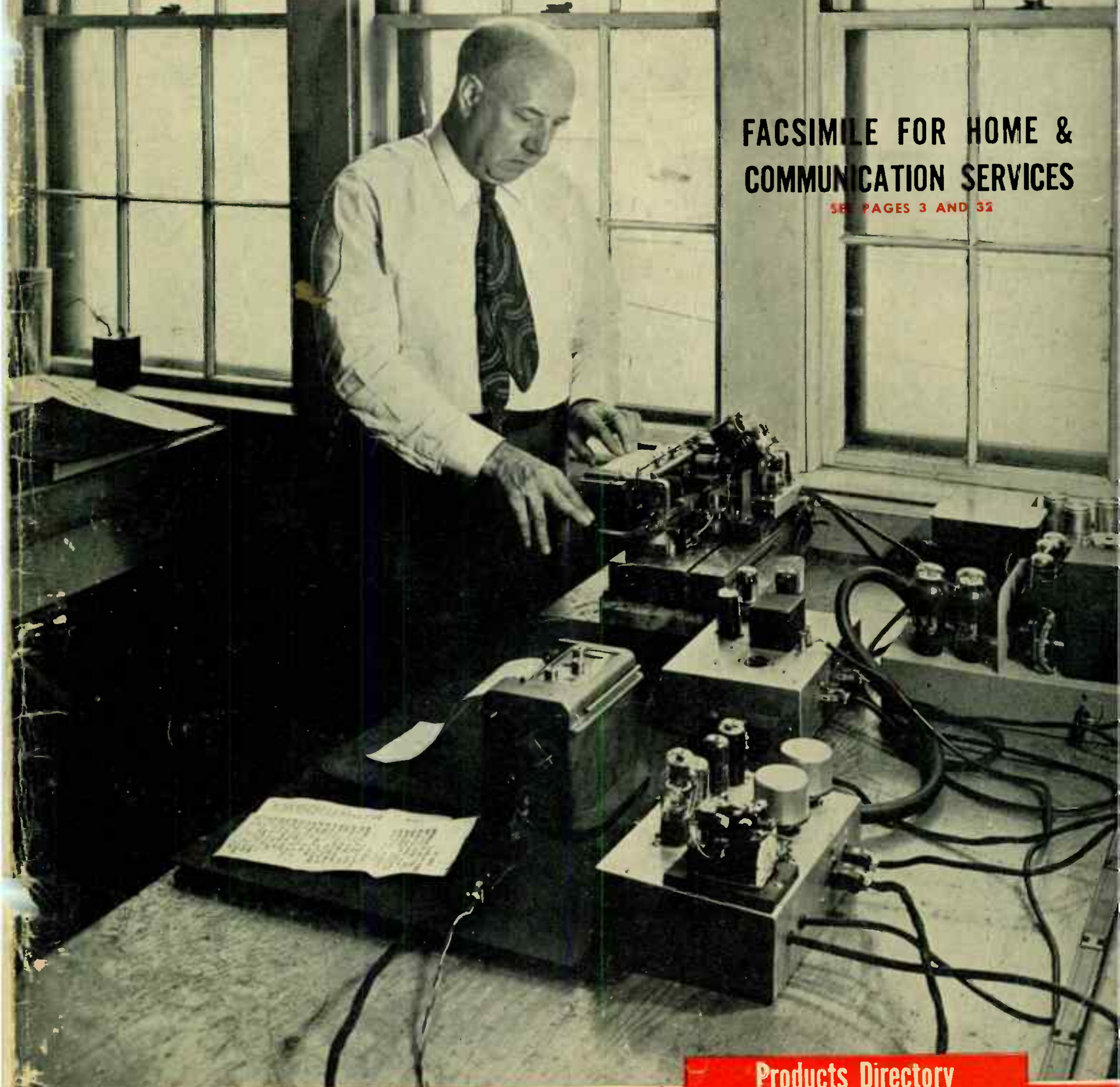
PRICE—TWENTY-FIVE CENTS

FM AND TELEVISION

AUG. 1945



FACSIMILE FOR HOME & COMMUNICATION SERVICES

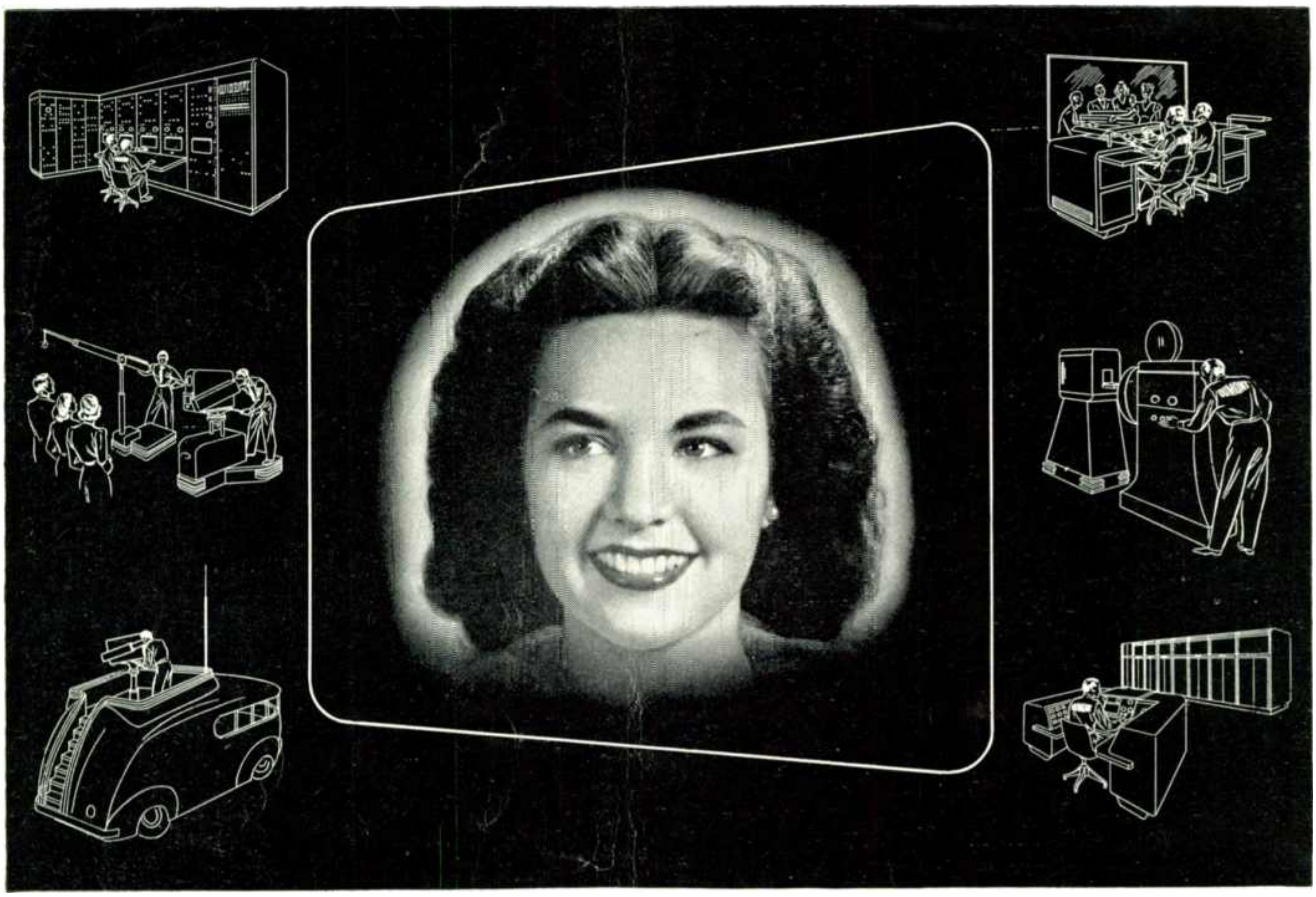
SEE PAGES 3 AND 32

Products Directory

★ ★ *Edited by Milton B. Sleeper* ★ ★

REG. U.S. PAT. OFF.

World Radio History



DuMONT—FOR THE TOOLS OF TELEVISION

PROOF OF THE PUDDING!

DuMont has designed and built *more* television stations than any other company. DuMont-built stations, every week, are demonstrating the high efficiency, rugged dependability and low operating cost of DuMont-engineered equipment.

DuMont's simplified precision control—the dominant keynote of *all* DuMont design—is brilliantly exemplified in the tools of television featured above. These postwar designs incorporate all the flexibility and refinements dictated by more than 4 years of continuous and increasingly elaborate experimentation by hundreds of program producers.

DuMont's Station WABD, New York, has pioneered a pattern for commercial television that you can make your own whenever you choose to study it. And DuMont's Equipment Reservation Plan insures early peacetime delivery of your equipment and competent training of your personnel. *Television is our business!*

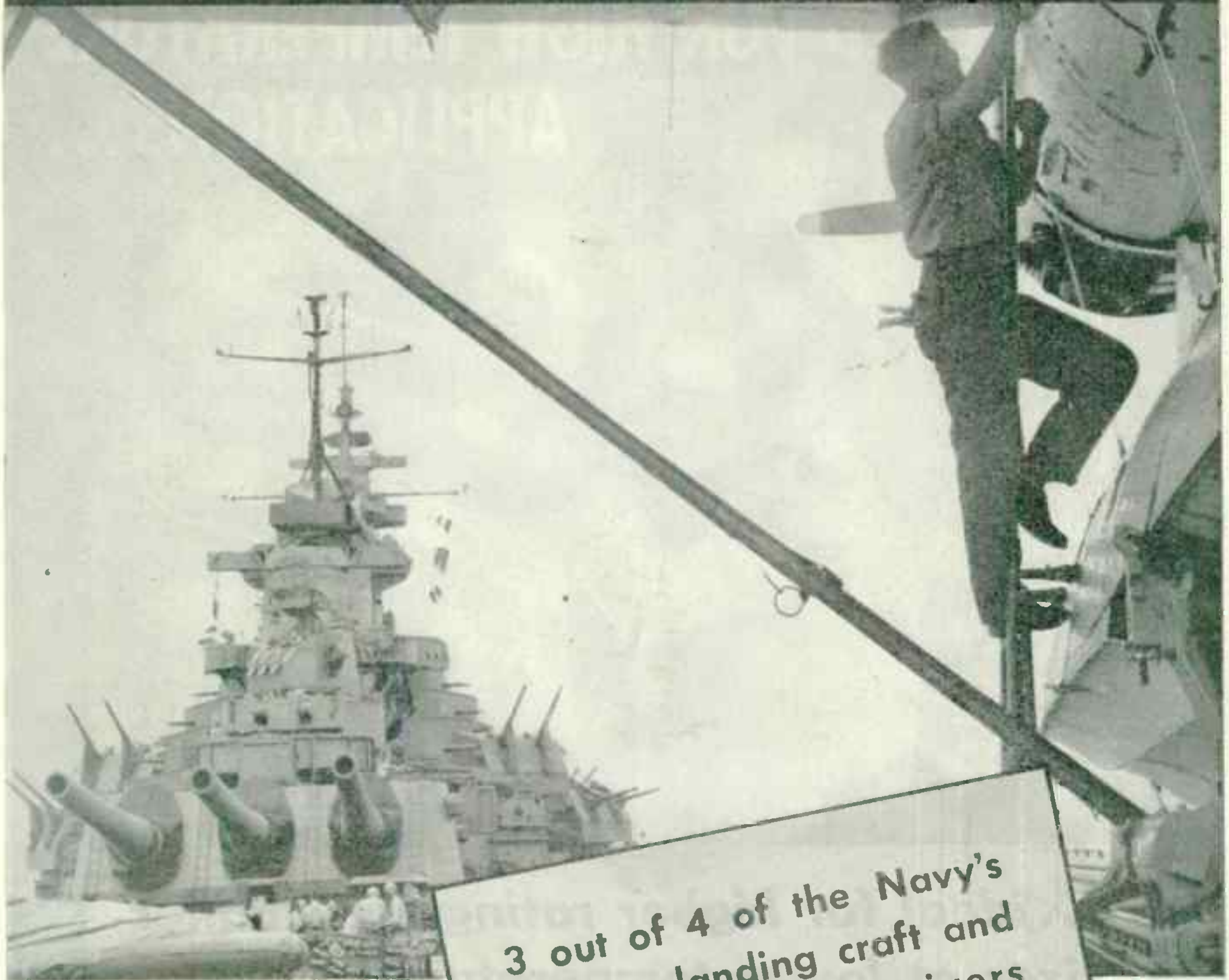
Copyright 1945, Allen B. DuMont Laboratories, Inc.

