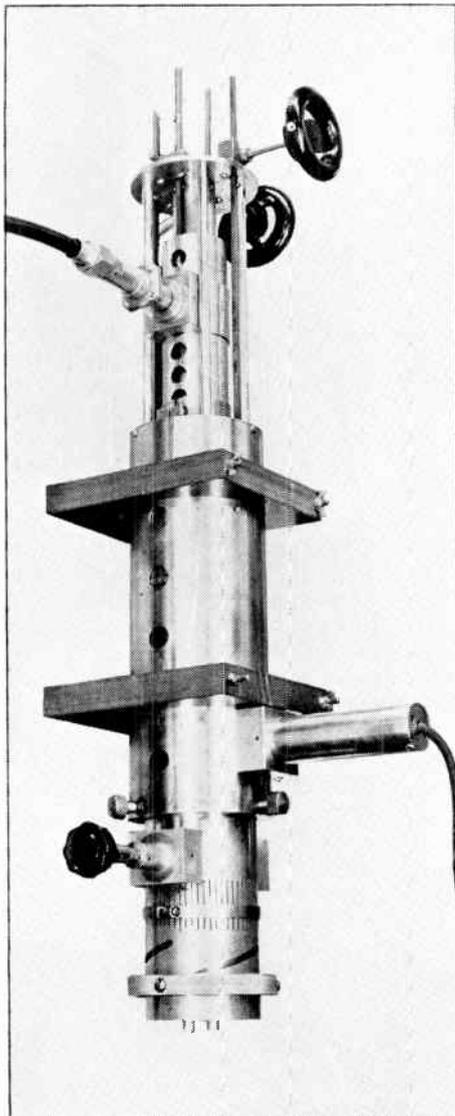


FIG. 4, LEFT. CONSTRUCTION OF THE 500-MC. COAXIAL AMPLIFIER. FIG. 5, ABOVE. 5-STAGE VIDEO AMPLIFIER HAS UNIFORM RESPONSE FROM DC TO 10 MC.

tube, which is a triode of high mutual conductance and low plate resistance, uses the ring-seal technique to reduce the inductance of the leads to the electrodes, and to make the tube suitable for operation in the ultra-high-frequency portion of the spectrum. The anode is a solid block of copper fitted with a water jacket for cooling. With a water flow of 1 gallon per

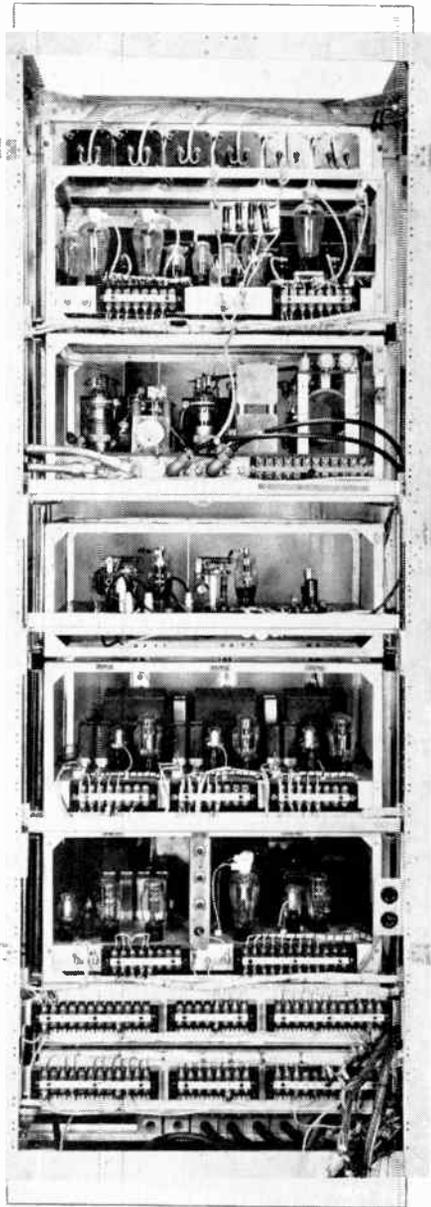


FIG. 6. REAR OF VIDEO AMPLIFIER SECTION

minute, the tube can be used for plate dissipations up to 1 kw. in radio-frequency service. In applications where no grid dissipation is encountered, as is common in video frequency amplifiers, somewhat greater dissipation is permissible, and with a water flow of 2 gallons per minute, a dissipation of 2 kw. is reasonable.

The fifth stage of the radio-frequency chain consists of a type 6C22 tube in a coaxial circuit, operating as a frequency doubler at high power level. With an input of 120 watts at 122.5 mc., the stage delivers 250 watts output at 245 mc. In

this stage, the cathode of the tube is bypassed to ground, and the grid circuit is excited with driving energy. The anode circuit is a quarter-wave line, shorted at the end farthest from the tube. Tuning is by a movable piston.

The sixth stage of the radio-frequency chain also uses a type 6C22 tube in a frequency doubler circuit, but in this case it is no longer possible to ground the cathode, because of the cathode lead inductance. Therefore, the grid is grounded, and the drive energy is fed into the cathode circuit. With 250 watts of driving power, this stage delivers 300 watts output at the final carrier frequency of 490 mc.

The seventh stage is a neutralized amplifier, using the type 6C22 in a grounded-grid circuit. With 300 watts of drive, it delivers approximately 700 watts output at 490 mc. This is considerably more than is required to drive the final stage of the transmitter to its rated peak output of 1 kw., but the excess power is dissipated in a damping resistor attached to the coupling line between the driver stage and the modulated amplifier stage. The load imposed by this resistor acts to maintain constant output voltage from the driver in spite of changing load imposed by the output as its bias is varied through the modulation cycle. This improves the linearity of the modulation characteristic, and somewhat reduces the voltage required from the modulator stage.

The eighth stage of the chain is the final, or modulated amplifier stage. This also uses a type 6C22 tube in a neutralized, grounded-grid circuit, Fig. 4. With a drive of 350 watts from the preceding stage, it will deliver any output from zero to 1 kw., depending on the grid bias at the time. For dissipation reasons, it is not possible to deliver 1 kw. continuously. Peak power of 1 kw., or 600 watts average, is the rated output of the stage.

The Video Frequency Modulator ★ The modulator system consists of a 5-stage video frequency amplifier having uniform response from DC to 10 mc. Two views of the modulator unit are shown in Figs. 5 and 6. The method of high-frequency compensation is quite conventional. It is based on principles of design arrived at from filter theory, using both 2-terminal and 4-terminal networks. One unusual feature of the amplifier system is the absence of any method of DC restoration. Since the DC component of the signal is retained throughout the chain, restoration is not required.

The method of low-frequency coupling is illustrated in Fig. 7. No high-frequency compensation is shown, but, of course, any type desired can be used without affecting the principles discussed. A condenser C_1 is connected from the plate of the first stage to the grid of the second. From each side of this condenser, isolating resistors R_1 are connected to the terminals of a reg-

ulated power supply, referred to as a coupling pack. No other path from the grid of the second stage to ground is provided. The cathode of the second stage is directly grounded. The isolating resistors are made very much larger than the first stage load resistor R_L so that the capacitance of the coupling pack to ground will not impose a shunt on the first stage at high frequencies, but for such frequencies the coupling condenser carries the signal without any appreciable change in the potential to ground of either terminal of the coupling pack. For very slow changes in potential on the plate of the first stage, it will be apparent that both terminals of the coupling pack are raised or lowered in potential by the same amount as the plate of the first stage, thus transferring the signal to the second stage through a path consisting of the isolating resistors and the pack itself. When the coupling condenser greatly exceeds the capacitance to ground

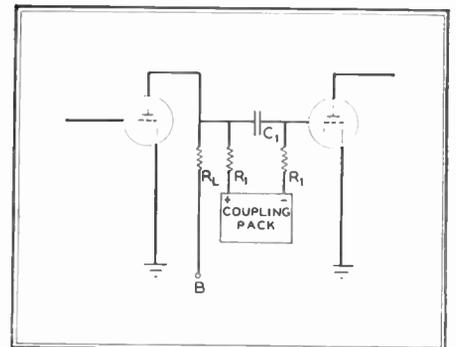


FIG. 7. LOW-FREQUENCY COUPLING

of the coupling pack, the region of transfer of signal from one path to the other is gradual and smooth, and the response of the amplifier is uniform from a moderate frequency which passes through the condenser, to DC, which is transferred through the pack.

This system of coupling is used throughout the video-frequency system to retain the DC component of the signal and to insure good response at the very low frequencies. In spite of the possibility that a small instability in one of the early stages could be magnified to cause "bounce" or flicker in the output, no such troubles have been encountered, principally due to thorough attention to the proper regulation of the coupling packs in the low-level stages of the system.

The first stage of the modulator uses a type 6AG7 tube. Normal input for the stage is approximately 2 volts peak-to-peak. (All signal voltages discussed in the video-frequency portion of the system will be referred to in terms of their peak-to-peak amplitude.) The stage gain is 7, giving an output of 14 volts.

The following stage uses a type 807 tube, giving a gain of 2.8 and an output of 40 volts.

The third stage uses three type 807 tubes in parallel. This is necessitated by the relatively large input capacity of the

succeeding stage. The gain is 4.5 and the normal output 180 volts.

The fourth stage uses a type 6C22 tube as a conventional triode amplifier. Although the inter-electrode capacitances of the tube are not large, the Miller effect increases the apparent input capacity of the stage to a considerable degree. With a suitable driver stage, no other detrimental effects are found. The gain of this stage is 3.5 and its output, 700 volts.

The fifth stage is a cathode-follower using two type 6C22 tubes. The principal purpose of this stage is to supply a driving signal from a source of sufficiently low impedance that the effects of the changing load imposed by the output stage grid circuit will be negligible. In the region in which they are operated for this service, the mutual conductance of each tube is approximately 10,000 micromhos, so that the source impedance can be considered as 50 ohms. In addition, the high current capabilities of this stage and the negative feedback present in the cathode follower connection enable the preserving of a flat frequency response in spite of the shunt capacitance of the radio-frequency amplifier load. The stage gain is 0.8 and the output voltage 550 volts.

Power Supplies and Control Equipment ★ The video-frequency amplifier and modulator use a relatively large number of power units, since a separate coupling pack is required for each stage and, in addition, separate regulated supplies are used for the 6AG7 and the two 807 stages. The two stages using 6C22 tubes are fed from a common anode supply. This produces a desirable effect, since the current drawn by the cathode follower stage is increasing when that drawn by the amplifier stage is decreasing, and vice versa. This effect reduces the magnitude of current change in the pack load, and improves the low-frequency response.

The radio frequency system also uses a number of supplies, not only because a variety of voltages are required, but also to permit easy control and tune-up, and to prevent interaction between the modulated amplifier and the stages feeding it. Separate supplies are provided for the low-voltage stages of the exciter, for the two doublers, for the driver stage, and for the final amplifier.

Control of all power units, the water circulating pump, the main power circuit breaker, and all other necessary functions of the transmitter control are centralized in one cabinet, Fig. 8. From this point the transmitter can be completely started and stopped, or any portion of the unit turned on, as desired. Whenever it is desired to isolate any portion of the equipment, or whenever the opening of a door interlock switch or other protective device necessitates the interruption of any circuit, all other circuits dependent on that for proper functioning are automatically cut off. That is, complete interlocking for protec-

tion of personnel and equipment is included in the design of the control circuit. Pilot lights check the operation of each power circuit to speed the location of trouble in the system.

Sound-on-Sight ★ As previously mentioned, CBS and Federal engineers have utilized the sound-on-sight principle for the sound channel of the transmitter.

tion of personnel and equipment is included in the design of the control circuit. Pilot lights check the operation of each power circuit to speed the location of trouble in the system.

The impulses characterizing the sound channel are timed to coincide with the instant the cathode-ray beam is returning to the beginning of its sweep to start a new line. During that time no picture signal is being transmitted, so the sound impulses

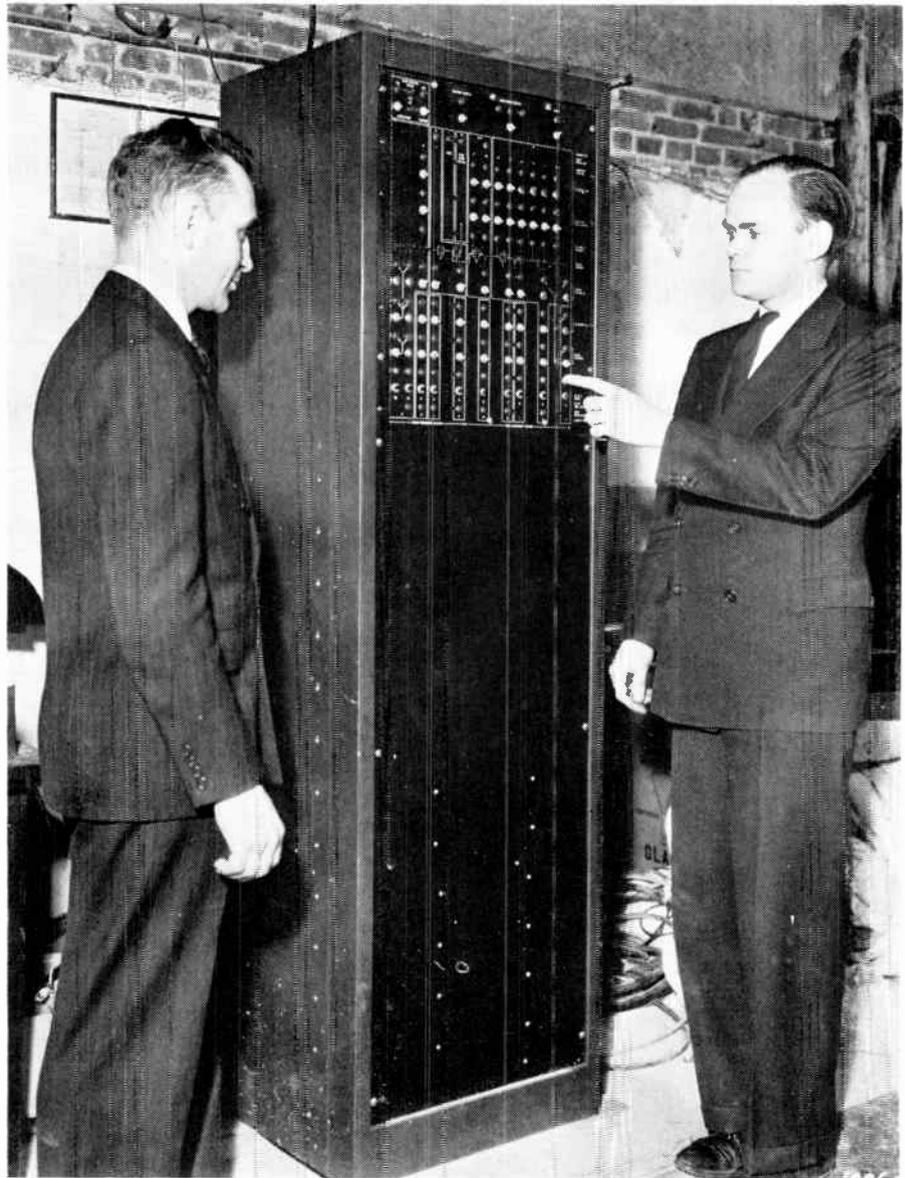


FIG. 8. FEDERAL ENGINEER NORMAN YOUNG AND CBS ENGINEER ORVILLE SATHER AT THE SECTION WHICH CONTROLS ALL THE UNITS OF THE TRANSMITTER

In transmitters intended for either high-definition black-and-white signals or for color television, one important advantage can be realized. The line repetition frequency in such systems is normally of the order of thirty thousand per second. By examining the amplitude of the sound wave at intervals of one thirty-thousandth of a second, and converting that information into impulses, all frequencies up to approximately twelve thousand cycles can be transmitted. The upper frequency limit is imposed by the number of times per second the sound signal is ob-

can be mixed with the video signal without interfering with the picture reproduction. Suitable pulse selectors remove the sound impulses from the composite signal and the resulting train of pulses is demodulated and fed through the conventional audio amplifier to the loud speaker.

Advantages of sound multiplexing are many, including simplification of the receiver by eliminating the separate sound IF system, eliminating resonant traps to keep the sound signal out of the picture IF system, reducing the criticalness of tuning required to secure a satisfactory signal,

insuring that the antenna location best for picture signal is also best for sound, and that there is adequate sound field strength wherever the picture signal is satisfactory. In the transmitting station the most spectacular advantage is the complete elimination of the sound transmitter, thereby reducing greatly the problems of maintenance, operating, and spare equipment. The only apparatus added to effect this replacement is a small chassis using a few receiver type tubes, added to the synchronizing generator in the control room.

Transmitting Antenna ★ Fig. 9 is a view of the Chrysler Building tower, showing the old low-frequency antennas at the top and the new 490-mc. antenna at the lower right. Fig. 9 shows only the 490-mc. array on the north side of the tower. However, a similar array is also installed on the south side. Designed and installed by CBS engineers, it is essentially a 2-array, horizontally polarized antenna with a power gain in the vertical plane of approximately 20 to 1. Each array consists of 4 elements with a total height of about 20 ft. At the frequency used, it is possible to mount the array only a few inches from the side of the building.

Practically circular coverage is obtained with the two arrays in use. The theoretical shape of the transmitted beam is similar to that of a flat plate, and is such that the field strength is approximately a constant in all parts of the service area, provided no obstructions are in the path of the signal. Similar types, called "cosecant" antennas, were used in radar work during the war with great success.

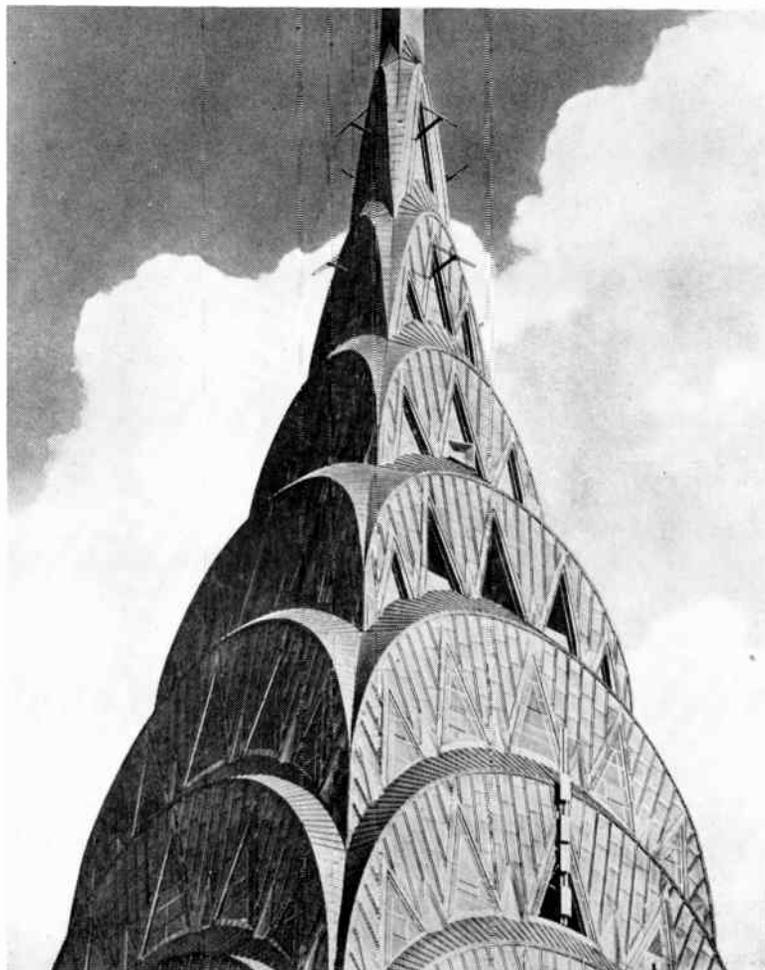


FIG. 9. 490-MC. ANTENNA CAN BE SEEN AT THE EXTREME LOWER RIGHT

Receiving Antenna ★ The receiving antenna for the CBS demonstration consisted of a 10-in. horizontal bar with a parabolic re-

near the receiver. The antenna was remotely controlled from this point. During the demonstration, excellent signals were received from 7 or 8 different directions. As far as could be determined visually, with the receiver brilliance reduced to a low value, signals reflected from the Empire State and G.E. buildings were as good as those from the direct wave. Ghost reflections were picked up with the antenna pointing approximately 180° away from the Chrysler Building but they were relatively very weak. This was not surprising, because of the highly directive receiving antenna. However, with the exception of this one direction, ghosts were not evident in any other antenna positions. Dr. Goldmark conducted the demonstration on the ability of the ultra-high frequencies to overcome the problem of multiple reflections. He pointed out that interference was practically non-existent on these new frequencies. With smaller antennas required, receiver installation problems would be simplified, particularly in large apartment houses. Directional antennas have already been designed that will automatically bear on the station being tuned in, making manual adjustments unnecessary.

Field surveys are currently being conducted by CBS to determine the coverage obtained with the newly designed transmitting antenna, and to determine the

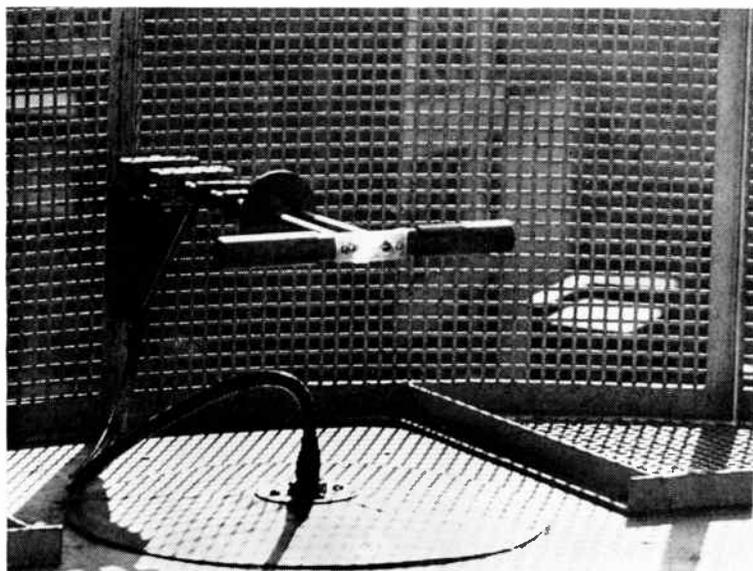


FIG. 10. 490-MC. RECEIVING ANTENNA TURNS WITH PARABOLIC REFLECTOR

The old antennas shown at the top of Fig. 9 are folded dipole affairs. The sound antennas are located directly above those used for the video signal. These are for Columbia's low-frequency black-and-white transmitter, WCBW, on 60 to 66 mc.

flector. Fig. 10, which provided a highly directional receiving system with a beam of approximately 15 degrees. A map of the New York area, with a large pointer indicating the direction and size of the receiving beam, had been placed on the wall

effectiveness of 500 mc.

Color Receiver ★ The 490-mc. receiver was designed and built in the television labo-

at 1,200 rpm, and automatically maintained in synchronism with the transmitter filter. A projection type of receiver with a screen width of 22 ins. is now under

the CBS receiver seemed satisfactory, with definition, contrast, and brilliance comparable to that of black and white, but with the advantages of color. The color itself was an improvement over anything previously seen. The basic colors were not over-emphasized, and the results showed a good proportion of intermediate shades, tending to make the reception more realistic. Blurring of color, due to rapidly moving objects, was not evident. The 1,200-rpm scanning disc caused a small amount of noise which was not noticeable with the sound channel on.

It is not yet possible to appraise the performance of this CBS contribution in terms of its significance to the public and the radio industry. There are many controlling factors, the effect of which can be determined only over a considerable period of time. Among these are the public attitude toward color television in its present state of development, the cost of receivers, space requirements in metropolitan apartments, and the mechanical problems involved in the erection of receiving antennas. Other factors are the competitive situation with respect to black-and-white television, and the relative cost and availability of black-and-white receivers. The feeling on the part of the public and the trade that color television may render black-and-white receivers obsolete is another influence that only time can indicate.

At least, Columbia's contribution will accelerate the activity of those who are working to make television, in one form or another, available to the public.

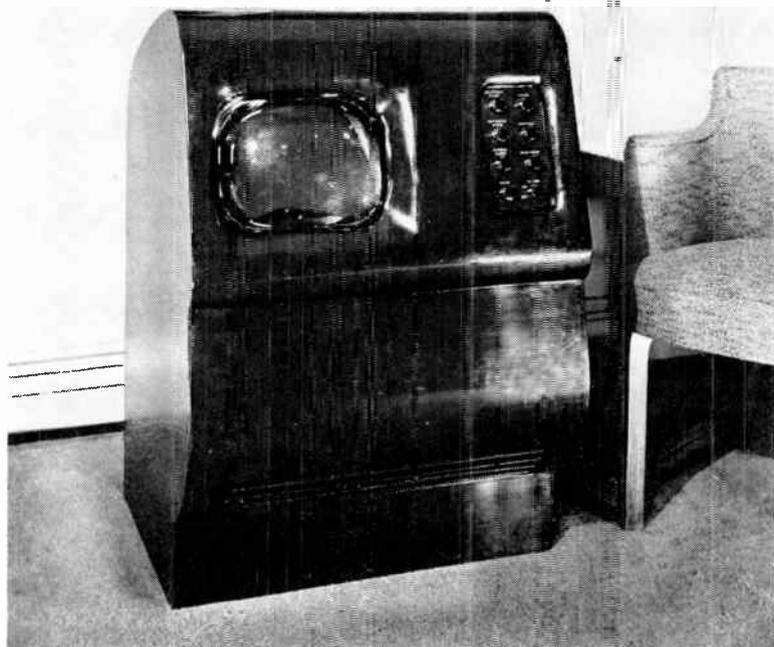


FIG. 11. COLOR TELEVISION RECEIVER USED FOR COLUMBIA'S DEMONSTRATION

ratories of CBS. It is shown in Fig. 11. A 10-in. viewing tube is magnified through a glass lens to a width of approximately 12 ins. Directly over the face of the tube, a 22-in. three-color plastic disc is rotated

development and will be demonstrated in the near future.

Observer's Conclusions ★ To this observer, the reception of the 16 mm. colored films on

RAILROAD COMMUNICATIONS PROBLEM

THE following letter presents an interesting problem in radio communications, and its use as a safety measure in railroad operations:

SEABOARD AIR LINE RAILWAY
JACKSONVILLE 2, FLORIDA

February 6, 1946

Dear Mr. Sleeper,

I have read an item entitled "No Radio" on the Spot News page of your December issue of *F.M. AND TELEVISION* journal, in which it is stated that train-to-train radio might well have warned the engineer on Seaboard Line's *Silver Meteor* that he was approaching the *Sun Queen*, thereby avoiding the wreck on December 16th, at Kollock, S. C.

Not knowing the facts in this case, I am wondering if such is really helpful to the radio interest. In this case a radio would not have prevented this accident. The *Silver Meteor* had a direct meet order with the *Sun Queen* at Kollock. Within a station of the point at which these trains were to meet, he was given an order calling his attention to the meet order at Kollock with the *Sun Queen*. On approaching Kollock, the conductor of the *Silver Meteor* pulled the cord according to our

rules, calling the engineer's attention to the meet order. In accordance with the rules, he answered the conductor which confirmed the full understanding of the order to meet the *Sun Queen*. A radio could not have done more. The engineer lost his life in this accident and, of course, we do not know why he failed to stop. The evidence showed that he was alive until the moment the accident occurred.

Yours very truly,

(Sgd) T. W. PARSONS,

Chief of Safety & Operating Rules.

In that item we stated that the use of train-to-train radio "might well have warned" the engineer, because we did not presume to express the definite opinion to which only a railroad man is entitled. However, it does seem to us that if the *Silver Meteor* and the *Sun Queen* had been equipped with train-to-train radio, the engineers would have communicated with each other to check their scheduled meeting at Kollock long before this point was reached. That, as we understand it, would be one of the important safety applications of train-to-train radio. In this case, the engineers could have exchanged information while they were at least 20

miles apart. There is no doubt but what those responsible acted in accordance with the rules, but it appears that this was not enough.

That is what radio communications men, without railroad experience cannot understand. To them it appears like the case of the patient who died under a successful operation. In the case of the Kollock wreck, it is difficult for an outsider to agree that, even though the established procedure was carried out to the letter by the men responsible, the wreck was inevitable, and that it could not have been prevented if the engineers and conductors on each train had had exact knowledge of their relative location and movement while they were still 20 or even 10 miles apart.

With all due respect to Mr. Parsons' railroad experience and his position as Chief of Safety & Operating Rules for the Seaboard Air Line, his statement that "A radio could not have done more," is a challenge to those of us who have seen radio communications meet needs previously unmet in other services.

Since Mr. Parsons' letter brings up a point in which railroad radio engineers and consultants working on railroad communications are vitally interested, we would like to have their comments on this situation.

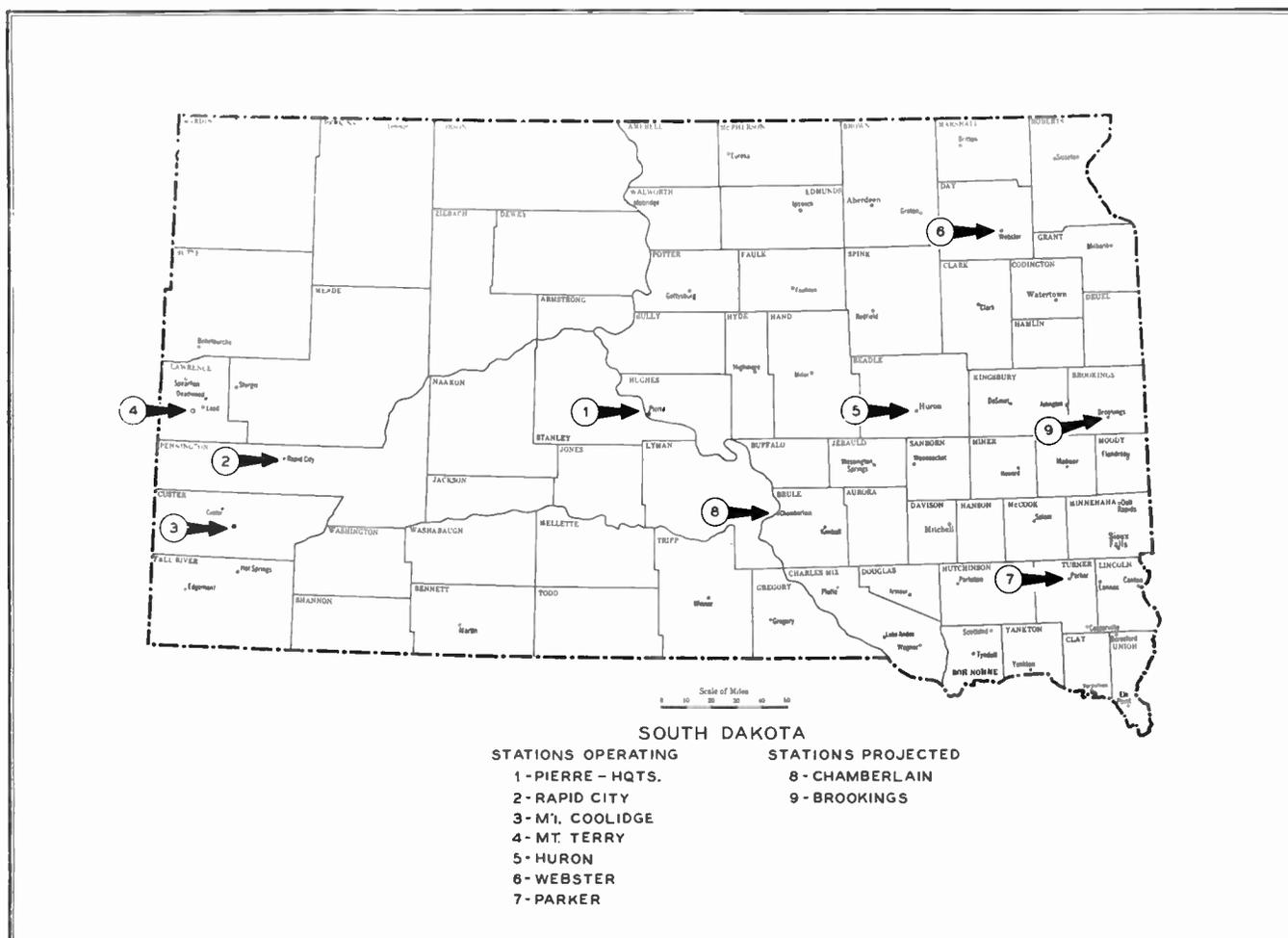


FIG. 1. DISTRIBUTION OF STATIONS IN SOUTH DAKOTA'S SYSTEM. INSTALLATIONS AT 8 AND 9 WILL BE AUTOMATIC REPEATERS

FM PERFORMANCE OVER RUGGED TERRAIN

Seven State Police Transmitters Blanket South Dakota with Its Black Hills and Bad Lands

BY FRED EBEL *

IF Les Price, Chief Agent of the Attorney General's Law Enforcement Division in South Dakota, seems a little smug about his State Police radio system, you really can't blame him. He not only has an FM system of 7 transmitters that virtually blankets 77,000 square miles, but a system that operates dependably over some of what radio engineers call the worst terrain in the United States. And 77,000 square miles represent an area one-half that of California, for example, or 16 times that of Connecticut. Yet the transmitters are of only 250 watts output! The equipment at the fixed stations and in the patrol cars was supplied by the Galvin Manufacturing Corporation.

As the map shows in Fig. 1, the headquarters station is at Pierre, the capital city, located almost exactly in the center of the state and, incidentally the geo-

graphical center of the United States. This station is tied in with Rapid City, near the western border, through Mt. Terry, northwest of Rapid City, and Mt. Coolidge, to the southwest. Pierre is connected by radio to the east by direct communication with Huron.

In the eastern part of the state are transmitters at Webster, Huron, and Parker. Their coverage overlaps with Pierre, thus completing the operating

range of this FM system. When repeater stations are added at Chamberlain and Brookings, cars will be able to talk 2-way from any point in the entire state.

Operation of the System ★ Pierre, headquarters of the Attorney General's Law Enforcement Division, is the control center of the system. This is point 1 on the map. From here, the eastern plains are covered by direct communication with

FIXED TRANSMITTERS

	Watts Output	Talk Back Range Mi.	Talk Out Range Mi.	Remote Control Mi.	Antenna Hght. Ft.	Base Alt. Ft.	Total Hght.
Pierre	250	75	75-100	3	400	1934	2334
Huron	250	50	50-70	¼	200	1281	1481
Rapid City	15		27-35	0		3300	
Mt. Coolidge	250	100	140-175	27	125	6400	6525
Mt. Terry	250	100	140-175	35	125	7070	7195
Webster	250	50-70	50-80	1	200	1840	2040
Parker	250	40-60	50-85	½	200	1350	1550

* Galvin Manufacturing Corp., Chicago 51, Ill.

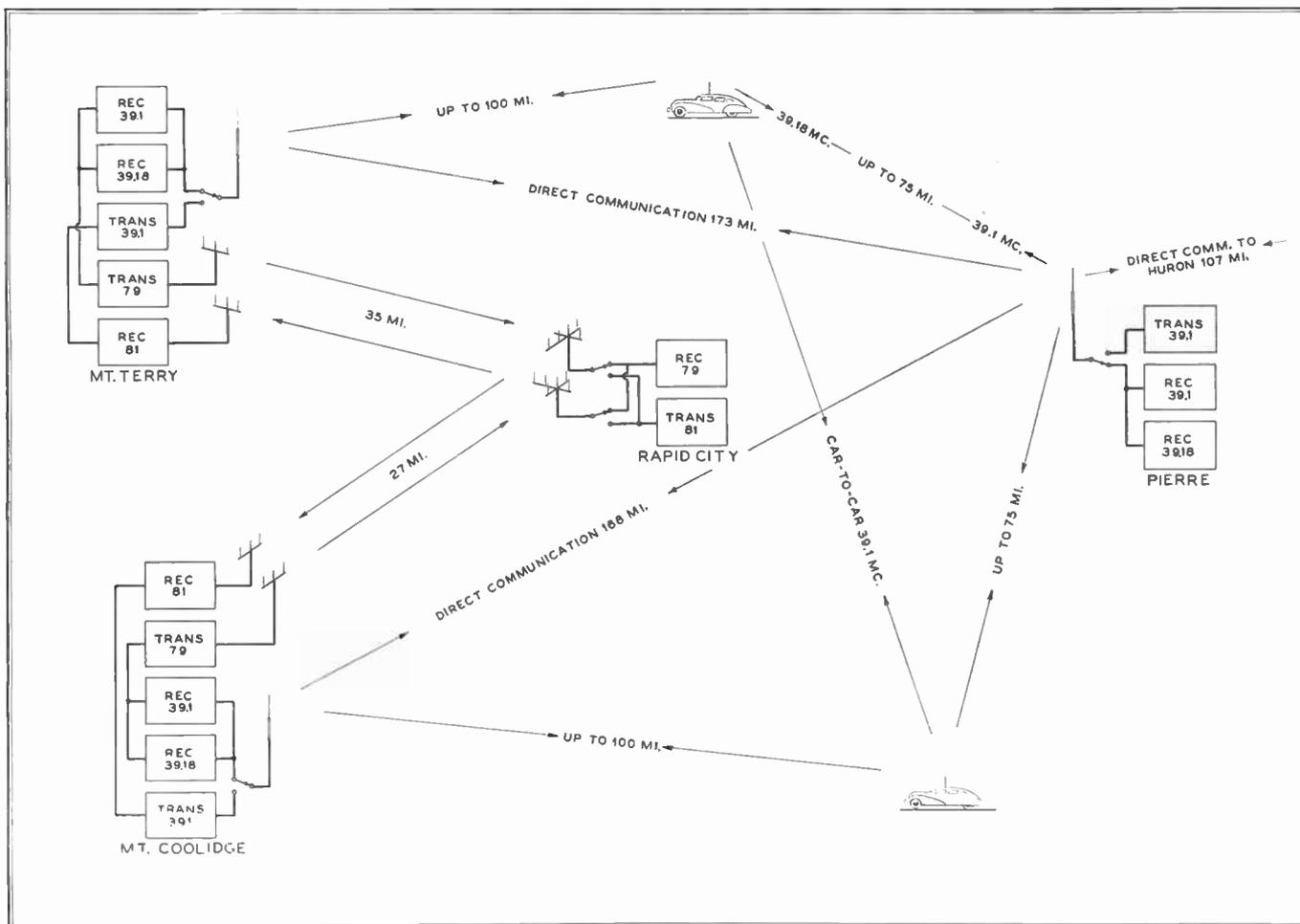


FIG. 2. DIAGRAM OF FREQUENCIES AND OPERATION METHODS OF THE UNIQUE SYSTEM EMPLOYED IN WESTERN SOUTH DAKOTA

Huron, point 5. Huron, in turn can communicate directly with both Webster, 6, and Parker, 8. Automatic repeaters will be installed at Chamberlain, 8, and Brookings, 9. To operate the Chamberlain repeater, signals on 79 mc. will be beamed from Pierre to Chamberlain, where they will be repeated to the cars on 39.1 mc. Car signals on 39.18 mc. will be picked up at Chamberlain, and beamed back to

Pierre on 81 mc. The arrangement at Brookings will be similar, except that Huron will be the control point.