DUMONT *Precision Electronics and Television*

ALLEN B. DUMONT 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

World Radio History

NATIONAL RECEIVERS ARE THE EARS OF THE FLEET



OFFICIAL U. S. NAVY PHOTOGRAPH

3 out of 4 of the Navy's ships — landing craft and larger. — use receivers designed by National.

The OS2U "Kingfisher" observation scouting plane provides eyes for the battleship's muscle. Radio provides the indispensable link. It has to be reliable.

HRO

NC-200

NATIONAL COMPANY

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

World Radio History

UNEXCELLED FOR HIGH TEMPERATURE APPLICATIONS...

CAN TYPES 25P

Two standard types, one for 105° C. and one for 95° C. continuous operation. Other ratings available.

HERMETICALLY SEALED IN GLASS TUBES

Famous Sprague glass-to-metal end seals. Extended construction gives maximum flash-over distance between terminals.

...ideal for higher ratings in smaller sizes at lower temperatures

Sprague Capacitors impregnated with the exclusive VITAMIN Q impregnant make possible the use of much smaller units—with a substantial safety margin—on numerous high-voltage, high temperature applications ranging from transmitting to television. Where high temperature is not a factor, their unique characteristics assure materially higher capacity ratings for a given size.

Type 25 P VITAMIN Q Capacitors operate satisfactorily at thousands of volts at ambient temperature as high as 115° C. Insulation resistance at room temperature is *more than 20,000 megohms per microfarad.* Throughout the temperature range of +115° C. to —40° C. they retain all virtues of conventional oil-impregnated capacitors.

WRITE FOR NEW CATALOG

Sprague Catalog 20—just off press—brings you details on VITAMIN Q Capacitors in both can and glass tube types as well as dozens of other paper dielectric types for today's exacting uses.

SPRAGUE ELECTRIC COMPANY • North Adams, Mass.

SPRAGUE

ARMY E NAVY

VITAMIN "Q" CAPACITORS

TRADE MARK REG. U. S. PAT. OFF.

World Radio History

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 5 AUGUST, 1945 NO. 8

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CONTENTS

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★ ★ ★ ★ ★ ★

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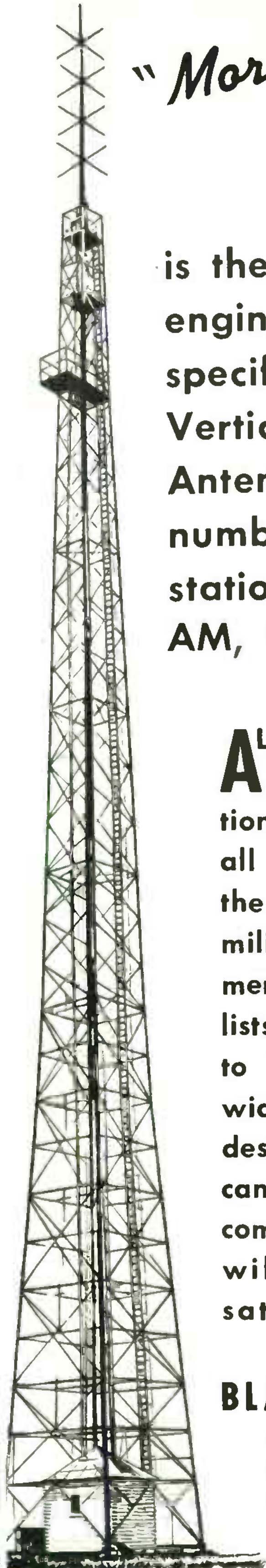
THIS MONTH'S COVER

FM has proved to be the long-missing key which has opened the door to successful facsimile. Newspapers operating or planning FM broadcast stations, police departments, airlines, and railroads are already at work on facsimile applications. The old concept of broadcasting newspapers during early morning hours has given way to simultaneous reception of sound and facsimile pictures, news, and advertising during regular listening hours. This month's cover is a photograph of Milton Alden, one of the facsimile pioneers, taken in the laboratory where revision of wartime models for peacetime service is being pushed with all possible speed.



"More than Satisfactory"

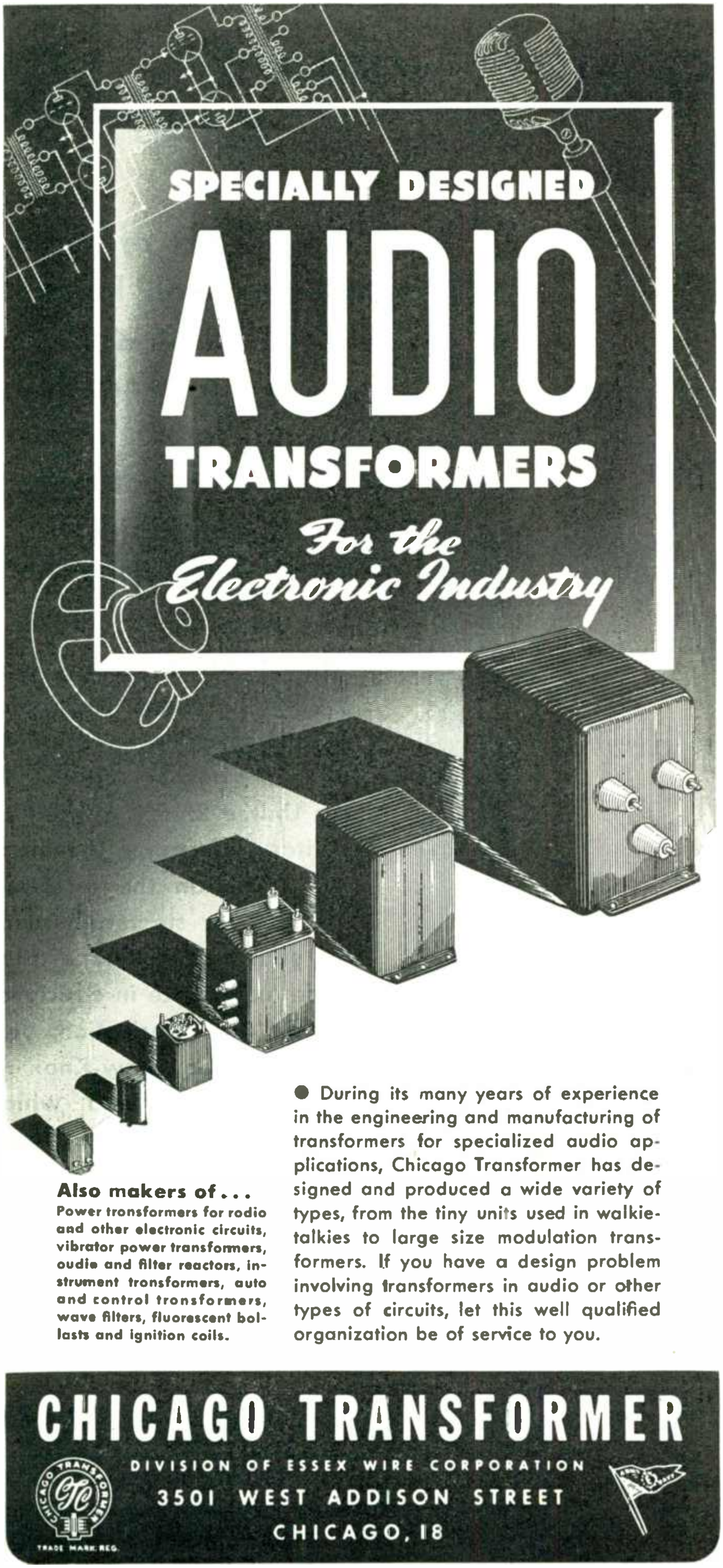
is the verdict of radio engineers who have specified Blaw-Knox Vertical Radiators and Antennas for an imposing number of important stations employing AM, FM and VHF.

ALSO, Blaw-Knox has supplied Towers for Directional Radio Beacons to guide all air transport service in the United States, as well as military electronic developments still on the restricted lists . . . For strict adherence to your specifications plus wide experience in structural design and fabrication, you can count on Blaw-Knox to complete a contract which will prove "more than satisfactory."

BLAW-KNOX DIVISION
of Blaw-Knox Company
2046 FARMERS BANK BLDG.
PITTSBURGH PENNA.

BLAW-KNOX VERTICAL RADIATORS

Application for entry as second-class matter at Great Barrington, Mass. and Concord, N. H. is pending



WHAT'S NEW THIS MONTH

STRATO-STATIONS

THE Westinghouse strato-station plan for FM and television, announced at a New York City press luncheon on August 8th, has many elements that stir the imagination. Undoubtedly, 1-kw. transmitters at 30,000 ft. could cover areas 400 miles in diameter, and 14 such installations could serve 78% of U. S. listeners.

But have Westinghouse and Glenn Martin engineers proved, even to their own satisfaction, that this is the *right* way? Or have they taken too much for granted as did the originator of this plan when he gave the press to understand that color television is an accomplished fact?

Glenn Martin's enthusiasm for anything that uses airplanes is understandable, but wouldn't it be better to demonstrate that television in the upper band can be operated on the ground before announcing a nation-wide strato-station network?

This plan combines a communications system, in the form of relays, with the operation of broadcast stations. Will the FCC permit it? AT & T gave up its broadcasting operations. Will the present networks make use of the strato-stations? It would mean abandoning their affiliates and the operation of their own stations, and re-establishing their audiences.

The strato-net plan, according to its sponsors, would have to carry four television and five FM coast-to-coast network programs in order to pay expenses. Certainly there is not an existing volume of radio advertising, or the listener demand, to justify such a block of added facilities. Again, strato-stations would be no substitute for existing ground stations which serve listeners by combining network originations with programs of stricly local character.

Finally, as was shown in the map of existing Bell System lines now carrying 15,000 cycles or more (published as a supplement to the February, 1945 issue of *FM* AND TELEVISION) wire facilities for FM nets will be available as soon as stations can be erected to use them. Perhaps television may require such a system to reduce the number of relays needed for transcontinental nets. Only time can tell about that.

As for FM, the sponsors of the strato-plan have proposed possibilities that are intriguing to conjure with, but none, so far, that is competitive with ground facilities now in use or to be available presently, either from the point of view of public service or operating cost. — *M. B. Sleeper*.

World Radio History

SYLVANIA NEWS
ELECTRONIC EQUIPMENT EDITION

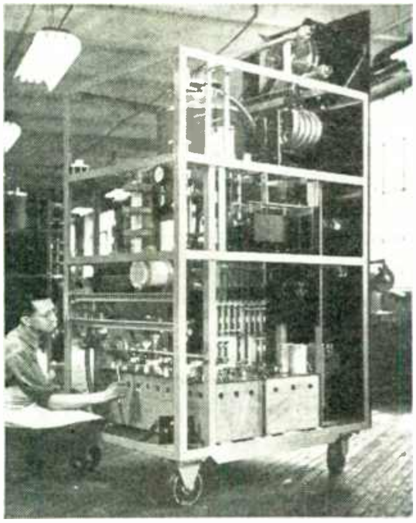
AUGUST *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

HIGH FREQUENCY INDUCTION FURNACE USED IN TUBE PLANT

The bombarder or high frequency induction furnace pictured below is another example of high-precision, modern equipment manufactured at Sylvania Electric's plant in Williamsport, Pa.

Flexible in Application

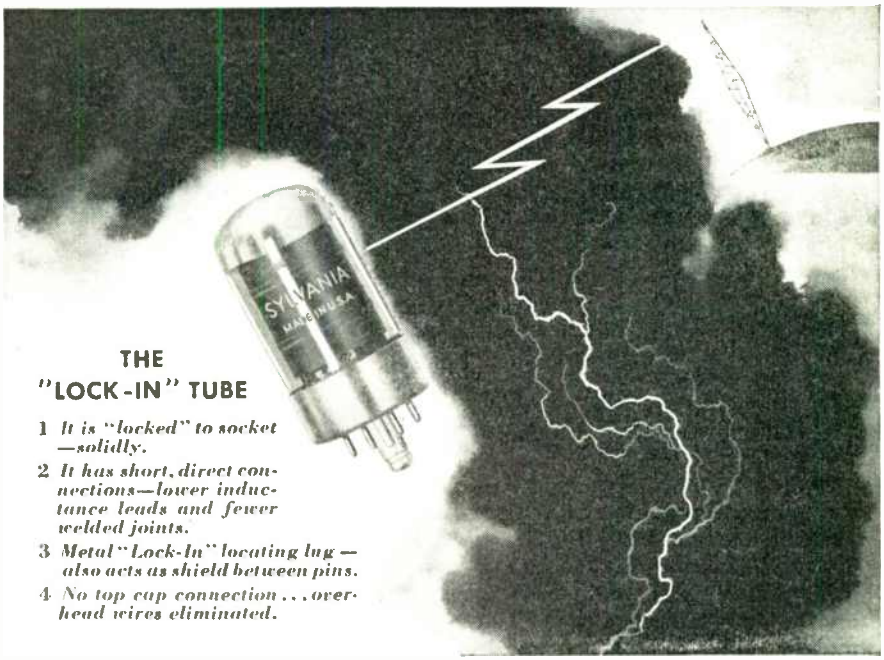
Used in all radio tube plants where exhaust machines operate, this essential apparatus may also be adapted for use in practically any application that requires high frequency induction heating by the connection of the proper heating coils. Its rated input is 25KVA, uses Type 207 tube as oscillator, frequency about 300KC.



High frequency induction furnace used in all radio tube plants where exhaust machines operate. Made by Sylvania Electric at Williamsport, Pa.

LOCK-IN TUBES PERFECTLY IN LINE WITH RECENT FCC DECISION

High Frequency Sets (FM) Will Get Benefit of Tubes' Electrical Superiority



Sylvania Electric's revolutionary type of radio tube — the Lock-In — is so mechanically stronger and electrically more efficient that it takes in its stride the recent FCC decision assigning to frequency modulation the band between 88 and 106 megacycles. The basic electrical advantages of the Lock-In construction are ideally suited to the adoption of higher frequencies.

Mechanically it is more rugged because support rods are stronger and thicker—there are fewer welded joints and no soldered joints—the lock-in lug is metal not molded plastic—the elements are prevented from warping and weaving.

Electrically, it is more efficient because the element leads are brought directly down through the low loss glass header to become sturdy socket pins—reducing lead inductance—and interelement capacity.

Today, the many special features of the Sylvania Lock-In Tube are even more up-to-date than when they were introduced in 1938—a fact of increasing importance when considering the numerous postwar developments in the field of communications.

SYLVANIA ELECTRIC

Emporium, Pa.

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

World Radio History

NEW VACUUM TUBE FREQUENCY METER...

...FOR FREQUENCIES IN 400 800 1200 1600 2400 3600 CYCLE BANDS

MODEL 39-VTF, Series A, a new development of J-B-T engineers, measures frequencies in six specific bands with accuracy of ± 0.25% of the frequency being measured, and with sufficient amplitude to be easily read.

Vacuum tube multivibrator circuits divide the incoming frequency by 1, 2, 3, 4, 6 or 9, depending on the position of the multiplier switch, and show the result on the time-tested, standard 400 cycle meter.

Regular line current is used for power supply, permitting an input sensitivity of 500,000 ohms. Response is not affected by irregular wave form, nor by harmonic content of unknown frequencies of less than 10% or 15% . . . and input control permits use from 100 to 350 volts.

The result is an instrument of high accuracy and high stability with permanent calibration . . . especially useful for checking audio oscillators, frequency converters, radar equipment, and for standardizing less accurate frequency measuring units.

Check These Points

- **EXTREME ACCURACY** ...within ± 0.25% of frequency being measured.
- **PERMANENT ACCURACY** . . . no further calibration or standardization required at any time.
- **STABILITY** ...no temperature drift after initial 30 second warm-up.
- **BURN-OUT PROOF** . . . no protection needed against accidental above-range frequencies.
- **SENSITIVITY** . . . 500,000 ohms.
- **SIMPLICITY** ... uses standard tubes.
- **POSITIVE SWITCHING** . . . built-in switch is J-B-T's own rugged, coin-silver plated instrument switch, as supplied for high quality testers.

New Booklet . . . just off press, illustrates other types of J-B-T Vibrating Reed Frequency Meters. Ask for Bulletin VF-43-1C.

J-B-T

Manufactured under J-B-T and/or Triplett Patents and Patents Pending

8-JBT-6

J-B-T INSTRUMENTS, INC.

473 CHAPEL STREET • NEW HAVEN 8, CONNECTICUT

ADVERTISERS INDEX

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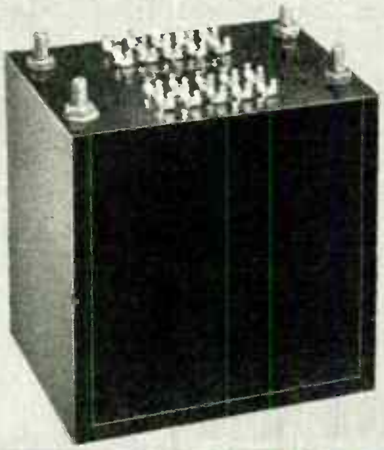
TRANSFORMERS *of Special Design*

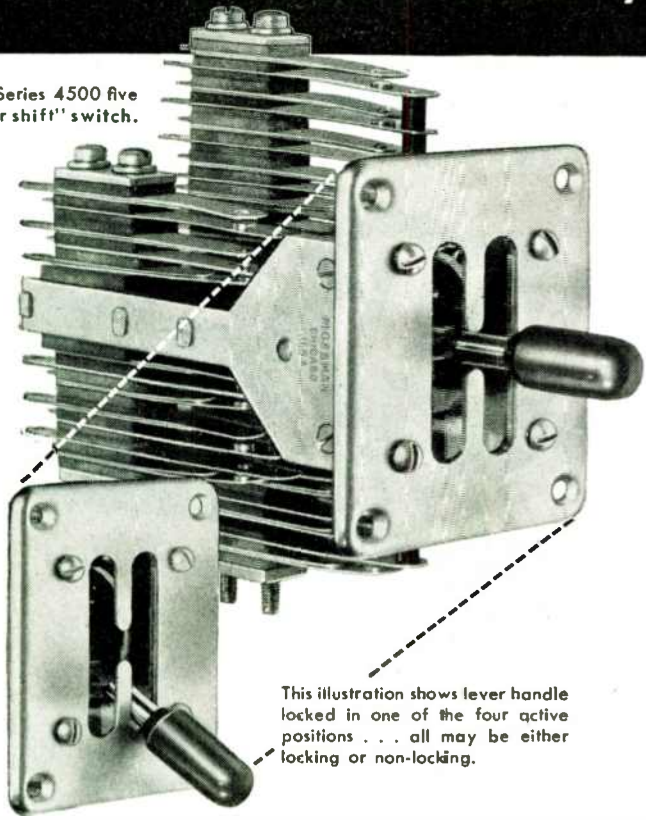
A few of the many high quality transformers manufactured to critical specification. Rigid control of material and process—*PLUS* conservatism in design insure a dependable long-life product. We solicit your inquiries. Sizes to 5 KVA.



The Langevin Company
INCORPORATED
SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING
NEW YORK SAN FRANCISCO LOS ANGELES

World Radio History

This MOSSMAN "Gear Shift Switch" Adds Choice of Five Positions To Unusual Circuit Flexibility



New Mossman Series 4500 five position "gear shift" switch.

This illustration shows lever handle locked in one of the four active positions . . . all may be either locking or non-locking.

A new Mossman Switch—Series 4500—has been developed to meet new and unusual requirements for precision electrical components adapted to radio and electronic control circuits. This is a five position heavy duty lever switch, built of high grade materials specified by the U. S. Navy.

The rigidly braced, heavy brass frame supports a chromium plated latch plate and spring-actuated piston, in which a roller is mounted clevis fashion. Axles, stop pins and piston are stainless steel. Plated phosphor bronze springs have spun-in heavy duty silver contacts.

Series 4500 Switch has four independent contact spring pile-ups, each of which is actuated either locking or non-locking. Contact assemblies are built up from standard forms.

A special feature of the Series 4500 Switch is that it is not provided with fixed stops. Action of the different positions may be changed by inserting or removing stop plates beneath the escutcheon. Also available are a special safety latching feature, special housings, wiring and other features to meet your requirements.

Many types of Mossman heavy duty, multiple circuit lever switches, turn switches, push switches, plug jacks and other special switching components are shown in the Mossman Catalog. Send for your copy.

DONALD P. MOSSMAN, INC., 612 N. Michigan Ave., Chicago 11, Illinois

MOSSMAN
Electrical Components

ENGINEERING SALES

Stromberg-Carlson: Will be represented in the Cincinnati area by Tepfer Appliance Company, 49 Central Avenue, Cincinnati, Ohio. Jack Tepfer has had long experience in the refrigerator field, and sales manager G. D. Haley has a background of both sales and engineering.