West of Pierre lies rugged country such as no radio communications system has ever been called upon to serve. This includes the Black Hills area, near the western border, where the mountains ranging up to Harney Peak which, with an elevation of 7,242 ft., is the highest point

in the United States east of the Rockies. North of Harney is Mt. Terry, 7,070 ft. high and, to the southeast, Mt. Coolidge, 6,400 ft. high. These two locations are indicated on the map as points 4 and 3, respectively. In this part of the state lie the famous Bad Lands, an area 120 miles long and 30 to 50 miles in width, where rock formations have been eroded in strange, weird forms, fantastically colored.

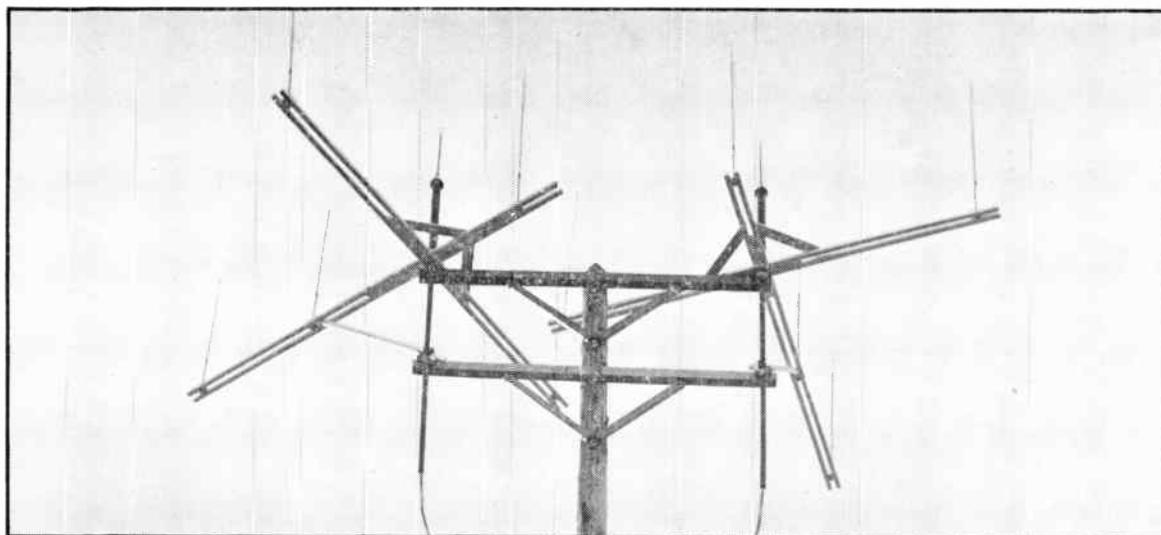


FIG. 3. CLOSE-UP OF THE TWO SETS OF TRANSMITTING AND RECEIVING ARRAYS EMPLOYED AT RAPID CITY



FIG. 4. THE 125-FT. ANTENNA ON MT. COOLIDGE. BEAM ARRAYS ARE FOR COMMUNICATION WITH RAPID CITY

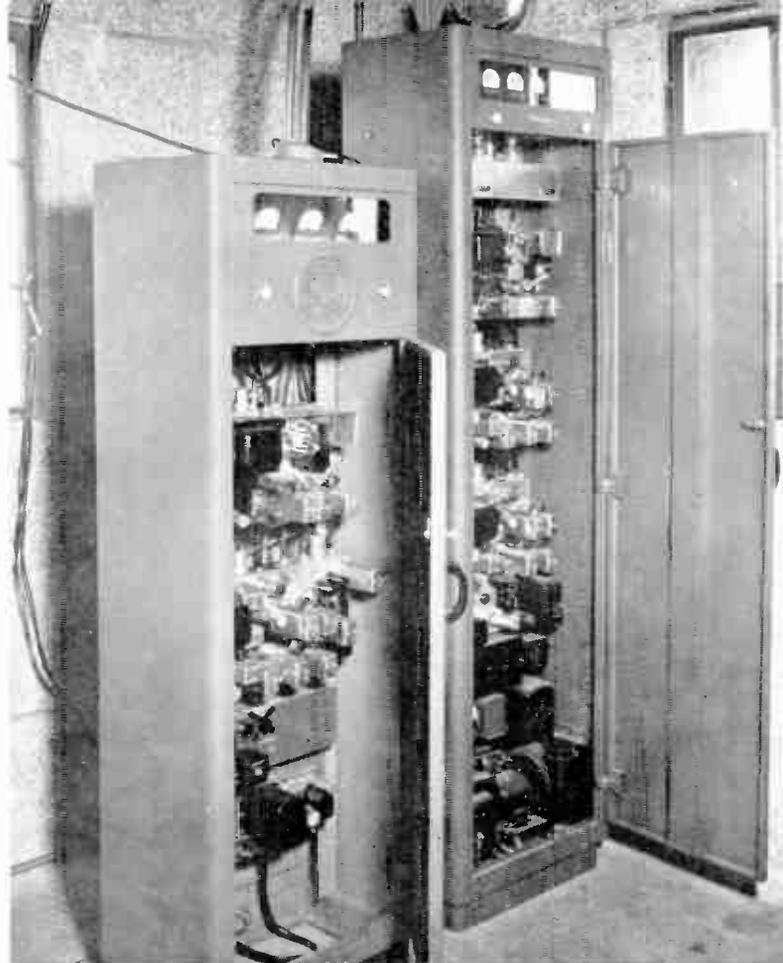


FIG. 5. EQUIPMENT AT MT. COOLIDGE. LEFT, BEAM TRANSMITTER AND RECEIVER. RIGHT, 250-W. TRANSMITTER & RECEIVERS

Still, despite this unusual terrain, solid 2-way coverage is provided to patrol cars in the manner illustrated in Fig. 2. Pierre is in direct communication with installations on Mt. Terry, point 4 in Fig. 1, and

Mt. Coolidge, point 3, on 39.1 mc., but Pierre cannot reach the Rapid City sub-headquarters, point 2, directly.

However, signals received on 39.1 mc. at Mt. Terry or Mt. Coolidge are repeated

on 79 mc. and are beams to Rapid City. The 125-ft. antenna with the 79- and 81-mc. arrays and the equipment at Mt. Coolidge are shown in Figs. 4 and 5. The antenna arrays at Rapid City and the in-

FIG. 6. DISPATCHER MAYNARD HAYES, AT RAPID CITY, CAN REACH ALL CARS IN WESTERN SOUTH DAKOTA ON THIS RELAY

FIG. 7. RAPID CITY INSTALLATION, WITH ARRAYS FOR 2-WAY COMMUNICATION WITH MT. TERRY AND COOLIDGE STATIONS



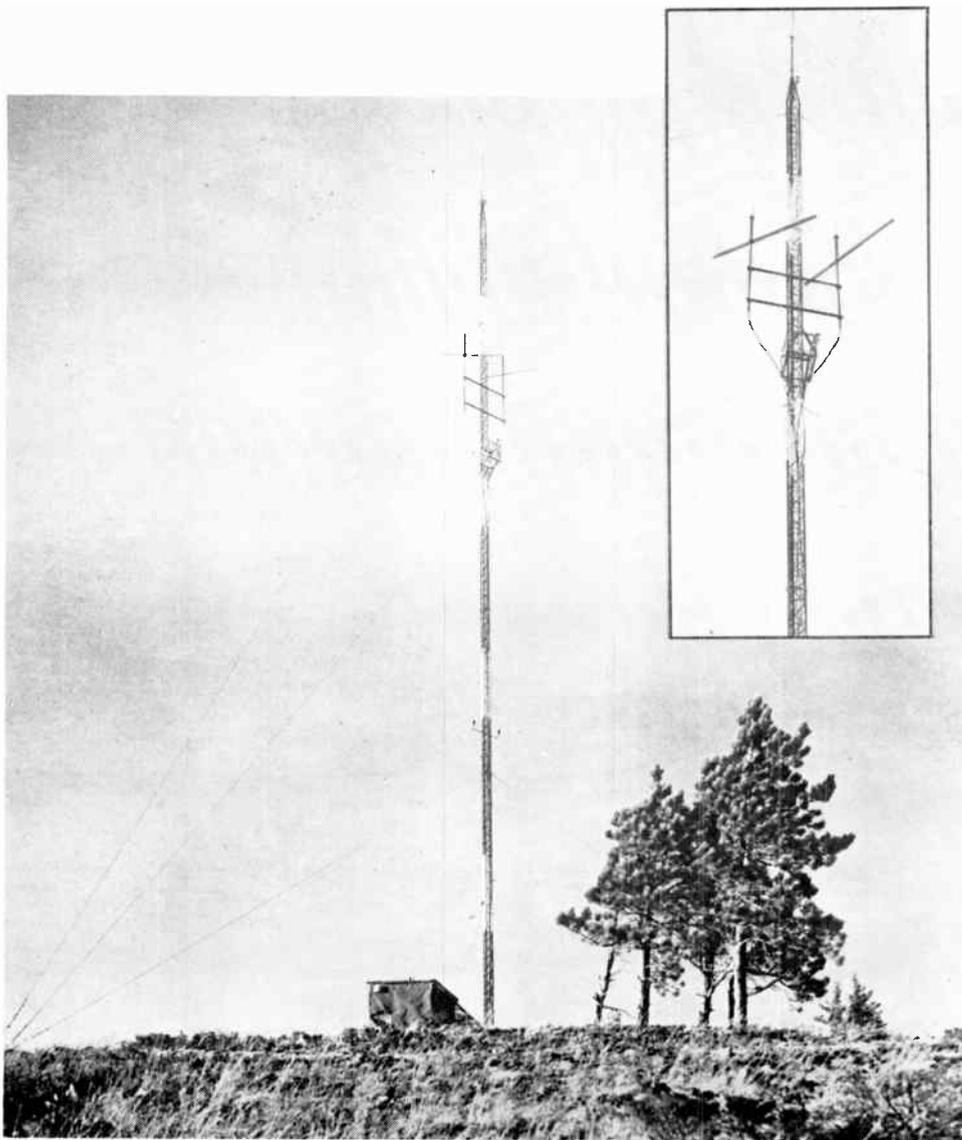


FIG. 8. THE 125-FT. TOWER ON MT. TERRY, ONE OF THE HIGHEST POINTS EAST OF THE ROCKIES. INSERT SHOWS BEAM ARRAYS FOR COMMUNICATION WITH THE RAPID CITY STATION

terior of the station are illustrated in Figs. 3, 6, and 7, while Fig. 8 shows the 125-ft. antenna at Mt. Terry, with a detail view of the 39.1-39.18-mc. main antenna for reception on 39.1 and 39.18 mc. and transmission on 39.1 mc., and the arrays for beam transmission on 79 mc. and reception on 81 mc.

The operator at Rapid City, listening to the 79-mc. repeaters on the mountain tops, can tell if he should relay messages for transmission on 39.1 mc. from either Terry or Coolidge, or both. He has a selector switch on the antennas so that he can use whatever combination of receiving and transmitting arrays is required. This unusual arrangement was worked out by Motorola Engineer Horace Boylan and William Jones, chief radio engineer for the State Police. It is one of those installations that some engineers might undertake to prove inoperable, but Maynard Hayes, dispatcher at Rapid City, gleefully relates that the Fish and Game patrols have not met his challenge to find a spot in western South Dakota where they can't hold a 2-way conversation with him!

The only difficulty encountered at

Rapid City was due to shock excitation of one transmitting array by the other. For example, when the array directed to Mt. Coolidge was in use, the other array was sufficiently shock-excited to deliver a signal to Mt. Terry. This condition was remedied by the simple expedient of detuning the first IF stage at the mountaintop receivers until the sensitivity was low enough to respond only to direct transmission.

Patrol Problems ★ With a population of 643,000, South Dakota has an average of only 4 people per square mile. This compares with 340 in Connecticut, and 550 in New Jersey, for example. Nor is the population concentrated in large cities, for there are only 21 centers of more than 2,000 population, of which the largest is Sioux Falls, with a population of 33,000. Thus, the State Police has a heavy responsibility for patrolling great areas that are sparsely populated in order to protect the residents and also tourists who, before the war, spent upwards of \$4,000,000 annually in South Dakota. The extremes of temperature and terrain encountered between the plains in the east and the

mountains and the Bad Lands country in the west, have put many a traveler in a panic. With the new radio system in operation, these hazards have been reduced to a minimum, for the duties of the Troopers include the protection of lives and property, in addition to enforcement of the law.

Whether it is a traveler in trouble on an unfrequented road, or a suspected cattle-rustler who must be stopped for an examination of his Brand Board papers, he can be located quickly on a giant map in Chief Dispatcher Oldacker's office at Pierre. Lights on the map indicate the location of each patrol car on duty. Thus it is easy to determine what car is nearest the scene of an emergency, or to set up a road block with certainty and dispatch, for 500 lights on the map, controlled by a switch console, follow the movements of the patrol cars as they report their positions.

Behind the dispatcher is another map. It is called the spot-map, because of the 1/2-in. magnetic markers, colored and numbered, which it carries. The numbers indicate: 1) Sheriff's Office, 2) County

(CONCLUDED ON PAGE 73)

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

Mobile Radiotelephone Service: A T & T summarizes the possibilities of their new metropolitan mobile radiotelephone service for commercial vehicles in these words: "Back-hauls and dead mileage can be reduced to a minimum with consequent increased operating efficiency at lowered costs. Ability to telephone to vehicles — for example delivery trucks — will permit changing instructions, rerouting, and so forth, and in many cases will make it unnecessary to send a second truck to accommodate customers whose requests for service are received after the vehicle serving their territory has been dispatched.

"When reporters and photographers are out on assignments, newspapers can promptly dispatch them to the scene of important news. Buses can be rerouted in emergencies or additional buses dispatched to take care of unusual or peak load conditions. Drivers can reach their garage or headquarters in case of breakdowns without leaving vehicles or their contents unprotected. This may be extremely important, especially at night. In emergencies where speed is essential, minutes saved may make a tremendous difference, for example, in the prompt dispatching of ambulances.

"And so it goes all through the long list of businesses and professions using vehicles and boats. These include:

"Ambulance services, armored car services, burglar and fire alarm services, construction contractors, doctors, express companies, food distributors (meat packers, dairies, bakeries, etc.), newspapers, oil companies, pick-up and delivery services serving department stores and other retail establishments, public service companies (electric light and power, gas, water, steam, transportation and communication), refrigerator services, taxicab companies, trucking companies, boats in adjacent rivers and harbors, and railroads."

Consolidation: Purchase of Howard B. Jones Company by Cinch Manufacturing Corporation has been announced by Cinch president Lester Tarr. Howard Jones will continue as consultant on Jones products. Cinch is a wholly-owned subsidiary of United Carr Fastener Corporation.

Washington — N. Y. Television: Transmission of television from Washington to New York over AT & T coaxial cable was inaugurated on February 12th, sponsored by CBS, DuMont, and NBC.

The demonstration was divided into three parts, beginning with an interview on the steps of the Capitol with Senators Kenneth McKellar of Tennessee, Burton K. Wheeler of Montana, and Wallace White, Jr. of Maine; Representative and

Speaker of the House Sam Rayburn of Texas, and Clarence F. Lea of California; and Paul A. Porter, chairman of the FCC. In a group, the men walked down the snow-covered steps of the Capitol toward the television camera. After each had said kind words about the future of television, the scene switched to the DuMont studio in Washington for the second phase, involving an explanation of the coaxial cable and an outline of the proposed national network.

The pièce de résistance was a visit to the Lincoln Memorial for the ceremony commemorating Lincoln's birthday. An apparent delay in the arrival of General Eisenhower to lay President Truman's wreath at the foot of the Lincoln statue forced the announcer to fill in with descriptive talk, including a description of the Lincoln Memorial.

While the reception at New York was marred at times by flickering and distortion, results showed that, when new equipment is ready to complete the system, transmission over the coaxial line will be excellent. This will require another 5 to 6 months.

AM Broadcasters' Problem: "W. L. Gleason, president of KPRO, at NAB district convention, Hollywood, January 7th":

"The other day I counted in the *Saturday Evening Post* 7 radio set ads, five of which were full pages in colors. Analyzing these seven ads, there were 3 large cabinet models advertised, and 26 models of the table variety. Every one of the ads emphasized the quality of the table variety in such language that people who read those ads would form the conclusion that a table model radio is just as good, and performs just as well, as the large sets do. Now, fellow broadcasters, let me tell you what is happening to you in this matter. In the homes having a large, high-quality set, properly adjusted with the proper antenna, the people listen to the radio 70% more than they do in those homes which have little four- or five-tube sets. . . .

"Along this same line, in the engineering division of the National Association of Broadcasters, receiver standards should be set up, and the NAB should issue a label to be placed on every set manufactured which meets the approval of the NAB Committee. All of the broadcasters should support the NAB in calling to the attention of the public the fact that a set without the NAB label is not an approved set. In this manner we will get away from these little *peanut whistle* sets which I have chosen to call *hard-of-hearing* sets. These *hard-of-hearing* sets will not reproduce the frequency, that is the quality, that you put into the air. Why should we increase our power and put in fine equip-

ment to increase our coverage with added signal strength when we have just as much interference in the reception of our programs right under the nose of our transmitters by reason of these *hard-of-hearing* sets as we have out in the 0.5 millivolt region?"

Mr. Gleason has a good idea, but only half the answer. Experience just prior to the war showed that the degree of improvement afforded by an FM receiver with a good audio end is necessary to convince any large number of set buyers that any substantial investment is justified. Most of the higher-priced AM sets cost more because an automatic phonograph is added to a cheap radio chassis in an expensive cabinet.

New Address: Business offices of Muzak broadcasting station WGYN have been moved to 25 W. 45th Street, New York 19, but the studios will be continued at 70 Pine Street.

TBA: Newest affiliate members of Television Broadcasters Association are Pilot Radio Corporation and The Hallicrafters Company.

Protest to FCC: Arthur Freed, chairman of the Pioneer FM Manufacturers Conference, to FCC Chairman Porter by telegraph:

"For the protection of the investment of 500,000 owners of FM sets, and for the moral support of the broadcasters, radio manufacturers, distributors and dealers who have supported FM, strongly urge Commission revoke order to broadcasters in the 42-50 FM band requiring them to change over to 88-108 band service by January 1, and order FM stations to maintain service in the 42-50 band at their full authorized power until their new transmitting equipment is received, installed, field tested, and operating at full authorized power. Also order all stations that have discontinued FM service in the 42-50 band because of Petrillo demands to resume service with recorded programs until the broadcasting industry settles their differences with Petrillo."

Any More Takers? Wager between Sarkes Tarzian, Bloomingdale consultant, and Dale Pollack of Temple Radio is on these terms: If, for any calendar year between 1946 and 1951 inclusive, the total dollar volume of home receivers incorporating FM reception exceeds the total dollar volume of receivers which do not provide for FM reception, Tarzian will pay to charity \$1,000.

However, if for each of the calendar years from 1946 to 1951, inclusive, the

(CONTINUED ON PAGE 74)



NEWS PICTURE

IT MAY be hard to accept the idea that salesmen are now being given instruction in selling, but such is the grim postwar reality that faces them! Soon, those individuals who developed the fine art of ducking orders and evading customers during the war years will be out on the job with catalogs and order pads in one hand

and landing nets or lariats in the other.

This photograph shows part of the Federal Telephone & Radio transmitter sales organization called in from all over the United States to take a concentrated course planned by boss Norman Wunderlich. Here is one of the Federal engineers giving them an illustrated demonstration of the new 1-kw. FM transmitter.

A feature of the one-week session that made a deep impression on these men was the FM transmission and reception of

stock commercial records. The quality was so superior that the salesmen thought they must be listening to special high-fidelity transcriptions.

One man remarked: "I haven't cared for canned music, but FM puts a new aspect on the use of recordings. I never heard such music on AM from live-talent shows!" Federal salesmen went home from this session primed with enthusiasm and loaded with information on the competitive advantages of FM.

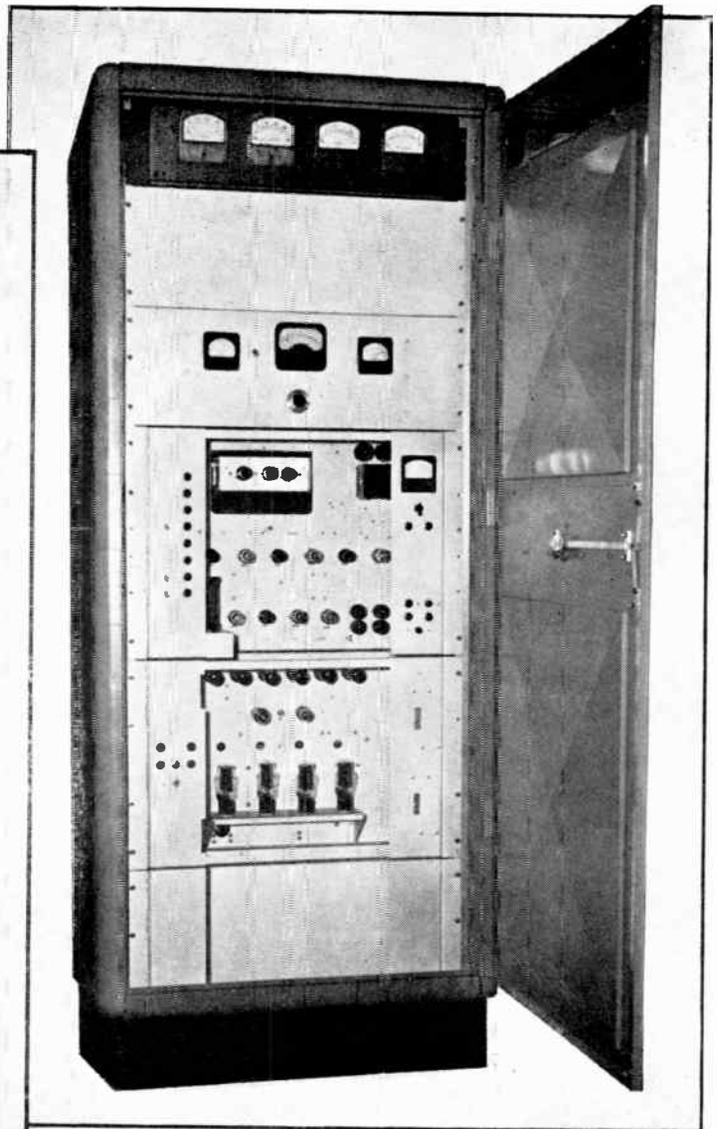
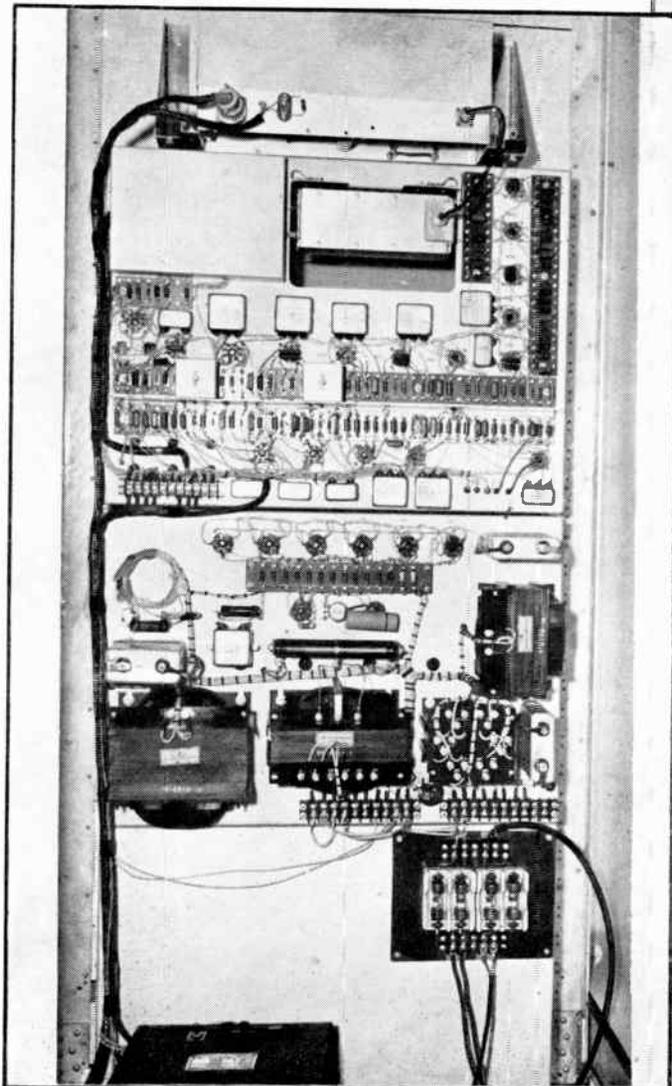


FIG. 1. FRONT OF MODULATOR AND CENTER-FREQUENCY UNIT USED WITH FM TRANSMITTERS OF 1 TO 50 KW. FIG. 2, LEFT. COMPONENTS OF THE MODULATOR AND C.F. CONTROL CIRCUITS ARE MAINLY RESISTORS & CONDENSERS

FEDERAL FM BROADCAST TRANSMITTER

Miller Effect Modulator and Vacuum Tube Center-Frequency Control Simplify FM Circuits

BY MARTIN SILVER*

SIMPLE circuits are a cardinal virtue in any transmitter intended for the continuous service required for broadcast stations. Accordingly, engineers at Federal Telephone and Radio Corporation undertook to devise means of obtaining frequency modulation that would reduce outages through the simplification of circuits and circuit elements.

The results of this effort were the development of a modulator employing the

Miller effect, and a system of center-frequency control in which vacuum tubes replace mechanical means for frequency correction. These circuits are built into the basic unit, illustrated in Figs. 1 and 2, for transmitters of 1, 3, 10, and 50 kw. The simplicity of the circuits can be judged from Fig. 2, which shows the complete assembly of components for the modulator, crystal control, and center-frequency correction.

Modulator Unit ★ The modulator is con-

tained in a small, shielded box, made up as a removable unit. It is mounted in an opening in the top panel, Fig. 2, and it can be identified in Fig. 1 by the three tubes it carries. A circuit diagram is shown in Fig. 3, and its relation to the other circuits, in Fig. 4.

The modulator operates on the following principle: A change in the grid bias of a vacuum tube results in a change of the input admittance of the tube. If the plate circuit load is purely resistive, the grid admittance will be purely capacitive.

*Engineering Dept., Federal Telephone & Radio Corp., 200 Mt. Pleasant Ave., Newark, N. J.

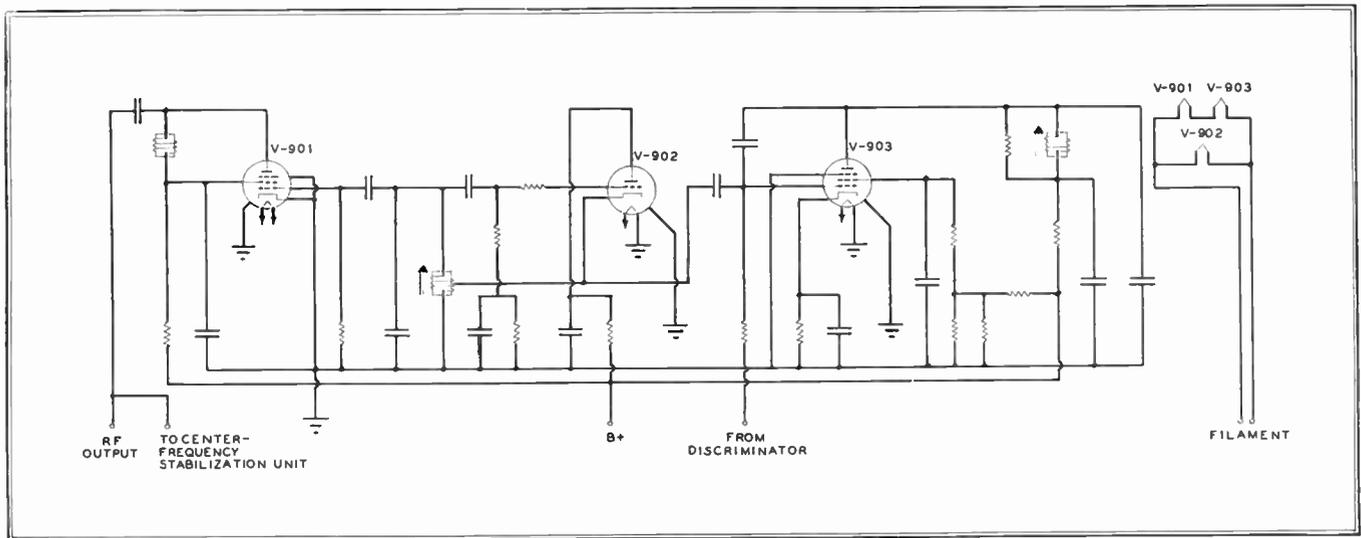


FIG. 3. DIAGRAM OF THE MODULATOR UNIT, IDENTIFIED IN FIG. 4 BY DOTTED LINES

If the audio modulating voltage is applied to the grid to accomplish the change in grid bias, the grid capacitance will change proportionately. Therefore, if the grid circuit of the modulator is connected in parallel with the tank of a Hartley oscillator, the changing capacity of the grid circuit of the modulator produces frequency modulation of the oscillator output.

In the modulator unit, the three tubes employed are a 6AB7 to produce the Miller-effect modulation, a 12J5 master oscillator, and a 6AB7 buffer, followed by the RF amplifiers.

Actually, the total voltage on the 6AB7 modulator tube is the sum of the AF program voltage and that of the phase discriminator used in conjunction with the center-frequency stabilizer. Thus the modulator tube not only converts the AF voltage into frequency modulation, but also acts in conjunction with the stabilizer to maintain the center frequency at the frequency of the crystal oscillator.

Center-Frequency Control ★ Center-frequency control is maintained by the automatic synchronization of the crystal oscillator and the master frequency-modulated oscillator. As the block diagram in Fig. 4 shows, the frequencies of the crystal oscillator and the modulated oscillator are divided and combined in a balanced phase detector. Then the integrated, rectified output is used to actuate the modulator, so as to pull in and lock the mean frequency of the master oscillator to that of the crystal oscillator.

The operation of these circuits can be understood by a study of the following explanation:

If the two frequencies are assumed to be in synchrony, the output of the balanced phase detector depends upon their relative phase. Any attempt of the center frequency of the master oscillator to drift from the crystal frequency results in an instantaneous change of the phase difference of the two oscillations, and a corresponding change in the rectified output of the phase detector, thereby acting on

the modulator to increase or decrease the frequency of the master oscillator, and so restore synchronization.

If it assumed that the two frequencies are not synchronized, then the output of the detector is the beat difference between the divided crystal oscillation and the divided frequency-modulated master oscillation. This beat frequency, acting on the modulator, swings the carrier frequency of the master oscillator at a rate equal to the beat frequency, and with a deviation proportional to the amplitude of the beat. If the deviation is sufficiently large, and the beat rate sufficiently low, the instantaneous frequency of the modulated oscillator is in near-synchronization with the crystal oscillation for a sufficient number of oscillation cycles for the condition of synchronization to take hold. Therefore, the condition described in the previous paragraph exists.

It would not be possible to synchronize a frequency-modulated oscillator with a crystal oscillator at the carrier frequency because, under modulation, the carrier

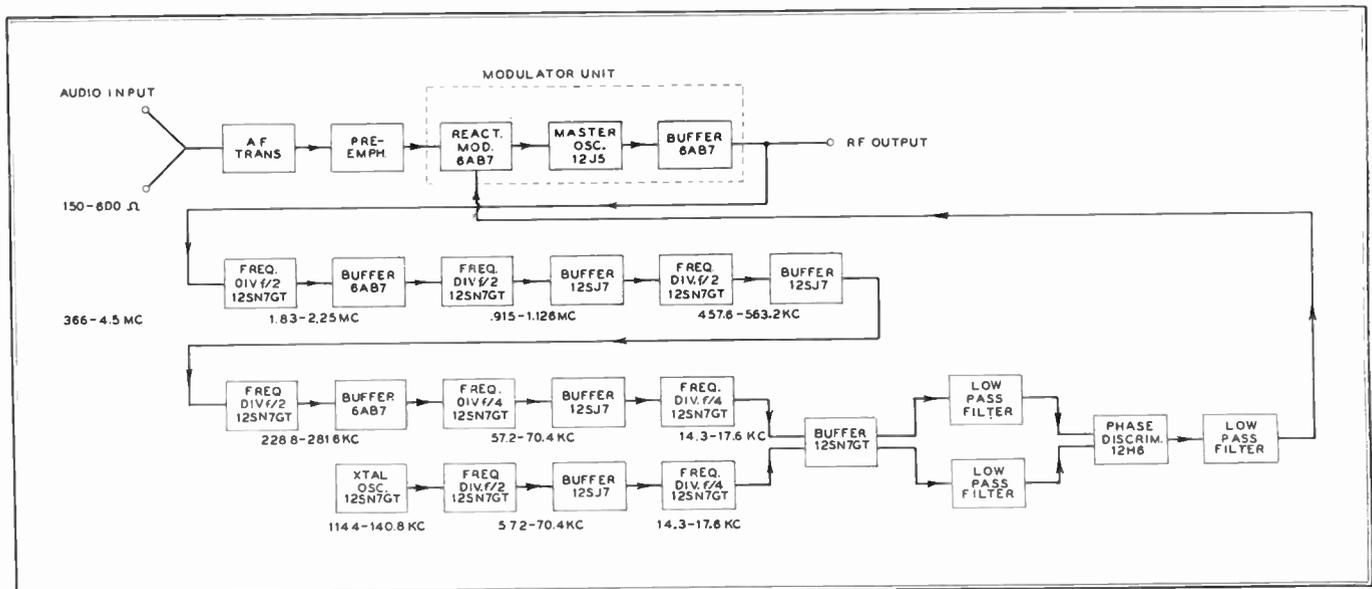


FIG. 4. BLOCK DIAGRAM OF THE MODULATOR, ABOVE, THE CENTER-FREQUENCY CONTROL, AND PHASE DISCRIMINATOR

frequency amplitude is reduced and passes through innumerable conditions of zero amplitude. However, if frequency division is performed, the effect is to reduce the frequency swing and the modulation index to an extent where the reduction of carrier amplitude is very small. In the present case, the maximum swing is 3 kc. at an oscillator center frequency of 4 mc. A frequency division of 256, as indicated in Fig. 4, brings the maximum swing to $3,000/256$, or 12 cycles per second. Since the lowest audio frequency of 30 cycles, the maximum modulation index is $12/30$, equal to .4 radian or 24° . This index reduces the carrier to .096 of its unmodulated value, giving an essentially constant carrier for synchronization. The crystal oscillator is also divided to a frequency corresponding to the divided frequency of the master oscillator.

The dependence of control on a balanced phase detector imposes the condition that the instantaneous phase variation at the detector shall not exceed plus-or-minus 90° , since this is the maximum range over which the detector operates as a phase-control device. In this circuit, the frequency division reduces the phase variation due to modulation to less than 24° . Therefore, the phase detector exercises control when the system is under synchronization. As a matter of fact, control is maintained under continuous 200% modulation.

The output circuit of the phase detector is essentially an integrator and low-pass filter that responds only to slow frequency drifts, and removes the residual modulation.

FM Antennas ★ Fig. 5 illustrates another Federal development—the square loop antenna, consisting of four dipole radiators arranged in the form of a square. Such an FM antenna can be mounted on the type of tower shown in Fig. 5, or on a tubular steel mast.

In addition to its high efficiency, this design has the advantage of great mechanical strength, so that it can withstand winds of high velocity and heavy sleet loads. The gain per layer of the square loop is greater than that of either the turnstile or circular antenna, for the reason that there are twice as many effective

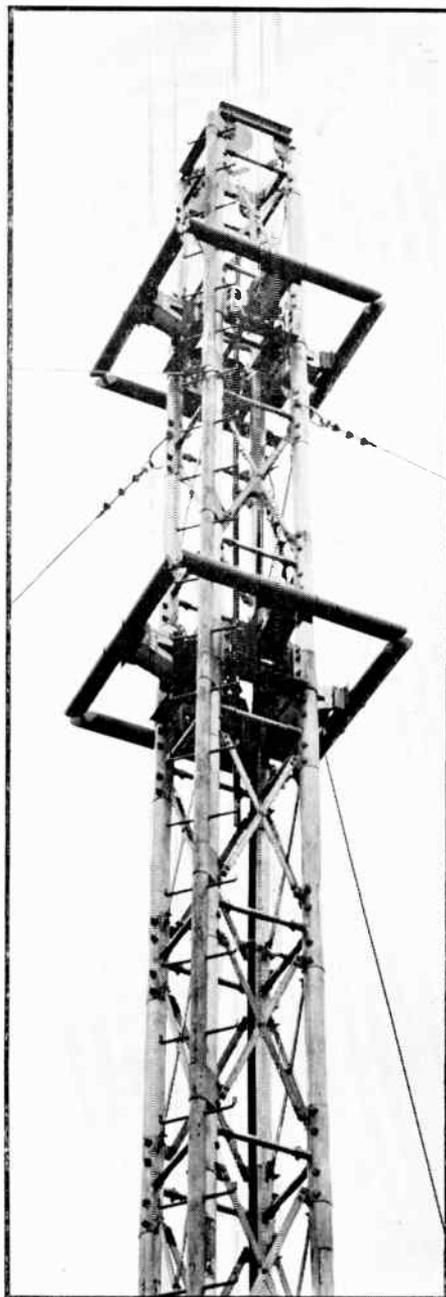


FIG. 5. SQUARE LOOP FM ANTENNA

radiators as the turnstile.

Federal FM equipment also includes studio and station speech input consoles, transcription turntables, studio records, and monitor speakers.

NEW YORK RADIO WAGE AGREEMENT

PAY increases have been granted to 15,000 radio workers in the metropolitan New York area under an agreement reached between UE-CIO and 18 companies represented by the Electronics Manufacturers Association.

This wage increase, amounting to 20% applied uniformly in cents per hour, was announced by James McLeish, president of the New York-New Jersey district of UE-CIO, and Walter Wyckoff of Pilot

Radio, president of the EMA. Negotiations were begun in November, 1945.

The joint statement characterized the agreement as "a signal step forward in the industrial relations of the radio manufacturing industry. It provides a model for collective bargaining between labor and the manufacturers throughout the country. The industry-wide agreement in this area insures stability for management planning, and guarantees a rapid expan-

sion of production and employment in the metropolitan labor market.

"In addition to the 20% payroll increase, the contract provides a minimum of $6\frac{1}{4}$ paid holidays annually (the $\frac{1}{4}$ holiday being two hours on election days), vacations of one-half week for one-half year's employment rising up to two weeks for three years, a closed shop, and hiring through the union. The union retains the right to reopen the contract for wage increases after nine months.

"Under the new agreement, the hiring-in minimum for radio set companies is 75 cents an hour with automatic advancement to a plantwide minimum of 90 cents an hour regardless of sex."

EMA includes the following radio and component parts manufacturing concerns:

Adams Laboratories
DeWald Radio Mfg. Corp.
Electronic Corp. of America
Emerson Radio & Phonograph Corp.
Espey Mfg. Co.
Fada Radio Corp.
Federal Mfg. & Engineering Corp.
Freed Radio Corp.
Hammarlund Mfg. Co.
Kurman Electric Co.
Micamold Radio Corp.
Minerva Radio Co.
Panoramic Radio Corp.
Philharmonic Radio Corp.
Presto Recording Corp.
Solar Mfg. Corp.
United Transformer Corp.
University Laboratories

All the companies, except Solar, are in New York City and under contract with UE Local 430. Solar is located in Bayonne, N. J., and is under contract with UE Local 427.

The EMA negotiating committee included Ben Abrams, president of Emerson; J. M. Marks, president of Fada; Bernard Fein, vice president of E.C.A.; Arthur Freed, president of Freed Radio; I. A. Mitchell, president of U.T.C.; Lloyd Hammarlund, president of Hammarlund; Paul Hentenyi, president of Solar; A. P. Hirsch, president of Micamold; David Wald, president of DeWald; and Charles Bernell, secretary of Clarostat.

The union's negotiating committee was headed by president Anthony Salese and business manager Al Stearn of Local 430, and president Clifton Cameron and shop chairman Joseph Mroz for Local 427, with district president James McLeish entering the negotiations in their final stages.

This new UE contract is the result of efforts by EMA members to establish uniform rates and conditions for the metropolitan New York area. Prior to this time, separate contracts were in force which varied considerably in their details because they were negotiated at different times when the shops were first organized.

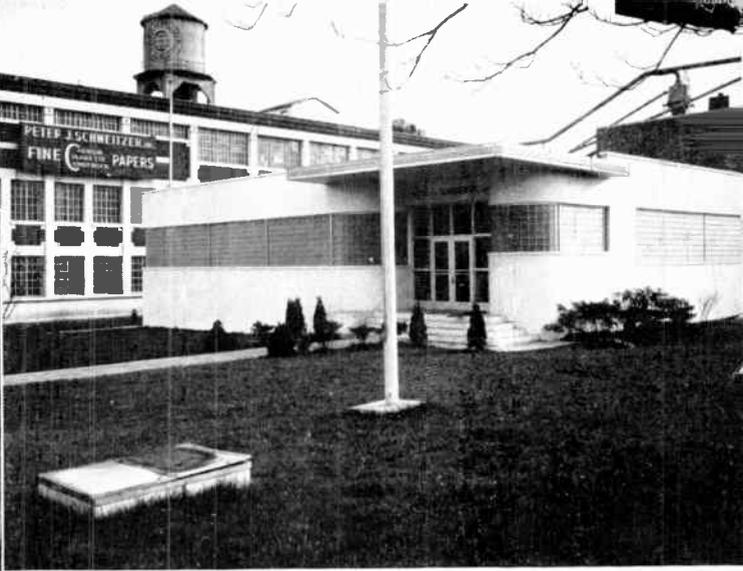


FIG. 1, ABOVE. IN THE FOREGROUND IS THE MODERN LABORATORY BUILDING WHERE SOME OF THE ACCOMPANYING PHOTOGRAPHS OF PAPER TESTS WERE TAKEN

FIG. 2, LEFT. INSPECTING THE FORMATION OF A SHEET OF PAPER. THIS INSPECTION SUPPLEMENTS A MICROSCOPIC EXAMINATION OF THE FIBRE FORMATION

MANUFACTURE OF CONDENSER PAPER

A Detailed Account of the Manufacturing Processes, and the Methods Employed to Control Production

BY WILLIAM P. SCHWEITZER*

CENTURIES ago, when our ancestors found they could use the bark of trees as a medium to record their thoughts, they could hardly have conceived that some day, in our allegedly advanced civilization, a paper of flawless texture would be produced so thin as to be less than one-fifth the thickness of a human hair.

In all fairness to our ancestors we must add that, to the vast public of today, some of the why's and wherefore's embodied in such commonplace devices as a radio or television components are still almost as much a mystery as they would have been to any long departed Egyptian script-writer. So, if the man on the street says, "Condenser paper! what's that?" those of us who struggle daily with the problems involved in its manufacture should not be perturbed.

The subject of condenser paper can best be understood if it is considered in two stages, first its development as the finest product in the field of papermaking and, second, its metamorphosis into an insulating material.

Condenser paper draws its name from a device so vital and varied in its applications that it needs no introduction here.

One of the earliest and certainly one of the most important applications of paper condensers was in telephone equipment.

*Vice President, Peter J. Schweitzer, Inc., Chrysler Building, New York, N. Y.

It was realized that, for economy's sake, the paper should be the thinnest and cleanest available. Therefore, it became a problem for those manufacturers who specialized in light-weight papers.

The evenness of texture and the absence or presence of pin-holes were judged by visual inspection. Thus, the decision as to whether or not a condenser paper was acceptable was really more imaginative than scientific. Very often the estimate of quality depended more on the intensity of the light held behind the paper during inspection than on the sweat and tears wrung from the paper-mill superintendent. Paper is still examined in this manner, Fig. 2, but at the Schweitzer Paper Company, where the accompanying photographs were taken, production is controlled by continuing chemical and physical tests, carried on in the laboratory building shown in Fig. 1.

Mention was made of the cleanliness of the paper. Here, too, the eye was quicker than the handiwork. Dirt specks were counted, and the matter of acceptance or rejection depended largely on the mood of the moment, although a little later a chemical test was added to uncover the insidious specks that were iron or rust. The number of such specks permissible per square foot of paper varied as greatly as the test methods used. Much later the method of testing con-

denser paper for conducting particles by means of a roll and plate provided a much more accurate means of determining this important impurity in insulation papers. A microscopic examination of the dirt particles surprisingly enough disclosed that 90% were carbon that had never been indicated by the test for metallic particles only.

Materials & Their Preparation ★ The problem of closing-up a sheet of paper, which can best be described as the production of a paper structure uniform enough in texture to present a homogenous mass free from lumps and thin spots, is undoubtedly the most difficult in the art of paper making, and it is truly an art. We are accustomed to thinking of thin metals produced by rolling metallic sheets under high pressure, and the common belief is that thin papers are produced in some similar manner. Nothing could be farther from the truth, as will be made clear in this discussion of the processes involved in the manufacture of condenser paper.

If the paper is to be produced from linen or rags, the choice of such materials receives careful consideration. The linen or cotton rag is selected for its cleanliness and its strength. That usually precludes the use of anything but new waste materials.

The rag waste or cuttings are first

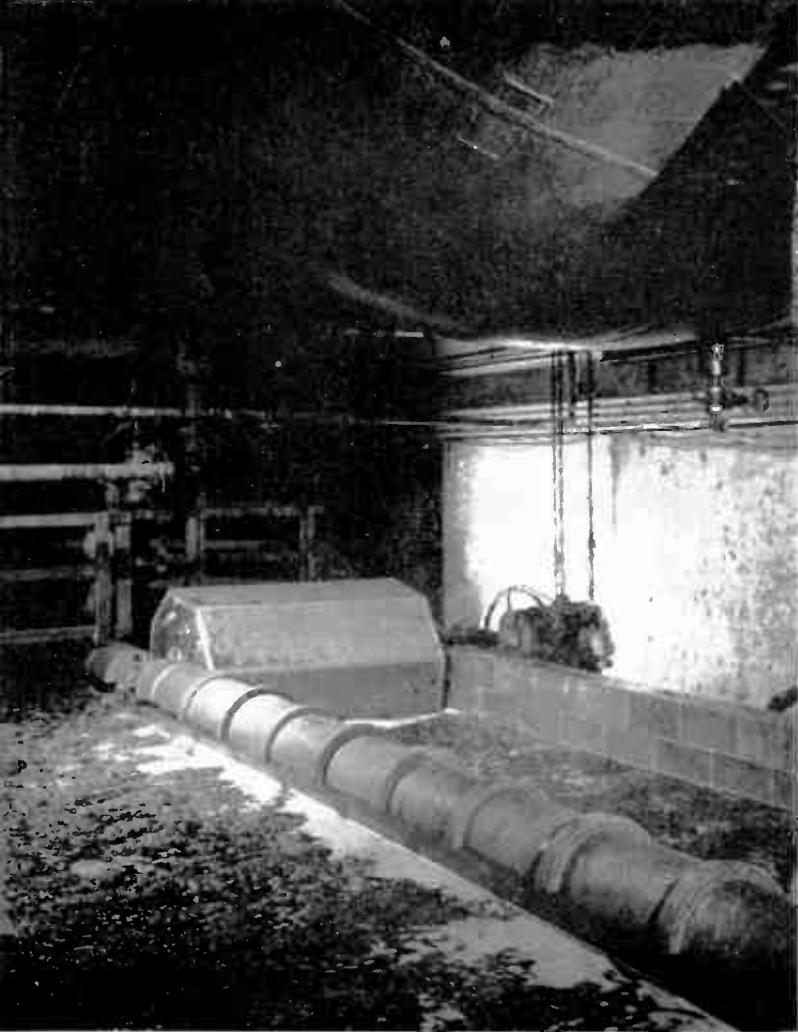


FIG. 3. THE HUGE BOILER ABOVE IS EMPTIED INTO THE WASHER BELOW, WHERE IMPURITIES ARE REMOVED



FIG. 4. A BATCH OF STOCK COOKED IN A SMALL LABORATORY BOILER, OR DIGESTER, BEING EMPTIED INTO A WASHER

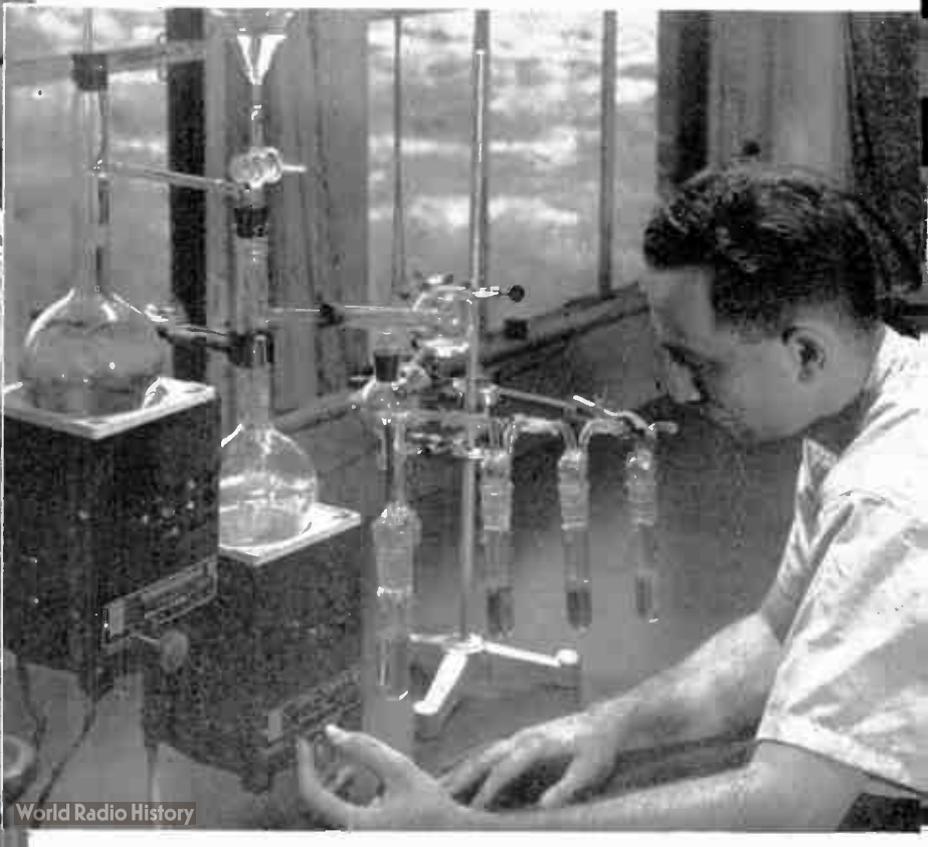
brought to a rag-cutter. Here a rotary knife reduces the size of the cuttings so that later, in the cooking and beating operations, the material will not tend to

string-up. The rags, after they have gone through the rag-cutters, are usually brought by a belt conveyor to a device known as a duster. The types of dusters

vary somewhat, but their purpose is nevertheless the same. A dusting action, similar in most respects to that accomplished when you beat the family rag on



FIG. 7. UNIFORM BEATING OF EACH BATCH OF STOCK IS ASSURED BY RECORDING INSTRUMENTS WHICH SHOW THE BEATER ACTION
 FIG. 8. CHECKING CHEMICAL PURITY OF THE PULP. IMPROVED METHODS OF STOCK PREPARATION PRACTICALLY ELIMINATE FOREIGN SUBSTANCES





FM BROADCAST TRANSMITTERS...

- Direct crystal control
- One crystal
- Less distortion
- Modulation independent of frequency control
- Lower noise level
- Greater frequency stability
- Fewer tubes
- Fewer circuits and controls

use this revolutionary **NEW CIRCUIT**

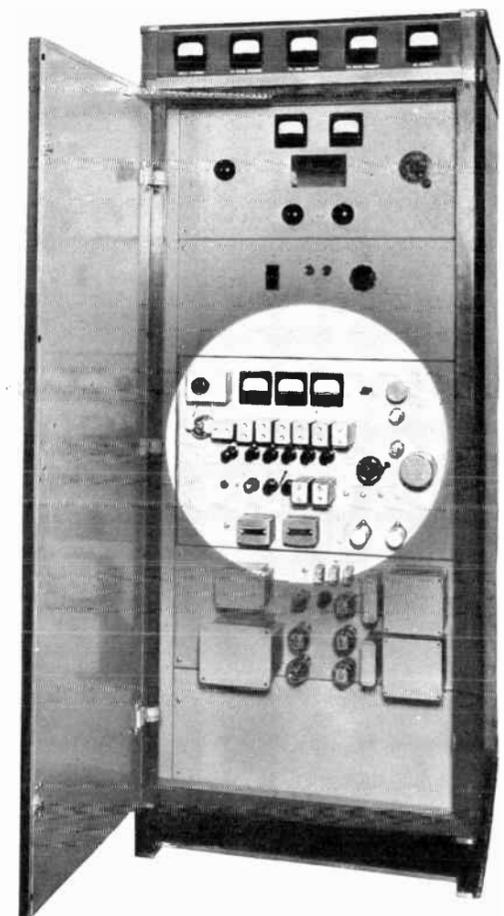
GENERAL ELECTRIC FM transmitters open a new era in broadcasting with a modulator and frequency-control circuit as sweeping in importance as the introduction of crystal control.

Operating under principles of frequency modulation and frequency control completely different than those employed in conventional FM broadcast transmitters, this *simplified all-electronic* circuit makes possible direct frequency control independent of modulation—with a frequency multiplication of only 432! Here is a dependable and straightforward system that uses no frequency conversion, permits extremely wide modulation phase shifts at low frequencies and improves transmitter signal-to-noise ratio. Simplicity with one crystal, fewer tubes, fewer circuits, and fewer components insures greater dependability, makes every G-E transmitter easier to tune and to maintain.

Heart of the G-E FM modulator circuit is the G-E Phasitron—a combined electronic tube achievement of the Zenith Radio Corporation and General Electric Company. This tube is capable of producing directly wide-swing frequency modulation without need for intricate frequency multiplier chains and frequency conversion. With the Phasitron, reactance-tube and crystal-reference circuits are eliminated.

For complete facts about the new modulator circuit and for full technical specifications on General Electric's complete line of FM broadcast transmitters call your G-E broadcast sales engineer, or drop a line to: *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

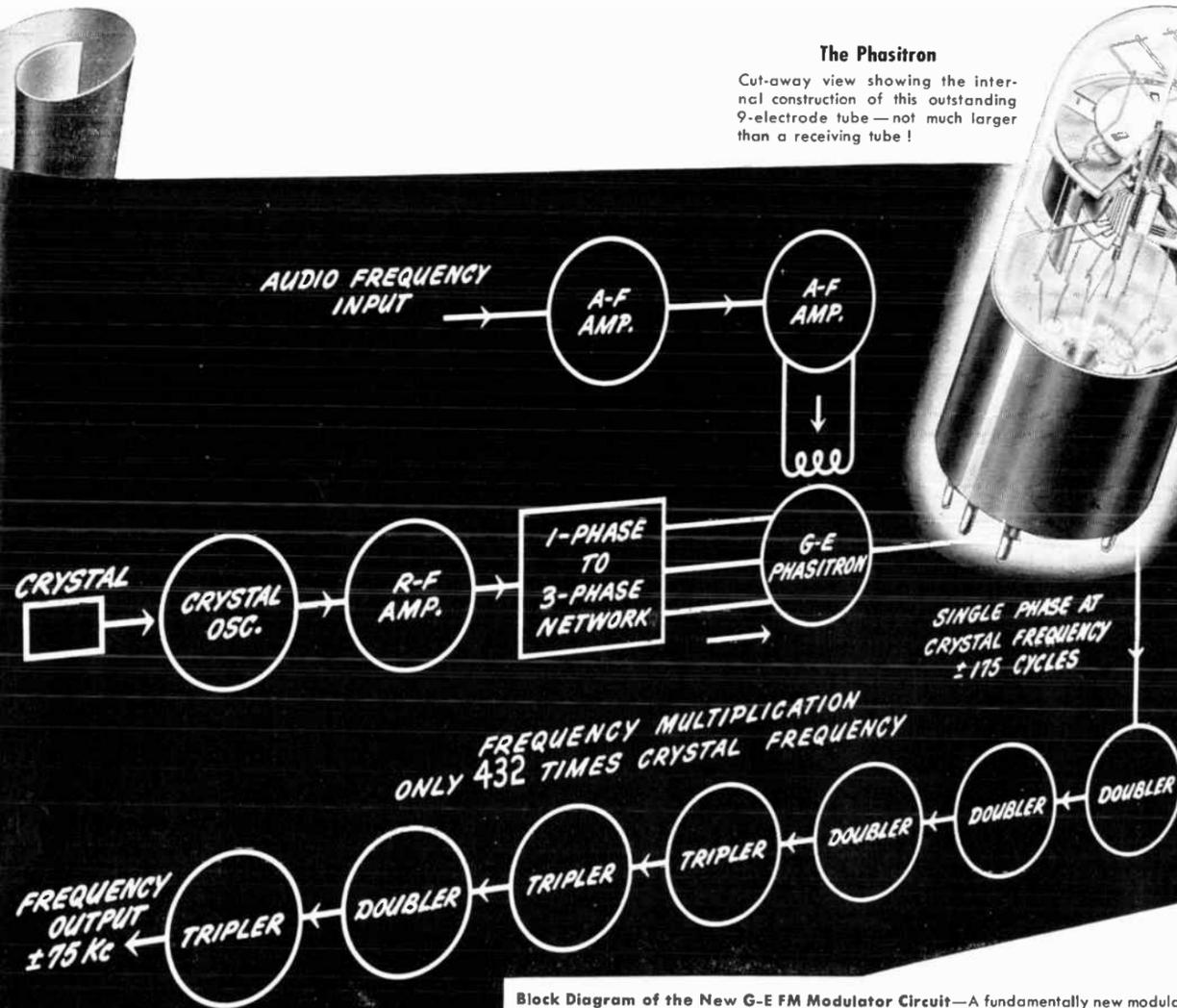
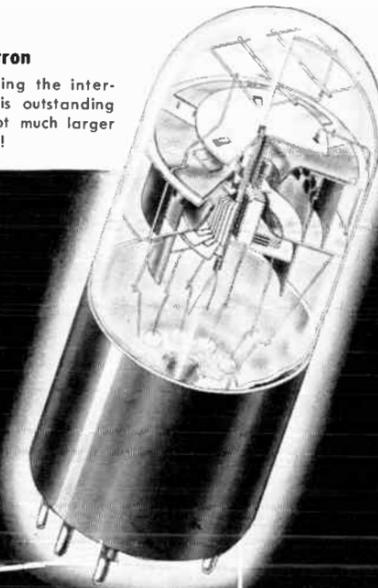
For earliest possible delivery of your broadcast equipment, place your order now.



New 250-watt G-E FM Broadcast Transmitter, Type BT-1-A—Carrier Frequency Range, 88 to 108 Mc. More than Meets every F.C.C. Specification. The Section in the Circle is the New All-Electronic Modulator system that uses only 12 tubes! Ask your G-E broadcast sales engineer for complete data.

The Phasitron

Cut-away view showing the internal construction of this outstanding 9-electrode tube—not much larger than a receiving tube!



Block Diagram of the New G-E FM Modulator Circuit—A fundamentally new modulation and frequency-control circuit, the G-E FM modulator provides new simplicity, easy tuning, and a minimum of maintenance. Control center of the circuit is the Phasitron—a 9-electrode tube pioneered by Zenith, developed and built by General Electric. The Phasitron in effect produces a "rotating electron wheel" within the tube itself. An external coil around the tube acts to momentarily accelerate and retard this "wheel" magnetically at an audio-frequency rate. The action produces wide-swing frequency modulation without need for frequency conversion and intricate frequency multiplier chains.

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

ANTENNAS • ELECTRONIC TUBES • HOME RECEIVERS

GENERAL ELECTRIC

LEADER IN RADIO—TELEVISION—ELECTRONICS

160-E2-6914

See G.E. for all three!
FM • TELEVISION • AM

fibres can be cooked at one time. In Fig. 3, part of a spherical boiler can be seen above, while Fig. 4 shows a small laboratory boiler from which cooked fibre is being dumped into a washer.

The function of the cooking is to remove non-cellulose materials from the fibre mass. The chemical used is either lime or caustic soda. The latter is preferable since, in the washing that follows the cooking operation, the excess caustic soda is much more easily removed than the less soluble lime. In the cooking stage, steam is introduced into the boiler containing a mixture of rags and chemicals, to which water has been added in a quantity sufficient to immerse all the rags. The boiler is stationary during the first portion of the cooking, and an outlet is left open at the top of the boiler so that the incoming steam will drive out the air left in the boiler. This is a necessary precaution to minimize the possibilities of boiler explosions. When all the air has been removed, the outlet is closed and the boiler is rotated slowly. The purpose of this rotation is to insure a proper mixture of chemicals and fibre, with a resultant uniform cooking of the mass. The cook takes from 10 to 12 hours. Then the mass of cooked fibre is dumped from the boiler and transferred to a washer, shown in the foreground of Fig. 3.

The washer consists of either a concrete or wooden tub containing a roll with protruding bars underneath which is set at a bed-plate with bars at a slight angle to the bars on the roll. The roll is usually lowered

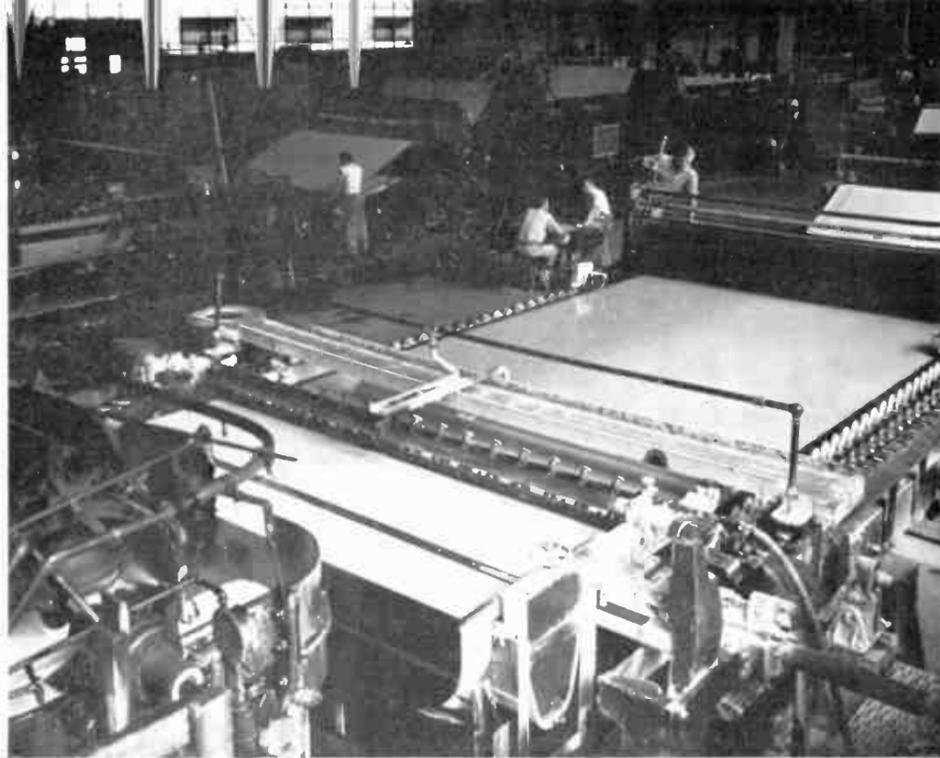


FIG. 11. FIBRE AND WATER ARE FED AT THE FOREGROUND ONTO AN ENDLESS BELT OF WIRE MESH SUPPORTED BY ROLLERS. WATER DRAINS THROUGH THE WIRE

to close proximity with the bed-plate, and provides a tearing action in the rags that tends to shorten the length of fibre as well as facilitate the release of impurities held in the structure of the rags. A cylindrical washer drum, at the left in Fig. 3, is mounted in the tub so that it will rotate when immersed in the mixture of fibre and

water, and extract the water with cooked impurities at the same rate fresh water is added.

The fibre is now ready for bleaching, if necessary. Otherwise the stock, as the fibre in this state is called, is dropped into drainers where it is held until required in the beating stage. The bleaching operation is either performed in the washer or, as is sometimes done, the fibre is transferred to bleachers. The construction of a bleacher is similar to that of a washer with the exception that a roll and plate are unnecessary, and the mass is circulated in the tub by means of a paddle wheel. The bleaching can be accomplished in

several ways, but in all methods chlorine is the basic chemical used. Chlorine can be introduced as a gas, or mixed with either lime or caustic to form a hypochlorite. Once the desired whiteness in the stock has been attained, the bleaching action is terminated, and fresh water is added until the excess bleach has been removed.

This final washing operation must be carried out thoroughly to remove any remnants of residual bleach which might remain in the stock and later contaminate the finished paper with an undesirable chloride content. Fig. 5 shows the equipment used by the bleach control chemist to test samples of the stock during the bleaching operation.

The stock is then ready for the process by means of which the fibre length is considerably shortened in a beater engine, Fig. 6. This beater engine is similar in almost every respect to the washer previously described. The difference however may be best explained by saying that the beater engine must perform a precision job. The roll settings with respect to the bed-plate are very accurately controlled and, in most up-to-date paper mills, this beating action is recorded visually, as in Fig. 7, so that batch after batch of stock can be beaten in an identical manner.

At this point it is important to state that although the description of the steps taken in stock preparation apply to linen or rag fibres, in the United States within the past few years condenser paper has been almost entirely manufactured from an unbleached kraft wood-pulp. The pulp is processed by the pulp producers to a point that enables the paper manufacturer to furnish it directly to the beater engine without any preliminary treatment.

FM AND TELEVISION

FIG. 13. THICKNESS OF PAPER IS REDUCED AND MADE UNIFORM BY RUNNING IT BETWEEN ROLLS IN THIS CALENDER

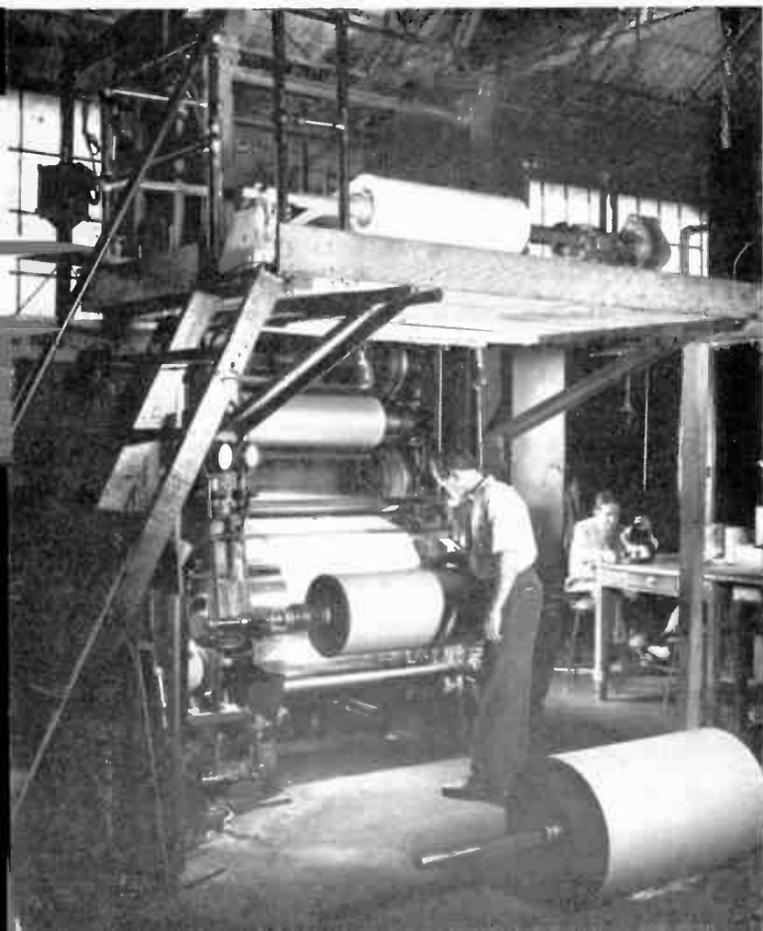


FIG. 5. RESIDUAL BLEACH WOULD CONTAMINATE THE FINISHED PAPER. THE BLEACH CONTROL CHEMIST CHECKS THE STOCK

the garden line, takes place in these dust-ers, and a surprisingly large amount of dust and dirt is removed from even the newest rags by this treatment.

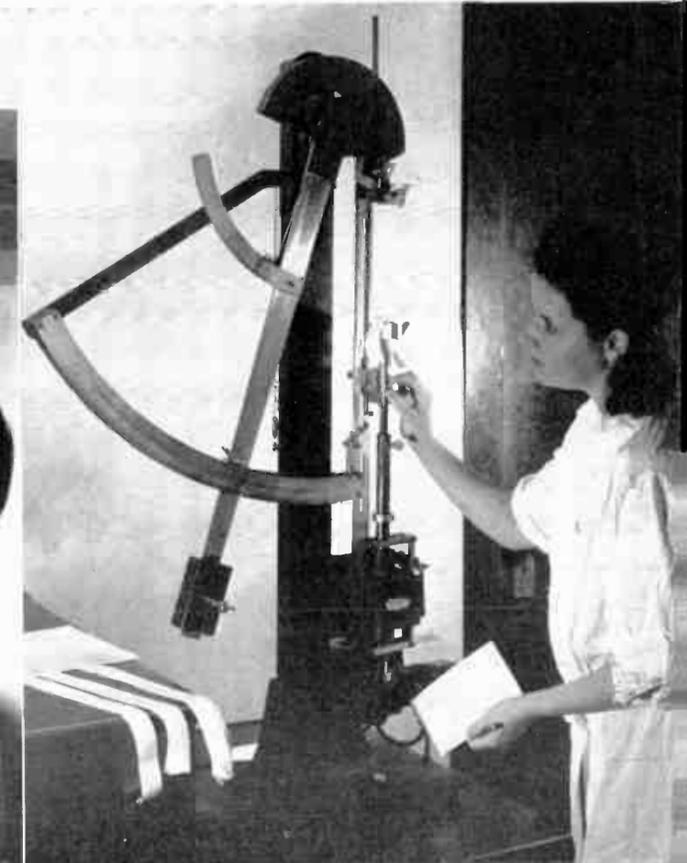
FIG. 9. BELOW, MAKING PH TEST TO DETERMINE THE ACIDITY OR ALKALINITY OF SAMPLES OF FINISHED PAPER FOR CONDENSERS
FIG. 10. THIS IS THE MACHINE USED TO TEST SAMPLE STRIPS FOR TENSILE STRENGTH, AN IMPORTANT FACTOR IN THE MANUFACTURE OF PAPER CONDENSERS



FIG. 6. THE FIBRE IS FURTHER SHORTENED IN THE BEATER, FROM WHICH IT GOES TO THE PAPER MACHINE

The cuttings are then ready for the cooking operation, illustrated in Fig. 3. Either cylindrical or spherical boilers, also called digesters, capable of withstanding

steam pressures up to 100 pounds, are used for this purpose. Their capacity varies anywhere from 5 tons to some of recent construction in which 25 tons of



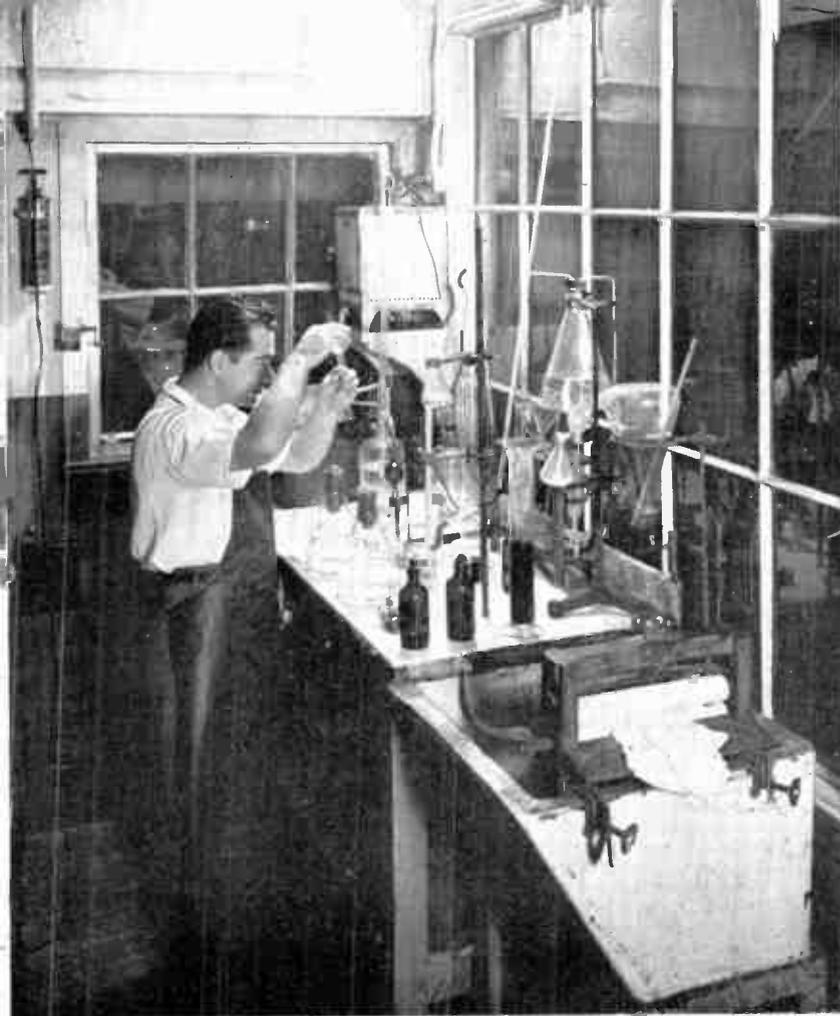


FIG. 5. RESIDUAL BLEACH WOULD CONTAMINATE THE FINISHED PAPER. THE BLEACH CONTROL CHEMIST CHECKS THE STOCK



FIG. 6. THE FIBRE IS FURTHER SHORTENED IN THE BEATER, FROM WHICH IT GOES TO THE PAPER MACHINE

the garden line, takes place in these dust-ers, and a surprisingly large amount of dust and dirt is removed from even the newest rags by this treatment.

The cuttings are then ready for the cooking operation, illustrated in Fig. 3. Either cylindrical or spherical boilers, also called digesters, capable of withstanding

steam pressures up to 100 pounds, are used for this purpose. Their capacity varies anywhere from 5 tons to some of recent construction in which 25 tons of

FIG. 9, BELOW. MAKING PH TEST TO DETERMINE THE ACIDITY OR ALKALINITY OF SAMPLES OF FINISHED PAPER FOR CONDENSERS
FIG. 10. THIS IS THE MACHINE USED TO TEST SAMPLE STRIPS FOR TENSILE STRENGTH, AN IMPORTANT FACTOR IN THE MANUFACTURE OF PAPER CONDENSERS



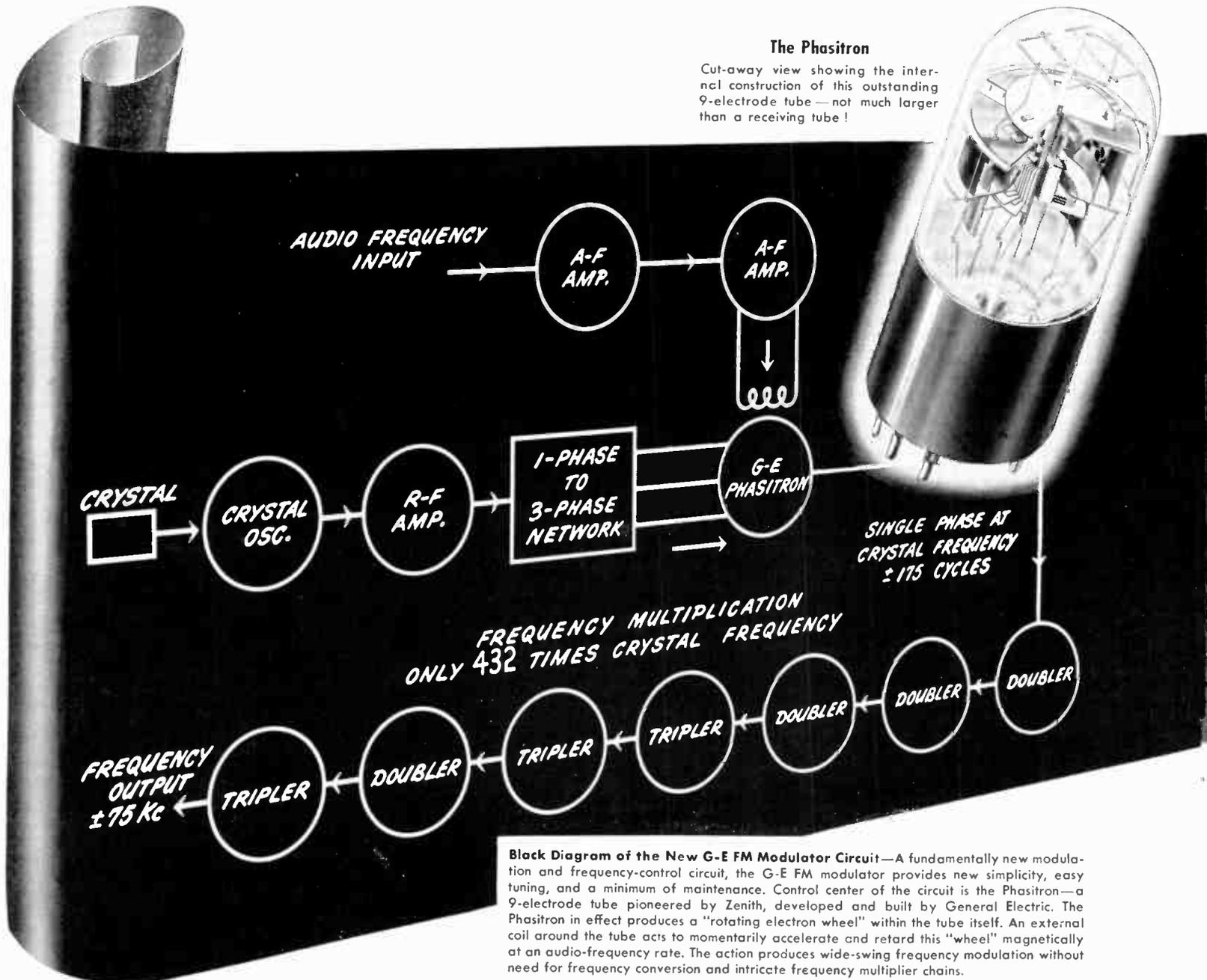
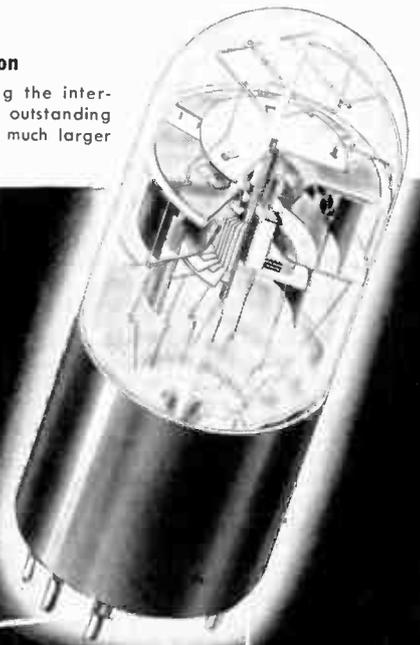


FM BROADCAST

- Direct crystal control
- One crystal
- Less distortion
- Modulation independent of frequency control
- Lower noise level
- Greater frequency stability
- Fewer tubes
- Fewer circuits and controls

The Phasitron

Cut-away view showing the internal construction of this outstanding 9-electrode tube — not much larger than a receiving tube!