Clarostat: As a part of its postwar preparations, Fran Chamberlain has been appointed assistant sales manager of the jobber division, and two new representatives have been named. They are Wood & Anderson Company, 915 Olive Street, St. Louis, Mo., and Henry P. Segal Company, 143 Newbury Street, Boston, Mass. They will cover both jobber and industrial accounts.

Bendix: Added distributors are Van Deren Hardware Company, Lexington, for eastern Kentucky — radio manager Raymond A. Wilkie; A. B. Gray Company, Fort Wayne, for northern Indiana and northwestern Ohio — under the direction of A. B. Gray; D'Elia Electric Company, Bridgeport, Conn. — president Charles A. D'Elia; Peninsular Distributing Company, Detroit, for the state of Michigan — president J. H. Ryall; American Sales and Distributors, Inc., Columbus, for central Ohio — president A. Goldenberg.

Meck Sales: Henry Hutchins, formerly head of the sales department of the National Union Radio Corporation, has been elected president of John Meck Industries Sales Corporation. He will make his headquarters at the Meck sales office, 35 East Wacker Drive, Chicago.

RCA: David J. Finn, formerly RCA Victor regional sales manager at Chicago, has been named manager of the renewal sales department of the tube division. In this new capacity, he will be in charge of the sale of tubes, components, and replacement parts handled through jobbers and dealers. Harold C. Vance, formerly manager of broadcast and police transmitter sales in the middle west, has been named manager of the direct sales department of the tube division. He will supervise tube sales to broadcast and police stations, air lines, schools, and industrial users.

James Knights: Has opened a Chicago office at 175 W. Jackson Boulevard. Telephone

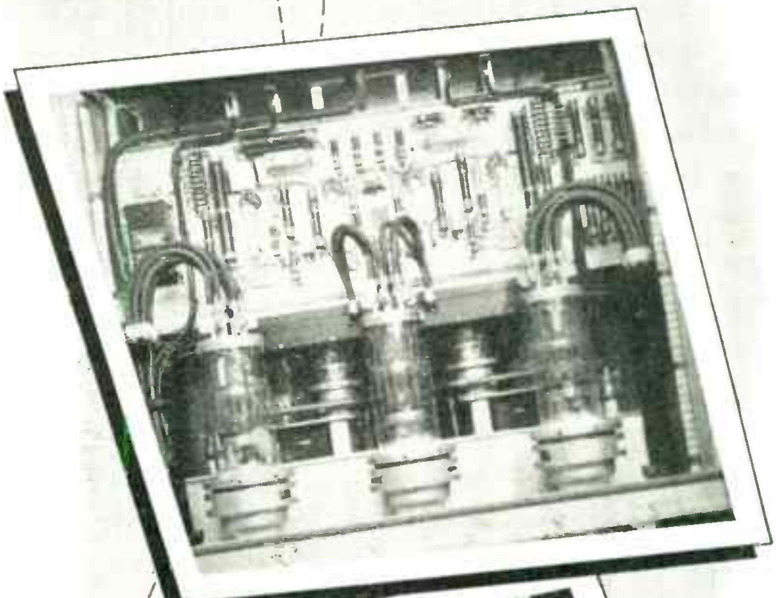
(CONCLUDED ON PAGE 86)

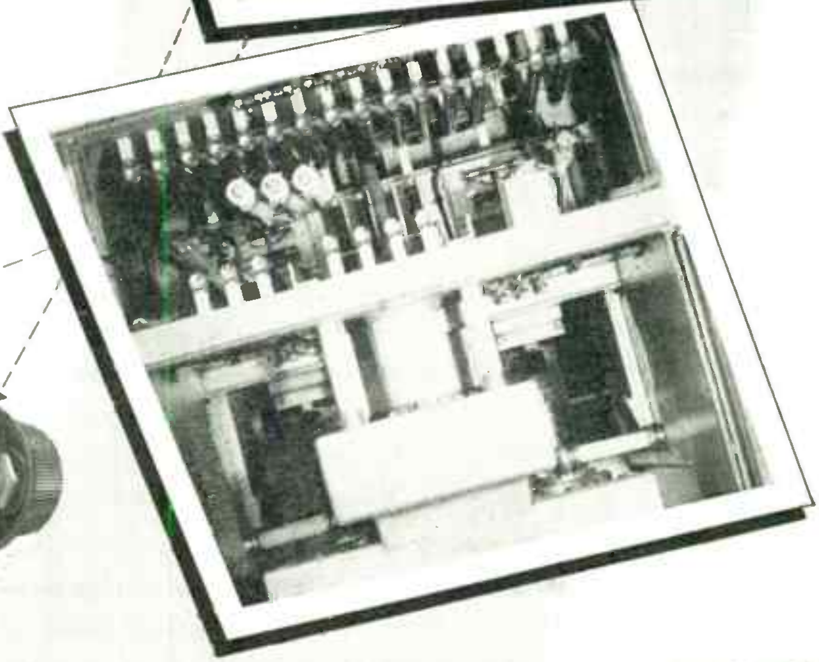
World Radio History

OHMITE RHEOSTATS and RESISTORS

IN 200 KW

Bethany Transmitters





From six of the world's mightiest shortwave stations, the "Voice of America" shoots "bullets of truth" to combat enemy lies. These transmitters, 200 KW each, located in Bethany, Ohio, were designed and built for the OWI by the Crosley Corporation.

The two interior photo-views of one transmitter reveal more than 60 Ohmite Resistors of various sizes . . . and one Ohmite Tandem Rheostat assembly.

The knowledge and experience that enabled Ohmite to "produce" on this psychological warfare job is at your service in solving resistance problems . . . today and post-war.

OHMITE MANUFACTURING COMPANY
4854 FLOURNOY ST. • CHICAGO 44, U.S.A.

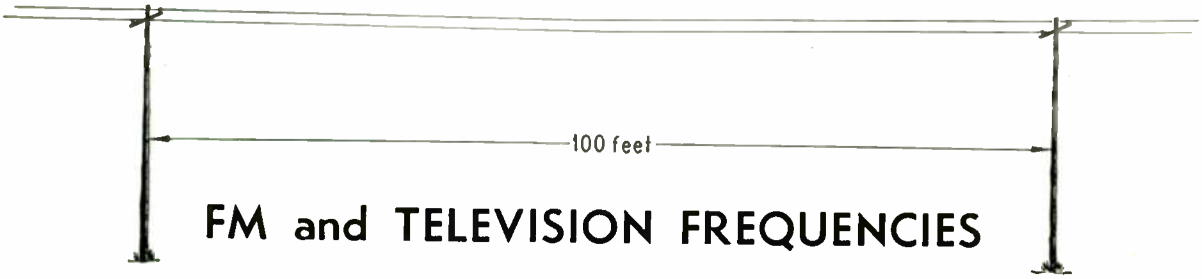
Write on company letterhead for helpful Catalog and Engineering Manual No. 40. Gives valuable data on resistors, rheostats, tap switches, chokes and attenuators.

Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

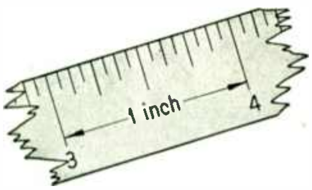
World Radio History

How to Analyze the MARKET *for your* PRODUCTS



FM and TELEVISION FREQUENCIES

This distance of 100 ft. represents the band of frequencies from 25 to 30,000 mc. which the FCC has made available principally for television and for services which will employ FM. These include broadcasting, facsimile, police, railroad, and other communication services, and cross-country relay systems.



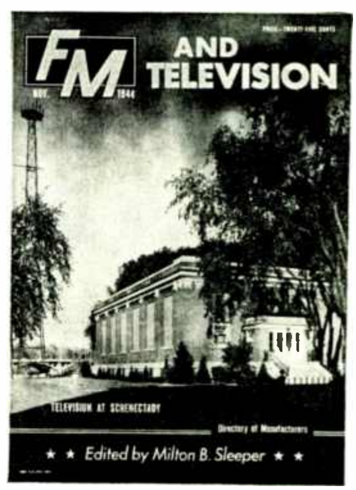
AM FREQUENCIES

If the distance of 100 ft. represents the new frequencies, then 1 in. represents the old band of AM frequencies from .01 to 25 mc. which, before Pearl Harbor, accommodated all the broadcast and communications services. This comparison indicates the expansion upon which the radio industry is launched now that World Victory is an accomplished fact.

KEEP THIS PICTURE IN MIND:

AM = 1 INCH: Before the war, with all radio services crowded into the AM band of .01 mc. to 25 mc., the industry was reaching the saturation point. There will be no turning back to prewar AM business, except for replacements, because the limited AM band, represented above by 1 inch, cannot accommodate new services.

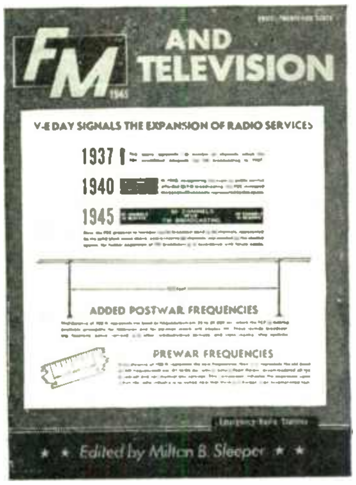
FM & TELEVISION = 100 FEET: All the new services, representing 95% of the post war radio market, will be in the FM and television band, represented above by 100 feet. In other words, the spectrum from 25 mc. to 30,000 mc., which the FCC has now made available for post war radio expansion, is *one thousand two hundred times as wide* as that used for AM radio before the war. . . . If you picture the already-crowded AM band as 1 inch wide, as compared to 1200 inches for the band now available for FM broadcasting and communications, and television, then you'll see the true proportions of the market to which *FM* AND TELEVISION Magazine is devoted.

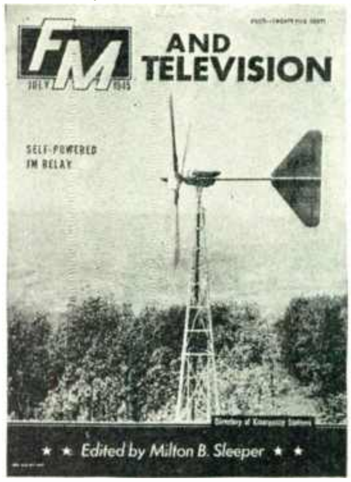


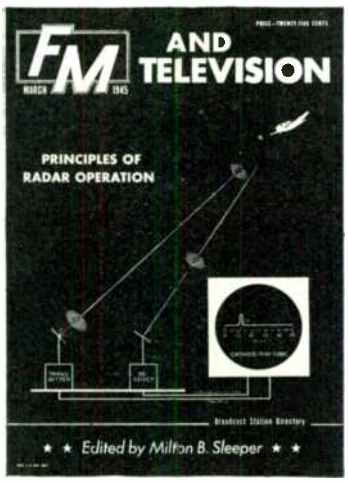
AND THAT'S WHY *FM* AND TELEVISION Magazine is so widely read by The Men Who Set the Pace the Industry Follows.

"THE COMPLETE AND AUTHORITATIVE SOURCE OF INFORMATION ON FREQUENCY MODULATION AND TELEVISION"

World Radio History







Facts You should know about

"*FM* and TELEVISION"

FM AND TELEVISION Magazine, by virtue of the fact that it is devoted to the two fields of greatest importance to everyone connected with radio, provides horizontal coverage of the men who count in the radio industry. Included are those engaged in:

MANUFACTURING: To engineers and executives engaged in manufacturing home receivers and broadcasting, facsimile, and communications equipment, *FM* AND TELEVISION is the principal source of information on both new developments and the requirements of new services.

BROADCASTING: During the past five years, broadcast engineers and executives have come to regard *FM* AND TELEVISION as a powerful influence in their field because of its splendid presentation of factual data available in no other publication.

COMMUNICATIONS: Military use of FM has paved the way for its application to many peacetime services, from police and railroad communications to telephone and television relay systems. *FM* AND TELEVISION carries more articles on such equipment than all other papers.

MERCHANDISING: Among the subscribers to *FM* AND TELEVISION are the buyers of the largest department stores, the principal musical instrument and phonograph dealers, leading radio dealers, and the most aggressive distributors of parts and sets, all of whom are building their future merchandising plans on FM and television.

SERVICE: The highly skilled servicemen of the type who now maintain FM communications equipment, and who will service home FM and television sets, look to *FM* AND TELEVISION as their source of information on new apparatus, circuits, and installation practice.

IN ITS FIFTH YEAR OF SERVICE TO THE RADIO INDUSTRY

for the men who set the pace the industry follows

FM AND TELEVISION

WILLIAM T. MOHRMAN, *Advertising Manager*
511 Fifth Avenue, New York 17, Tel. VA 6-2483

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MARIAN FLEISCHMAN
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West Coast Representative:
MILO D. PUGH
541 S. Spring St., Los Angeles 13, Tel. Tucker 7981

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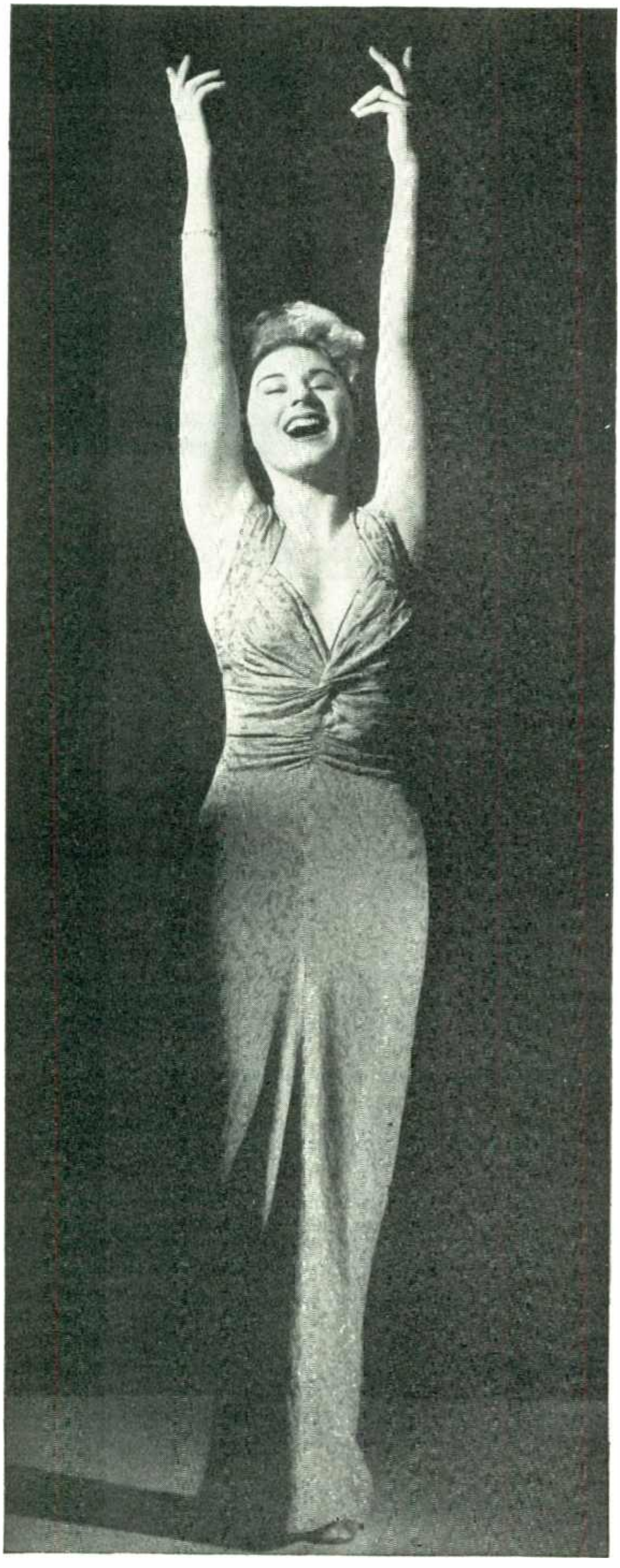


"I like to know how I'm doing

. . . and a Presto recording tells me frankly!"

"A Presto recording is my severest critic," says Hildegarde, radio's fabulous singing star. "I have each of my Raleigh Cigarette programs transcribed so that after the show I can check my voice and delivery. When you use Presto equipment—with its accurate reproduction and fidelity to musical tones—you know you're getting the truth!"

Major broadcasting stations all over the country have found that Presto produces high quality work—consistently. What's more, busy recording studios know that Presto equipment can take it, year in and year out, and still remain in perfect operating condition over long periods without adjustment. For every Presto unit is a precision instrument embodying fine materials and workmanship and the highest operating skill. Write for complete information.

PRESTO

RECORDING CORPORATION

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

Walter P. Downs, Ltd., in Canada

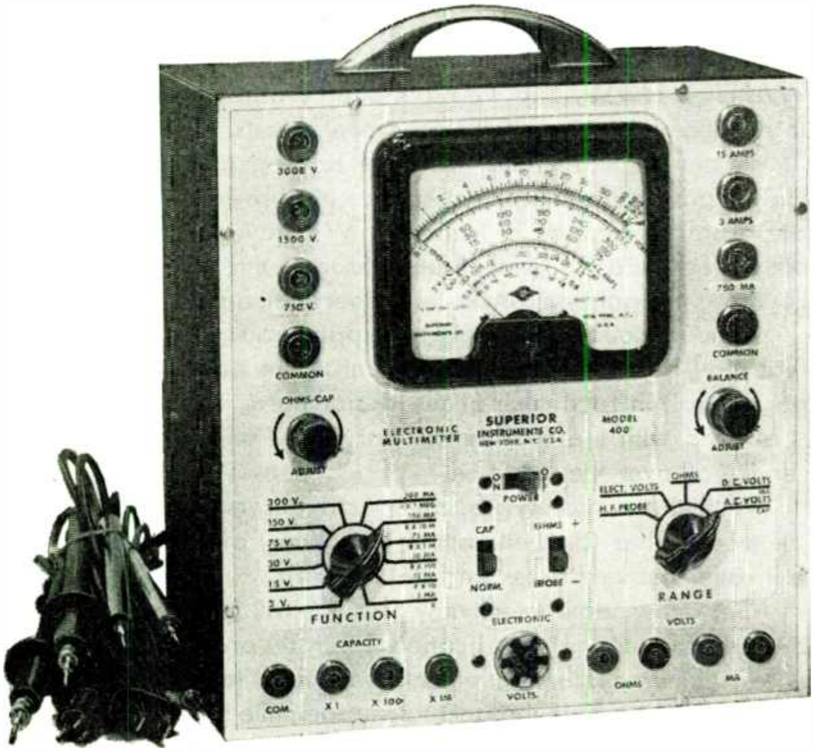
WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

World Radio History

Announcing —

The New Model 400

ELECTRONIC MULTI-METER



A COMBINATION

ELECTRONIC

VOLTMETER

AND

VOLT-OHM

MILLIAMMETER

PLUS

CAPACITY

INDUCTANCE

REACTANCE

AND

DECIBEL

Measurements

Specifications:

D. C. ELECTRONIC VOLTS:
(At 11 Megohms input resistance)
0 to 3/15/30/75/150/300/750/1500/3000 Volts

D.C. VOLTS:
(At 1,000 Ohms Per Volt)
0 to 3/15/30/75/150/300/750/1500/3000 Volts

A.C. VOLTS:
(At 1,000 Ohms Per Volt)
0 to 3/15/30/75/150/300/750/1500/3000 Volts

D.C. CURRENT:
0 to 3/15/30/75/150/300/750 Ma.—0 to 3/15 Amperes

RESISTANCE:
0 to 1,000/10,000/100,000 Ohms—
0 to 1/10/1,000 Megohms

CAPACITY: (In Mfd.)
.0005—.2 .05—20 .5—200

REACTANCE:
10 to 5M (Ohms) 100—50M (Ohms)
.01—5 (Megohms)

INDUCTANCE: (In Henries)
.035—14 .35—140 35—14,000

DECIBELS:
−10 to +18 +10 to +38 +30 to +58

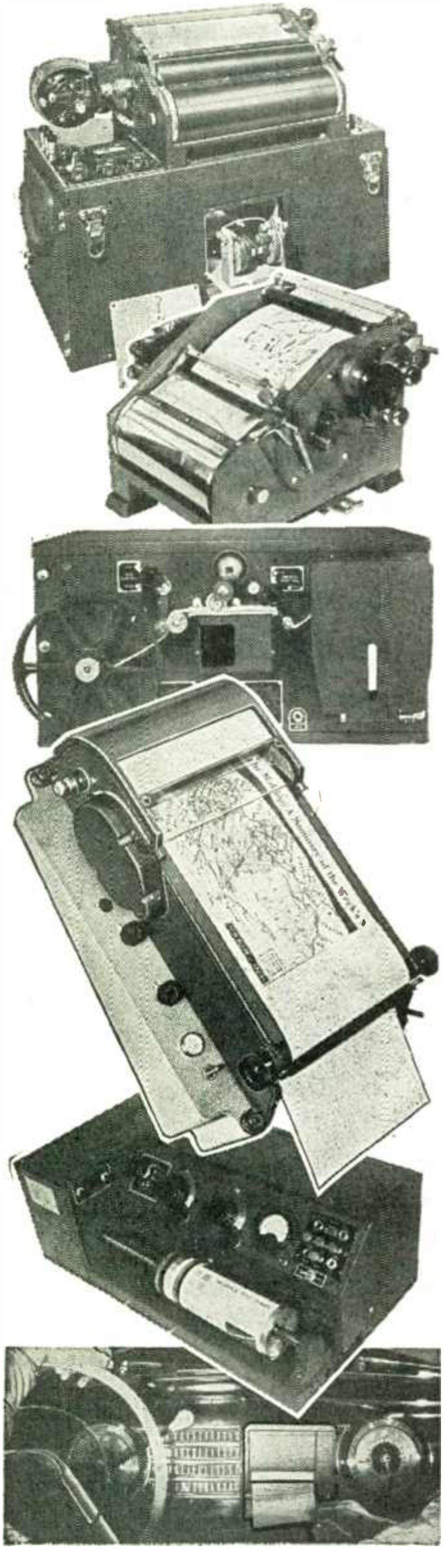
The Model 400 comes housed in a rugged crackle-finish steel cabinet complete with batteries, two sets of test leads, one set of V.T.V.M. probes and instructions. Size 5½" x 9½" x 10". Net **$52.50**

SUPERIOR INSTRUMENTS COMPANY

DEPT. FM., 227 FULTON STREET, NEW YORK 7, NEW YORK

ALDEN

MODERN FACSIMILE IS *New!*



New equipment is usually offered only as a complete final product—BUT—with facsimile, an unusual condition exists—**FACSIMILE IS WANTED NOW,** and we have been urged by those with real needs to produce prototypes for experimental tests.*

To meet this demand, we have agreed to build a broad enough line of prototype equipment so that its "use-tests" will determine any desirable refinement or changes. We have accepted a number of orders for such equipment and through this advertisement, are announcing this policy in order that others can have the same advantage.