Block Diagram of the New G-E FM Modulator Circuit—A fundamentally new modulation and frequency-control circuit, the G-E FM modulator provides new simplicity, easy tuning, and a minimum of maintenance. Control center of the circuit is the Phasitron—a 9-electrode tube pioneered by Zenith, developed and built by General Electric. The Phasitron in effect produces a "rotating electron wheel" within the tube itself. An external coil around the tube acts to momentarily accelerate and retard this "wheel" magnetically at an audio-frequency rate. The action produces wide-swing frequency modulation without need for frequency conversion and intricate frequency multiplier chains.

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

GENERAL ELECTRIC

160-E2-6914

LEADER IN RADIO—TELEVISION—ELECTRONICS

TRANSMITTERS...

use this revolutionary

NEW CIRCUIT

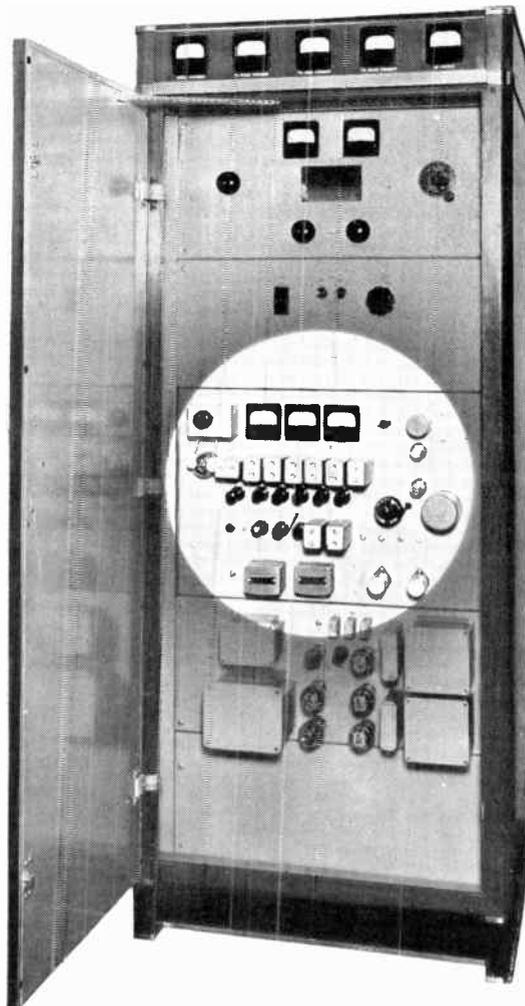
GENERAL ELECTRIC FM transmitters open a new era in broadcasting with a modulator and frequency-control circuit as sweeping in importance as the introduction of crystal control.

Operating under principles of frequency modulation and frequency control completely different than those employed in conventional FM broadcast transmitters, this *simplified all-electronic* circuit makes possible direct frequency control independent of modulation—with a frequency multiplication of only 432! Here is a dependable and straightforward system that uses no frequency conversion, permits extremely wide modulation phase shifts at low frequencies and improves transmitter signal-to-noise ratio. Simplicity with one crystal, fewer tubes, fewer circuits, and fewer components insures greater dependability, makes every G-E transmitter easier to tune and to maintain.

Heart of the G-E FM modulator circuit is the G-E Phasitron—a combined electronic tube achievement of the Zenith Radio Corporation and General Electric Company. This tube is capable of producing directly wide-swing frequency modulation without need for intricate frequency multiplier chains and frequency conversion. With the Phasitron, reactance-tube and crystal-reference circuits are eliminated.

For complete facts about the new modulator circuit and for full technical specifications on General Electric's complete line of FM broadcast transmitters call your G-E broadcast sales engineer, or drop a line to: *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

For earliest possible delivery of your broadcast equipment, place your order now.



New 250-watt G-E FM Broadcast Transmitter, Type BT-1-A—Carrier Frequency Range, 88 to 108 Mc. More than Meets every F.C.C. Specification. The Section in the Circle is the New All-Electronic Modulator system that uses only 12 tubes! Ask your G-E broadcast sales engineer for complete data.

ANTENNAS • ELECTRONIC TUBES • HOME RECEIVERS

See G.E. for all three!

FM • TELEVISION • AM

fibre can be cooked at one time. In Fig. 3, part of a spherical boiler can be seen above, while Fig. 4 shows a small laboratory boiler from which cooked fibre is being dumped into a washer.

The function of the cooking is to remove non-cellulose materials from the fibre mass. The chemical used is either lime or caustic soda. The latter is preferable since, in the washing that follows the cooking operation, the excess caustic soda is much more easily removed than the less soluble lime. In the cooking stage, steam is introduced into the boiler containing a mixture of rags and chemicals, to which water has been added in a quantity sufficient to immerse all the rags. The boiler is stationary during the first portion of the cooking, and an outlet is left open at the top of the boiler so that the incoming steam will drive out the air left in the boiler. This is a necessary precaution to minimize the possibilities of boiler explosions. When all the air has been removed, the outlet is closed and the boiler is rotated slowly. The purpose of this rotation is to insure a proper mixture of chemicals and fibre, with a resultant uniform cooking of the mass. The cook takes from 10 to 12 hours. Then the mass of cooked fibre is dumped from the boiler and transferred to a washer, shown in the foreground of Fig. 3.

The washer consists of either a concrete or wooden tub containing a roll with protruding bars underneath which is set a bed-plate with bars at a slight angle to the bars on the roll. The roll is usually lowered

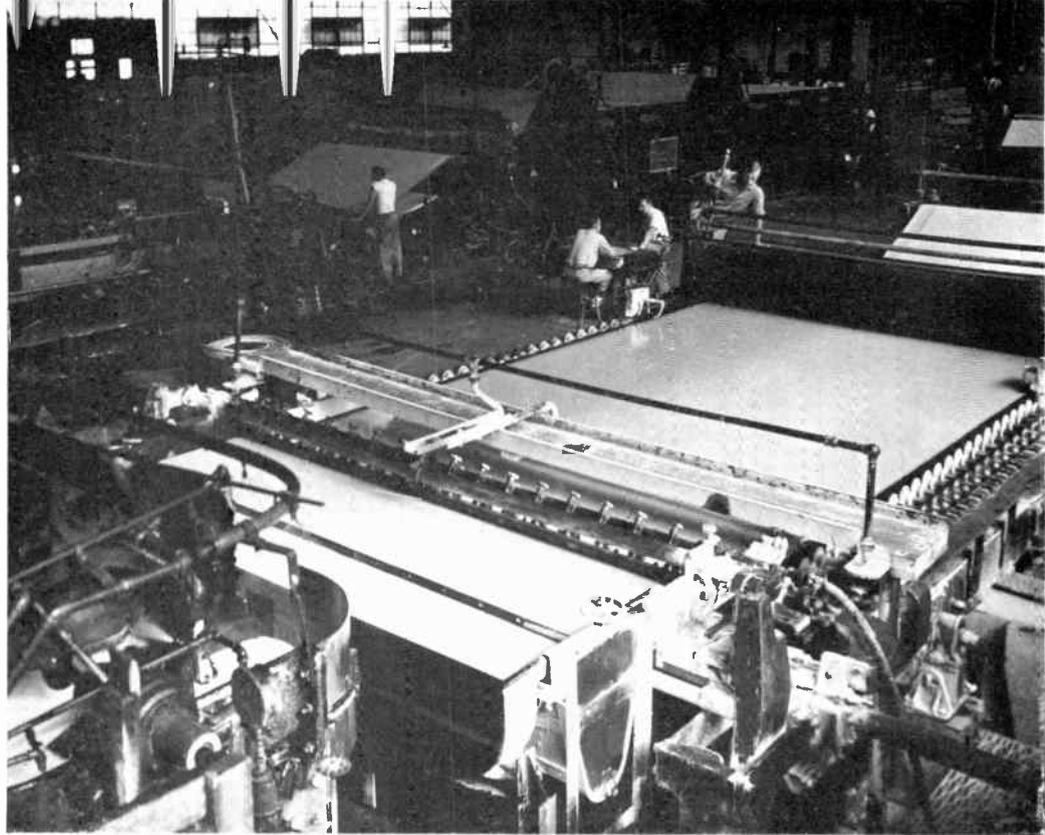


FIG. 11. FIBRE AND WATER ARE FED AT THE FOREGROUND ONTO AN ENDLESS BELT OF WIRE MESH SUPPORTED BY ROLLERS. WATER DRAINS THROUGH THE WIRE

to close proximity with the bed-plate, and provides a tearing action in the rags that tends to shorten the length of fibre as well as facilitate the release of impurities held in the structure of the rags. A cylindrical washer drum, at the left in Fig. 3, is mounted in the tub so that it will rotate when immersed in the mixture of fibre and water, and extract the water with cooked impurities at the same rate fresh water is added.

The fibre is now ready for bleaching, if necessary. Otherwise the stock, as the fibre in this state is called, is dropped into drainers where it is held until required in the beating stage. The bleaching operation is either performed in the washer or, as is sometimes done, the fibre is transferred to bleachers. The construction of a bleacher is similar to that of a washer with the exception that a roll and plate are unnecessary, and the mass is circulated in the tub by means of a paddle wheel. The bleaching can be accomplished in

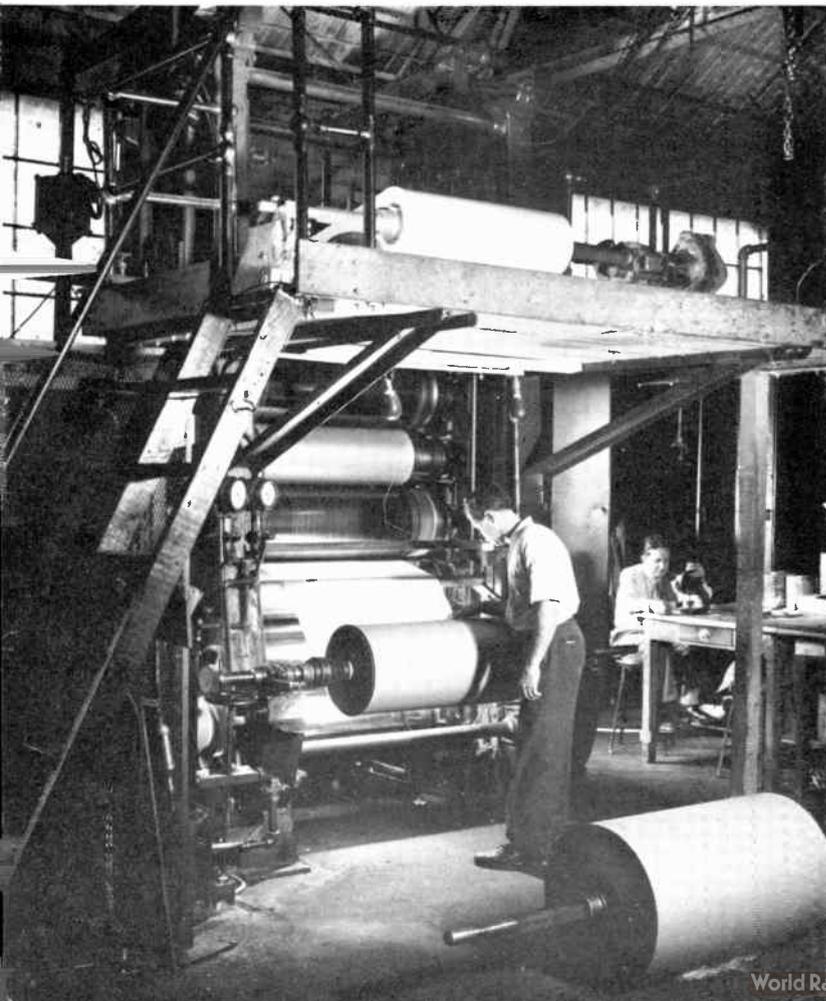
several ways, but in all methods chlorine is the basic chemical used. Chlorine can be introduced as a gas, or mixed with either lime or caustic to form a hypochlorite. Once the desired whiteness in the stock has been attained, the bleaching action is terminated, and fresh water is added until the excess bleach has been removed.

This final washing operation must be carried out thoroughly to remove any remnants of residual bleach which might remain in the stock and later contaminate the finished paper with an undesirable chloride content. Fig. 5 shows the equipment used by the bleach control chemist to test samples of the stock during the bleaching operation.

The stock is then ready for the process by means of which the fibre length is considerably shortened in a beater engine, Fig. 6. This beater engine is similar in almost every respect to the washer previously described. The difference however may be best explained by saying that the beater engine must perform a precision job. The roll settings with respect to the bed-plate are very accurately controlled and, in most up-to-date paper mills, this beating action is recorded visually, as in Fig. 7, so that batch after batch of stock can be beaten in an identical manner.

At this point it is important to state that although the description of the steps taken in stock preparation apply to linen or rag fibres, in the United States within the past few years condenser paper has been almost entirely manufactured from an unbleached kraft wood-pulp. The pulp is processed by the pulp producers to a point that enables the paper manufacturer to furnish it directly to the beater engine without any preliminary treatment.

FIG. 13. THICKNESS OF PAPER IS REDUCED AND MADE UNIFORM BY RUNNING IT BETWEEN ROLLS IN THIS CALENDER



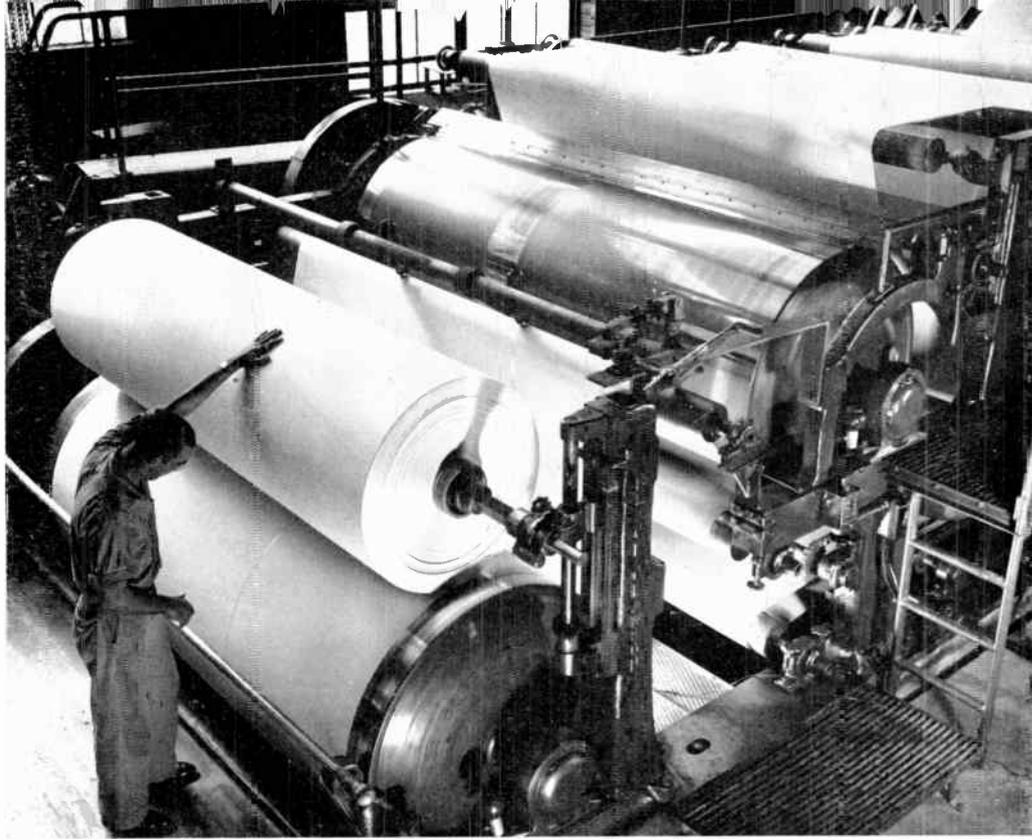


FIG. 12. WHEN THE PAPER LEAVES THE DRYING SECTION, IT IS WOUND ON A CORE, UPPER LEFT, AND IS SLIT TO FORM SEVERAL INDIVIDUAL JUMBO ROLLS

It is important, however, for the condenser paper manufacturer to select the pulp he is to use with great care, as not all kraft pulps are suitable for the manufacture of very thin papers.

The pulp must be strong and the fibre such that it will hydrate properly during the beating action. This hydration just mentioned is a change in the fibre structure that takes place as the stock is progressively ground between the beater-roll and the bed-plate. When microscopically examined, the fibre appears to be shredded into countless strips that will mesh together on the paper-making machine, aided by the prayers of the paper maker, to form an acceptable sheet of paper.

At the completion of the beating cycle, the stock is dumped into a chest and water added until the fibre is only about 2% of the total mixture. From this dump chest the mixture is pumped to a Jordan engine which is essentially a concentrated beater, in that the fibre receives a further shortening. More water is added, and the mixture is finally ready for the paper-forming machine.

Paper-Making Machine ★ Since freedom from conducting particles is so essential to insulating papers, the mixture of fibre and water is passed through centrifuges, and these very effectively remove the particles that have a greater specific gravity than the fibre.

The paper machine itself is divided into three sections: the wet end, presses, and the driers. The wet end, which is the vital portion of the paper-making machine, can be seen in Fig. 11.

An endless belt of close-meshed bronze screen, called the "wire," receives the mixture of fibre and water from the tank at the left in Fig. 11. As this very watery mass travels along the wire, water is extracted through the pores of the wire wherever the wire contacts the supporting rolls over which it travels. Since this method of water extraction would require a wire of unreasonable length, once the mixture has had the opportunity to acquire proper formation, aided by a shaking action imparted to the wire, suction boxes operated by vacuum pumps and placed on the underside of the wire extract a large portion of the water, leaving a perfectly-formed although still very wet web of fibre.

The thickness of the finished paper is controlled by the rate at which the stock is fed onto the wire, and by the rate of speed at which the wire travels.

The wet sheet, by now actually a sheet of paper, is then transferred to a woolen felt that

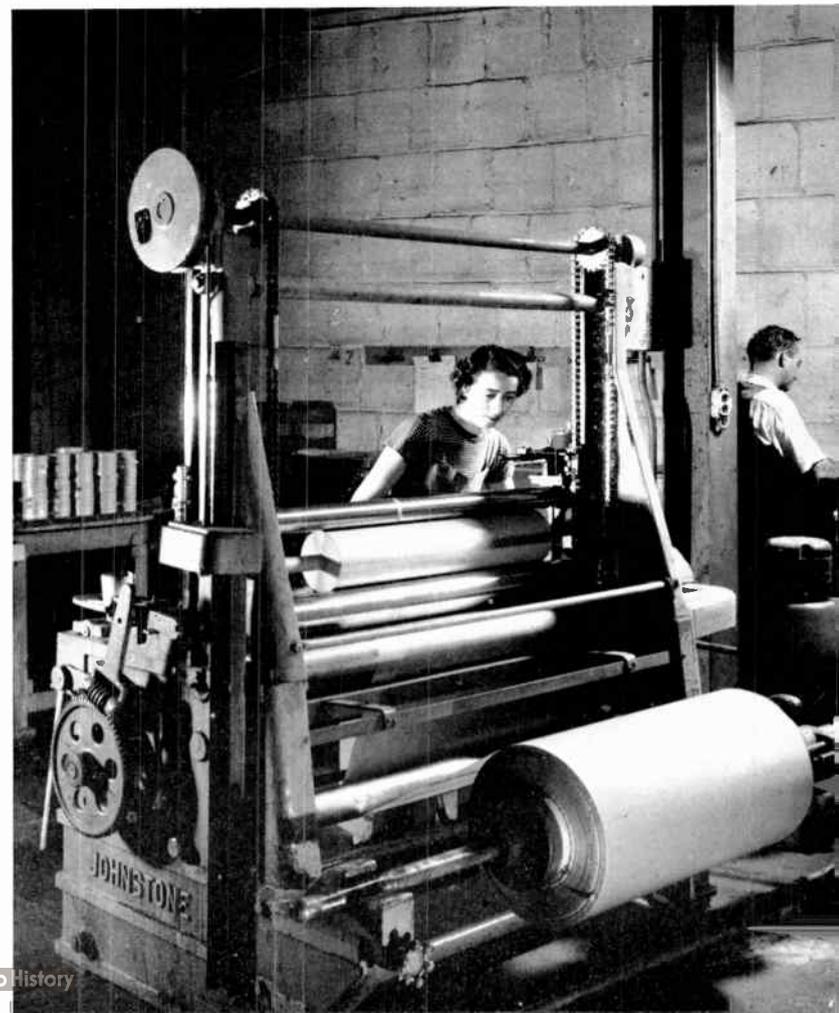
carries the wet web through presses where an additional amount of water is extracted by pressure. The sheet of paper is approximately 40% dry when it enters the drying section, Fig. 12, composed of hollow steam-heated cylinders. As the moisture is removed progressively, the sheet of paper travels around the driers, until, at the end of the drier section, it is a completely dried sheet of paper. When the paper reaches the end of the drier section, shown in Fig. 12, it is slit into jumbo rolls. The entire paper machine is so geared, from wire to drier rolls, that the paper moves at constant speed.

Condenser paper, with the exception of that used in electrolytic condensers, is subjected to calendering in a machine such as is shown in Fig. 13, by means of which its thickness is substantially reduced. Then it is only necessary for the paper to be slit into the widths specified by the customers, Fig. 14, and to undergo a thorough inspection before it is shipped from the paper mill, on its way to a final resting place in some miracle-performing electrical device.

The various stages of paper making described above apply not only to the manufacture of insulating papers but actually to most grades of thin paper. It is interesting to note, however, the changes in conception as condenser paper emerged from simply being just another grade of thin paper to becoming more specifically a layer of insulation.

Evolution of Condenser Paper ★ Since there are, as we all know, many insulating materials,

FIG. 14. ON THIS SLITTING MACHINE, EACH JUMBO ROLL IS SLIT INTO NARROW ROLLS ACCORDING TO REQUIREMENTS



it is worth while to examine the properties of paper that make it suitable and generally preferable as an insulating substance for most types of condensers.

Since cost is an important factor, we find that paper is advantageous because of its low density and correspondingly enormous coverage per pound of material. Some of the thinnest papers yield over 100,000 square inches to the pound.

Today, the density of condenser paper is made subject to rigid laboratory control. Fig. 15 shows the equipment used for checking density. This factor is the ratio of dry weight in grams to the volume in milliliters, determined by weighing a sheet of predetermined dimensions in a precision balance. Specifications for condenser paper usually call for a density of .95 to 1.05.

Another very important consideration is that paper must be readily subject to impregnation. This insures maximum insulating properties and increased capacity contributed by the impregnating material, thereby providing condensers of long life-expectancy. To check this characteristic, we have set up in our Chrysler Building laboratories a miniature condenser plant.

Fig. 16 shows a small impregnating tank, reproducing standard production conditions, where sample condensers, rolled in the machine at the right in Fig. 17, can be treated with various impregnating compounds.

Laboratory tests affirm the success of efforts to improve the insulating proper-

FIG. 15. DENSITY OF THE PAPER IS DETERMINED BY WEIGHING A SAMPLE SHEET OF PREDETERMINED DIMENSIONS

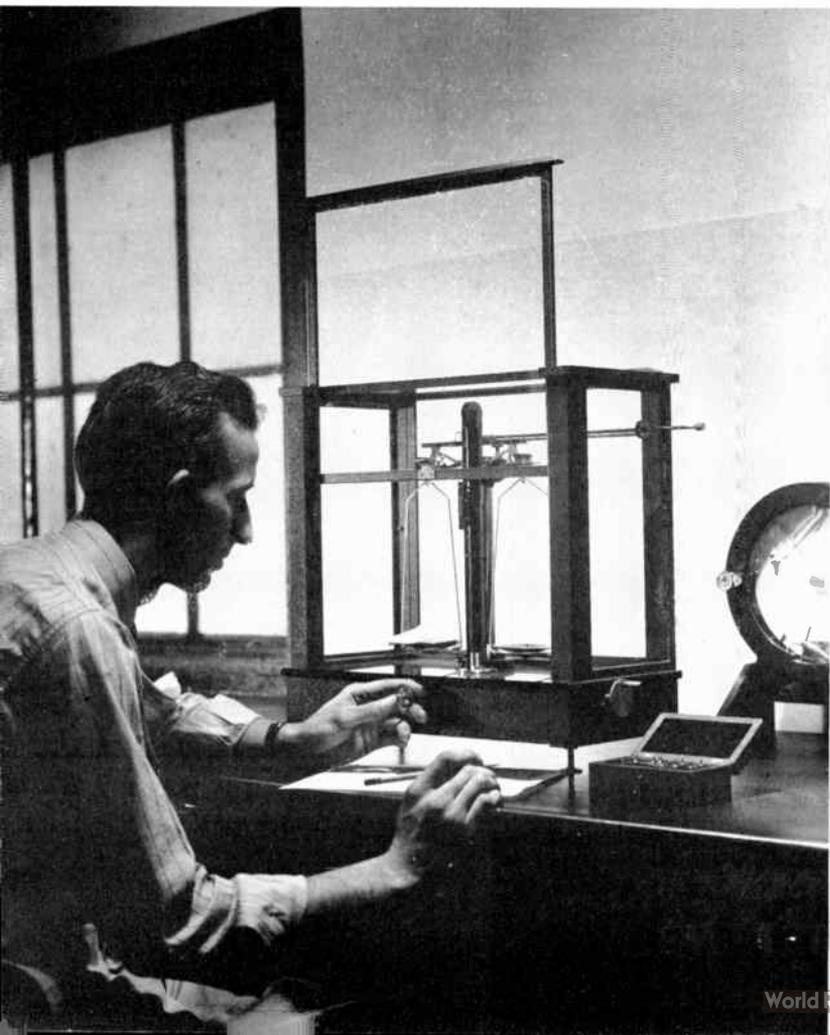


FIG. 16. A SMALL-SCALE IMPREGNATING TANK IS USED TO MANUFACTURE SAMPLE CONDENSERS SO THAT THE CHARACTERISTICS OF THE PAPER CAN BE TESTED

ties of paper. For example, thin paper is now produced with almost complete absence of air porosity. This is another of the factors checked by laboratory controls, using the method illustrated in Fig. 18.

Porosity is rated by measuring the volume of air that passes through a single thickness of paper in 15 seconds, when one surface is exposed to atmospheric pressure. In this test, the paper is sealed over an orifice below which there is a tube containing water. As air enters above the water through the paper, the water drops in the tube. Thus, the amount of air passing through the paper is measured during a 15-second interval. The best grades of paper approach zero porosity.

Condenser papers have also been improved by the virtual elimination of foreign materials, and are now of very high chemical purity. This has resulted in substantial reduction of cost to condenser manufacturers, and in the mechanical dimen-

sions of condensers, since improved, thinner papers withstand higher voltages, and increase the capacity per square inch of foil.

Naturally, as the requirements of the condenser manufacturers became more stringent, additional burden was placed on the condenser paper manufacturers in order to keep step with progress. No longer can visual inspection alone insure an acceptable product. Uniformity to a degree previously considered unfeasible is taken for granted today. The entire procedure has changed, and instead of remaining the product of the paper-making artisan, the sheet of insulation has become the creature of inanimate scientific control. The variations due to human error have largely been eliminated by watchful test equipment. One of the axioms of paper making has always been that, "Paper is made in the beaters." This is still very much the case, but where once the final result was dependent on the skill of the individual beater-man, now automatically controlled beating, the result of patience and countless trials, has made possible the day-in and day-out production of paper whose uniformity is much appreciated by the condenser manufacturer.

Applications ★ The importance of condenser papers as an insulator is more or less of recent origin. Compared to the utilization of thin paper for other purposes, it is a lusty youngster, and from the comparatively few thousand pounds a year required at first by the telephone industry, the advent of radio peaked the requirements into millions of pounds annually. The slump of 1929 that so deeply cut into the volume of American industrial output also produced a competitor to condenser



FIG. 17. LEFT TO RIGHT, EQUIPMENT FOR MEASURING POWER FACTOR, ACCELERATED LIFE TEST, AND A CONDENSER WINDING MACHINE FOR MAKING TEST UNITS

paper. That villain, in the person of electrolytic condensers, played havoc in the favorite hunting ground of paper condensers, the power-pack filters in radio sets. Once the most important field for paper condensers, the electrolytic filter condensers were designed to use the more economical cheese cloth. But as every sad story should have a happy ending, here too paper came into its own again, and present-day electrolytics are now made with a special prepared, extremely pure condenser paper whose absorbency has been developed to a point that has eliminated the cheese cloth and provided a further economy of great importance.

It is now obvious that when we speak of condenser paper we must differentiate sharply between the conventional material and that used in electrolytic condensers.

The procedure for the manufacture of both kinds is very similar, with one marked difference. We spoke of the importance of the beating action in the manufacture of condenser paper, and of the precautions taken to prepare a fibre of a certain length and hydration. In the production of electrolytic papers, the consideration of absorbency is of prime importance, while the beating action or reduction in fibre length necessary for the formation of a proper sheet, imposes the necessity of minimum hydration. Fortunately for the paper maker, porosity in electrolytic papers is of small importance, and a well closed-up sheet is unnecessary. In the preparation of the stock, cutting, rather than shredding of the fibre, is the rule, thereby eliminating the hydration that would otherwise reduce the absorbency of the finished electrolytic paper.

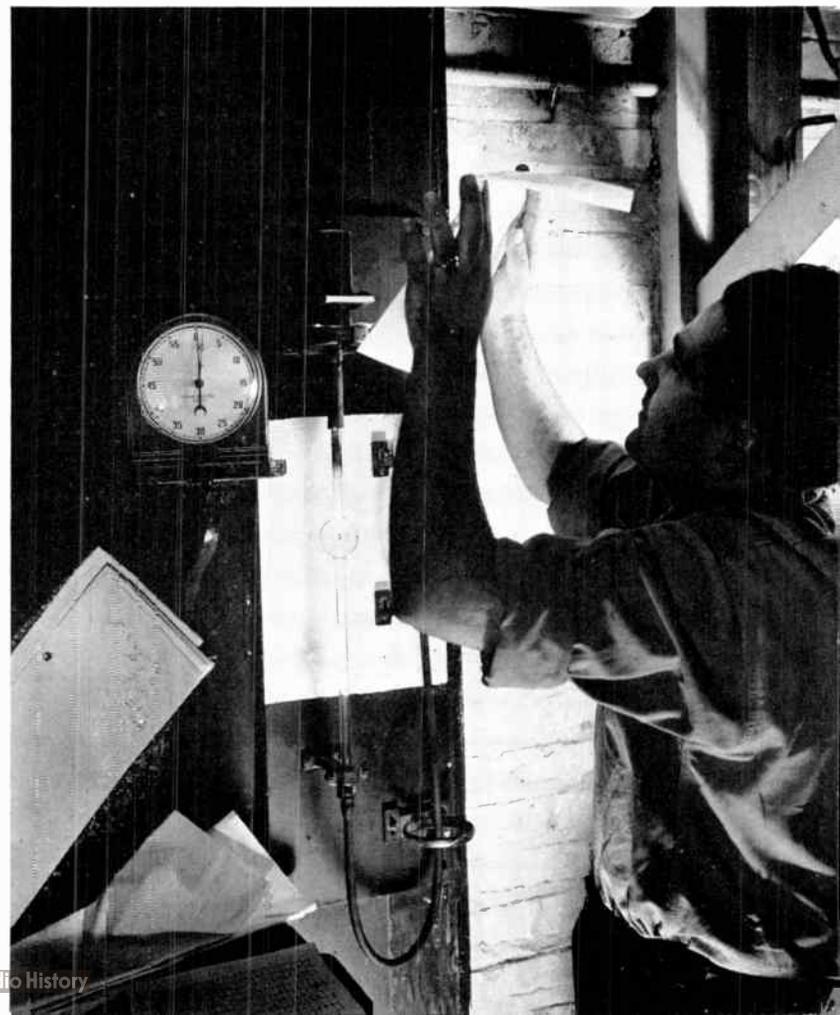
Up to this point we have neglected a very important field for paper condensers, namely, power factor correction. Power

factor correction provides a usage for paper condensers that is greatly removed from the domain of communications. Through the use of condensers in power lines carrying alternating current, a maximum efficiency in the current carrying capacity of a power line can be obtained whereby almost all of the current through the lines performs useful work instead of having part of its potential capacity reduced by the poor power factor of the electrical device connected to the line. Since power factor correction condensers operate on alternating current, the condenser paper requirements are at slight variance with those involved in the direct current applications, and greater consideration is given to those properties in the paper that have a direct bearing on the final power factor of the finished condenser than is necessary in connection with other types of capacitors. For this reason, our paper-making laboratory includes equipment for checking power factors, as shown in the extreme left of Fig. 17.

We have thus covered the three broad applications applying to condenser paper: filter condensers, electrolytics and power factor correction. Our everyday activities bring us at every turn in contact with some device that harbors within it a paper condenser, and new uses seem to spring up at an accelerated tempo.

Condenser papers for units other than electrolytics are produced in thicknesses ranging from .0002 in., and for electrolytic purposes anywhere from .001 to .004 in. Mention of the thickness of condenser paper brings to mind a recent requirement the importance of which cannot be over-emphasized. The VT fuse, considered the greatest technical achievement of the war aside from the atomic bomb, could not have been produced unless a condenser paper had been made available thinner than anything previously known. It meant the manufacture of a paper of such substance that it would require over 4,000 thicknesses to the inch. The challenge was accepted, and such a paper was produced. It was produced, in fact, without any sacrifice of the many restrictions imposed by the specifications covering present-day condenser paper. Now, as our Nation passes from exploits of war to the pursuit of peaceful enterprise, we expect that condenser paper will fit into still more spots in the jigsaw puzzle we call scientific development. Today, as never before, paper manufacturers are in a position to meet any new requirements.

FIG. 18. SETUP FOR TESTING POROSITY OF PAPER. AIR DRAWN THROUGH PAPER IS MEASURED BY FALL OF WATER IN TUBE



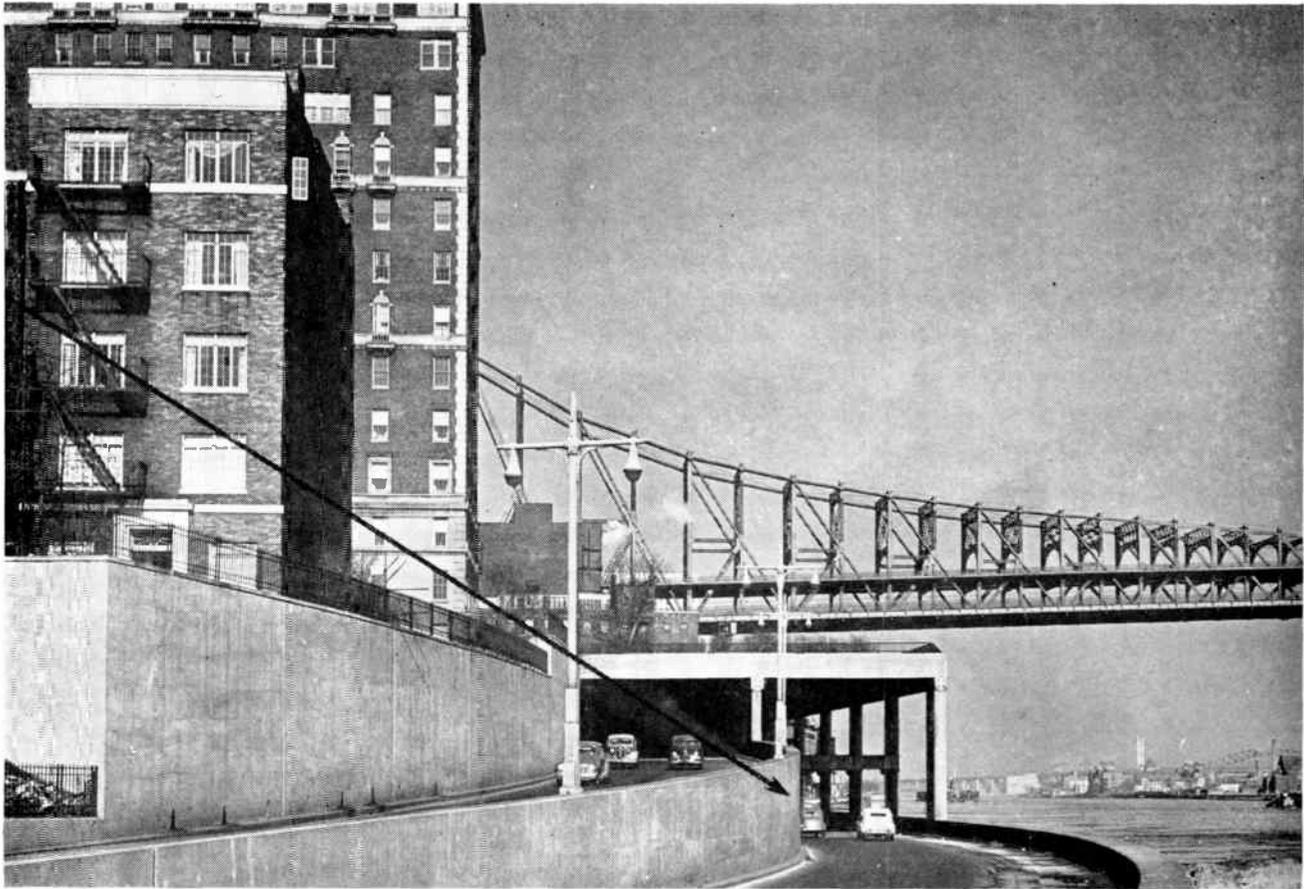


FIG. 1. EVEN UNDER THE EXTREME CONDITIONS ILLUSTRATED HERE, AT THE ENTRANCE OF THE EAST DRIVE UNDERPASS, WITH SIGNALS COMING FROM THE DIRECTION INDICATED BY THE ARROW, THERE WAS NO TROUBLE

SELECTIVE CALLING IN NEW YORK ON 157 MC.

Dial Selection on 157 Mc. Proves Successful Despite Noise and Shielding Effects

BY MILTON B. SLEEPER

THE allocation of frequencies for police and other mobile services in the band from 152 to 162 mc. was originally greeted with little enthusiasm and much unfavorable conjecture. It was predicted that such high frequencies could be used only for police radio systems in small communities located in open country, and that even this limited use would be restricted by the high cost of the equipment.

All of which indicates that those who are too quick with their answers invite correction from those who do the work first and talk afterward for, during the I.R.E. Winter Conference, January 23rd to 26th, Link Radio gave an astonishingly successful demonstration of 2-way FM communication on 157 mc. in New York City, with the added feature of selective dial calling. And, it should be noted, the cost of the headquarters and mobile transmitters and receivers is about the same as similar equipment for 30 to 40 mc.