Although our purpose is to supply equipment for "service-tests" that may be considered experimental, the equipment itself is not experimental; in fact much of the designing in this prototype equipment is offered with the confidence that comes only from the acid tests of service all over the world.

With these prototypes, prospective users will find for themselves the possibilities (as well as the limitations) of modern facsimile. They will save costly mistakes and delays later.

Get actual equipment now. Designs will crystallize soon and it will be costly to change specifications later. By ordering now, your experience will insure later equipment best suited to your particular needs.

Advise us how you expect to use facsimile (with as much operational detail as possible) and we will advise you to what type of equipment that is being scheduled your order could be added.

Here is a check list of suggestions:

WHAT "USE-TESTS" CAN PROVE

CUSTOMERS' REACTIONS—to actual equipment placed in his hands, and to programs or messages of various composition.

STYLING AND MOUNTING—what style has most appeal—table or bench models, chairside or kitchen-utility; what type of mounting—in rack, wall, panel, dashboard or desk.

PAPER WIDTH: For your application, whether 4", 6", 8", 18" or some intermediate size is most practical.

PAPER SPEEDS: At what rate you want the copy to appear, consistent with cost of wire circuits or band widths.

DEFINITION—Whether 100 lines per inch is satisfactory.

CIRCUITS—Whether your present or proposed circuits are adequate to give the desired speeds.

*Although WPB limit orders prevent regular manufacture of communication equipment, manufacture for experimental work (or the preparation for civilian production when the limit orders are removed) is approved and encouraged.

ALDEN PRODUCTS COMPANY

117 NORTH MAIN STREET • BROCKTON (64F3), MASS.

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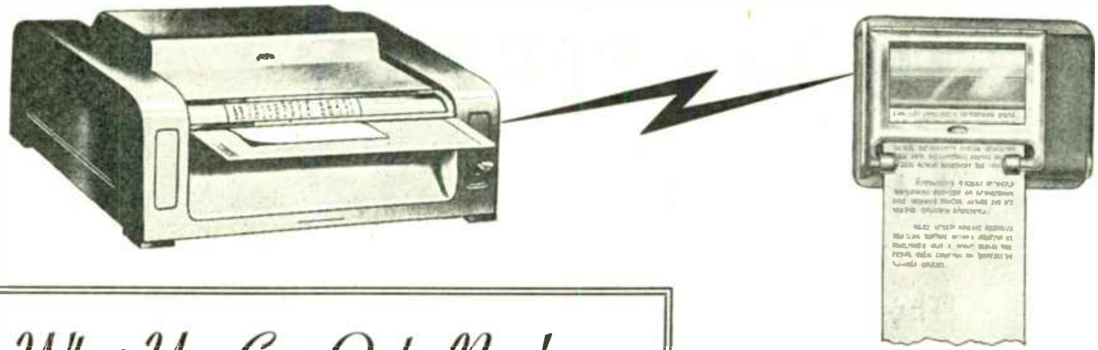
FACSIMILE



What You Can Order Now!

You can order a Universal—Standard—Signal Scanner and Recorders.

"STANDARD SIGNAL"— UNIVERSAL SCANNER (9009)

This gives you a scanner that is universal enough to put out scanning signals for existing recorders or to meet any standards that are likely to be set by F.C.C.

The scanning signal can be considered a quality Standard Signal in that it will be free from inherent quality defects, such as gear hash and vibration. It is supplied with drums to provide signals for 4", 6", 8" or 18" recorders, and with change gears to provide for operating at various paper feed speeds and with definition of 60, 96, 100, 125 or 200 lines per inch.

Nearly every unknown can be explored with three sizes of recorders 9000-8" 9031-4" 9021-18"

9000—This is a Laboratory Type (Hogan Patent) page size continuous recorder using Alfax paper. Page size records 4 news columns or 8 inches actual recording, 100 lines per inch—interchangeable gears and helices for 1", 2" or 3" per minute recording.

9031—4-INCH FLUSH MOUNTING MODEL

This may be the ultimate home size recorder because of its convenience in size, operation and paper use, but in any case it has unlimited use in dispatch and special purpose recording. It records 4 inches or 2 news columns, 100 lines, 3 inches per minute.

9021—18" CONTINUOUS RECORDER

With this, a full size newspaper can be recorded, and large maps or drawings sent. Thus, all large space problems can be tried out, as well as high speed duplication and transmission problems with U.H.F. microwaves or coaxial cable links.

Dispatch problems require a slightly different approach than broadcasting.

Most Dispatch Problems include—where do *you put the scanner—how simple is it to operate—can instructions be simple and clear—*while for the recorder, the questions are—*how much room does it take up—is paper refilling easy—is servicing simple, etc.*

DISPATCH SCANNER (9012) and 4" DISPATCH RECORDER (9010)

This new Alden System has endeavored to anticipate that which is wanted, but actual trial by those who are to use it, will make possible the extra improvement or changes to approach meeting your needs 100%.

The scanner and recorder are designed especially for dispatching and recording short messages. Copy is placed on scanner table; scanner picks up, scans message and resets for another message.

Scanner signal automatically starts the recorder, prints message and stops. Copy can be recorded same size as original or enlarged 1½ times for easy reading at a distance.

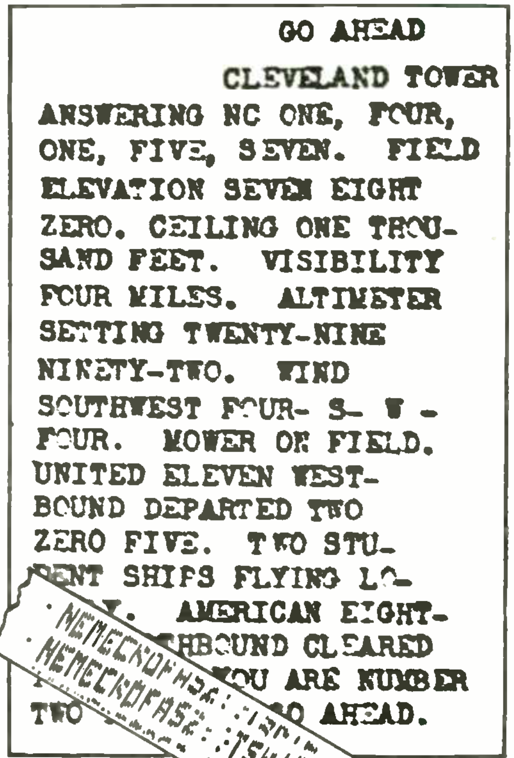
Synchronizing Equipment

Many "use-tests" will be conducted in areas in which the power circuits are 60 cycle synchronously operated. In those instances, the equipment, both scanner and recorder can be operated with 60 cycle synchronous motors.

Where this is not the case, synchronization is obtained from an 1800 Cycle Compensated Tuning Fork Oscillator, No. 9023. Operating with this is a multivibrator to divide 1800 cycles to 60 cycles, No. 9027.

Special Recorders

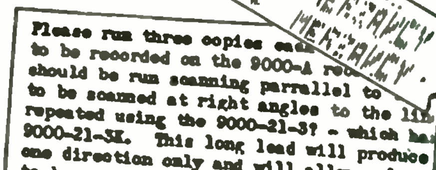
Recording problems are all special and in these, large numbers of elements are being developed and tooled so that nearly any varied or special problem has in part been solved.



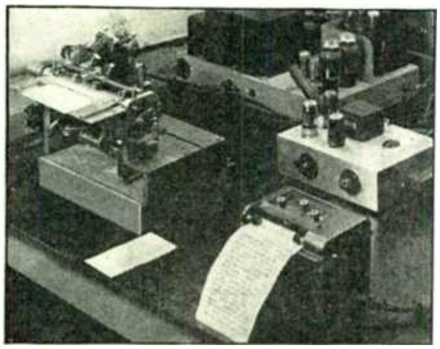
GO AHEAD

CLEVELAND TOWER

ANSWERING NC ONE, FOUR, ONE, FIVE, SEVEN. FIELD ELEVATION SEVEN EIGHT ZERO. CEILING ONE THOU-SAND FEET. VISIBILITY FOUR MILES. ALTIMETER SETTING TWENTY-NINE NINETY-TWO. WIND SOUTHWEST FOUR- S- W - FOUR. MOWER ON FIELD. UNITED ELEVEN WEST-BOUND DEPARTED TWO ZERO FIVE. TWO STU-DENT SHIPS FLYING LO-... AMERICAN EIGHT-...HBOUND CLEARED ...YOU ARE NUMBER TWO ...GO AHEAD.



Please run three copies eac... to be recorded on the 9000-A rec... should be run scanning parrallel to ... to be scanned at right angles to the lin... repeated using the 9000-21-3? - which ha... 9000-21-3X. This long lead will produce one direction only and will allow only o... to be recorded.

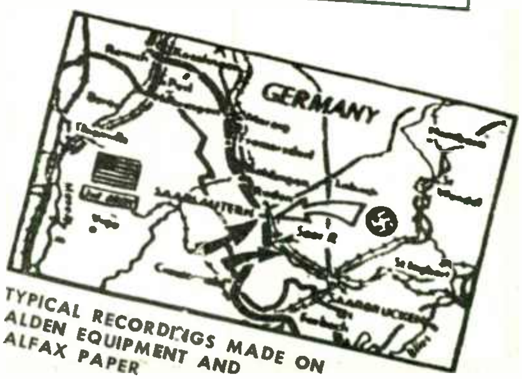


DISPATCH SCANNER AND RECORDER UNDER PERFORMANCE TEST

• Instead of starting from scratch, you can take advantage of the engineering plus "service-testing" that has already been completed to make these units available now. Present runs are small and prices not cheap, but the design is anticipating quantity production with reasonable costs.

• • • • •

BRING YOUR PLANS TO A HEAD—let us send you photos and quote you price and delivery on whatever graphic recording equipment you have in mind.



TYPICAL RECORDINGS MADE ON ALDEN EQUIPMENT AND ALFAX PAPER

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IN THE SERVICE OF PEACE

The Victory which has brought peace to the world signals a tremendous expansion of police and emergency communications in the U. S. A.

Our capacity to accommodate thousands of new transmitters on trucks, buses, and railroad trains, in addition to great numbers of added police cars, will be determined largely by the care with which each transmitter is maintained at its allocated frequency.