Purpose of the Demonstration ★ The purpose of the demonstration was twofold. First, the performance of the test setup showed that the 15-watt car installations, as illustrated here, could talk car-to-car upward of 2 miles despite the shielding effects of New York City's steel and concrete structures, or 15 to 18 miles in open country, while the one-way range of the 250-watt FM headquarters transmitter was at least 40 miles.

Second, the demonstration showed the simplicity and positive action of selective dial calling by which the squelch of the desired receiver could be opened, and a light or other signal actuated, without response from any other receiver in the system.

Following is a description of the test installation and its operation.

Headquarters Installation ★ For the purpose of this demonstration, a 250-watt transmitter, operating on 156.975 mc., was

installed at Madison Avenue and 53rd Street, where the DuMont television studios and station are located. A colinear coaxial antenna, with a gain of 2.7, was mounted on the television tower, 725 ft. above the street level. The transmitter, on the 42nd floor, was controlled remotely from television studio B, on the 2nd floor.

Fig. 6 shows the headquarters control console and the telephone instrument used for dialing. The latter is a standard type, except that the handset has a push-to-talk button. When the dial is operated, tone impulses are sent out on 570 cycles.

In addition, the headquarters receiver was equipped with a selector unit, so that the cars could call each other, the headquarters station, or another station set up at the Link factory on West 17th Street.

Mobile Installations ★ Figs. 2 to 5 show details of one of the mobile installations. The 157-mc. FM transmitter and receiver.



FIG. 2. ACTING CHIEF INSPECTOR WILLIAM ALLEN, NASSAU COUNTY POLICE DEPARTMENT, TOURED NEW YORK'S WORST DEADSPOTS. EVERY TIME HE DIALED "HEADQUARTERS" THE OPERATOR SNAPPED BACK IN ANSWER TO HIS CALL

Fig. 4, are of conventional appearance, and are designed for operation either with or without the dial system.

The selective calling circuits, in turn, are designed as an adjunct to any type of communications equipment for any frequency.

Fig. 2 illustrates the standard telephone dial and handset assembly used for the mobile installations. It should be noted, in this connection, that the handset is not removed from the hook until the number has been dialed.

Below the dash is the oscillator unit, containing two tubes and a voltage regulator. It also carries a red light which goes on when the car is called, and is only switched off when the handset is lifted.

The selector unit, Fig. 5, is mounted with the radio equipment, as shown in Fig. 4. It contains the checking relays and a stepping relay with a 10-point selector switch. Standby current drain for the selector is 1 ampere at 6.3 volts, and 10 milliamperes at 180 to 250 volts. While selecting, there are current peaks of 3 amperes at 6.3 volts and 15 milliamperes at 180 to 250 volts. The selector unit used with the headquarters receiver is of similar design.

Method of Dial Selecting ★ Call numbers of 4 digits adding up to 10 are assigned to each receiver. There are 84 such call numbers possible, as 1-1-6-2, or 2-3-1-4. All the different combinations are listed on the

FIG. 3. THIS 18-IN. WIRE IS USED AS AN ANTENNA FOR 2-WAY COMMUNICATION



long side of the chart in Fig. 7. If there are more than 84 receivers in a system, additional audio calling frequencies can be employed, since the filter in each selector unit accepts only the operating impulses of its particular frequency. When a number is dialed, every receiver and corresponding selector unit responds, of course. If the number 4-2-1-3 is wanted, every stepping relay will first advance to the fourth contact. The position of the selector switch is immediately checked by a checking relay. At each receiver whose number begins with 4, the selector will remain at the 4th position. At all others, the selector switches will drop back to the normal position.

As number 2 is dialed, every selector switch will be advanced 2 points, its position will be checked again, and the switch held or released. Finally, when 1 and 3 have been dialed, only the switch in car 4-2-1-3 will have been advanced to its 10th position, at which point the receiver squelch is opened and a relay operated to turn on the red light or other indicating signal, such as a bell or horn.

In addition to calling individual receivers, groups can be reached simultaneously by the use of numbers with 1, 2, or 3 digits. The group combinations are indicated by the black squares in Fig. 7. If 0 is dialed, 10 impulses will be transmitted, and every receiver will respond. The number 1-9 will turn on all receivers from 1-1-1-7 to 1-7-1-1, while 1-2-7

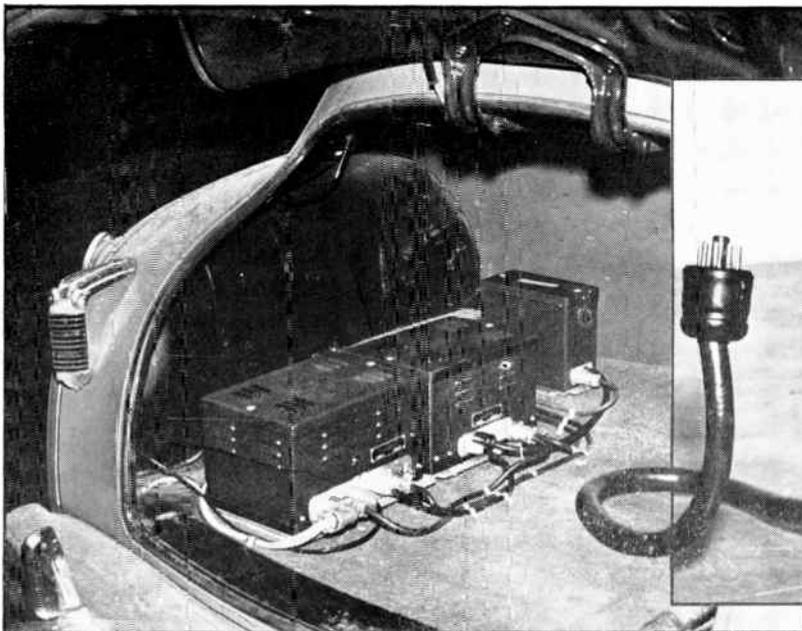


FIG. 4. THE 157-MC. TRANSMITTER AND RECEIVER. THE SMALL CASE AT THE FRONT CONTAINS THE RELAYS ACTUATED BY DIAL IMPULSES

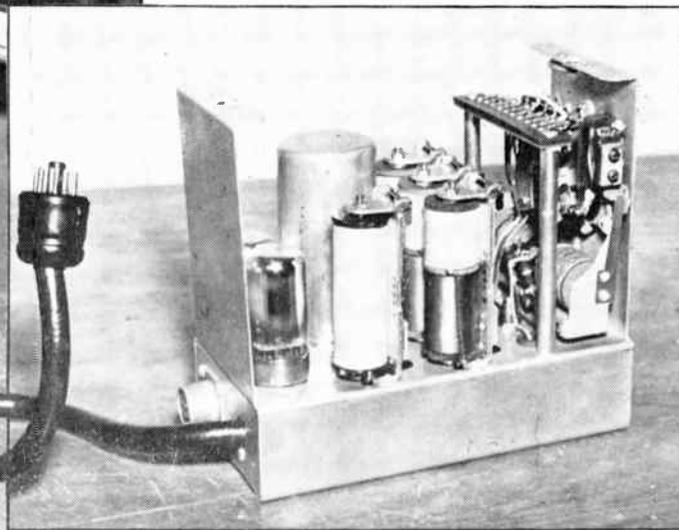


FIG. 5. CONSTRUCTION OF THE SELECTOR UNIT WHICH, IN RESPONSE TO THE PROPER SIGNALS, TURNS ON SPEAKER AND RED LIGHT

will actuate receivers 1-1-1-7 and 1-2-1-6 to 1-2-6-1.

It can happen that operators in two cars, or at headquarters and in one car, might dial simultaneously. In such a case, the stronger signals would prevail. This is likely to happen on only rare occasions, however. When a call is dialed from headquarters, the relays are actuated in all the cars, and clicks are caused in the speakers, even though the squelches remain closed except in the car called. Those clicks, therefore, serve as a warning that someone is putting in a call.

If a car calls another car or headquarters "while the line is busy," no interference is caused, since the relays are locked while the handset is off the hook. Furthermore, if a car is called while the operator is absent, the red signal light stays on, even though the receiver picks up other dial impulses in

the meantime. Altogether, the dialing system, simple as it is, operates in a fool-proof manner, and cannot be tricked into making mistakes, either by accident or intent.

Performance of the System ★ The experience of riding in one of the demonstration cars and operating the 157-mc. dial system was amazing for two reasons: 1) signals from headquarters were clear and clean and of constant volume level, and 2) the dial calling operation was as quick and certain as that of the familiar telephone.

One of the worst receiving conditions is illustrated in Fig. 1. This is at the East Side Drive underpass. With signals coming from the direction indicated by the arrow, there was no change in the speaker output level when the test car entered the up-town lane, or came out of the down-town lane. Yet the car antenna

was shielded not only by the steel construction of the underpass but by tall, adjacent buildings.

This does not mean that the field strength was constant everywhere, but that there was sufficient signal coming in to the receiver to operate the limiter. Therefore, the speaker output was constant even though the field strength varied.

Furthermore, it was possible not only to call and communicate with headquarters from the underpass, but with another car a mile away, on the other side of Manhattan.

Speech was of somewhat better quality than the ordinary telephone, both from the loudspeaker and the receiver in the handset. The only interference noise observed was in certain blocks where moderate background noise occurred. Link engineers identified this as diathermy interference.

This had no effect on the dial operation. In the course of a 2-hour drive through sections that are considered dead spots by New York City police radio engineers, there was not a single instance of failure in dial calls transmitted or received.

Applications ★ There are numerous applications for this new system among police departments, fire departments, public utilities, taxicabs, buses, remote pick-ups for broadcasters, and private telephone service in rural sections and from individual automobiles to central offices when this service is established.

Other services authorized to operate in this new frequency range, and for which the new dial-calling equipment is suited, include relay press services, forestry conservation groups, maritime mobile stations, urban mobile installations, rural subscriber telephone service, relay broadcast systems, and railroad communications particularly for freight and passenger yards.



FIG. 6. THE HEADQUARTERS CONSOLE IS OF CONVENTIONAL APPEARANCE, BUT THE ADDITION OF A DIAL PHONE IDENTIFIES THE SELECTIVE CALLING

THESE NUMBERS REACH GROUPS OF CARS, AS INDICATED BY BLACK SQUARES
 READ DOWN FROM BLACK SQUARES TO FIND CALL NUMBERS OF CARS IN ANY GROUP

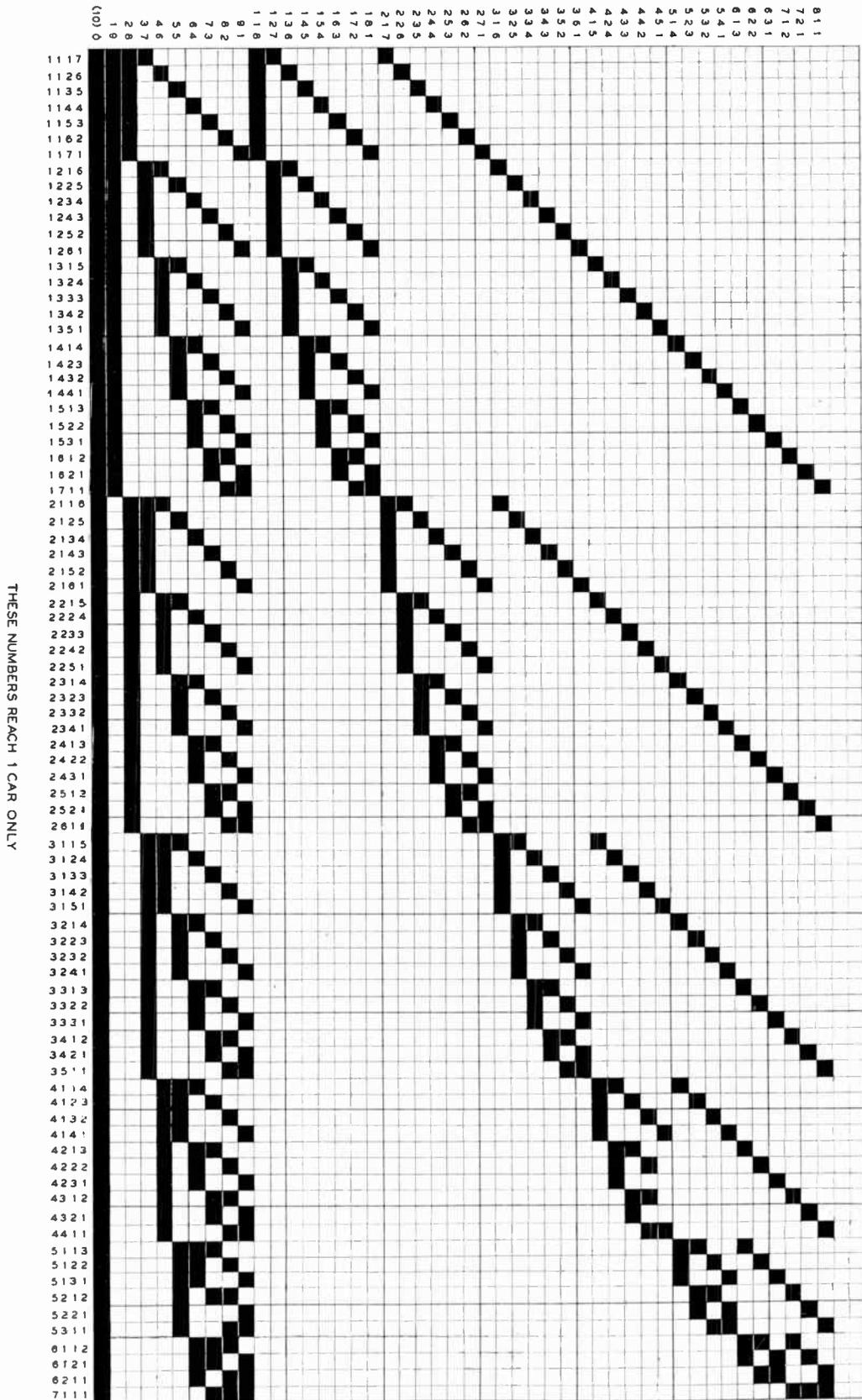


FIG. 7. THIS PATTERN SHOWS WHAT GROUPS OF NUMBERS CAN BE REACHED BY 1, 2, AND 3-DIGIT GROUP DIAL CALLING



L. TO R. OFFICER OF THE DAY AT THE SEATTLE RADIO STATION — A DIRECT-CONTROL 50-WATT STATION — PATROLS ON DUTY "SOMEWHERE IN CHINA" — A DIFFERENT TYPE OF PATROL CAR

THE NAVY'S WARTIME FM EMERGENCY SYSTEM

One of the Largest FM Systems in the World, Operated by the U. S. Navy

BY COMDR. H. J. WATERS *

IT MAY be surprising to learn that, during the war, the U. S. Navy owned and operated what was probably the largest two-way FM emergency radio communications system in the world. This network, known as Internal Security and Industrial Control Radio, was many times larger in both number of installations and the amount of money invested than all the police radio equipment in use in any one state.

The Internal Security and Industrial Control Radio performed several functions. The primary purpose was to assure the security of Government property and personnel. Secondary objectives were the protection of the public from the hazards of firing ranges and other dangerous areas, the prevention of unauthorized entrance into restricted zones, furnishing communication service during disasters, and dispatching orders to vehicles transporting war material.

The problem of preventing unauthorized persons from entering restricted zones was no small task, when it is realized that some areas covered more than 200 square miles. It was solved by having squads patrol the territories in

Jeeps or other vehicles equipped with two-way radio, in the same manner that police squad cars patrol the cities. Each central station issued orders to its group of guards to direct their movements in unexpected emergencies. The mobile stations could, of course, make reports to their headquarters, and communicate with each other.

A very important function of the Internal Security and Industrial Control Radio was the fire watch, maintained by the guards as part of their routine duties. When fires occurred, the exact location and extent was reported immediately. Often the crew of a guard car could partially extinguish a blaze before the regular

fire-fighting equipment arrived. And it is possible that many small fires might have got beyond control if the crews had been compelled to go to telephones or fire alarm boxes to summon assistance.

Much of the fire apparatus and many of the fire marshals' cars were equipped with two-way FM, under a program of extending this practice as fast as radio equipment could be allocated to this use.

The value of our system was well demonstrated on one occasion during an explosion in which wire communications were totally destroyed. This and similar emergencies proved repeatedly the great usefulness of two-way FM service.

If a poll were taken, it is possible that a railroad would be voted a most unlikely enterprise for the Navy to operate but, believe it or not, the Navy owns many miles of track and operates many locomotives. These are in large areas adjacent to Naval Supply Depots and similar activities. During the war, they were equipped with two-way radio, the purpose being to properly dispatch switch engines. It is estimated that three locomotives directed by radio accomplished as much as four could have done without radio equipment, and with greater ease and expedition. The

FM INSTALLATIONS WERE MOUNTED ON JEEPS IN THIS MANNER



*Navy Department, Bureau of Ships, Washington, D. C.



cost of a locomotive, the wages of its crew, and the amount of its upkeep are so great compared with a radio installation and its maintenance that the Navy regarded such mobile stations as a necessity for efficient train operation.

The majority of Internal Security and Industrial Control Radio installations used standard Galvin and Link police type equipment, which proved very satisfactory. Frequency modulation, in the band of 30 to 40 Mc., was used almost exclusively.

The transmitters employed were of three powers: the 250-watt fixed station, the 50-watt fixed station, and the 25-watt mobile station. Since the 250-watt final stage was excited by the regular 50-watt unit, repairs were speeded and inventories simplified. The Galvin 250-watt fixed station used two 100TH tubes in the final; the Link one 250TH tube. The last stage in the 50-watt transmitters consists of two 807 tubes operated in parallel, while the mobile transmitters were almost identical except for the power supply and the omission of one 807, thus reducing the output to 25 watts. The Navy standardized on fixed station antennas of the vertical half-wave coaxial type.

Remote control units, with meters to indicate both radiation and modulation, were used in conjunction with many of the fixed stations. In some cases, one transmitter was connected for operation from several remote points. This feature often made the installation of extra transmitters unnecessary.

Gasoline-driven alternators of 1.5 kw. were used to supply automatic emergency power for the fixed stations, and were so constructed that any interruption of the normal line current resulted in completely independent operation in less than thirty seconds.

The range of our 50-watt fixed stations, with 50-ft. antenna elevation, to vehicles using the rear mounted whip, was about

20 miles in flat country. Car-to-car communication under the same conditions was about half that figure. In hilly country, the crews soon learn to take advantage of every rise. No installations on mountain tops were made, due to the cost of running power lines. However, Jeeps and other vehicles sometimes climbed to considerable elevations and the improvement in communication was easily evident. One 50-watt fixed station, using an antenna 75 ft. high, communicated regularly with a ship equipped with a 25-watt mobile unit up to 60 miles, and often still farther.

One feature of this policy of standardization was an arbitrary decision to use Link radio equipment in the eastern part of the United States and Galvin radio equipment in the western. Territories beyond the continental limits were similarly organized.

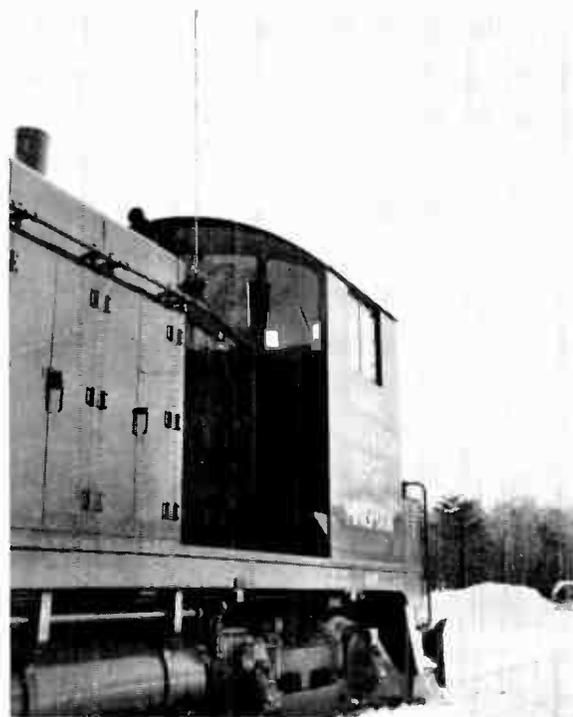
The types of equipment used were held rigidly to a minimum consistent with the performance requirements, and the design of all material was frozen for the duration. The various standard equipments were as follows:

- 250-watt fixed station
- 50-watt fixed station
- 25-watt mobile station
- 1.5 kw emergency power unit
- Remote control units
- Adjustable and calibrated fixed station antenna

This policy permitted minimum inventories of both new material and spare parts, and led to better maintenance. The crews became especially skilled in trouble shooting, as the mobile and fixed stations were very similar electrically, except for the power supply.

This equipment was installed and maintained under the direction of Comdr. Henry E. Bernstein, USN, Head of the Installation and Maintenance Branch of the Bureau of Ships' Electronics Division.

RADIO-EQUIPPED LOCOMOTIVE AND OPERATING HEAD-QUARTERS AT HINGHAM, MASSACHUSETTS



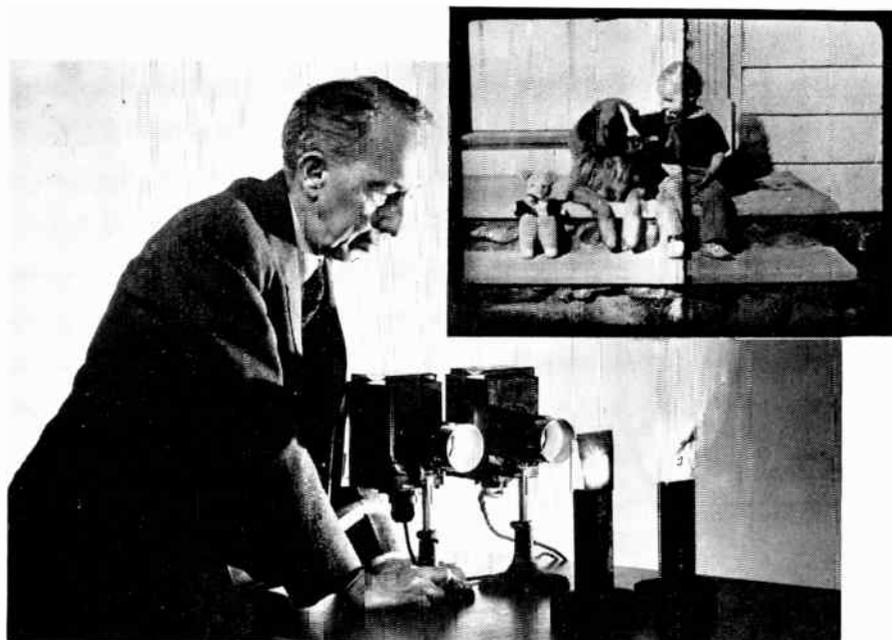


FIG. 1. NEW GLASS TRANSMITS MORE LIGHT BUT ABSORBS THE HEAT

RADIO DESIGNERS' ITEMS

Notes on Methods and Products of Importance to Design Engineers

More Light, Less Heat: A new kind of glass which may prove important in television studio lighting has been developed by the American Optical Company, Southbridge, Mass. According to research director E. D. Tillyer, the new glass absorbs 90% of the infra-red (heat) radiation, and transmits approximately 85% of light out of a possible 92%. (8% is lost in reflections.)

Fig. 1 shows that a piece of paper is prevented from burning by a shield of heat-absorbing glass, left, while paper behind a piece of ordinary glass is ignited. Insert picture shows the difference in light transmission when a picture was projected through the new glass, left half, and ordinary glass, right half.

Point-of-Light Source: A crater-type glow tube, for use in facsimile and sound-on-film recording, has been brought out by Sylvania Electric Products, Inc., Boston, Mass. Operated by the single-ended output stage of a push-pull amplifier, it provides a useful light range between 3,500 to 6,500 angstroms, responding to frequencies of 15 to 15,000 cycles. Rated at 135 volts DC, the current varies from 5 to 35 milliamperes.

UHF Tube Sockets: The NLA acorn tube sockets developed for military use by National Company, Inc., Malden, Mass., are now available for civilian equipment. The sockets accommodate the 6F4 tubes as well as the 950 series. Also released are the silver-plated shields for pentode acorns, and ceramic condensers, designed for mounting inside the socket, of 7, 25, 50, or 100 mmf. capacity.

Electrical Instruments: A 28-page postwar catalog of standard and hermetically-sealed instruments has been issued by Marion Electrical Instrument Company, Manchester, N. H. Copies are available on request.

VHF Transmitting Tube: The Eimac 3X2500A3, a medium mu. forced-air cooled, external anode transmitting triode, has been announced by Eitel-McCullough, Inc., of San Bruno, Calif. Illustrated in Fig. 2 it incorporates features which make it suitable for frequencies well into the VHF range. The grid terminates in a ring interposed between the plate and filament, to permit maximum convenience in the use of a tube as a grounded-grid amplifier at high frequencies, with coaxial plate and filament tank circuits. The tube is provided with a rugged, low-inductance cylindrical filament-stem structure, which allows a smooth transition between a linear filament tank circuit and the tube. As a result of these unique grid and filament terminal arrangements, it is possible to install or remove the tube without the aid of tools.

A single tube will deliver a radio-frequency output of 5 kw. at 3,500 plate volts at low frequencies, and 3.5 kw. at 3,000 plate volts at 110 mc. The tube is of extremely compact design, with a diameter of less than 4½ ins.

Rotary Converter: A rotary converter with a built-in frequency meter is now available from Carter Motor Company, 1608 Milwaukee Avenue, Chicago. This converter, producing 117 volts at 60 cycles AC from

110 to 120 volts DC, can be regulated as to the AC frequency by a rheostat in series with the motor field coils. The vibrating-reed J-B-T frequency meter, built into the base of the unit, is calibrated for 58 to 62 cycles.

Recording Turntable: Many refinements have been built into a new recording turntable model 14-A by Presto Recording Corporation, 242 W. 55th Street, New York 19. Gear-driven at both 78.26 and 33.33 rpm by a synchronous motor, speed regulation during each revolution is obtained by the combination of a heavy cast iron turntable, flexibly coupled discs, precision gear train, and a powerful motor. Mechanical filtering is used to suppress vibration. The cutting head mounting is designed for the use of either a vertical or lateral unit. Any one of five pitches can be selected by a gear-shift lever, with either outside-in or inside-out cutting.

Quiet Fader Contact: A self-cleaning contact of interesting design is now being used on faders manufactured by Cinema Engineering Company, 1510 W. Verdugo Avenue, Burbank, Calif. Inside the circular wire-wound resistance element is a metal ring. The adjustable contact is a wedge-shaped roller, carried on the end of an arm attached to the shaft. As the arm is swung around, the roller rides between the resistance element and the metal ring. This eliminates any friction contact through the shaft bearing, and provides a smooth-



VHF TRANSMITTING TUBE

action contact so quiet, it is claimed, that the brush noise is below the noise level of studio amplifiers.

Ceramic Condensers: An illustrated bulletin, available from Electrical Reactance Corporation, Franklinville, N.Y., describes in detail the characteristics of a complete line of type CI silver electrode ceramic condensers with axial leads.



**TINY EIMAC 3X100A11/2C39
TRIODE FOR OPERATION
UP TO 2500 MEGACYCLES**

Designed for special military purposes—this tiny external anode triode will find valuable commercial application. In the FM and television bands as a relay or isolated amplifier or in conventional amplifiers its high operation efficiency will be appreciated. Observe the precision engineered mechanical functions in the cross section view. Note actual size shown in photo above.

The Eimac 3X100A11/2C39 is a fitting example of Eimac engineering to achieve outstanding performance. It is precision engineering on a mass production scale that has made Eimac first choice of leading Electronics Engineers throughout the world.

1153-L

FOLLOW THE LEADERS TO



EITEL-McCULLOUGH, INC., 1153L San Mateo Ave., San Bruno, Calif.

Plants located at: San Bruno, Calif., and Salt Lake City, Utah

Export Agents: Frozar and Hansen, 301 Clay St., San Francisco 11, Calif., U.S.A.

1. Parts are Radio Frequency brazed in final assembly.
2. Cathode heater.
3. Terminal arrangement for use in cavities. Tube elements thus become part of the circuit.
4. Precision-engineered cathode.
5. New Eimac hard glass to metal seals join tube elements in a rugged bond—with low RF resistance.
6. Shield.
7. Transit time reduced by microscopically close spacing. From grid to cathode: .005 inches. From grid to plate: .022 inches.
8. Plate dissipation (100 watts) is extremely high in comparison to the small effective plate area.
9. Metal tip-off at the top of anode.
10. Thermal insulation.

**TYPE 3X100A11/2C39 EIMAC TRIODE
GENERAL CHARACTERISTICS**

ELECTRICAL	
Cathode: Coated unipotential	
Heater Voltage	6.3 volts
Heater Current	1.1 amps
Amplification Factor (Average)	100
Direct Interelectrode Capacitances (Average)	
Grid-Plate	1.95 <i>uufd</i>
Grid-Cathode	6.50 <i>uufd</i>
Plate-Cathode	0.030 <i>uufd</i>
Transconductance (ig 75 ma., Eb 600 v.) (Av.)	20,000 <i>umhos</i>
Maximum Plate Dissipation	100 watts
MECHANICAL	
Maximum Overall Dimensions	
Length	2.75 inches
Diameter	1.26 inches

CALL IN AN EIMAC ENGINEER FOR RECOMMENDATIONS

ROYAL J. HIGGINS (W9AIO)... 600 South Michigan Avenue, Room 818, Chicago 5, Illinois. Phone: Harrison 5948. Illinois, Wisconsin, Michigan, Indiana, Ohio, Kentucky, Minnesota, Missouri, Kansas, Nebraska and Iowa.

VERNER O. JENSEN, General Sales Co., 2616 Second Avenue, Seattle 1, Washington. Phone: Elliott 6871. Washington, Oregon, Idaho and Montana.

M. B. PATTERSON (W5CI)... 1124 Irwin-Kessler Bldg., Dallas 1, Texas. Phone: Central 5764. Texas, Oklahoma, Arkansas and Louisiana.

ADOLPH SCHWARTZ (W2CN)... 220 Broadway, Room 2210, New York 7, N. Y. Phone: Cortland 7-0011. New York, Pennsylvania, New Jersey, Maryland, Delaware and District of Columbia.

HERB B. BECKER (W6QD)... 1406 South Grand Avenue, Los Angeles 15, California. Phone: Richmond 6191. California, Nevada and Arizona.

TIM COAKLEY (W1KKP)... 11 Beacon St., Boston 8, Mass. Phone: Capitol 0050. Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island.

CAUTION! Look for the latest serial numbers on Eimac Tubes. Be sure you get the newest types.

Part 2: EMERGENCY COMMUNICATIONS STATIONS

State & Zone Police, Fire, Forestry, and Special Emergency Transmitters Licensed Jan. 1, 1946

STATE POLICE

ALABAMA

DEPT. OF PUBLIC SAFETY, Montgomery			
Fixed Stations			
WKVG	Anniston	Mtr	37500 FM
WLBA	Birmingham	Mtr	37500 FM
WHTX	Box Springs	Mtr	37500 FM
WKSD	Decatur	Mtr	37500 FM
WKSJ	Dodds	Mtr	37500 FM
WKXR	Dodds	Mtr	37500 FM
WXE	Evergreen	Mtr	37500 FM
WKSG	Gadsden	Mtr	37500 FM
WKSP	Huntsville	Mtr	37500 FM
WKSQ	Mobile	Mtr	37500 FM
WQXG	Opelika	Mtr	37500 FM
WKSJ	Selma	Mtr	37500 FM
WRBU	Snowdoun	Mtr	37500 FM
WQXP	Tuscumbia	Mtr	37500 FM

ARIZONA

HIGHWAY DEPARTMENT, Phoenix			
Fixed Stations			
6XKF	Crown King	Comp	116550 AM
KNGG	Phoenix	Termc	1698 AM

ARKANSAS

STATE POLICE, Little Rock			
Fixed Stations			
KFDL	Clarksville	RCA	1722 AM
KQSR	El Dorado	RCA	1722 AM
KFDK	Forrest City	RCA	1722 AM
KLZX	Hope	RCA	1722 AM
KASP	Little Rock	RCA	1722 AM
KBSL	Newport	Comp	1722 AM
KFDO	Warren	RCA	1722 AM

CALIFORNIA

HIGHWAY PATROL, Sacramento			
Fixed Stations			
KALC	Bakersfield	Thdn	1682 AM
6XJC	Bloomer Mtn.	Mtr	118150 FM
6XII	Blue Canyon	Mtr	118550 FM
KSCC	Chino	Mtr	39900 FM
KAWF	Culver City	Mtr	1682 AM
KADJ	Davis	Comp	1682 AM
6XID	Grapevine Smt.	Mtr	118550 FM
KAFI	Grass Valley	Comp	1682 AM
6XHL	Lyons Peak	Mtr	118550 FM
6XAR	Modjeska Peak	Mtr	118550 FM
6XIJ	Mt Diablo	Mtr	118550 FM
6XFY	Mt Hamilton	Mtr	118550 FM
KQUL	Newhall	Comp	1682 AM
KPFE	Oak Glen	Mtr	1682 AM
KRBU	Oakland	Mtr	1682 AM
KSCO	Oroville	Comp	1682 AM
KQUG	Pomona	Comp	1682 AM
KSPR	Reidling	Comp	1682 AM
KSRF	Repressa	Mtr	39900 FM
KRPH	Ridge Rte. Sta.	Thdn	1682 AM
KAAAS	Sacramento	Comp	1682 AM
6XIK	Sacred Oak Pk.	Mtr	118550 FM
KALF	Salinas	Comp	1682 AM
KQID	San Luis Obispo	Comp	1682 AM
6XIM	San Marcos Pass	(Co) Mtr	118550 FM
KSQP	San Quentin	Mtr	39900 FM
6XII	S. Mountain	Mtr	118550 FM
KSPK	Stockton	Comp	1682 AM
6XIH	Strawberry Pk	Mtr	118550 FM
KIUF	Ventura	Comp	1682 AM
6XIJ	Wexler	Mtr	118550 FM
KASG	Willows	Comp	1682 AM
KSCY	Yreka	Comp	1682 AM

COLORADO

HIGHWAY COURTESY PATROL, Denver			
No fixed stations			

CONNECTICUT

DEPT. OF STATE POLICE, Hartford			
Fixed Stations			
WJTI	Avon	Link	39500 FM
WJTB	Becky	Link	39500 FM
WJTA	Brookfield	Link	39500 FM
WJTD	Brooklyn	Link	39500 FM
WJTK	Colechester	Link	39500 FM
WJTE	Killingworth	Link	39500 FM
WJTF	Ledyard	Link	39500 FM
WJTG	Litchfield	Link	39500 FM
WJTH	Norfolk	Link	39500 FM
WJTI	Stafford	Link	39500 FM
WJTG	Wilton	Link	39500 FM

DELAWARE

STATE HIGHWAY DEPT, Wilmington			
Fixed Stations			
WAYF	Bellefonte	Link	39500 FM
WAYZ	Bridgeville	Link	39500 FM
WJRF	Dover	Link	39500 FM
WAYY	Georgetown	Link	39500 FM
WDSP	State Road	Link	39500 FM

FLORIDA

HIGHWAY PATROL, Bartow			
Fixed Stations			
WLIU	Chipley	Mtr	31100 FM
WJXJ	DeLand	Mtr	31100 FM
WSPD	Py Myers	Mtr	31100 FM
WKSO	Highland City	Mtr	31100 FM
WKDR	Lake City	Mtr	31100 FM
WSYP	Miami	Mtr	31100 FM
WJXI	Ocala	Mtr	31100 FM
WKVM	Okeechobee City	Mtr	31100 FM
WRSE	Palm Beach	Mtr	31100 FM
WJXJ	Penny Farms	RCA	31100 FM
WSWR	Pensacola	Mtr	31100 FM
WKTF	Tallahassee	Mtr	31100 FM
WKGZ	Tampa	Mtr	31100 FM

SPECIAL INFORMATION

1. So great has been the increase in emergency radio stations licensed during the past six months that state, zone, and interzone police, fire, forestry, and special emergency station listings are published in Part 2 of this Directory, with municipal police in our February issue.

2. Space limitations also made it necessary to omit the names of radio supervisors.

3. Listings are for fixed, portable, and portable-mobile transmitters, but portable and portable-mobile stations are not identified separately for, except in rare cases, they use the same call as the associated fixed station.

GEORGIA

DEPT. OF PUBLIC SAFETY, Atlanta			
Fixed Stations			
WSLK	Albany	WE	1666 AM
WGPS	Atlanta	WE	1666 AM
WGRN	Gainesville	Comp	1666 AM
WSLN	Griffin	Comp	1666 AM
WSIJ	Reidsville	WE	1666 AM
WSIO	Washington	Comp	1666 AM

No fixed stations

IDAHO

ILLINOIS

DIVISION OF HIGHWAYS, Springfield			
Fixed Stations			
WQPB	Blue Island	Mtr	39500 FM
WQPC	Chicago	WE	1610 AM
WQPD	DuQuoin	WE	1610 AM
WQPE	Ethgiam	WE	1610 AM
WQPF	Elgin	Mtr	39500 FM
WQPJ	French Village	Comp	1610 AM
WQPO	Joliet	Mtr	39500 FM
WQPM	Macomb	WE	1610 AM
WQPL	Peoria	Comp	1610 AM
WQPN	Panther	WE	1610 AM
WQPP	Rock Island	Mtr	39500 FM
WQPS	Springfield	WE	1610 AM
WQPG	Sterling	WE	1610 AM
WQPH	Urbana	Mtr	39500 FM

INDIANA

DEPT. OF PUBLIC SAFETY, Indianapolis			
Fixed Stations			
WBMO	Charleston	Comp	1634 AM
WPIS	Chesterton	Comp	1634 AM
WQFW	Columbia City	WE	1634 AM
9XGX	Connersville	Comp	116550 FM
WPHE	Indianapolis	Comp	1634 AM
WPHU	Jasper	Comp	1634 AM
WQFW	Ligonier	SP	1634 AM
WRNR	Pendleton	Comp	1634 AM
WQGB	Putnamville	Comp	1634 AM
9XGC	Rochester	Comp	116550 FM
WQFE	Seymour	Comp	1634 AM
WROR	W. Lafayette	Comp	1634 AM

IOWA

DEPT. OF PUBLIC SAFETY, Des Moines			
Fixed Stations			
KACD	Atlantic	Coll	1682 AM
KNFN	Cedar Falls	WE	1682 AM
KGHO	Des Moines	Coll	1682 AM
KACC	Fairfield	Coll	1682 AM
KNFO	Storm Lake	WE	1682 AM

KANSAS

HIGHWAY COMMISSION, Topeka			
Fixed Stations			
KAQB	Chanute	Mtr	39900 FM
9XIE	Council Grove	Mtr	118550 FM
9XIE	Frankfort	Mtr	118550 FM
9XID	Horton	Mtr	118550 FM
KBMO	Norton	Comp	1698 AM
9XIC	Olathe	Mtr	118550 FM
KAZZ	Topeka	Comp	1698 AM

KENTUCKY

HIGHWAY PATROL, Frankfort			
Fixed Station			
WQWY	Frankfort	Mtr	39900 FM

LOUISIANA

STATE POLICE, Lake Charles			
Fixed Stations			
KRAD	Alexandria	RCA	1682 AM
WLSF	Baton Rouge	RCA	1682 AM
KSPB	E. Lake Charles	RCA	1682 AM
KSPF	Franklin	RCA	1682 AM
KHQS	Lafayette	Comp	1682 AM
KSPJ	Leesville	RCA	1682 AM
KSPC	Monroe	RCA	1682 AM
WNHI	New Orleans	Mtr	39500 FM
KSPS	Shreveport	RCA	1682 AM

MAINE

STATE POLICE, Augusta			
Fixed Stations			
WBNV	Augusta	HW	39900 AM
		HW	1642 AM
WKQP	Bangor	Comp	1642 AM
WSYX	Boothbay Harbor	HW	1642 AM
WLDQ	Houlton	Comp	1642 AM
WSTR	Thomaston	HW	1642 AM
		HW	39900 AM
WSWD	Wells	HW	1642 AM
WBVW	W. Scarborough	HW	1642 AM
WSYD		HW	1642 AM

MARYLAND

STATE POLICE, Baltimore			
Fixed Stations			
WBYN	Belair	Comp	1698 AM
		Comp	39100 FM
WMSH	Conowingo	Link	1698 AM
		Link	39100 FM
WMSC	Cumberland	Comp	1698 AM
WMEX	Dan's Rock	Link	39100 FM
WMSE	Easton	Comp	1698 AM
		Link	39100 FM
WMSF	Frederick	Comp	1698 AM
		Link	39100 FM
WMQL	Hagerstown	Link	39100 FM
WMNR	Randallstown	Comp	1698 AM
		Link	39100 FM
WWSG	Salisbury	Comp	1698 AM
		Link	39100 FM
WMSW	Waldorf	Comp	1698 AM
		Link	39100 FM
WHSW	Waterloo	Comp	1698 AM
		Link	39100 FM

MASSACHUSETTS

DIVISION OF STATE POLICE, Boston			
Fixed Stations			
WKFI	Adams	Link	35900 FM
WKFA	Andover	Link	35900 FM
WBKU	Bridgewater	Htr	1666 AM
WPEL	Dorchester	Del	1666 AM
WBVP	Brookline	Comp	1666 AM
WPEW	Hadley	Link	35900 FM
WKGC	Fall River	Link	35900 FM
WBQN	Frammingham	Comp	1666 AM
WMP	Milton	Link	35900 FM
WSPN	Nantucket	Link	1666 AM
WPYM	Northampton	Comp	35900 FM
WSPQ	Oak Bluffs	Link	35900 FM
WPEL	Plymouth	Link	35900 FM
WSQL	Princeton	Link	35900 FM

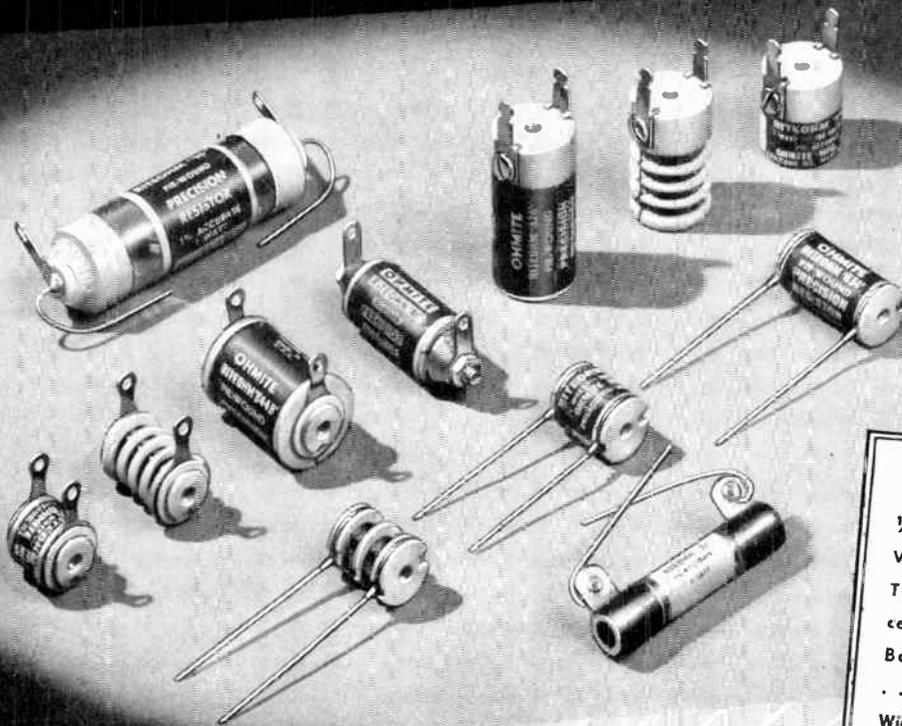
MICHIGAN

STATE POLICE, Lansing			
Fixed Stations			
WHQI	Alpena	Mtr	37500 FM
WHRI	Atlanta	Mtr	37500 FM
WHQT	Brighton	Mtr	37500 FM
WDAI	Baldwin	Mtr	37500 FM
WIWG	Battle Creek	Mtr	37500 FM
WITR	Bay City	Mtr	37500 FM
WJBS	Blissfield	Mtr	37500 FM
WDAQ	Boyer City	Mtr	37500 FM
WAOB	Brighton	Mtr	37500 FM
WBQN	Cadillac	Mtr	37500 FM
WBTO	Center Line	Mtr	37500 FM
WKJU	Cheboygan	Mtr	37500 FM
WJBR	Clinton	Mtr	37500 FM
WSPK	Crystal Falls	Mtr	37500 FM
WAPU	Detroit	Mtr	37500 FM
8XAV		Mtr	117750 FM
WRDS	E. Lansing	RCA WE	1642 AM
WBQL	E. Tawas	Mtr	37500 FM
WJBP	Erle	Mtr	37500 FM
WBRC	Escanaba City	Mtr	37500 FM
WDSG	Iwen	Mtr	37500 FM
WAPW	Platrock	Mtr	37500 FM
WITQ	Flint	Mtr	37500 FM
WBUN	Fort Brady	Mtr	37500 FM
WKJR	Gaylord	Mtr	37500 FM
WBQI	Gladstone	Mtr	37500 FM
WBWA	Gladwin	Mtr	37500 FM
WRLS	Grand Haven	Mtr	37500 FM
8XBI	Houghton Lake	Mtr	116550 FM
WRDH	Houghton Lake	RCA	1642 AM
WRDH		Mtr	37500 FM
WBST	Iron Mountain	Mtr	37500 FM
8XBG	Jackson	Mtr	118550 FM
WBXF	Jonesville	Mtr	37500 FM
WITN	Jackson	Mtr	37500 FM
		Mtr	33100 FM
WITP	Keego Harbor	Mtr	37500 FM
WBQR	Lansing	Mtr	37500 FM
WBQT	Manistiquie	Mtr	37500 FM
WBKZ	Mio	Mtr	37500 FM
WKJM	Mt Pleasant	Mtr	37500 FM
WBYK	Muskegon	Mtr	37500 FM
WBQP	Newberry	Mtr	37500 FM
WBQI	New Buffalo	Mtr	37500 FM
WSVP	Niles	Mtr	37500 FM
8XAU	Okemos	Mtr	116550 FM
WRDS		Mtr	37500 FM
		Mtr	33100 FM
WBRE	Palmer	Mtr	37500 FM
WRDP	Paw Paw	RCA	1642 AM
		Mtr	33100 FM
WRIE	Reed City	Mtr	37500 FM
WMSF	Rockford	Mtr	37500 FM
		Mtr	33100 FM
WJBL	Romeo	Mtr	37500 FM
WBTS	Romulus	Mtr	37500 FM
WIVA	Roscommon	Mtr	37500 FM
WJBI	St Clair	Mtr	37500 FM
WQST	St Ignace	Mtr	37500 FM
WJAT	Sandusky	Mtr	37500 FM
WMIC	St. Ste. Marie	Mtr	37500 FM
WJHT	South Haven	Mtr	37500 FM
WKJK	Traverse City	Mtr	37500 FM
WBQV	Wakefield	Mtr	37500 FM

OHMITE

RITEOHM PRECISION RESISTORS

Non-Inductive... Pie-Wound... 1% Accurate



NEW

1/2 Watt and 1 Watt
Vacuum Impregnated
Types... Hole in
center for Through-
Bolt Mounting
... Equipped with
Wire Leads or Lugs

Available from Stock... or Made to Order

OHMITE presents a *new* line... a *full* line... of finer precision resistors! Every type... every size... ready for every need! Each Riteohm is designed and built with all the specialized skill and experience that have made OHMITE units the standard in this field. However critical the application... consistent accuracy and reliability are assured. In these Riteohms, you get *time-proved protection against humidity, temperature and corrosion.*

Ideal for use in voltmeter multipliers, laboratory equipment, radio and electrical test sets, attenuation pads, and in electronic devices requiring *extremely accurate* resistance components.

AVAILABLE FROM STOCK in 1/2 watt and 1 watt units in a wide range of values, in various types of mountings and terminals... or made to order. Complete line of 6 different series includes non-inductive pie-wound vacuum impregnated units... single-layer wound vitreous enameled units... and non-inductive pie-wound hermetically glass sealed units. Some units are in a range of 0.1 ohm to 2,000,000 ohms. *Get full facts today!*

OHMITE MANUFACTURING CO., 4853 Flournoy St., Chicago 44, U. S. A.

Send for Bulletin No. 126

This handy Riteohm Bulletin makes it easy for you to select the exact units for your needs. Gives complete data... lists stock units and made-to-order units... includes dimensional drawings. Write for it now.



Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES • CHOKES • ATTENUATORS

STATE POLICE, continued

WBQQ	West Branch	Mtr	37500 FM
WJAW	White Pigeon	Mtr	37500 FM
WAQG	Ypsilanti	Mtr	37500 FM

MINNESOTA

STATE POLICE, St. Paul			
Fixed Stations			
KNHD	Redwood Falls	WE	1658 AM
WAMV	St Paul	Comp	1658 AM

MISSISSIPPI

DEPT OF PUBLIC SAFETY, Jackson			
Fixed Stations			
WJFW	Brookhaven	Comp	1690 AM
WJKZ	Grenada	Comp	1690 AM
WMHP	Hattiesburg	Mtr	1690 AM
WRJL	Jackson	RCA	1690 AM

MISSOURI

HIGHWAY PATROL, Jefferson City			
Fixed Stations			
9XGL	Carthage	Mtr	118150 FM
9XGD	Ft Leonard Wood	Mtr	118150 FM
9XHU	Hannibal	Mtr	118150 FM
KHPF	Jefferson City	Mtr	39900 FM
		Coll	1674 AM
KHPC	Kirkwood	Coll	1674 AM
KHPA	Lee's Summit	Coll	1674 AM
KHPB	Macon	Coll	1674 AM
9XGF	Osborn	Mtr	118150 FM
KHPG	Poplar Bluff	Coll	1674 AM
9XGE	Rolla	Mtr	118150 FM
9XGG	Shannon Co	Mtr	118150 FM
KHPD	Springfield	Coll	1674 AM

MONTANA

HIGHWAY PATROL, Helena			
No Fixed Stations			

NEVADA

STATE POLICE, Reno			
Fixed Stations			
KODH	Carson City	Mtr	1634 AM
KRNP	Reno	Comp	1634 AM

NEW HAMPSHIRE

STATE POLICE, Concord			
Fixed Stations			
WMOE	Bow	Mtr	33500 FM
WRPT	Concord	WE	1682 AM
IXUD	Warner	Mtr	118550 FM

NEW JERSEY

STATE POLICE, Trenton			
Fixed Stations			
3XTI	Absecon	Link	27925 FM
3XTK	Berlin	Link	27925 FM
WATM	Camden	RCA	35900 AM
3XTG	Cape May	Link	27925 FM
3XTS	Cherryville	Link	27925 FM
3XTJ	Edwood	Link	27925 FM
3XTO	Flanders	Link	27925 FM
2XZS	Freehold	Link	27925 FM
3XTH	Haleyville	Link	27925 FM
3XTE	Hightstown	Link	27925 FM
2XZU	Keyport	Link	27925 FM
3XTL	Malaga	Link	27925 FM
3XWS	Mantua	Link	27925 FM
3XTQ	Morristown	Link	27925 FM
3XTN	New Brunswick	Link	27925 FM
3XTF	Newton	Link	27925 FM
WBVM	Del. River Bdg	RCA	35900 AM
2XZQ	Ramsey	Link	27925 FM
3XTW	Riverton	Link	27925 FM
2XZR	Scotch Plains	Link	27925 FM
3XTM	Sharpstown	Link	27925 FM
3XTR	Somerville	Link	27925 FM
2XZT	Toms River	Link	27925 FM
2XZP	Tuckerton	Link	27925 FM
3XTP	Washington	Link	27925 FM
3STV	W. Trenton	Link	27925 FM
3XTU	Wrightstown	Link	27925 FM
	Boate	Link	27925 FM
WRPZ	Anne E	RCA	1610 AM
WRNS	Director	JT	1610 AM
WRPF	Elizabeth C	RCA	1610 AM
WRSL	Navigator	JT	1610 AM
WRSM	Polaris	JT	1610 AM

NEW YORK

STATE POLICE, Albany			
Fixed Stations			
WKVA	Altamont	Link	1658 AM
WJKW	Babylon	Link	37500 FM
WBTC	Batavia	Link	1658 AM
WZP	Bayshore	Link	37500 FM
WIZO	Bethpage St Pk	Link	37500 FM
WLSA	Commack	Link	37500 FM
WKVC	Fliskill	Link	1658 AM
WIZL	Jones Beach	Link	37500 FM
KIZG	Kings Park	Link	37500 FM
WIZC	Lake Success	Link	37500 FM
WPJK	Oneta	Link	1658 AM
WJGA	Riverhead	Link	37500 FM
WJKR	Montauk	Link	37500 FM
WAKP	Sidney	Link	1658 AM
WPGC	S. Schenectady	GE	1658 AM
WTOH	Troy	Link	39100 FM
WIZA	Valley Stream	Link	37500 FM

NORTH CAROLINA

HIGHWAY PATROL, Raleigh			
Fixed Stations			
4XAF	Clingman's Pk	Link	116950 FM
WANL	Elizabethtown	GE	1658 AM
4XAR	Park	Link	116950 FM
WANH	Raleigh	GE	1658 AM
WANK	Sallsbury	GE	1658 AM
4XAU	Seppernong	Link	116950 FM
WANJ	Swannanoa	GE	1658 AM
4XAS	Troy	Link	116950 FM
4XAAQ	Ward's Corner	Link	116950 FM
4XAE	Wllmar	Link	116950 FM
4XAT	Winston-Salem	Link	116950 FM
WANI	Williamston	GE	1658 AM

NORTH DAKOTA

STATE PATROL, Bismarek			
Fixed Station			
KAZB	Bismarek	Dool	1674 AM

OHIO

STATE HIGHWAY PATROL, Columbus			
Fixed Stations			
WOZY	Athens	Mtr	39100 FM
WOHD	Belleue	Mtr	39100 FM
WLSZ	Bridgeport	Mtr	39100 FM
WPHH	Cambridge	WE	1730 AM
		Mtr	39100 FM
WWCL	Chillicothe	Mtr	39100 FM
WPGQ	Columbus	WE	1730 AM
		Mtr	39100 FM
WODH	Dayton	WE	1730 AM
WPGJ	Findlay	WE	1730 AM
		Mtr	39100 FM
WLSW	Geneva	Mtr	39100 FM
WWCJ	Kent	Mtr	39100 FM
WWCN	Lima	Mtr	39100 FM
WOLG	Lorain	Mtr	39100 FM
WLSV	Marion	Mtr	39100 FM
WOGN	Marion	Mtr	39100 FM
WPHC	Massillon	WE	1730 AM
		Mtr	39100 FM
WWCI	Medina	Mtr	39100 FM
WOUB	Middletown	Mtr	39100 FM
WWCK	New Phila.	Mtr	39100 FM
WODX	Perrysburg	Mtr	39100 FM
WHNT	Portsmouth	Mtr	39100 FM
WOJX	Salem	Mtr	39100 FM
WWCM	Steubenville	Mtr	39100 FM
WBGQ	Warren	Link	1730 AM
WPHK	Wilmington	WE	1730 AM
		Mtr	39100 FM

OKLAHOMA

DEPT OF PUBLIC SAFETY, Oklahoma City			
Fixed Stations			
KOSC	Ardmore	Comp	1626 AM
KOSU	Claremore	RCA	1626 AM
KOSX	Clinton	RCA	1626 AM
KOSY	Lawton	RCA	1626 AM
KOSW	McAlester	RCA	1626 AM
KOSO	Oklahoma City	Comp	1626 AM
KOSP	Perry	RCA	1626 AM

OREGON

POLICE AND HIGHWAY DEPT., Salem			
Fixed Stations			
KOHA	Astoria	Coll	1706 AM
KOHB	Baker	Coll	1706 AM
KOHN	Bend	Coll	1706 AM
KOHU	Burns	Coll	1706 AM
KOHC	Coquille	Coll	1706 AM
KOHD	The Dalles	Coll	1706 AM
KOHE	Eugene	Coll	1706 AM
KOHL	Gov. Camp	Comp	1706 AM
KOHG	Grants Pass	Coll	1706 AM
KOHO	John Day	Coll	1706 AM
KOHL	Klamath Falls	Coll	1706 AM
KOHL	LaGrande	Coll	1706 AM
KOHJ	Medford	GE	1706 AM
KOHL	Orelet Lake	Comp	1706 AM
KOHP	Pendleton	Coll	1706 AM
KOHL	Portland	Coll	1706 AM
KOHR	Roseburg	Coll	1706 AM
KOHS	Salem	Coll	1706 AM
KOHJ	Santiam Jet.	Comp	1706 AM

PENNSYLVANIA

STATE POLICE, Harrisburg			
Fixed Stations			
8XNF	Allegheny Mt.	GE	33940 FM
8XN1	Clinton	RCA	117350 AM
8XNL	Bedford	RCA	118150 AM
WBJL	Hockley	RCA	37500 AM
3XNR	Blue Mt.	GE	33940 FM
3XRD	Blue Mt.	RCA	116150 AM
WBJY	Blue Mt.	RCA	37500 AM
WBJZ	Breezewood	RCA	37500 AM
WBJW	Carlisle	RCA	37500 AM
WBJO	Donegal	RCA	37500 AM
WBJS	Everett Mt Shed	RCA	37500 AM
WBJC	Ft. Ligon	RCA	37500 AM
WPSP	Harrisburg	RCA	37500 AM
		RCA	1674 AM
		RCA	33940 FM
WBJM	Irwin	RCA	37500 AM
WBJR	Kegg Mt Shed	RCA	37500 AM
8XND	Laurel Hill	GE	33940 FM
8XNH	Laurel Hill	RCA	116150 AM
WBJN	New Stanton	RCA	37500 AM
WBJT	Newville	RCA	37500 AM
8XNJ	Rays Hill	RCA	116950 AM
8XNK	Slidell Hill	GE	33940 FM
8XNL	Slidell Hill	RCA	117350 AM
WBJP	Somersets	RCA	37500 AM
WBJQ	Somersets	RCA	37500 AM
8XNG	Tusearora Mt.	RCA	118550 AM
WBJL	Willow Hill	RCA	37500 AM
WPAJ	Wyoming	Mtr	33940 FM

RHODE ISLAND

STATE POLICE, Providence			
Fixed Station			
WRSA	Seltuate	WE	1634 AM

SOUTH DAKOTA

STATE POLICE, Pierre			
Fixed Stations			
KSDL	Custer	Mtr	39100 FM
9XSL	Custer	Mtr	81240 FM
KSDG	Deadwood	Mtr	39100 FM
9XSD	Deadwood	Mtr	81000 FM
KSDH	Huron	Mtr	39100 FM
KSDA	Parker	Mtr	39100 FM
KSDP	Pierre	Mtr	39100 FM
9XSI	Rapid City	Mtr	81000 FM
9XSK	Rapid City	Mtr	81240 FM
KSDW	Webster	Mtr	39100 FM

TENNESSEE

DEPARTMENT OF SAFETY, Nashville			
Fixed Stations			
4XTB	Bells	Link	116950 AM
WJBV	Chattanooga	Comp	1618 AM
4XTH	Henry	Link	116950 FM
WBVM	Jordonja	Comp	1618 AM
WKVT	Knoxville	Comp	116950 FM
4XTL	Linden	Link	1618 AM
WDBW	Memphis	Comp	1618 AM
4XTM	Monteagle	Link	116950 FM

TEXAS

DEPT OF PUBLIC SAFETY, Austin			
Fixed Stations			
KTNA	Austin	Wstr	1658 AM
KAAR	Austin	Comp	1658 AM
KTXF	Ft Worth	Comp	1658 AM
KTXU	Houston	Comp	1658 AM

UTAH

HIGHWAY PATROL, Salt Lake City			
Fixed Stations			
KUSH	Ogden	Comp	1674 AM
KPRV	Provo	Comp	1674 AM
KUHP	Salt Lake City	Comp	1674 AM

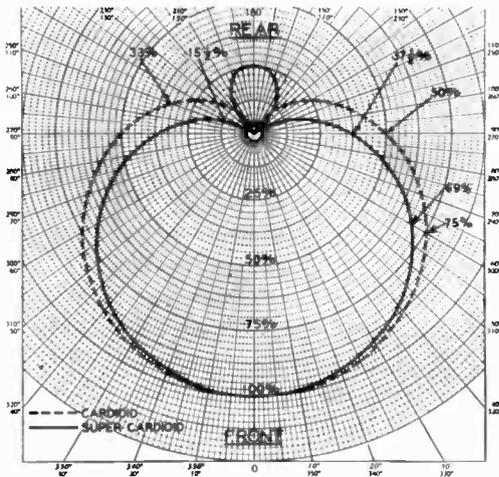
VIRGINIA

DEPT OF STATE POLICE, Richmond			
Fixed Stations			
WRIF	Appomattox	Comp	1690 AM
		Link	35500 FM
WSPH	Chesterfield	Comp	1690 AM
		Link	35500 FM
WRIG	Culpeper	Comp	1690 AM
		Link	35500 FM
3XVY	Christiansburg	Link	11650 FM
WAEX	Princess Anne	Comp	1690 AM
3XVX	Washington	Link	11650 FM
WAEX	Denbigh	Link	35500 FM
3XVW	Wise	Link	11650 FM
WBNQ	Wytheville	Comp	1690 AM
		Link	35500 FM

WASHINGTON

STATE PATROL, Olympia			
Fixed Stations			
KNFK	Bellingham	Nord	2490 AM
KQZT	Bremerton	R Lab	2490 AM
KNST	Chelan	Comp	2490 AM
KGHQ	Chinook Pass	Nord	2490 AM
KQCS	Colfax	Comp	2490 AM
KAXV	Colville	Comp	2490 AM
KWSF	Davenport	Nord	2490 AM
KNFX	Ellensburg	R Lab	2490 AM
KNGZ	Ephrata	Nord	2490 AM
KFDG	Everett	Nord	2490 AM
WRHX	Fort Lewis	Comp	2490 AM
KNGA	Goldendale	Comp	2490 AM
KBPW	Hoquiam	Nord	2490 AM
KNFY	Iwaco	Nord	2490 AM
KBKK	Kelso	R Lab	2490 AM
KQCF	K-M Hill	Nord	2490

... do you know these important performance advantages of the SHURE Super-Cardioid?



The improvement in unidirectional operating characteristics of the SHURE Super-Cardioid Microphone over the cardioid is indicated by the comparative pickup patterns shown above.

★ Maximum sensitivity (100%) is achieved by sounds entering the front of the Microphone.

★ A wide range of pickup is indicated by the fact that the Super-Cardioid is practically as sensitive as the cardioid at a 60° angle. (69% against 75%).

★ Beyond the 60° angle, the directional qualities of the Super-Cardioid become rapidly apparent. At 90°, the Super-Cardioid is 25% more unidirectional. At a wide angle at the back (110° to 250°) the Super-Cardioid is more than twice as unidirectional.

★ The ratio of front to rear pickup of random sound energy is 7:1 for the cardioid; 14:1 for the Shure Super-Cardioid.

For critical acoustic use, specify the Shure Super-Cardioid Broadcast Dynamic.

MODEL	IMPEDANCE	CODE
556A	35 ohm	RUDOM
556B	200 ohm	RUDOP
556C	High	RUDOR

List price . . . \$82.00

Patented by Shure Brothers

SHURE BROTHERS

Designers and Manufacturers of Microphones and Acoustic Devices
225 W. Huron St., Chicago 10, Illinois • Cable Address: SHUREMICRO



ZONE POLICE, continued

WQPG	Sterling	Comp	2804	2808	5140	A1
			5195	Wkg:	2812	
WQPP	Pontiac	Comp	2804	2808	5140	A1
			5195	Wkg:	2812	
WQPC	Chicago	Comp	2804	2808	5140	A1
			5195	Wkg:	2812	
WASE	Peoria	Comp	2804	2808	5140	A1
			5195			
WPGD	Rockford	Comp	2804	2808	2812	A1

INDIANA

WBMO	Charlestown	Comp	2804	2808	2812	A1
WPHS	Chesterton	Comp	2804	2808	2812	A1
			5140	5195		
WBHT	Comersville	Comp	2804	2808	2812	A1
WMDZ	Indianapolis	Comp	2804	2808	2812	A1
			5135	5140	5195	
WPHU	Jasper	Comp	2804	2808	2812	A1
			5140	5195		
WQFW	Ligonier	Comp	2804	2808	2812	A1
			5140	Wkg:	2808	A1
WRNR	Pendleton	Comp	2804	2808	2812	A1
WQGB	Putnamville	Comp	2804	2808	2812	A1
WQFE	Seymour	Comp	2804	2808	2812	A1
			5140	5195		
WROR	W. Lafayette	Comp	2804	2808	2812	A1
			5140	5195		

KANSAS

KGPZ	Wichita	RCA	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

LOUISIANA

WBRP	Baton Rouge	Comp	2804	2808	2812	A1
------	-------------	------	------	------	------	----

MASSACHUSETTS

WMP	Frammingham	Hfr	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MICHIGAN

WPEB	Grand Rapids	Comp	2804	2808	2812	A1
			5135	5140	5195	

MINNESOTA

KNFE	Duluth	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MISSOURI

KHPF	Jefferson City	Coll	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
KHPC	Kirkwood	Coll	2804	2808	2812	A1
			5140	5195		
KHPA	Lee's Summit	Coll	2804	2808	2812	A1
			5140	5195		
KHPB	Macon	Coll	2804	2808	2812	A1
			5140	5195		
KHPE	Poplar Bluff	Coll	2804	2808	2812	A1
			5140	5195		
KHPD	Springfield	Coll	2804	2808	2812	A1
			5140	5195		

OHIO

WPDO	Akron	Comp	2804	2808	2812	A1
WKDU	Cincinnati	RCA	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
WENB	Cleveland	Bnd	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
WPGG	Findlay	Coll	2804	2808	5140	A1
			5195			
WPHC	Massillon	Coll	2804	2808	2812	A1
			5140	5195		
WRDQ	Toledo	Comp	2804	2808	5140	A1
			5195			
WPHK	Wilmington	Coll	2804	2808	2812	A1
			5140	5195		
WPDG	Youngstown	Comp	2804	2808	2812	A1

OKLAHOMA

KOSO	Okl. City	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
KQEI	Tulsa	Comp	2804	2808	5140	A1
			5195	7935		

OREGON

KOHK	Klamath Falls	Comp	2804	2808	5140	A1
			5195			
KOHL	La Grande	Comp	2804	2808	5140	A1
			5195			
KOHS	Salem	Comp	2804	2808	5140	A1
			5195			

PENNSYLVANIA

WBTF	Butler	Comp	2804	2808		A1
WBTD	Greensburg	Comp	2804	2808		A1
WSP	Harrisburg	RCA	2804	2808		A1
WBTD	W. Reading	Comp	2804	2808		A1
WBTE	Wyoming	Comp	2804	2808		A1

TEXAS

KTNA	Austin	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
KGPJ	Beaumont	Comp	2804	2808	2812	A1
			5135	5140	5195	
KNHF	Denton	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

WASHINGTON

KNFK	Bellingham	Nord	2804	2808	2812	A1
			5140	5195		
KFDG	Everett	Nord	2804	2808	2812	A1
KBPW	Hoquiam	Nord	2804	2808	5140	A1
			5195			
KPHP	Mt Vernon	Nord	2804	2808	2812	A1
KGHD	Seattle	Nord	2804	2808	5140	A1
			5195			
KGHE	Snoqualmie Pass	Nord	2804	2808	5140	A1
KNGR	Spokane	Nord	2804	2808	5140	A1

KNGC	Vancouver	Nord	2804	2808	5140	A1
KNGQ	Wenatchee	Nord	2804	2808	5140	A1
KNGB	Yakima	Nord	2804	2808	5140	A1

WEST VIRGINIA

WRMP	Romney	RCA	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

WISCONSIN

WMPE	Elkhorn	Comp	2804	2808	2812	A1
WTZR	Madison	Comp	2804	2808	2812	A1
WQLJ	Racine	Comp	2804	2808		A1

INTERZONE POLICE STATIONS

ARKANSAS

KGHZ	Little Rock	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7805	7480	7935	

CALIFORNIA

KGHX	Santa Ana	Coll	2804	2808	2812	A1
			5135	5140	5195	

COLORADO

KGPX	Denver	Coll	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

FLORIDA

WPHN	Tampa	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

GEORGIA

WPDY	Atlanta	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

ILLINOIS

WQPS	Springfield	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

INDIANA

WPHI	Indianapolis	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

IOWA

KGHO	Des Moines	Coll	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

KANSAS

KGZC	Topeka	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7935			

KENTUCKY

WPDE	Louisville	Comp	2804	2808	2812	A1
			5135	5140	5195	

LOUISIANA

WPEK	New Orleans	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MASSACHUSETTS

WPEW	Northampton	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MICHIGAN

WGK	Detroit	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	
WRDS	E. Lansing	WE	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MINNESOTA

KGPB	Minneapolis	WE	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

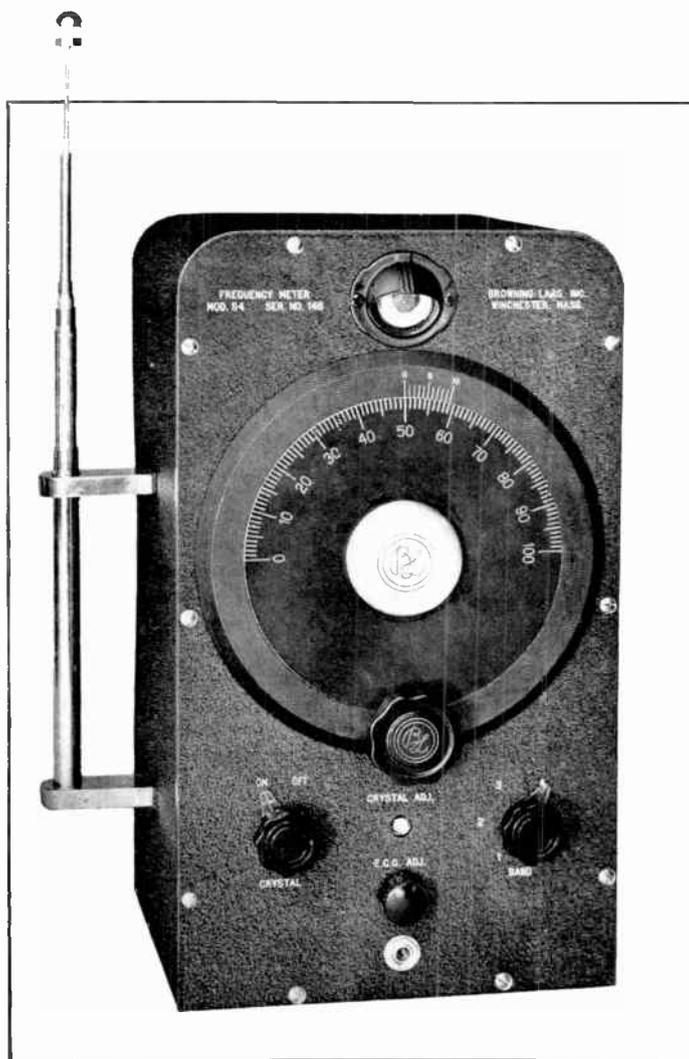
MISSISSIPPI

WRJI	Jackson	Comp	2804	2808	2812	A1
			5135	5140	5195	
			7480	7805	7935	

MISSOURI

KGPE	Kansas City	WE	2804	2808	2812	A1

The new Model S4 meets all FCC requirements for the emergency services. AC-DC operation



The Ideal Frequency Meter for Checking **BROADCAST RELAY TRANSMITTERS**

Before you send out a remote pickup relay transmitter, it should be checked with a BROWNING precision Frequency Meter. Relay transmitters are subject to drift while stored away between jobs. On location, they take a beating from exposure and rough handling.

Relay channels are narrow and crowded. To protect remote pickups from adjacent-channel interference, frequency must be maintained within FCC limits. Broadcast engineers have always liked to use BROWNING Frequency Meters because they are quick and easy

to operate. The Model S4, a completely new, postwar design, offers many added features of speed and accuracy for checking AM and FM equipment.

BROWNING Frequency Meters are calibrated for 1 to 5 different frequencies at any points between 1.5 to 120 mc., according to your requirements. Operating on both AC and DC, they meet FCC limits of plus-or-minus .0025% accuracy.

For information on prices and deliveries, write:

BROWNING LABORATORIES, Inc.
WINCHESTER + MASSACHUSETTS

FORESTRY SYSTEMS, continued

WDNN	Dennis	Mtr	31340	FM
WSNG	Duxbury	Mtr	31340	AM
WLDK	North Easton	RCA	31340	AM
WQYN	Falmouth	Mtr	31340	FM
WAAX	Middleboro	GE	31340	FM
WRGE	Plymouth	Link	31340	FM
WRKV	Wareham	GE	31340	FM

Licensed to Commonwealth of Massachusetts

WBMR	Andover	Hftr	31340	AM	
WRML	Andover	Comp	31340	AM	
WQYW	Barnstable	Comp	35940	39940	AM
WBIO	Billerica	Link	31340	FM	
WRNB	Boston	Comp	31340	AM	
WQWJ	Bourne	Link	31340	FM	
WRKT	Brimfield	Comp	35940	AM	
WCAW	Burlington	Comp	31340	AM	
WAJP	Carlsle	Comp	31340	AM	
WQYR	Carver	Link	31340	FM	
WSVG	Duxbury	Comp	35940	AM	
WRKQ	Fall River	Comp	35940	AM	
WQYV	Falmouth	Link	31340	FM	
WQYX	Falmouth	Comp	35940	AM	
WBQY	Foxboro	Comp	31340	AM	
WQYU	Hanson	Comp	35940	AM	
WQMG	Harvard	Link	31340	FM	
WQYA	Harwich	Comp	35940	AM	
WBKX	Haverhill	Link	31340	FM	
WRKP	Mendon	Hftr	31340	AM	
WQYQ	Middleboro	Comp	35940	AM	
WCAS	Monument Beach	Link	31340	FM	
WMNR	North Reading	GE	31340	AM	
WRKW	Osterville	Harv	35940	AM	
WRKU	Oxford	Comp	31340	AM	
WRKR	Petersham	Comp	31340	AM	
WQYS	Plymouth	Comp	35940	39940	AM
WRGE	Plymouth	Link	31340	FM	
WQWH	Princeton	Comp	35940	AM	
WRKO	Sharon	Comp	31340	AM	
WRBP	Sterling	Comp	31340	AM	
WBKW	Stoughton	Comp	31340	AM	
WBGD	Stow	Comp	35940	31340	AM
WRKY	Warsham	Comp	35940	AM	
WQW1	Westboro	Comp	31340	AM	

MICHIGAN

WBRD	Atlanta	RCA	30940	35740	AM
WDAY	Baldwin	RCA	39420	39940	AM
WSWB	Baraga	Mtr	30940	35740	AM
WDAQ	Boyer City	Comp	35940	39420	AM
WSWK	Crystal Falls	Mtr	30940	35740	AM
WRRC	Escanaba	Mtr	30940	35740	AM
WDSO	Ewen	RCA	30940	35740	AM
WBNA	Gladwin	RCA	30940	35740	AM
WBHX	Marquette	Comp	35940	39420	AM
WBKZ	Mio	RCA	30940	35740	AM
WEDM	Newberry	RCA	30940	35740	AM
WIVA	Rosecommon	Comp	39420	39940	AM
WMIC	Slt. Ste. Marie	Hftr	35740	AM	
WDAP	Traverse City	RCA	30940	35740	AM

MISSISSIPPI

WPMZ	DeKalb	Mtr	39420	FM
------	--------	-----	-------	----

NEW HAMPSHIRE

WKJY	Concord	Mtr	39420	AM
WSRF	Franklin	Mtr	39420	AM
WLOM	Loudon	Comp	39420	AM
WAVT	Manchester	Mtr	39420	AM
WKRH	Northwood	Comp	39420	AM
WFZW	Wolfboro	Comp	39420	AM

NEW JERSEY

WQVN	Bass River	Comp	39740	AM	
WQVR	Batsto	Comp	39420	39740	AM
WQVT	Beaufort	Comp	39940	AM	
WQVS	Belle Plain	Comp	39420	AM	
WQVC	Blue Anchor	Comp	37460	AM	
WQVE	Budd Lake	Comp	39940	AM	
WQVB	Butler	Comp	39940	AM	
WQVG	Catfish	Comp	39940	AM	
WQVP	Coyle Field	Comp	39740	AM	
WQVF	Culver Lake	Comp	39940	AM	
WQVM	Farmingdale	Comp	39740	AM	
WQVQ	Lakehurst	Comp	39740	AM	
WBPN	Lebanon St. Est.	Comp	35740	AM	
WQVU	McKeetown	Comp	39420	AM	
WRHU	Martinsville	Comp	39740	AM	
WQVL	May's Landing	Comp	39420	AM	
WQVT	Millville	Comp	39420	AM	
WQVJ	Milton	Comp	39940	AM	
WQVW	Mizpah	Comp	39420	AM	
WQVO	Retreat	Comp	39740	AM	
WQVK	Toms River	Comp	39740	AM	
WQVA	Trenton	Comp	39420	39940	AM
WQVD	Union Hill	Comp	39740	AM	
WQVH	Windbeam	Comp	35940	39940	AM

NORTH CAROLINA

WLSE	Hertford	USFS	2236	AM
WLSK	South Mills	USFS	2236	AM

OREGON

KQSD	Dallas	Comp	2236	30940	AM	
KRDP	Medford	Comp	31340	31580	31940	AM
KQHQ	Salem	Comp	2236	30940	AM	
			31340	31580	31940	AM

PENNSYLVANIA

WRNV	Clearfield	RCA	35940	AM
WRNT	Emporium	RCA	30940	AM
WRTT	Harrisburg	RCA	30940	AM
WJAB		RCA	35740	AM

SNVE	Kellogg Mtn. Fire Tower	RCA	30940	31580	AM					
			31940	35740	35940	AM				
			31340	39940	37460	39420	39740	AM		
SNVF	Knobs Fire Tower	RCA	30940	31940	AM					
			35940	37460	39420	39740	39940	AM		
SNUT	Lee Fire Tower	RCA	30940	31340	AM					
			31580	31940	35740	35940	37460	39420	AM	
			39740	39940	37460	39420	39740	39940	AM	
SNVL	Loop Fire Tower	RCA	30940	31340	AM					
			31580	31940	35740	35940	37460	39420	AM	
			35940	37460	39420	39740	39940	37460	39420	AM
WROE	Milroy	RCA	31940	35940	AM					
WRKM	Millinburg	RCA	30940	AM						
WROF	Petersburg	RCA	30940	AM						
3XPT	Peters Mtn.	RCA	30940	31940	AM					
			35740	39420	39740	39940	37460	39420	AM	
WRMQ	Renova	RCA	30940	AM						
W1YA	Seranton	RCA	30940	AM						
SNUN	Shaffers Path Fire Tower	RCA	31580	37460	AM					
WRJA	Stroudsburg	Comp	31940	AM						
WRIB	Williamsport	RCA	30940	AM						

RHODE ISLAND

WAWR	Seltuate	USFS	35940	31340	AM
				37660	AM

SOUTH DAKOTA

KAFQ	Hermosa	GE	35940	FM
------	---------	----	-------	----

TEXAS

KHWP	Cushing	Comp	2226	AM
KBWR	Hyatt	Comp	2226	AM
KBWO	Jefferson	Comp	2226	AM
KHJF	Lufkin	Comp	2226	AM
KBWK	Newton	Comp	2226	AM

VIRGINIA

WETN	Deep Creek	USFS	2236	AM
WETV	Suffolk	USFS	2236	AM

WASHINGTON

KGMD	Olympia	Stnc	2212	2236	AM
				2244	AM

SPECIAL EMERGENCY SYSTEMS

NOTE: The FCC listings of stations do not identify the stations with the operating companies. However, listings by call letters and locations will be supplied on request.