The BROWNING crystal-controlled Frequency Meter has reduced accurate frequency maintenance to a simple "60 seconds check." The low cost of the BROWNING Frequency Meter makes it economical to have these instruments available for each service area.

There is a BROWNING Meter for every emergency service requirement. Write for prices and deliveries, giving your operating frequencies. Address:

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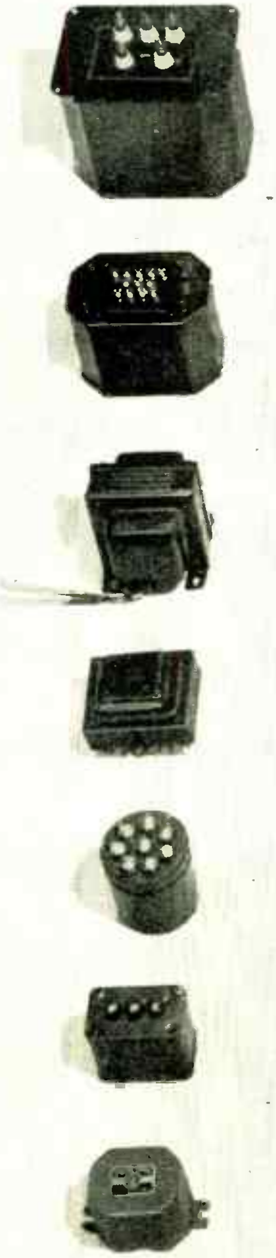

WHAT ARE YOUR TRANSFORMER PROBLEMS?

IS IT QUANTITY?

UTC, the largest supplier of transformers to the electronic industry, is in a strong position to meet your requirements for postwar applications — radio, communications, FM, Television, electro-medical, etc.

IS IT QUALITY?

UTC, in the collective opinion of critical users, is the "leader in the field" for units of lasting dependability. Incidentally, our Varick Street Plant is now running 98% hermetic sealing components.

IS IT DESIGN?

UTC, known for pioneering efforts, manufactures a range of designs from the smallest transformers in the world to 50,000 ampere current transformers and complex filters.

IS IT PRICE?

UTC, because of ingenious production methods, can give you a reliable product at a competitive price . . . war or postwar. And we can deliver now.

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EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

ALL PLANTS

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To Save Life

RAYTHEON TUBES ARE USED IN NEW ELECTRONIC STETHOSCOPE

The conventional "acoustic stethoscope," used by doctors since the horse-and-buggy days, now gives way to a revolutionary electronic stethoscope called the "Stethetron."

Human lives are saved by making diagnosis easier and more accurate with the "Stethetron" made by The Maico Company, Inc. Of particular interest to you is that miniature Raytheon High Fidelity Tubes are used in this remarkable device because of their complete dependability and precision performance.

This is just one more example of the superiority of Raytheon Tubes—the line that *you* should feature to give your customers the best possible service.

Feature Raytheon Tubes now—for greater profits—and watch for the Raytheon merchandising program designed especially for established radio service dealers who want to lead the field in postwar volume in their communities.

Increased turnover and profits, plus easier stock control, are benefits which you may enjoy as a result of the Raytheon standardized tube type program, which is part of our continued planning for the future.

Raytheon Manufacturing Company

RADIO RECEIVING TUBE DIVISION

NEWTON, MASSACHUSETTS • LOS ANGELES • NEW YORK • CHICAGO • ATLANTA

ALL FOUR DIVISIONS HAVE BEEN AWARDED ARMY-NAVY "E" WITH STARS

Devoted to Research and the Manufacture of Tubes for the New Era of Electronics

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"MEET YOUR NAVY"
AMERICAN BROADCASTING CO.
Every Monday Night
Coast to Coast
181 Stations

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★ *Star performance every time!*

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For

Dependable, Trouble-Free Performance
Advanced Features, Basic Improvements
Found in No Other Changer

Star Performance in Record Changers means positive changing action, low rumble, no broken records, perfect adjustment in spite of careless or accidental handling, minimum "wow".

Such performance has been little more than an engineer's dream, until the Ballentine Changer made it a reality.

New major principles of design and operation were developed after thorough research disclosed the basic requirements of the simple, dependable, trouble-free changer.

Today the Ballentine Record Changer stands unexcelled in the field, the quality record changer for the radio manufacturer, assuring complete customer satisfaction. Available in different price ranges.

The Ballentine Record Changer means Star Performance—every time

RUSSELL ELECTRIC COMPANY

362 W. HURON STREET, CHICAGO 10, ILLINOIS • *Manufacturers of*

BALLENTINE RECORD CHANGER

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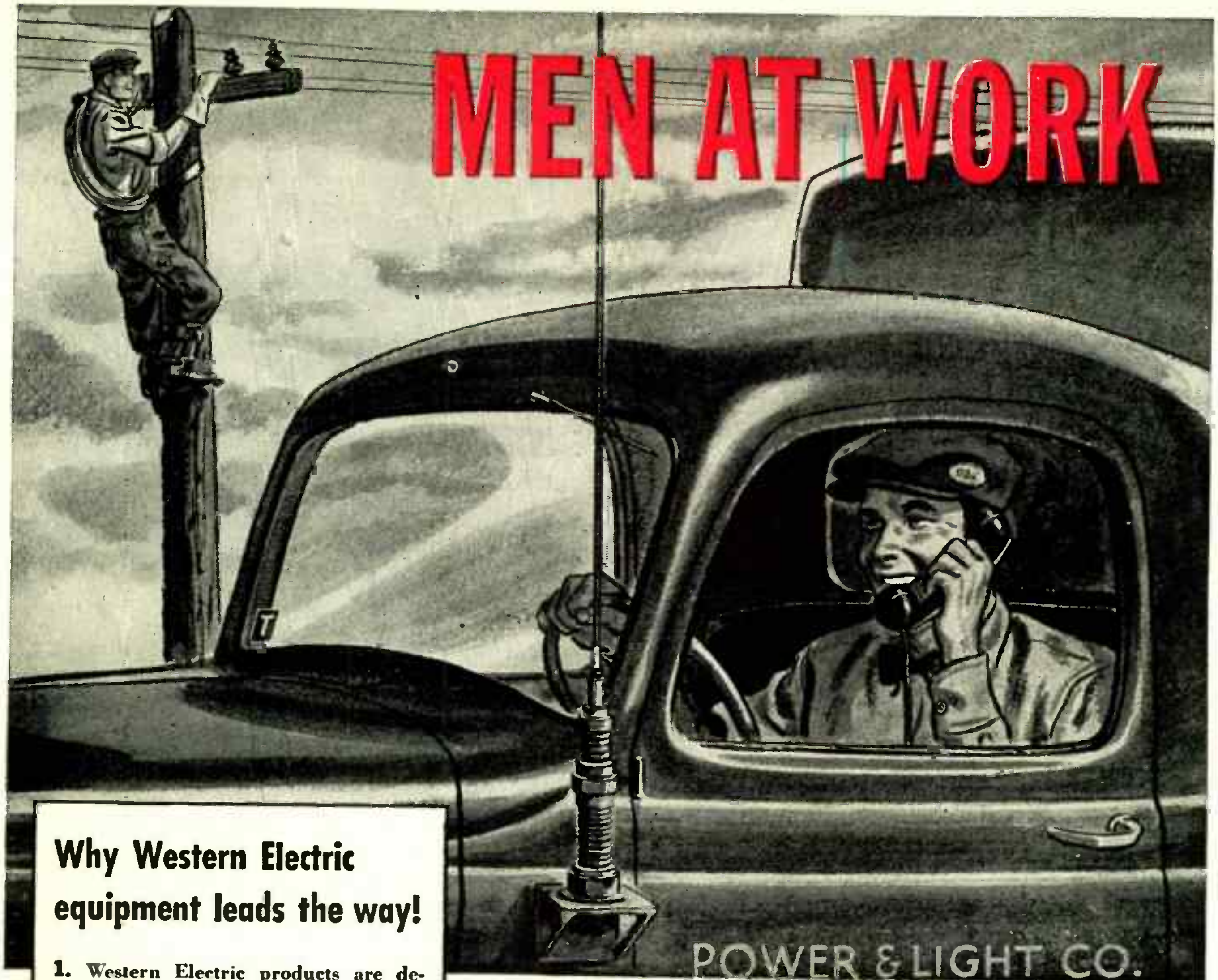

Why Western Electric equipment leads the way!

1. Western Electric products are designed by Bell Telephone Laboratories—world's largest organization devoted exclusively to research and development in all phases of electrical communication.

2. Since 1869, Western Electric has been the leading maker of communications apparatus. Today this company is the nation's largest producer of electronic and communications equipment.

3. The outstanding quality of Western Electric equipment is being proved daily on land, at sea, in the air, under every extreme of climate. No other company has supplied so much equipment of so many different kinds for military communications.

Western Electric

Global war has spotlighted and proved to all the world the tremendous value of instantaneous communication by mobile radio telephone. In the air, on land and at sea, it has helped to get the job done faster and to save countless lives.

Men at work or men at play, in the years ahead, will find mobile radio telephone an equally efficient means of keeping

Western Electric has specialized

AM • BROADCASTING • FM

MARINE RADIO

AVIATION RADIO

MOBILE RADIO

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equipment leads the way!

in quick, easy contact with business headquarters or with home.

For more than a quarter of a century, Bell Telephone Laboratories and Western Electric have pioneered in the field of mobile radio. When manpower and materials become available, count on Western Electric for the finest equipment for mobile communications services.

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Buy all the War Bonds you can . . . and keep all you buy!

knowledge in all of these fields

HEARING AIDS

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THE *Quiet* BALLENTINE RECORD CHANGER MOTOR

Has these four characteristics achieved by advanced design, skilled engineering and precision manufacturing.

• Lowest Rumble • Highest Efficiency • Most Compact Design • Longest Life

The *Quiet Ballentine* Changer Motor is recommended to record changer manufacturers seeking to provide the ultimate in performance.