ALABAMA

Birmingham	Birmingham Gas Co., 1018 1st Ave. N., South, Natural Gas Co., PO Box 2563
Montgomery	Dept. of Cons., Div. Forestry, 5 N. Bainbridge St.

ARKANSAS

Little Rock	City of Little Rock City Hall
-------------	-------------------------------

CALIFORNIA

Grass Valley	Nevada Irrigation Dist., City of Long Beach
Long Beach	City Hall
Los Angeles	Dept. of Water & Power, Box 240, Arcade Annex, Flood Control District, 751 S. Figueroa St., L. A. Railway Corp., 1060 S. Broadway, Pacific Lighting Corp., 810 S. Flower St., Sheriff's Dept., Rm. 220, Hall of Justice, S. Calif. Edison Co., Ltd., 601 W. 5th St., S. Calif. Gas Co., 810 S. Flower St., S. Counties Gas Co. of Calif., 810 S. Flower St., Superior Oil Co., 930 Edison Bldg., Modesto Irrigation Dist., 823 Eleventh St., Oakland, Key System, 1106 Broadway, Calif. Elec. Power Co., 3771 8th St., Robbins, Reclamation Dist., 1500 Dept. Pub. Wks., Div. H'ways, PW Bldg., 12th & N. Sts., San Diego, San Diego Elec. Ry. Co., 206 Union Bldg., San Diego Gas & Elec. Co., 861 6th Ave., Ambrose Cherin, 410 Mills Bldg., Havlyside Co., 40 Spear St., Pacific Gas & Elec. Co., 245 Market St., Pacific Tel. & Tel. Co., 140 New Montgomery, S. Calif. Tel. Co., 140 New Montgomery St., Southern Pacific Co., 65 Market St., Santa Cruz, Coast Counties Gas & Elec. Co., 22 Pacific Ave.

COLORADO

Denver	Mountain States Tel. & Tel. Co., Box 900
Montrose	Uncompangre Valley Water Assoc., 601 N. Park Ave.

CONNECTICUT

Hartford	Hartford Elec. Light Co., 266 Pearl St.
New Haven	S. New England Tel. Co., 227 Church St., United Illuminating Co., 80 Temple St., Conn. Light & Power Co., 250 Freight St.
Waterbury	

DELAWARE

Wilmington	Del. Power & Light Co., 600 Market St.
------------	--

DISTRICT OF COLUMBIA

Washington	Capital Transit Co., 36th & M St. NW, Chesapeake & Potomac Tel. Co., 725 13th St., NW, Potomac Electric Power Co., 10th & E Sts. NW, W. M. & A. Motor Lines, Inc., 1510 Southern Ave., SE.
------------	--

FLORIDA

Jacksonville	City of Jacksonville, 1040 Laura St.
Miami	Florida Power & Light Co., 25 SE 2nd Ave.
St. Petersburg	City of St. Petersburg City Hall
Tallahassee	Btl. Forestry & Parks, Box 1200

GEORGIA

Atlanta	S. Bell Tel. & Tel. Co., 67 Edgewood Ave., SE
Fargo	Superior Pine Prods. Co., Const. Timber Prot. Org'n
Homerville	

ILLINOIS

Chicago	Chicago Surface Lines, 231 S. 1 LaSalle St., Commonwealth Edison Co., 72 W. Adams, Ill. Bell Tel. Co., 212 W. Washington St., Nat. Gas Pipeline Co. of Amer., 20 N. Wacker Dr., Texoma Nat. Gas Co., 20 N. Wacker Dr., Menard Elec. Co'p., 122 S. 6th St., Dept. Pub. Works & Bldgs., 601 Sangamon Ave.
Petersburg	
Springfield	

INDIANA

Fort Wayne	Indiana Service Corp., 116 E. Wayne St., Northern Ind. Pub. Serv. Co., 220 S. Main St., Indiana Bell Tel. Co., 240 N. Meridian, Indianapolis Power & Light Co., 17 N. Meridian St., Pub. Service Co. of Ind., Inc., 110 N. Illinois St., Indiana Gen. Service Co., Indiana & Michigan Elec. Co., 220 W. Colfax Ave.
Marion	
South Bend	

IOWA

Des Moines	Iowa Power & Light Co., 312 Sixth Ave.
Jefferson	Jefferson Telephone Co., 105 W. Harrison

KANSAS

Independence	Union Gas System, Inc., 122 W. Myrtle
Wichita	Kansas Gas & Elec. Co., 1900 E. Central

KENTUCKY

Louisville	Louisville Gas & Elec. Co., 311 W. Chestnut
------------	---

LOUISIANA

New Orleans	Louisiana Power & Light Co., 142 Delaronde St.
New Orleans	Public Service, Inc., 317 Baronne St.

MARYLAND

Baltimore	Ches. & Pot. Tel. Co. of Balt. City, 108 E. Lexington, Cons. Gas, Electric, Light & Power Co. of Baltimore, 39 W. Lexington St.
-----------	---

MASSACHUSETTS

Boston	Boston Cons. Gas Co., 100 Arlington St., Boston Edison Co., 182 Tremont St., Boston Elevated Ry. Co., 31 St. James Ave., New England Power Co., 441 Stuart St., New England Tel. & Tel. Co., 50 Oliver St., Brockton, Brockton Edison Co., 36 Main St., Holyoke, Holyoke Water Power Co., 1 Canal St., Springfield, Western Mass. Electric Co., 73 State St., Worcester, Worcester St. Ry. Co., 107 Main St.
--------	--

MICHIGAN

Detroit	Detroit Edison Co., 2000 2nd Ave., Dept. of Street Railways, 11200 Shoemaker Ave., Michigan Bell Telephone Co., 1365 Cass Ave., Tri-Co. Electric Co'p., Box 1838
Portland	

MINNESOTA

Minneapolis	Minneapolis Gas & Light Co., 739 Marquette Ave., Northern States Power Co., 15 S. Fifth St., Rainy River Improvement Co., 500 Baker Arcade Bldg.
-------------	--



Looms Large on the **CERAMIC** Firmament

Your search for a "hard-as-diamond" versatile material ends when you discover the myriad possibilities of Steatite.

Let us tell you more about STEATITE . . . a material that may solve your production problems.

Centralab

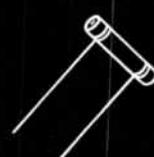
Division of GLOBE-UNION INC., Milwaukee



Ceramic Trimmers
Bulletin 695



Variable Resistors
Bulletin 697



Tubular Ceramic
Capacitors
Bulletins 630 and 586



Selector Switches
Bulletin 722

PRODUCERS OF



Ceramic High Voltage Capacitors
Bulletin 814

SPECIAL EMERGENCY SYSTEMS
continued

MISSOURI

Kansas City Panhandle East. Pipe Line Co.
1221 Baltimore Ave.
Kansas City Pub. Service Co.
728 Delaware St.
Kansas City Power & Light Co.
1330 Baltimore St.
St. Joseph St. Joseph Railway, Light, Heat & Power Co.
520 Francis St.
St. Louis St. Louis Pub. Serv. Co.
3869 Park Ave.
Southwestern Bell Tel. Co.
1010 Pine St.
Union Electric Co. of Mo.
315 N. 12th St.

MONTANA

Butte Montana Power Co.
40 E. Broadway

NEBRASKA

Omaha Northwestern Bell Tel. Co.
118 S. 19th St.

NEW JERSEY

Atlantic City Atlantic City Electric Co.
1600 Pacific Ave.

NEW YORK

Binghamton Home Gas Co.
267 Court St.
Buffalo Buffalo Niagara Elec. Corp.
535 Washington St.
Division of Water
504 City Hall
Far Rockaway Queens Boro Gas & Elec. Co.
1610 Far Rockaway Blvd.
Jamestown Amer. Legion, Ira Lou Spring Post No.
149, Emerg. Unit
1 Penton Place
Mineola Long Island Lighting Co.
Amer. Tel. & Tel. Co. (L.I. Dept.)
32 Sixth Ave.
New York Bd. of Transportation
250 Hudson St.
Cons. Edison Co. of N. Y.
1 Irving Place
New York Telephone Co.
140 West St.
Western Union Telegraph Co.
60 Hudson St.
New York & Queens Elec. Light & Power Co.
Long Island City
Central N. Y. Power Corp.
300 Erie Blvd. W.

OHIO

Akron Ohio Edison Co.
47 Main St.
Alliance Ohio Pub. Service Co.
247 E. Main St.

Canton Ohio Power Co.
606 2nd St. SE.
Cincinnati Cincinnati St. Railway Co.
Dixie Term. Bldg., 4th & Walnut
Cleveland Division of Transportation
1404 E. 9th St.
Ohio Bell Telephone Co.
750 Huron Rd.
Columbus Columbus & Southern Ohio Electric Co.
215 N. Front St.
Dayton Dayton Power & Light Co.
225 S. Main St.
St. Clairsville Belmont Electric Coop., Inc.
Toledo Dept. Public Serv., Div. of Water
Toledo Edison Co.
Edison Bldg.

OKLAHOMA

Oklahoma City Oklahoma Gas & Electric Co.
321 N. Harvey
Tulsa Public Service Co. of Okla.
609 S. Main St.
Standard Pipe Line Co.
PO Box 591

OREGON

Medford California Oregon Power Co.
216 W. Main St.
Portland Northwestern Electric Co.
920 SW Sixth Ave.
Portland Gas & Coke Co.
920 SW Sixth Ave.
Portland Gen. Electric Co.
621 SW Alder St.

PENNSYLVANIA

Allentown Penna. Power & Light Co.
901 Hamilton St.
Johnstown Pennsylvania Electric Co.
Parkers Landing Central Electric Coop., Inc.
Box 397
Philadelphia Philadelphia Electric Co.
1000 Chestnut St.
Bell Telephone Co.
1835 Arch St.
Philadelphia Trans. Co.
1405 Locust St.
Pittsburgh Duquesne Light Co.
435 6th Ave.
Peoples Natural Gas Co.
545 Wm. Penn Way
Pittsburgh Railway Co.
435 Sixth Ave.

PUERTO RICO

Guayama Dept. of the Interior
San Juan Utilization of Water Resources
P. R. Water Res. Auth.

RHODE ISLAND

Pawtucket Blackstone Valley Gas & Elec.
5 Hight St.

TENNESSEE

Chattanooga Electric Power Board
6th & Cherry Sts.
Memphis Light, Gas & Water Div.
179 Madison Ave.

TEXAS

Beaumont City Water Dept.
Walnut & Mulberry Sts.
Corpus Christi Gulf States Utilities Co.
Central Power & Light Co.
120 N. Chaparral St.
Fort Worth Texas Electric Service Co.
Box 970
Granbury Brazos Riv. Trans. Elec. Coop.
Box 201
Houston Houston Light & Power Co.
1016 Walker Ave.
Mercedes Maple Valley Elec. Coop., Inc.
109 N. Ohio
San Antonio City Public Service Board
201 N. St. Mary's
San Antonio Transit Co.
310 S. St. Mary's
B-K Electric Coop., Inc.

UTAH

Salt Lake City Telegram Publishing Co.
137-143 S. Main

VIRGINIA

Alexandria Barcroft & Wash. Trans. Co.
600 N. Royal St.
Arlington Wash. Va. & Md. Coach Co.
707 N. Randolph St.
Richmond Chesapeake & Potomac Tel. Co. of Virginia
703 E. Grace
Roanoke Appalachian Elec. Power Co.
129 E. Campbell Ave.

WASHINGTON

Everett City Water Dept.
3102 Cedar St.
Seattle City of Seattle
1015 Third Ave.
Spokane Puget Sound Power & Light Co.
860 Stuart Bldg.
Washington Water Power Co.
825 Trent Ave.

WEST VIRGINIA

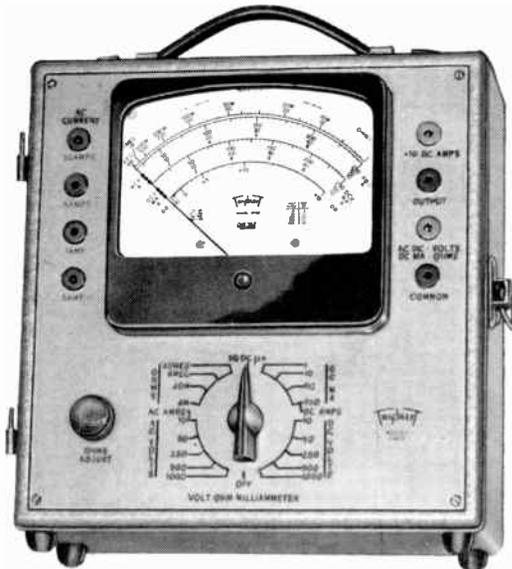
Charleston Chesapeake & Potomac Tel. Co. of W. Va.
816 Lee St.
Wheeling Wheeling Electric Co.
31 Sixteenth St.

WISCONSIN

Appleton Wisconsin Michigan Power Co.
137 W. Mill St.
Marshfield Electric & Water Dept.
City Hall Bldg.
Milwaukee Wisconsin Electric Power Co.
213 W. Michigan St.
Wisconsin Gas & Electric Co.
231 W. Michigan St.
Wisconsin Telephone Co.
722 N. Broadway

WYOMING

Rock Springs Mountain Fuel Supply Co.
615 Conn. Ave.



NEW ENGINEERING • NEW DESIGN • NEW RANGES
50 RANGES

Voltage: 5 D.C. 0-10-50-250-500-1000 at 25000 ohms per volt.
5 A.C. 0-10-50-250-500-1000 at 1000 ohms per volt.
Current: 4 A.C. 0-.5-1-5-10 amp.
6 D.C. 0-50 microamperes — 0-1-10-50-250 milliamperes—0-10 amperes.
4 Resistance 0-4000-40,000 ohms—4-40 megohms.
6 Decibel -10 to +15, +29, +43, +49, +55
Output Condenser in series with A.C. volt ranges.

Model 2400 is similar but has D.C. volts Ranges at 5000 ohms per volt.

Write for complete description

MODEL 2405

Volt•Ohm•Milliammeter

25,000 OHMS PER VOLT D.C.



SPECIFICATIONS

NEW "SQUARE LINE" metal case, attractive tan "hammered" baked-on enamel, brown trim.

- **PLUG-IN RECTIFIER**—replacement in case of overloading is as simple as changing radio tube.
- **READABILITY**—the most readable of all Volt-Ohm-Milliammeter scales—5.6 inches long at top arc.
- **RED•DOT LIFETIME GUARANTEE** on 6" instrument protects against defects in workmanship and material.

Triplet
ELECTRICAL INSTRUMENT CO.

BLUFFTON OHIO.

THESE **SNc** REPRESENTATIVES
offer you

184 YEARS of RADIO EXPERIENCE



JACK BEEBE
 General Sales Manager

We invite you to call on them and their long experience for assistance in solving any problems having to do with the transformer field. Because of the long experience of these men . . . the invaluable knowledge they have accumulated . . . their demonstrated integrity and sincerity, our sales and production policies will be coordinated with the advice and suggestions they bring from their field contacts.

Joe Muniot
 Southern Sellers . . . 918 Union Street
 New Orleans, La.

Fred B. Hill
 256 First Avenue, N.
 Minneapolis, Minn.

G. G. Willison
 West Building . . . Houston, Texas



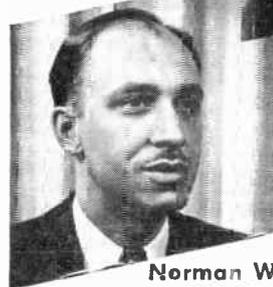
S. K. MacDonald
 1531 Spruce Street
 Philadelphia 2, Pa.



Bert Huvelman
 Instrument Sales
 325 W. Huron St.
 Chicago, Ill.



Jack Cota
 5 Ivy Street Bldg.
 Atlanta 3, Georgia



Norman W. Kathrinus
 1218 Olive Street
 St. Louis 3, Mo.



J. J. Perlmuth
 942 Maple Avenue
 Los Angeles 15, Calif.

SWAIN NELSON COMPANY

GLENVIEW

ILLINOIS

Compression Molded
PLASTIC
P R O D U C T S

★ Here at Rogan, you are invited to avail yourselves of our complete knowledge and long experience in all phases of plastic molding. Our staff of trained experts will be glad to assist you with your plastic problems, no matter how involved or comprehensive.

In addition to compression molding, we also offer an exclusive "deep relief" branding process that goes a long way toward reducing the cost of plastics that must bear markings, lettering or other descriptive matter.

Write for facts on this lower cost, combination service today.

ROGAN BROS.

Compression Molders and Branders of Plastics
2000 S. MICHIGAN AVENUE - CHICAGO 16, ILLINOIS

FILTER CONDENSER BARGAINS!

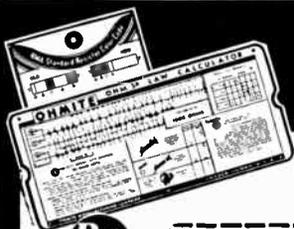
Thousands of rugged, oil-filled, oil-impregnated condensers at ridiculously low prices. Write for list! New Time Payment Plan if desired.

BIG NEW CATALOG! By mailing us your name and address, you will be among the first to get a copy of our own big new catalog, plus latest announcements of new and bargain components and equipment. Write today! Address Dept. F of nearest Newark branch.



FREE TO YOU
COLOR CODE AND
OHMS LAW CALCULATOR

A great convenience. Easy to work. Solves many problems. Attach coupon to your letterhead. Free to radio men, engineers, etc.



BURSTEIN-APPLEBEE COMPANY
1012 McGee St.
Kansas City 6, Mo.

Mail Coupon Now

BURSTEIN-APPLEBEE COMPANY
1012 McGee, Kansas City 6, Mo
Send me FREE Color Code and Ohms Law Calculator along with latest catalog

I am _____
STATE CONNECTION IN INDUSTRY _____

NAME _____
ADDRESS _____
TOWN _____ STATE _____

April 1st

*Closing date for advertising
in the first edition of the*

FM RADIO HANDBOOK

A limited number of advertising pages will be carried in the FM RADIO HANDBOOK. Far-above average results will be obtained by manufacturers of high-quality broadcast transmitters and receivers, communications equipment, amplifiers and speakers, test and measuring instruments, components, and high-frequency insulating materials.

With all AM services limited by lack of frequencies, the great postwar expansion in both broadcasting and communications lies in the FM field.

Moreover, the high standards set by the FCC for FM broadcast performance calls for equipment, components, and measuring instruments of the highest quality. This is equally true of FM emergency and communication services, where a premium is set on dependability.

For five years, engineers, executives, designers, operators, servicemen and buyers have asked us to publish a complete handbook on FM broadcast transmitters, home receivers, communications equipment, antennas, and related reference data.

Now, such a volume, the FM RADIO HANDBOOK, is in its final stage of publication. Planned to set a new standard of format for reference handbooks, it will contain over 200 large pages, 8½ by 11½ ins., elaborately illustrated and handsomely printed.

Advertising space available in full-page units 7 by 10 ins., at the following rates:

1 Page \$200 4-Page Section \$720
2 Facing Pages \$380 Red, extra per page \$50

NOTE: The sale of 10,000 copies is guaranteed, with a bonus of 5,000 additional copies without extra charge to advertisers.

Sale of the HANDBOOK will be promoted by the largest advertising campaign ever used for any radio book, with full-page space in engineering and trade papers in all fields concerned with FM broadcasting, home receivers, and communications.

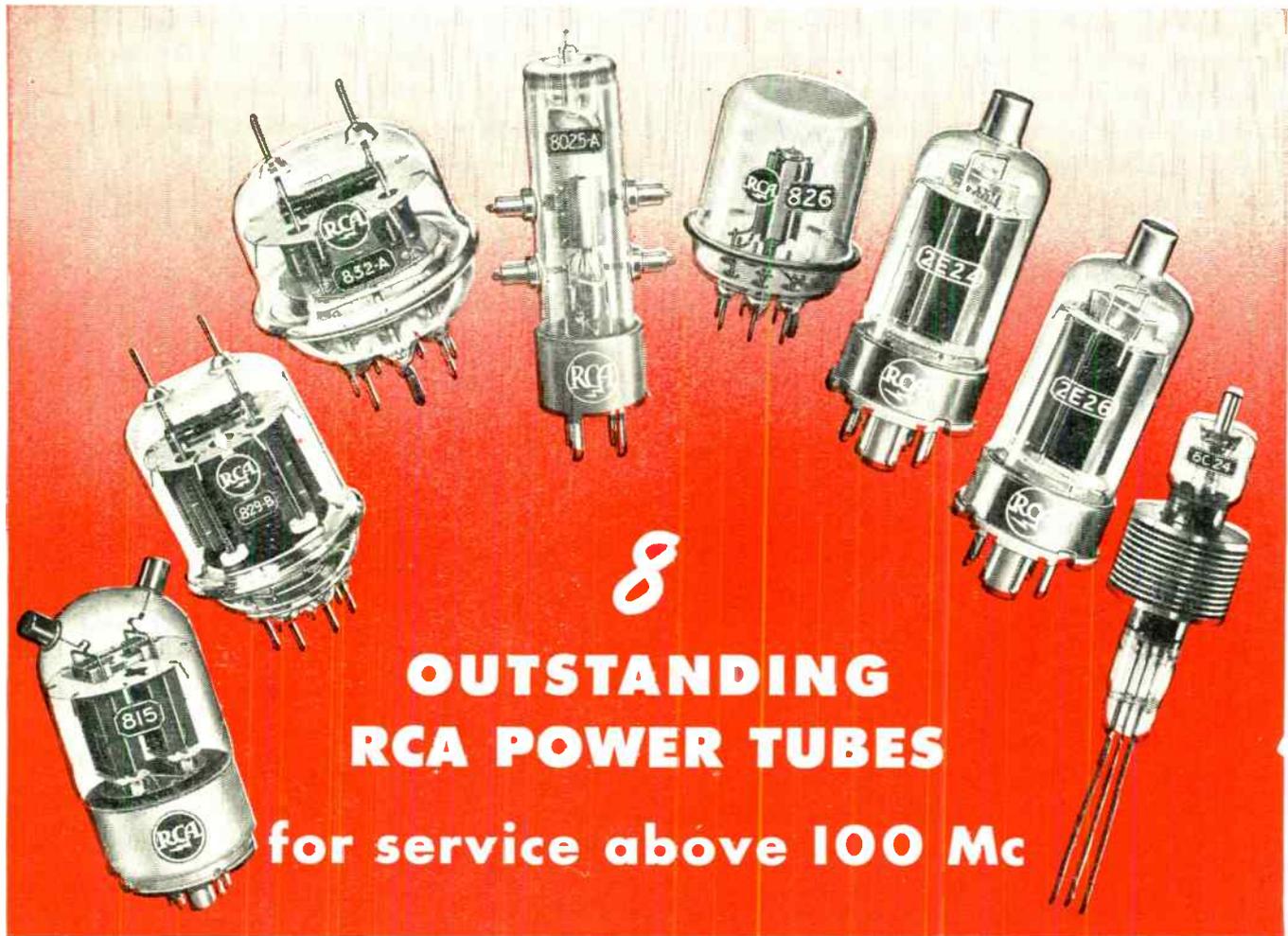
• • •

PLEASE MAKE YOUR SPACE RESERVATION
WITHOUT DELAY. FORMS CLOSE APRIL 1st

FM AND TELEVISION

511 Fifth Avenue + New York 17, N. Y.

FM AND TELEVISION



OUTSTANDING RCA POWER TUBES

for service above 100 Mc

Ideally suited to compact transmitter designs for emergency, aeronautical, and other upper-frequency applications

TWIN BEAM-POWER TYPES: The RCA 815, 829-B and 832-A push-pull beam-power tubes offer unusual compactness, combining high-power sensitivity with low plate-voltage requirements. Neutralization is seldom necessary.

SINGLE BEAM-POWER TYPES: The new RCA 2E24 is a quick-heating type for emergency stand-by service. Its sturdy *coated-type* filament reaches operating temperature in less than two seconds. The new RCA 2E26 is a slow-heating type particularly adaptable to FM transmitter designs.

POWER TRIODES: The RCA 826 and 8025-A triodes can be operated with unusual plate efficiency at frequencies as high as 250 and 500 Mc, respectively. Both tubes have a double-helical, center-tapped filament to minimize the effect of filament-lead

inductance. The 8025-A has double grid and plate connections that can be paralleled to reduce lead inductance. The new RCA-6C24 high-power triode employs forced-air cooling. Its relatively small size, center-tapped filament, and low inter-electrode capacitances account for its exceptional high-frequency performance.

RCA tube application engineers are ready to consult with you on any design problems you may have involving these or other RCA Electron Tubes. If you wish their services, or additional technical data on these tube types, write to RCA, Commercial Engineering Department, Section D-13B, Harrison, N. J.

COMPARATIVE TECHNICAL DATA (Plate-Modulated Class C Telephony)

Tube Type No.	Plate Input Watts	Driving Power at Tube	Max. Rating Freq. Mc	Plate Volts	List Price
2E24	ICAS 27	0.2	125	500	\$3.50
2E26	ICAS 27	0.2	125	500	3.20
6C24	CCS 1000	75.0	160	2500	45.00
815	ICAS 60	0.2	125	400	4.50
826	CCS 75	6.5	250	800	12.00
829-B	CCS 90	1.0	200	425	17.00
832-A	CCS 22	0.2	200	425	13.00
8025-A	ICAS 33	1.5	500	800	11.00

The Fountainhead of Modern Tube Development is RCA



TUBE DIVISION

RADIO CORPORATION of AMERICA

HARRISON, N. J.

**Federal's vast
TUBE-MAKING
EXPERIENCE**

focussed on

FM



**NEW HIGH-PERFORMANCE TUBES
FOR FM TRANSMITTERS**

Federal's notable achievements over the years in the development of high-power tubes to operate efficiently in the upper portions of the radio spectrum . . . now is reflected in the design and production of *new* power tubes for FM application.

Employed in the power amplifier stages of FM transmitters . . . these air-cooled, high efficiency vacuum tubes assure long life, dependable performance and stable operation.

In focusing its vast tube-making experience on FM . . . Federal adheres to all the eminent standards it established and has maintained during more than three decades of contribution to the art.

For the finest in FM tubes . . . specify Federal . . . because "Federal always has made better tubes."

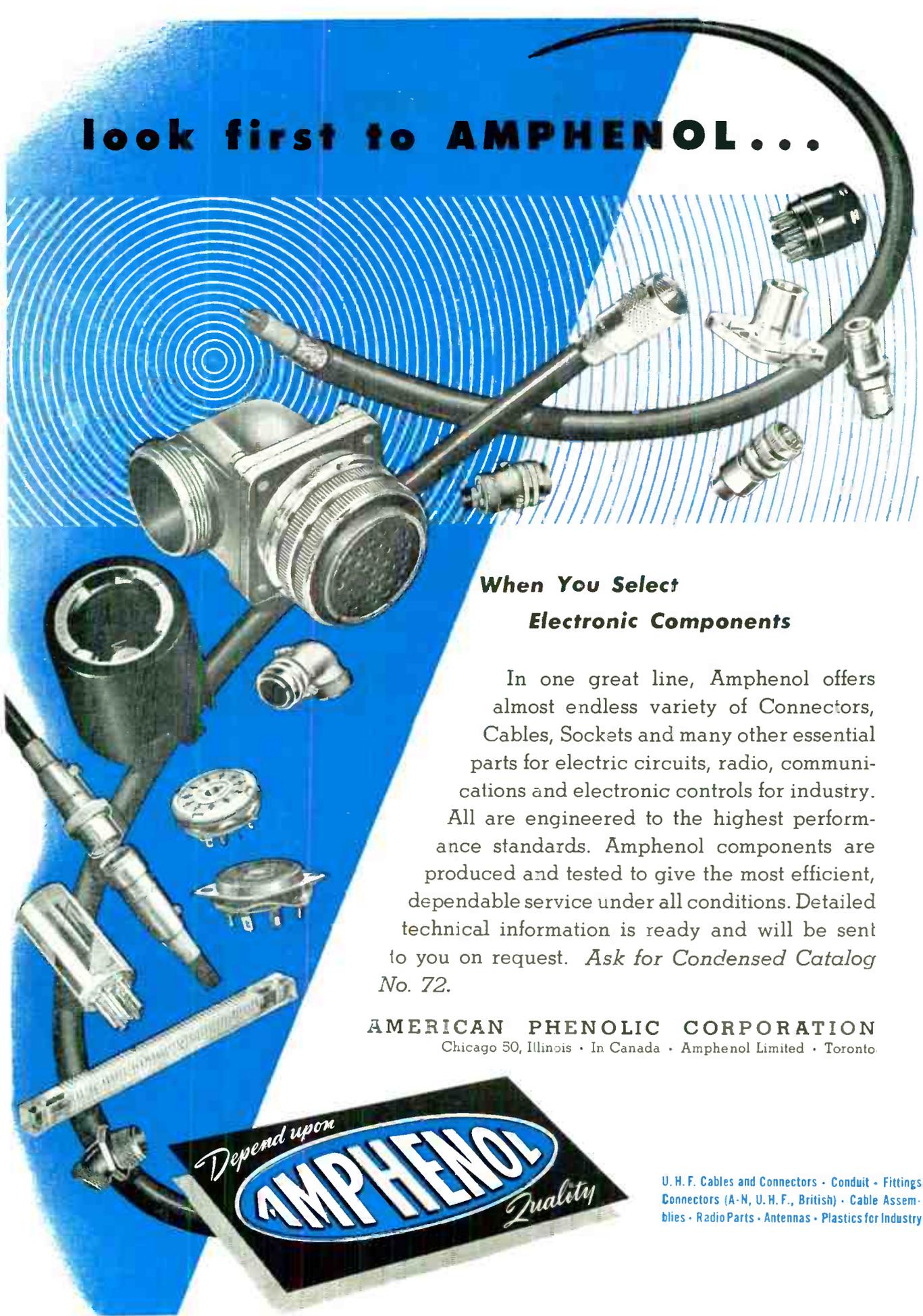
Federal Telephone and Radio Corporation

Export Distributor
International Standard Electric Corporation

**AN IT&T
ASSOCIATE**

Newark, N. J.

look first to AMPHENOL...



When You Select Electronic Components

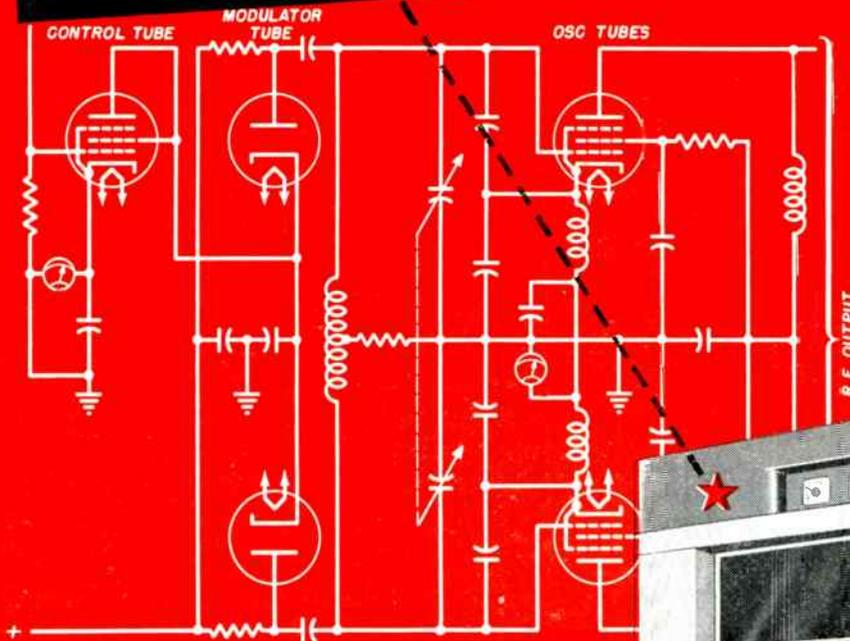
In one great line, Amphenol offers almost endless variety of Connectors, Cables, Sockets and many other essential parts for electric circuits, radio, communications and electronic controls for industry. All are engineered to the highest performance standards. Amphenol components are produced and tested to give the most efficient, dependable service under all conditions. Detailed technical information is ready and will be sent to you on request. *Ask for Condensed Catalog No. 72.*

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois • In Canada • Amphenol Limited • Toronto



U. H. F. Cables and Connectors • Conduit • Fittings
Connectors (A-N, U. H. F., British) • Cable Assemblies • Radio Parts • Antennas • Plastics for Industry

Look what you gain
with this basically new idea
in **fm** circuits



These new ideas in FM circuits designed by Westinghouse bring you important advantages never before available in FM transmitters.

Modulation, for example, is a simple, straightforward diode type . . . noncritical, non-microphonic, no-trick tubes (see drawing above). The effective resistance of the tubes is a function of plate current in the modulator-control tube.

Thus, the master oscillator tank circuit is frequency-modulated due to *resistance variation* in response to audio signals applied to modulator-control input circuit. And the frequency-modulated master oscillator operates at only 1/9th the F.C.C. assigned center-frequency.

There are other important benefits in the new Westinghouse design. Frequency is held without using critically-tuned elements or moving parts and nowhere does frequency stability depend upon a tuned circuit.

These new improvements are born of intensive wartime radar experience and actual operation of five FM stations . . . a background unmatched by any other transmitter manufacturer. Ask your nearest Westinghouse office today to give you all the facts, and look at Westinghouse before you buy! Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

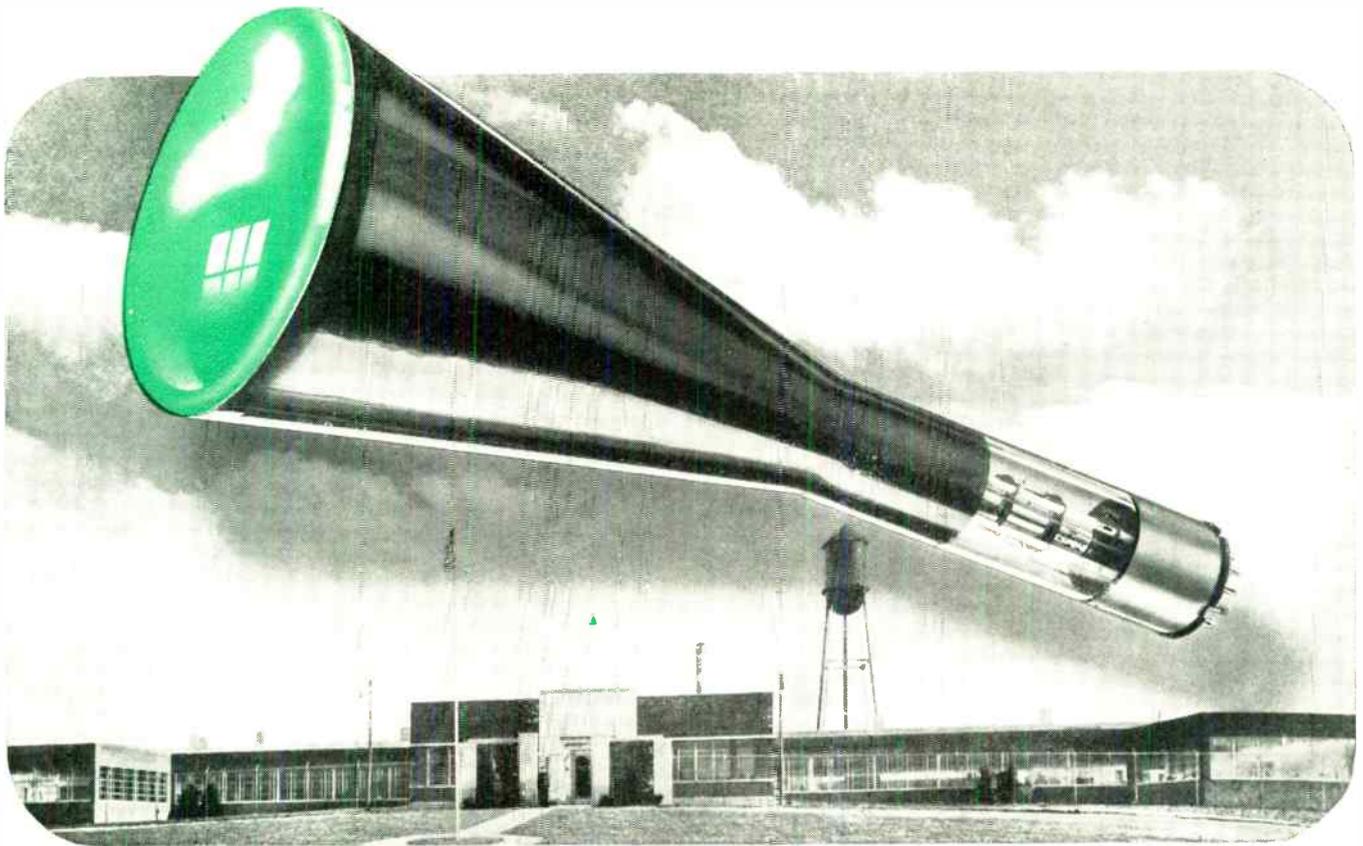
J-08158



Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

FM AND TELEVISION



A Bright Spot in the Television Picture

Now ready at National Union is a group of new cathode-ray tubes capable of picture reproduction superior to anything television has yet offered. Here are tubes whose ultra fine grain screens* catch the most subtle gradations of light and shadow. Pictures are far more detailed, clearer, more brilliant. When enlarged by projection, they hold their distinct, high-definition quality and depth of tone. Here, too, ion burn, as a major television problem, is a thing of the past!

National Union enters the "Age of Television," ideally equipped to supply high-grade C-R Tubes at mass market prices. Here, is a large modern plant . . . an ultra-efficient pro-

duction line . . . equipment designed for the most advanced manufacturing techniques . . . the highest standards of quality control . . . skilled workers . . . able engineers. All backed by one of this Industry's most extensive and fruitful Electronic Tube Research programs —assurance that N. U. will contribute its full share to future C-R Tube progress.

**So fine is the texture of the special florescent material developed by National Union Research Laboratories, it is calculated that a 10-inch picture on the screen of a National Union cathode-ray tube is reproduced on 10 billion crystals!*

**NATIONAL UNION
RADIO AND ELECTRON TUBES**

NATIONAL UNION RADIO CORPORATION • NEWARK 2, N. J.

MORE POWER OUTPUT **BUT** LESS BATTERY DRAIN WITH HYTRON INSTANT-HEATING BEAM TETRODES

ZERO STAND-BY CURRENT Thoriated tungsten filaments of the Hytron 2E25, HY69, and HY1269 permit simultaneous application of all potentials. During stand-by, no precious filament current is drawn from the battery. Especially with the larger tube complements of FM transmitters, is conservation of battery power mandatory.

MORE OUTPUT—GREATER RANGE Only 4% of the current required for cathode types, is necessary to operate the instant-heating 2E25, HY69, and HY1269. (See table below.) Even in a mobile FM transmitter, 100 watts output is practicable. Imagine the advantages of such increased output in police, marine, or other mobile equipment.

SPARES PROBLEM SIMPLIFIED Using the 2E25, HY69, and HY1269, you take full advantage of the beam tetrode's versatility. The 2E25, for example, can power a whole transmitter—AF and RF—AM or FM. If more output is required, HY69's or HY1269's in push-pull still confine the spares complement to only two types.

ADVANTAGES OVER CATHODE TYPES Yes, the 2E25, HY69, and HY1269 cost more than cathode types. But they are worth it. Not only are they easier on the battery, and permit larger outputs, but they are designed, built, and tested for transmitting. Some advantages are: centering of filament potential at 6.0 volts, r.f. shielding to eliminate the necessity for neutralization, low-loss insulation throughout, plate connection to top cap, and rugged construction.



BATTERY DRAIN OF A CONVENTIONAL TRANSMITTER AND KAAR FM-50X EQUIPPED WITH HYTRON INSTANT-HEATING TUBES

	Conventional 30 watt	KAAR FM-50X - 50 watt
AMPERE HOURS:	0 10 20 30 40 50 60 70	0 10 20 30 40 50 60 70
STANDBY DRAIN 24 HOUR PERIOD	55.2 AMPERE HOURS	0.0 AMP HRS YET READY TO TALK INSTANTLY!
AVERAGE TOTAL BATTERY DRAIN 24 HOUR PERIOD	56.8 AMPERE HOURS	2.2 AMPERE HOURS

This chart, prepared by Kaar Engineering Co., is based on typical metropolitan police use of 140 radiotelephone-equipped cars operating three shifts in a city of 600,000 population. The 24-hour survey included 904 messages originated by cars and 932 messages acknowledged by cars. Transmissions averaged: 13 per car, 15 seconds in length, and 3 minutes 15 seconds transmitting time.

ABBREVIATED DATA HYTRON INSTANT-HEATING BEAM TETRODES

Characteristic	2E25	HY69	HY1269
Filament Potential (volts)	6.0	6.0	6/12
Filament Current (amps.)	0.8	1.6	3.2/1.6
Plate Potential (max. volts)	450	600	750
Plate Current (max. ma.)	75	100	120
Plate Dissipation (max. watts)	15	30	30
Grid-to-Plate Capacitance (mmfd.)	0.15	0.25	0.25
Maximum Seated Height (inches)	3 5/8	5 1/4	5 1/4
Maximum Diameter (inches)	1 7/16	2 1/16	2 1/16
Class C Power Output (watts)	24	42	63
Class C Driving Power (watts)	Less than one watt		



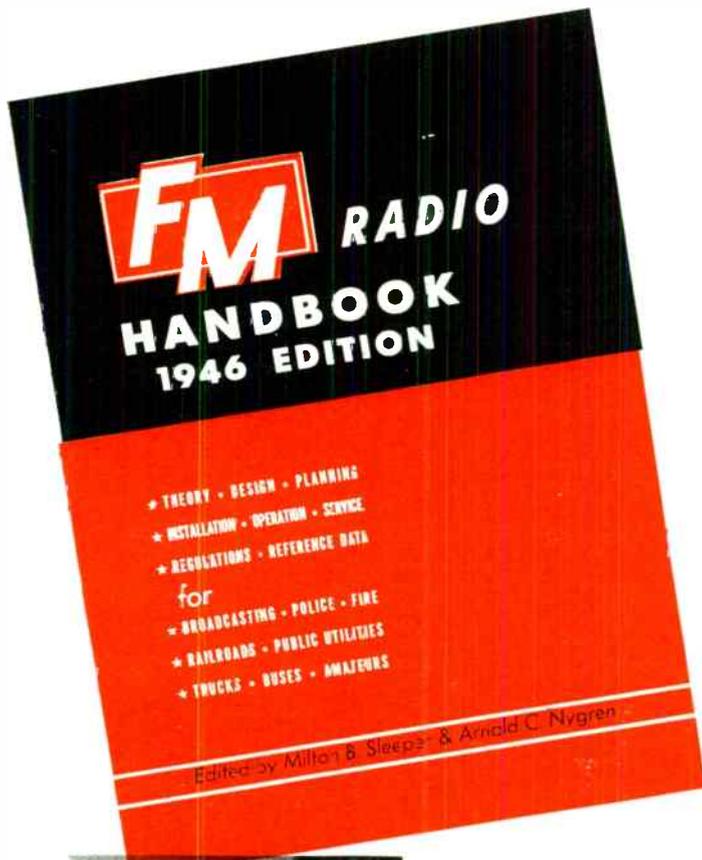
OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.



MAIN OFFICE: SALEM, MASSACHUSETTS



The Most Important RADIO BOOK

published in the
last 10 years—

The Standard
Handbook of

FM RADIO

for everyone engaged in the Radio Industry



FREE

with your subscription to **FM and TELEVISION Magazine**

FM and TELEVISION Magazine is the business journal of the post-war radio industry. It is devoted exclusively to the two principal fields of radio progress, development, and expansion.

Now in its 6th year of publication, it has the well-deserved reputation of being "The Complete and Authoritative Source of Information on Frequency Modulation and Television."

Articles on FM cover the business, engineering, and operating aspects of broadcasting and communications, and the design, manufacture, and merchandising of home receivers, plus analysis of FCC actions.

Television articles cover current developments in equipment, installations, methods, and techniques. Space devoted to television is being increased with the progress of the art.

Because of the tremendous post-war radio expansion is concentrated in these two fields, FM and TELEVISION is essential reading for everyone connected with this industry. Subscribe NOW and get a FREE copy of the FM Radio Handbook.

Here is the first and only book on post-war FM broadcasting, home receivers, and communications. Edited by recognized authorities and written by engineers who are specialists in their respective fields, this Standard Handbook of FM Radio is a complete source of information for every engineer, executive, merchandiser, and technician connected with the radio industry. It is a large book, 8¾ by 11½ ins. handsomely printed and beautifully illustrated.

PARTIAL LIST OF CHAPTERS.

1. Background of Frequency Modulation.
2. FM THEORY: Explained by original charts and diagrams, rather than mathematics.
3. FM BROADCASTING: All post-war practice, covering transmitters, studios, ST links, antennas, satellites, measurements, FCC standards, rules, and allocations.
4. FM COMMUNICATIONS—Municipal and state police systems, latest transmitters and receivers, railroad installations, selective calling systems, antennas and directive arrays, relays, and FCC rules.
5. FM HOME RECEIVERS—Post-war designs, schematics, installation notes, antennas, servicing, testing, alignment.
6. FM FOR AMATEURS—Design of transmitters and receivers for amateur communications.
7. REFERENCE DATA—Allocations, propagation, antenna liability insurance, tubes, and directories of consulting engineers and attorneys, broadcast stations, emergency stations, manufacturers.

Treatment of these subjects covers theory, design, planning, installation, operation, and maintenance of FM broadcast stations, home receivers, and communications systems. Each subject is treated fully, and detailed with special drawings, large photographs.

This very complete data is on *post-war* designs and design practice, making the FM Handbook up-to-the-minute in every respect.

Broadcasters and communications experts who have seen advanced proofs declare this the most practical, useful book ever published for everyone in the radio industry. **GET YOUR COPY AT ONCE!**

\$4.00 in lifetime library binding paper bound edition **\$1.50**

Order your FREE COPY NOW

FM and TELEVISION Magazine 511 Fifth Avenue, New York 17, N. Y.	
Enter my	<input type="checkbox"/> new subscription for <input type="checkbox"/> 1 yr. \$3.00 <input type="checkbox"/> renewal <input type="checkbox"/> 3 yrs. \$6.00
Add \$1.00 per year foreign; 50c Canada; send me ABSOLUTELY FREE a copy of the new FM RADIO HANDBOOK paper bound	
Name
Street
City & ZoneState
My official position is:
Company:
NOTE: If you want your FM RADIO HANDBOOK in the lifetime library binding, add \$2.50 to the subscription prices above.	

SYLVANIA NEWS

CIRCUIT ENGINEERING EDITION

FEB. Published by SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1946

NEW T-3 TUBE FILLS NEED FOR SMALLER UNIT IN TINY BROADCAST RECEIVERS



For any further details, or questions you may want answered about this tiny, sturdy vacuum tube, do not hesitate to write or call Sylvania Electric Products Inc., Emporium, Pa.

Commercial Version of Proximity Fuze Tube Is Rugged, Has Long Life

Following Sylvania Electric's recent announcement about the sensationally small vacuum tube—originally developed for the now-famous proximity fuze transeiver—have come many inquiries concerning this super-midget.

SET MAKERS ESPECIALLY INTERESTED

Since the commercial version of the "war-baby" is being produced, many set manufacturers are extremely interested in its qualities — with a view toward making radios about the size of the average wallet or package of cigarettes, miniature walkie-talkie sets and other units.

This new tube, then, is being made in a low-drain filament type and is able to operate at 1.25 volts. This takes advantage of a new, small battery developed during the war which, of course, is a further aid in the manufacture of remarkably small radio sets.

WILL BE AVAILABLE FOR ALL TYPES

Future designs of this versatile tube can be incorporated in radios ranging in size from tiny pocket sets up to deluxe receivers. It has a life of hundreds of hours, is rugged and exceptionally adaptable to operation at high frequencies.

SYLVANIA ELECTRIC

Emporium, Pa.

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

FM OVER RUGGED TERRAIN

(CONTINUED FROM PAGE 31)

Seat Police Department, 3) Motor Patrol, 4) Attorney General's Office, 5) Fish and Game Commission, 6) FBI, 7) Military Intelligence, 8) public utilities. Counties are numbered on this map, too.

Therefore, if a car calls in, identifying itself as 33-4, the dispatcher knows that the car is in county 33, and is attached to the Attorney General's Office.

In short, the efficiency and effectiveness of this system, extending over South Dakota's 77,000 square miles, give it the speed and certainty of radio communication in any single metropolitan area.

REVIEWS OF NEW BOOKS

TELEVISION SIMPLIFIED, by Milton S. Kiver, 375 pages, well illustrated, cloth binding, 5 $\frac{3}{4}$ by 8 $\frac{1}{2}$ inches. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York City. Price \$4.75.

The author has reviewed in simplified form the basic theory of television with particular emphasis on television receivers. He discusses in detail the various circuits such as RF amplifiers, IF oscillators, mixers, IF amplifiers, diode detectors, AGC circuits, and video amplifiers. In the chapters on cathode-ray tubes, deflection systems, FM sound channels, and synchronizing circuits, he brings in the relationship of receivers to the transmitters.

A basic introduction to color television is also presented with a review of the early systems developed, and ending with the scanning system currently in use. The final chapter discusses the servicing of receivers and gives simplified diagrams of common circuits with a review of troubles most commonly encountered.

The book should be particularly valuable to anyone wishing to review or learn the basic fundamentals of television with a minimum of theory and mathematics.

RADIO TEST INSTRUMENTS, by Rufus P. Turner, 219 pages, 182 illustrations, cloth, 9 $\frac{1}{2}$ by 6 ins. Published by Ziff-Davis Publishing Company, 350 Fifth Avenue, New York 1. Price \$4.50.

This is a book describing the construction of various homemade test instruments, ranging from simple ohmmeters and vacuum-tube voltmeters to signal generators and frequency measuring instruments.

All the instruments have been constructed by the author, and he gives assurance that they are adequate for the use of those who prefer to build their own equipment. Even for those who choose to rely on standard instruments, this book is interesting, however, because it gives much information on the why's and wherefore's of circuits and designs.



A dependable direct-reading instrument for determining the Q or the ratio of reactance to resistance, of coils. Used in design and production engineering of Radio and Electronic equipment. Condensers and other components readily measurable.

Determines effective inductance or capacitance



BOONTON RADIO

BOONTON, N. J.

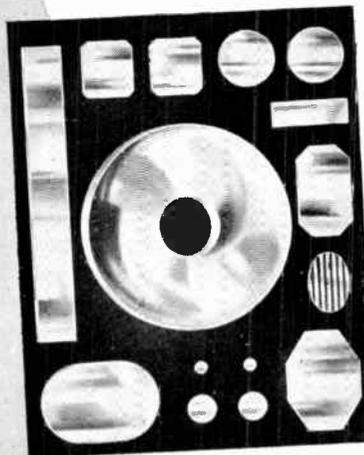
Corporation



DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

Front or Rear Surface

MIRRORS AND REFLECTORS



FOR TELEVISION, ELECTRONIC, OPTICAL, and SCIENTIFIC APPARATUS

Front or Rear Surface Mirrors and Reflectors made to your specifications. Closest optical and dimensional tolerances observed.

- EXCEPTIONAL REFLECTIVITY
- WILL NOT TARNISH
- OPAQUE OR SEMI-TRANSPARENT
- HEAT RESISTANT
- PROMPT SERVICE

We invite your inquiries. Samples and quotations will be submitted promptly.

Let Zenith help solve your Mirror and Reflector problems!

ZENITH OPTICAL LABORATORY

SPECIALISTS IN VACUUM DEPOSITION



123 WEST 64th STREET
NEW YORK 23, N. Y.

Radio Headquarters

for 25 years



We ship at once—parts, equipment, whatever you need!

This house began its career almost as early as Broadcasting itself! Today, 25 years later, we're the world's largest radio supply house! **Standard Lines:** National, Hammarlund, R.C.A., Hallcrafters, Bud, Cardwell, Bliely, and all the others!

SUPERSPEED SERVICE Orders shipped out same day received, on most goods.

ENGINEERING SERVICE If your engineering problem requires special equipment, we'll make it

FREE!

Latest bargain flyer includes test instruments, record changers, communication receivers, ham transmitting tubes and a host of electronic items you need today.



Originators and Marketers of the Famous **Lafayette Radio**

Radio Wire Television Inc.

NEW YORK 13 BOSTON 10 NEWARK 2

Cut out coupon, paste on penny post card, mail today

R. W. T. Dept. HB-6
100 AVENUE OF THE AMERICAS, NEW YORK 13

Gentlemen: Send me FREE copy of your Latest Bargain Flyer C-30, packed with recent electronic equipment and components.

NAME _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

SPOT NEWS NOTES

(CONTINUED FROM PAGE 32)

total dollar volume of home receivers without FM exceeds the total dollar volume of receivers with FM, Pollack will pay \$1,000 for the same purpose. RMA figures for complete receivers, at manufacturers' prices, are to be the basis of the wager.

Television Terminology: At DuMont's New York Television Studio, those two doors—if you know what we mean—carry the words "Alec Electron" and "Tillie Vision," respectively.

Selective Calling: Opens up a brand new field for amateur experimentation, and gives a new kick to the generally disregarded activity of talking to those less than a few hundred miles away. There are infinite possibilities in local "exchanges" connected by "central station" relays. This would make a fascinating combination of FM and AM systems, and would give a new purpose to YL's on the air!

RMA Forms Ham Section: Anticipating a revival of amateur radio activities which should add fifty million dollars to parts sales, RMA has formed an Amateur Radio Activities Section with W. J. Halligan of Hallcrafters as chairman and Frank Holstrom of H. H. Eby as vice chairman. Sub-committee chairmen are: Equipment, W. A. Ready, National Company; Parts, R. P. Almy, Sylvania; Frequency and Power Regulations, George Grammer, ARRL; Promotion, Walter Jablon, Hammarlund; Amateur Radio in Foreign Lands, Robert Adams, Airon.

FCC Predicts: In 1947, there will be 200,000 two-way citizens' radio units in use.

By July 1947, over 11,000 two-way installations will be in use on buses, trucks, ambulances, and taxicabs, for urban and highway service.

And by that same date, 3,300 installations will be operated by the railroads.

This represents nearly \$15,000,000 of FM equipment business in fields which did not exist before the war!

Radio Show Train: Prewar special train service to the Chicago Radio Parts Show is to run again this spring. According to Perry Saftler, 33 Park Place, New York, the Radio Industry Special will leave Grand Central Station at 4:15 p.m. on Sunday, May 12th, arriving at Chicago at 9:01 Monday morning.

Dinner, midnight supper, breakfast, liquid refreshments, smokes, and taxicabs with police escort at Chicago will be contributed by parts and set manufacturers. Side arms must be checked with the porter. Game committee will examine all dice brought aboard.

(CONCLUDED ON PAGE 76)

Long and Satisfying Service



IT'S ENGINEERED WITH **HI-Q** COMPONENTS

Ask any service man with years of radio set repair experience and he'll tell you most sets "go bad" because of the failure of some insignificant component. That's why it's important to give more than ordinary consideration to the selection of capacitors. Engineer a unit with Hi-Q components and you have strengthened every link in the chain of satisfying performance. Hi-Q ceramic capacitors are individually tested at every step of their manufacture. They'll stand up under the severest conditions of temperature, humidity, vibration and shock. Send for samples and complete data.



CERAMIC CAPACITORS

CN type with parallel leads
CI type with axial leads



WIRE WOUND RESISTORS

Sizes and quantities available promptly to required specifications.



CHOKE COILS

Uniform in quality—rugged construction tested for performance.

ELECTRICAL REACTANCE CORPORATION
FRANKLINVILLE, N. Y.

Note to Advertisers: Of the seven technical magazines represented among exhibitors at the IRE New York Winter Meeting, more engineers subscribed to *FM AND TELEVISION* than to all the other six combined ★ ★ The Reason: *FM AND TELEVISION* serves the postwar needs and interests of engineers engaged in radio manufacturing, broadcasting, and communications ★ ★ ★ ★

The **FINEST MICROPHONES**
for P.A. and RECORDING!



AMPERITE VELOCITY MICROPHONE
WITH
PATENTED ACOUSTIC COMPENSATOR

New P. G. DYNAMIC
WITH NEW
SUPERIOR ELIPSOID PICK UP PATTERN!

AMPERITE KONTAK MIKES
IDEAL FOR AMPLIFYING
STRINGED INSTRUMENTS
USED WITH ANY AMPLIFIER
AND WITH RADIO SETS.

ASK YOUR JOBBER . . . WRITE FOR FOLDER

AMPERITE

561 BROADWAY NEW YORK

SPOT NEWS NOTES

(CONTINUED FROM PAGE 74)

There will be accommodations for only 200, so make your reservations with Perry Saffler at once. His phone number is Rector 2-5334.

Herbert C. Florance: Is new chief engineer of Finch FM-facsimile station WGIF, 10 E. 40th Street, New York City. Prior to service as a warrant officer in the U. S. Navy, he was associated with NBC and WNYC.

Television Allocations Hearings: The FCC will conduct hearings for television stations in eleven cities.

In New York, 13 applicants will make bids for 4 channels still available, since the remaining three have already been allocated to NBC, DuMont, and CBS.

In Los Angeles, 13 applicants will vie for the 7 channels assigned to that area.

Ten organizations will compete for 3 of the 4 channels in Philadelphia. One channel has been assigned to Philco.

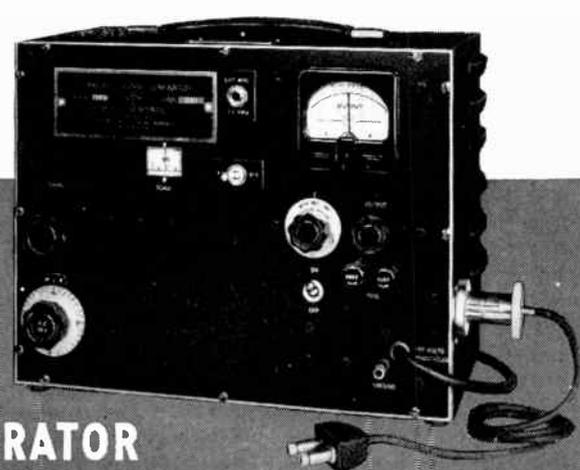
In Detroit, 5 companies will seek assignments to the 5 channels available, while in San Francisco 7 applicants will bid for 6 channels.

Five applicants will apply for Pittsburgh's 4 channels; 6 for Cleveland's 5 channels; 4 for Baltimore's 3 channels; and 2 each for 1 channel in Providence, R. I., Harrisburg, Pa., and Lancaster, Pa.

Chicago: Phillips Control Corporation, 612 N. Michigan Avenue, Chicago, has acquired the designs and all rights to relays formerly manufactured by G-M laboratories. This line of relays includes light and heavy duty power types, and telephone and midget multiple-contact relays. John E. Mossman, former vice president of C. P. Clare, has purchased controlling interest in the Phillips Corporation.

Laboratory Standards

FM
MODEL 78
SIGNAL GENERATOR



SPECIFICATIONS:
CARRIER FREQUENCY RANGE: 86 to 108 megacycles—individually calibrated dial.
OUTPUT SYSTEM: 1 to 100,000 microvolts with negligible carrier leakage.
OUTPUT IMPEDANCE: Constant at 17 ohms.
MODULATION: 400 cycle internal audio oscillator. Deviation directly calibrated in two ranges: 0 to 30 kc. and 0 to 300 kc.
 Can be modulated from external audio source.
 Audio fidelity is flat within two db from d.c. to 15,000 cycles.
 Distortion is less than 1% at 75 kc. deviation.

PRICE: \$300.00 F.O.B. Boonton, New Jersey

PROMPT DELIVERY

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

ENGINEERING SALES

(CONTINUED FROM PAGE 8)

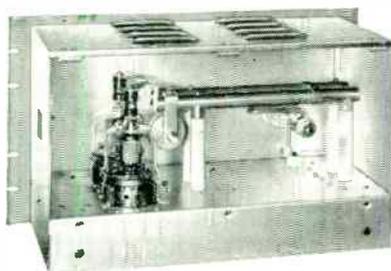
rector of Zenith's television station. He also took part in the construction of FM station WWZR, and was in charge of the Deerfield monitoring station.

Astatic: Has appointed J. K. Poff as service engineer of its jobber sales division. He will make his headquarters at the Astatic plant in Conneaut, Ohio.

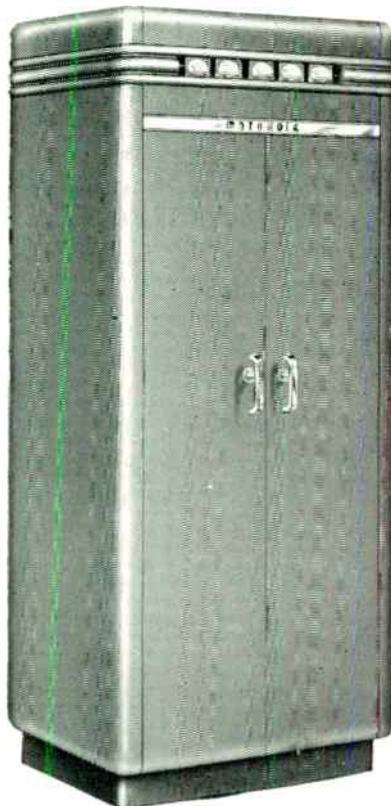
Sylvania: Bernard J. Erskine, back at Sylvania after three years with Naval Intelligence, has been appointed manager of parts sales. He will work out of Emporium, Pa.

Motorola Radio LEADS AGAIN

with 152-162 MC. 2-WAY RADIOTELEPHONE EQUIPMENT



Push-Pull Final Amplifier



Motorola RADAR RESEARCH Makes This Advance Possible!

Motorola's extensive RADAR development and productive activity is reflected in the new line of 152-162 mc. equipment. The use of cavities, lines and microwave techniques provide exceptional performance and trouble-free service in the new bands.

The new 152-162 mc. equipment has been field-tested and proved before being released. Recently, field tests were conducted at the Motorola factory before a group of APCO members. The tests included comparison of 250-watts 162 mc. and 30-40 mc. equipment using a 150-ft. tower for antenna support. The Central Station power was reduced to 15 watts. Two cars using 15-watt transmitters were cruised over a radius of 20 miles including areas like the loop, lower level of Wacker Drive and Lake Shore Drive with tall buildings between the cars and Central Station, in addition to the normal territory encountered in a large city. Solid 2-way coverage with marvelous fidelity and very high signal-to-noise ratio was reported. Comparison with 30-40 mc. over the same area showed marked superiority of 162 mc.

Motorola proudly announces its 152-162 mc. equipment with the Model FSTRU-250-BR 250-watt Central Station Transmitter-Receiver unit.

For the past five years over 80% of all police 2-way radio installations have been Motorola! Motorola Radiotelephone systems are widely used by leading railroads, fire departments, power companies, gas and oil pipe lines, taxi companies, cross-country bus and truck lines and municipal transit companies.

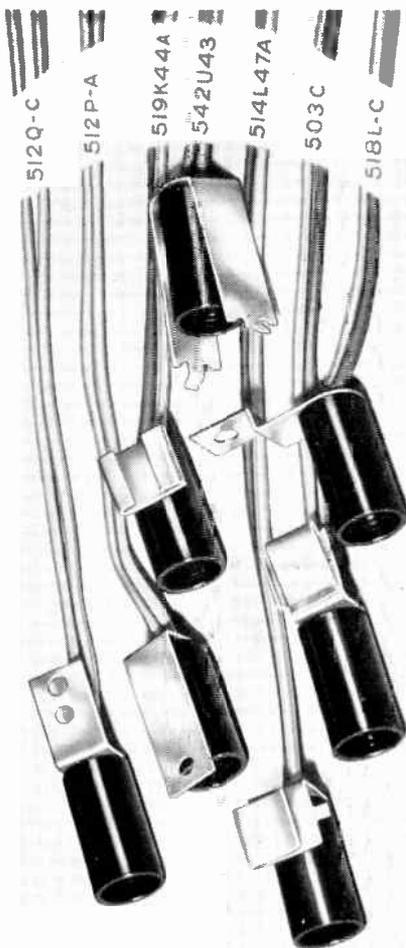
For information showing how Motorola Radiotelephone can solve your specific communications problems—write today!

GALVIN

MFG. CORPORATION • CHICAGO 51

COMMUNICATIONS AND ELECTRONICS DIVISION •

F-M & A-M HOME RADIO • AUTO RADIO • PHONOGRAPHS • TELEVISION • "HANDIE TALKIES" • POLICE RADIO • AIRCRAFT RADIO



TOP QUALITY AT LOW COST

DRAKE patents plus modern high speed methods and machinery go a long way toward achieving the traditional excellence and economy of our products. It should pay you in better performance and *lower costs* to specify DRAKE for all of the Socket and Jewel Light Assemblies you need. Ask for prices and the newest Drake Catalog.

DRAKE



SOCKET AND JEWEL LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.

1713 W. HUBBARD ST., CHICAGO 22, ILL.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

dered by self-supporting station operation favors a smaller number of wide-coverage stations rather than a larger number with limited coverage, they continue to support the CBS-Kesten plan.

4. And why the Commissioners give lip service to their obligation to assure rural listeners of FM reception, yet clamp down restrictions which limit FM reception to population centers, except for community stations of limited-program capabilities.

Only when the FCC gives the right answers to these questions of public interest, convenience, and necessity can the matter of FM allocations be considered as settled.

2. The FM and Television Station Directory, originally scheduled for this issue, has been put forward until March. The reason is that the number of police and emergency stations has increased so greatly since the previous directory was published, last July, that it was possible to run only Part 1 in January. Part 2 appears in this issue. We regret any inconvenience that may have been caused our readers by postponing the FM and Television Station Directory until next month.

3. Future actions by the FCC will be scrutinized closely for possible relation to Chairman Porter's recent appointment to the Democratic party's board of strategy.

Last March, commenting on Paul A. Porter's appointment as FCC Chairman, we noted that "a protest was filed against his nomination on the grounds that his appointment appeared to be a reward for his efforts in behalf of his party (as publicity director of the Democratic National Committee), a practice which is specifically forbidden by law."

We added, "However, this background will have proportions of significance only if Mr. Porter uses his office to channel other rewards to the faithful."

These comments are interesting now in the light of his position on the Democratic party's board of strategy. Headed by general manager Hannegan, this board will plot the course of the Democratic presidential campaign in 1948.

Chief strategic considerations are: 1) campaign contributions in cash, and 2) campaigning facilities such as broadcast time, both of which are vital factors in 3) mass production of votes.

Judging from the attitude of some AM operators toward FM, they would be so pleased with any FCC action detrimental to FM progress that no solicitation of their support in cash contributions or air time would be necessary. Chairman Porter, if he were so inclined, could get results for the Hannegan board without

(CONTINUED ON PAGE 79)

Low Residual Inductance

Higher Resonant Frequency



● A brand new molded-in-bakelite mica capacitor intended specifically for circuits where inductance must be kept at a minimum. Designed for least possible residual inductance, low r.f. losses, and lower r.f. resistance and impedance. Provides increased KVA ratings for given capacitor sizes.

May be advantageously applied as blocking capacitors in transmission lines; as tank capacitors for high-frequency oscillators; as by-pass capacitors for ultra-high-frequency currents; as coupling or by-pass capacitors in induction-heating circuits.

Exceptional compactness for given KVA ratings; exceptionally low-loss operation; ability to withstand constant duty and heavy overloads—for these and other reasons this latest Aerovox development marks a new performance standard for severe-service capacitors.

● DATA ON REQUEST



FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORP., NEW BEDFORD, MASS., U.S.A.
Export: 13 E. 40th St., New York 16, N.Y. • Cable: 'ARLAB'
In Canada: AEROVOX CANADA LTD., Hamilton, Ont.

FM AND TELEVISION

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 78)

laying himself open to such an attack as has been leveled against Edwin W. Pauley.

His record of some ten months has shown no evidence of effort to implement the progress of FM broadcasting, in spite of his favorable protestations. Even the "conditional grants" issued to FM applicants have proved so far to be a new kind of pocket veto.

Has the Commission been too busy to issue construction permits to cover those conditional grants? Suppose Chairman Porter had been right when he said on August 17th that "10-kw. FM transmitters will be immediately available for the new band." Or was that statement, which transmitter manufacturers knew to be without foundation, trumped up as a left-handed means of telling AM operators that no objection would be made to their discontinuing low-band FM broadcasting?

Well, if the Commission has been too busy to issue C.P.'s to cover FM conditional grants, what has been the AM situation?

The record shows that to be a different matter. Although Chairman Porter has stated that the AM frequencies are already overcrowded, the Commission, sitting en banc on January 30th and February 6th, authorized the construction of a new 1-kw. AM station, six new 250-watt AM stations, and power increases from 1 kw. to 5 kw. for four AM stations and from 5 kw. to 10 kw. for another.

In all the records of the FCC, from its inception to the end of James Lawrence Fly's administration, even those who disagreed most violently with the Commission had no reason to feel that the Commissioners acted in the service of party politics.

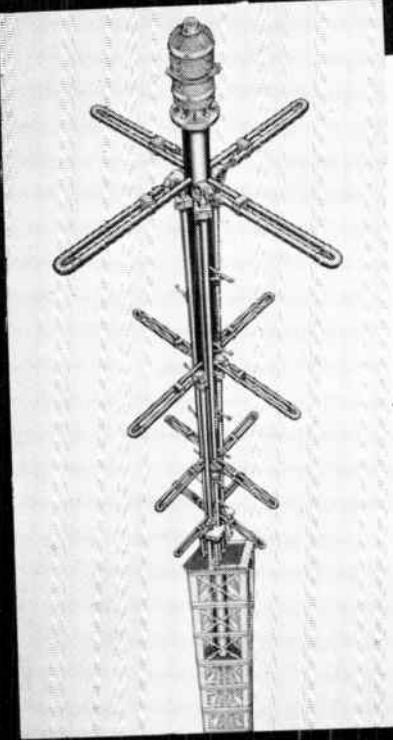
That cannot be said of Paul Porter's administration, for a step-by-step review of FCC actions since his appointment as Chairman seems to confirm the growing suspicion that the interests of the public have been sacrificed to those of AM operators who might be happy to contribute both funds and airtime in appreciation of whatever the FCC could do to delay the national expansion of FM broadcasting.

Whether or not this suspicion is justified, the fact remains that Chairman Porter, by accepting a place on the Hannegan committee, has discounted the dignity of his office, and prejudiced the high standing of the Commission as the servant of public interest, convenience, and necessity. It should be obvious to the Commissioners that any member of the FCC organization should resign his office before undertaking to engage in party politics.

We hope that the integrity of the Commission will be guarded jealously in the future, so that there will be no reason to wonder if political motives lie behind FCC actions.

At Long Last!

A FOLDED DIPOLE TURNSTILE F.M. ANTENNA



By **WINCHARGER**

- 1—VERY BROAD BAND — incorporates features of ordinary turnstile with vast improvement of FOLDED DIPOLE principle.
- 2—PROVED by 4 years actual service in leading 50 K.W. station.
- 3—FACTORY PRETUNED—no field adjustment.
- 4—LARGE SAFETY FACTOR
- 5—DESIGNED by high frequency and Radar antenna engineers of Zenith Radio Corporation.
- 6—COMPLETE "PACKAGE" — one company supplies everything — And No Extras to Buy.

Phone, Write or Wire

Antenna Tower Dept.
WINCHARGER CORPORATION
SIOUX CITY 6, IOWA

COMING

▼

THE STANDARD TELEVISION HANDBOOK

A new series to be published in
FM AND TELEVISION
and to appear later
in handbook form

▼

WATCH FOR THIS VERY IMPORTANT SERIES TO COME

JOB AHEAD

...and we're equal to it!
Each day we are shipping more for civilian use.



WIRES

MADE BY *Engineers*
FOR *Engineers*

cornish

WIRE COMPANY, inc.
15 Park Row,
New York City



✓✓
**ONLY HAMMARLUND RECEIVERS
 HAVE THIS FEATURE...**

UNITED STATES PATENT OFFICE 2,222,043

2,222,043
SELECTIVE WAVE TRANSMISSION

Donald K. Oram, Forest Hills, N. Y., assignor to
 The Hammarlund Manufacturing Company, In-
 corporated, New York, N. Y., a corporation of
 New York

Application June 28, 1939. Serial No. 281,612
 8 Claims. (Cl. 178-44)

This invention pertains to electrical apparatus
 and circuits of the type known as filters and
 more especially to such apparatus and circuits
 of the type referred to as band pass filter.
 One object of my in-

corporated in such receiver to such a degree as
 may be found necessary, and to make such re-
 duction quickly and to a predetermined degree.
 Another purpose is greatly to attenuate

Series 400
 "Super-Pro"



The variable crystal filter
 used in the "HQ-129-X"
 and the "Super-Pro" is an
 exclusive Hammarlund
 patent. It provides wide
 band crystal selectivity for
 use in crowded amateur
 phone bands and single
 signal code reception.

Write For Technical Details



HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N. Y.
 MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

PHASE-SHIFT MODULATORS

FOR **FM** BROADCASTING

BEFORE the war, REL was the only manufacturer of FM broadcast transmitters who advocated the use of the Phase-Shift method of producing Frequency Modulation. REL transmitters have always employed this method because of the very high order of stability and the low distortion characteristics that are inherent in the system.

IT IS with considerable pride, therefore, that we now find our judgment confirmed through the introduction to the art of crystal controlled, phase-shift arrangements that have been engineered by other manufacturers. It is certain that their decision to adopt the basic principle of the Armstrong Modulator will be helpful to the FM industry as a whole.

WE DO not believe that the circuitry employed to produce a phase-shift is as important as the recognition that the Phase-Shift principle is the best. We do contend, however, that the performance and reliability of the dual channel Modulator by REL cannot be surpassed, and we predict that the operating data on all systems that will soon become available to the industry will establish this fact.

REL built the first commercial Phase-Shift Modulator in 1938 and has built a substantial quantity of them during the last eight years. The experience gained over these years makes it possible for REL to offer the most advanced designs and insures the highest quality of performance and reliability.



Sales Representatives

SOUTHEAST

<p>John F. Bivins 1008 Wellington Road Highpoint, North Carolina</p>	<p>Electronic Supply Co. 112 North Main Street Anderson, South Carolina</p>	
<p>PACIFIC COAST Norman B. Neely Enterprises 7422 Melrose Avenue Hollywood 46, California</p>	<p>MIDWEST REL Equipment Sales, Inc. 612 N. Michigan Blvd. Chicago, Ill.</p>	<p>MICHIGAN M. N. Duffy & Co., Inc. 2040 Grand River Ave., W. Detroit, Mich.</p>

PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

RADIO ENGINEERING LABS., INC.
Long Island City, N.Y.

NOW — *Link* FM 2-WAY and 3-WAY RADIO FOR ALL THREE BANDS

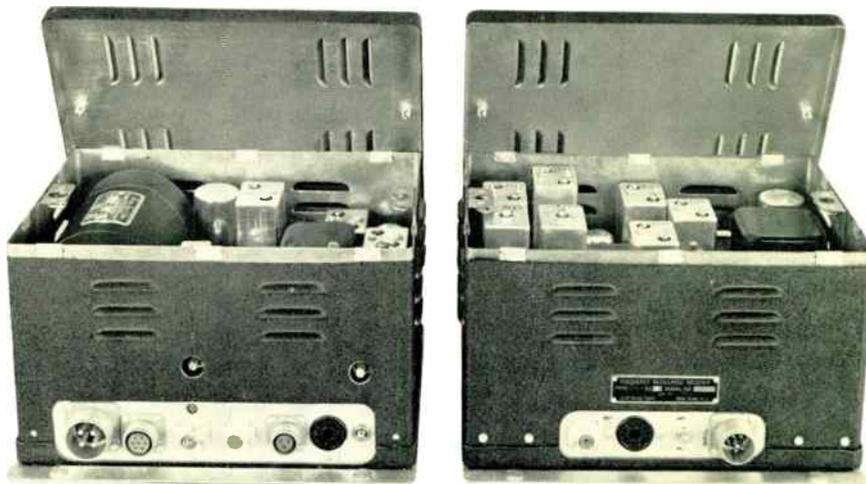
72-76 mc.
30-40 mc.
152-162 mc.



Illustrated is the Link 152-162 megacycle equipment which joins its predecessors in the 30-40 and 72-76 megacycle bands to give users a choice best suited to their needs.

Whatever the requirements, whether for city, county, or state coverage, complete Link two-way and three-way systems as well as relay and repeater equipments are now immediately available.

For police, fire, forestry, public utility, transportation and common carrier groups, and all government services, Link is best by proven performance.



**TYPE FMTR-7C MOBILE ASSEMBLY
TRANSMITTER—RECEIVER 152-162 mc.**

All fixed station and mobile equipments, regardless of frequency, can be supplied with Selective (Dial) Calling units as and when desired.



**THE TYPE 1938 DELUXE
REMOTE CONTROL 152-162 mc.**



**THE TYPE 1908 152-162 mc.
250 WATT MAIN STATION.**

SPECIFY LINK — OBTAIN THE FINEST

ENGINEER • MANUFACTURER

Fred M. Link

125 WEST 17th STREET • NEW YORK 11, N. Y.

**PREFERRED FM RADIO
COMMUNICATION EQUIPMENT**

MANUFACTURED UNDER LICENSE OF THE
ARMSTRONG PHASE SHIFT MODULATION PATENTS