RUSSELL ELECTRIC CO.
362 West Huron Street
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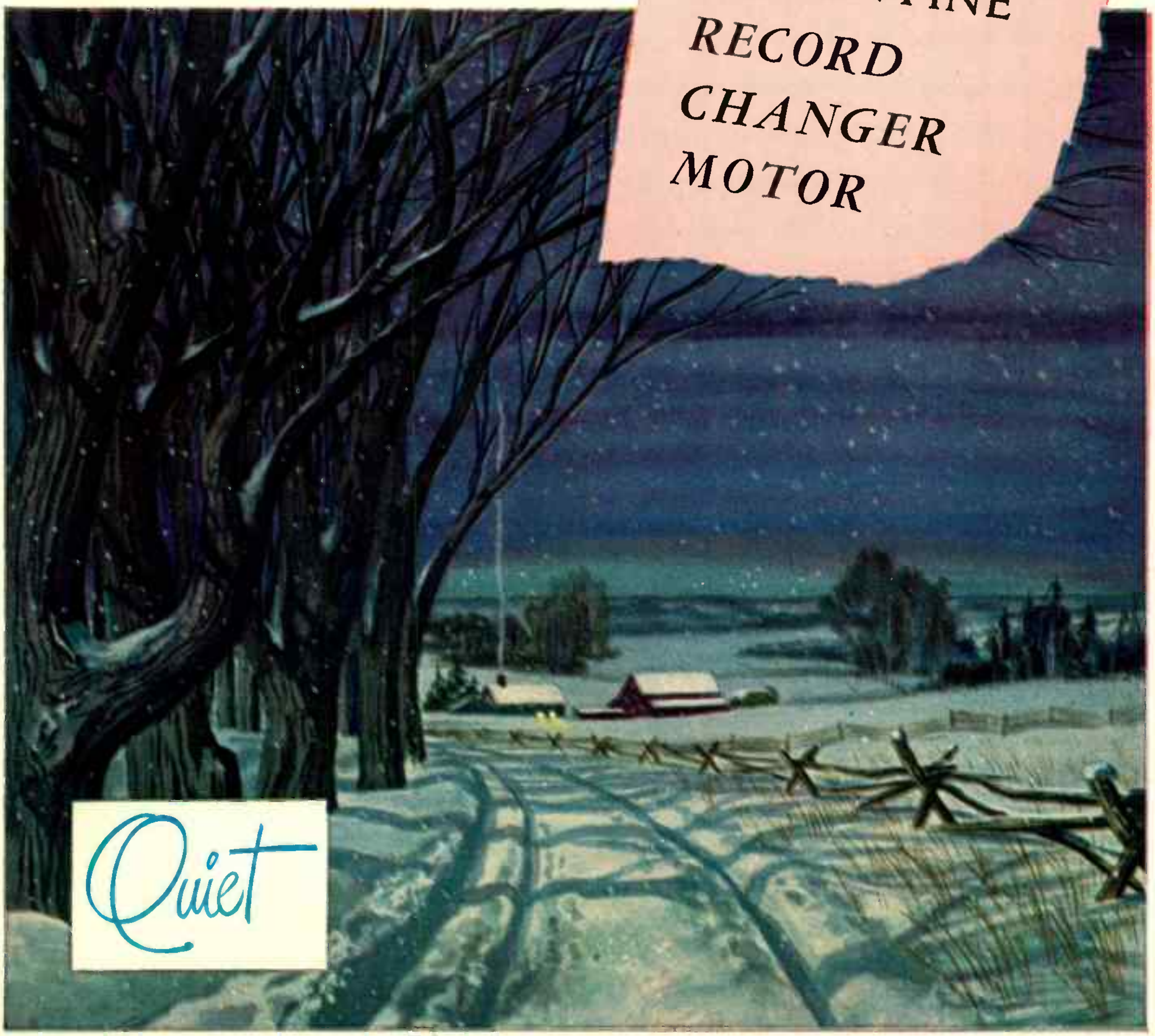
Manufacturers of
BALLENTINE
RECORD CHANGER MOTOR



TWO NEW GASEOUS VOLTAGE REGULATORS

In Miniature

The list of Hytron's customers for the standard OC3/VR105 and OD3/VR150 reads like the social register of electronics. Proved quality products, these Hytron tubes are found literally by the millions in military radar, communications, and electronic equipment.

Now in space-saving miniature bulbs, the new Hytron OA2 and OB2 offer the same careful engineering design, rigid control of processing and assembly, and adherence to tight factory specifications which have made the standard Hytron regulators famous. Life and performance of the miniature OA2 and OB2 equal those of the standard tubes, except that maximum operating current is 30 ma. for the miniatures. Construction is both simple and rugged. Note, for example, use of both top and bottom mica supports and the heavy stem leads. Compare the characteristic data given. Consider the possible space economies. Order your engineering samples today.

COMPARATIVE DATA

HYTRON MINIATURE AND STANDARD GASEOUS VOLTAGE REGULATOR TUBES

TYPE	PHYSICAL CHARACTERISTICS				AVERAGE OPERATING CONDITIONS			
	Max. Length (inches)	Max. Diam. (inches)	Bulb	Base	Supply Voltage† (min.)	Operating Voltage (approx.)	Regulation $E_{30}-E_5$‡ (volts)	Operating Current* (ma.)
OA2	2⅝	¾	T-5½	7-pin Min.	185	150	2	5–30
OD3/VR150	4⅛	1 9/16	ST-12	6-pin Octal				5–40
OB2	2⅝	¾	T-5½	7-pin Min.	133	108	1	5–30
OC3/VR105	4⅛	1 9/16	ST-12	6-pin Octal				5–40

†Sufficient resistance must always be used in series with the tube to limit current through it as follows: OA2 and OB2, 30 ma.; OD3/VR150 and OC3/VR105, 40 ma.
‡Regulation (either positive or negative polarity) is defined as the difference in voltage when the current is varied from 5 ma. to 30 ma.
*Operation for extended periods of time at low current will temporarily increase regulation of tube.

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS
PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE

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FOR ALL ELECTRICAL APPLICATIONS--

BH EXTRA FLEXIBLE FIBERGLAS SLEEVING

WON'T HARDEN, CRACK OR ROT!

SNUB TEST

Proves BH Non-Fray Feature

Make this test yourself. Tap a piece of ordinary saturated sleeving on your desk top and see how easily it frays. Then do the same with BH *Extra Flexible* Fiberglas Sleeving. It only fuzzes a little—doesn't break down—doesn't fray.

THE RESULT

BH *EXTRA FLEXIBLE* FIBERGLAS SLEEVING

2 WAYS BETTER

NON-FRAYING • NON-STIFFENING

WHY give a few cents worth of electrical insulation a chance to be the weak link in *your* product? Use BH *Extra Flexible* Fiberglas Sleeving—the *one* insulation with *all* these advantages:

It is *permanently* non-fraying, non-stiffening and non-burning, by virtue of the exclusive BH process. It will not dry out, crack or rot, retaining its original unusual resistance to high and low temperatures, moisture, oil, grease and chemicals *indefinitely*.

If you want an all-purpose sleeving that simplifies assembly and maintenance and gives longer maximum protection, standardize on BH *Extra Flexible* Fiberglas Sleeving. Available in all standard colors and sizes from ⅝" to No. 20, inclusive. Write for free samples today and compare by actual test!

HOW TO KEEP CUSTOMERS COOL AT 1200°F!

Direct contact with heat up to 1200°F does not harm BH Special Treated Fiberglas Sleeving, the non-burning, unsaturated, flexible-as-string sleeving that stays supple and won't fray when cut. Made in natural color only—all standard sizes. Get this *extra* protection now and keep customers' temper cool, too!

ALL BH PRODUCTS AVAILABLE IN STANDARD 36" LENGTHS and 500-FT. COILS

BH PRODUCTS

ALSO SLOW-BURNING IMPREGNATED MAGNETO TUBING • SLOW-BURNING FLEXIBLE VARNISHED TUBING • SATURATED SLEEVING • A.S.T.M. SPECIFICATIONS

BENTLEY, HARRIS MANUFACTURING CO.

Dept. B Conshohocken, Penna.

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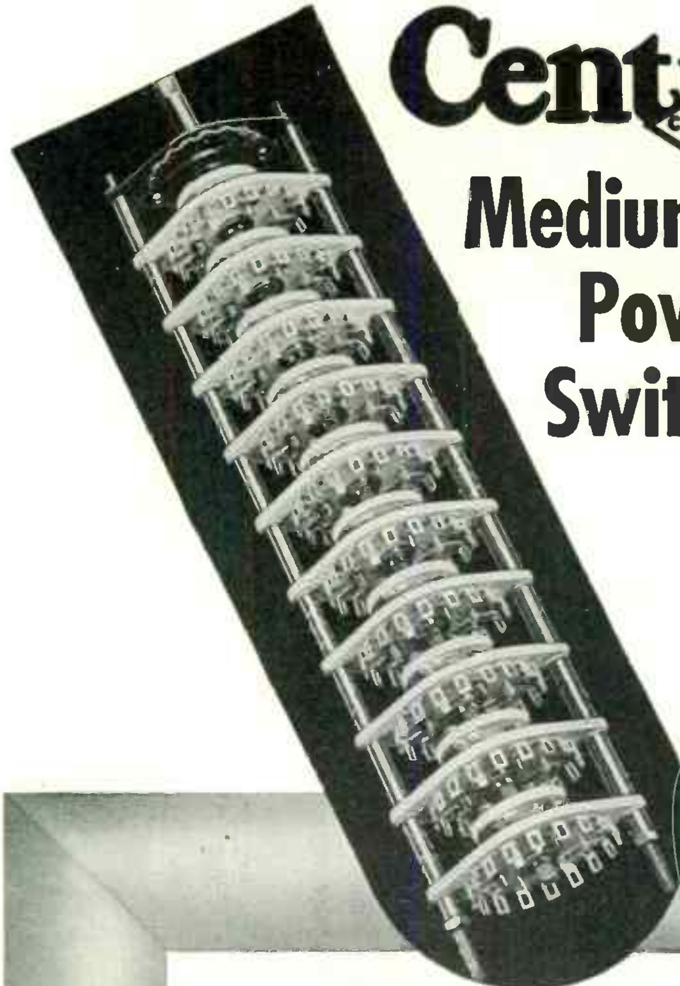
Centralab

Medium Duty Power Switches



- 7½ amp. 115 V. 60 cycle A. C.
- Voltage breakdown 2500 V to ground D. C.
- Solid silver contacts
- 25,000 cycles of operation without contact failure
- Fixed stops to limit rotation
- 20° indexing

Centralab medium duty power switches are now available for transmitters (has been used up to 20 megacycles) power supply converters and for certain industrial and electronic uses.

It is indicated in applications where the average Selector Switch is not of sufficient accuracy or power rating. Its accuracy of contact is gained by a square shaft, sleeve fit rotor, and individually aligned and adjusted contacts. It is assembled in multiple gangs with shorting or non-shorting contacts. Torque can be adjusted to suit individual requirements. Furnished in 1 pole . . . 2 to 17 positions (with 18th position continuous rotation with 18th position as "off"); and 2 or 3 pole . . . 2 to 6 position including "off".

Centralab

Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF Variable Resistors • Selector Switches • Ceramic Capacitors • Fixed and Variable • Steatite Insulators and Silver Mica Capacitors

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YOU NEED hallicrafters EQUIPMENT
in high frequency development work

• The new Hallicrafters AM/FM receiver, Model S-36, designed for maximum performance on the very high frequencies. Provides continuous frequency coverage from 27.8 to 143 Mc. Covers old and proposed new FM bands.

Rail and motor lines, maritime services and universally expanding aviation are planning new or improved communications systems to keep up with the forward pace. In these and many other fields of science there is an urgent demand for the latest developments in very high frequency and ultra high frequency apparatus. In your work in these fields, look to Hallicrafters for advanced communications and electronics equipment.

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

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WHAT'S BEHIND THE AM VS. FM BATTLE?

An Examination of the Single Market FM Plan Which, as Proposed, Would Make FM Stations Play the Pauper Rôle to Princely Multi-Market, Clear Channel AM Stations

BY MILTON B. SLEEPER

TO THOSE who have had an active and continuous part in the progress of Frequency Modulation since the inception of FM broadcasting and communications, the misstatements and the misrepresentations of fact contained in the records of the RTPB meetings and FCC hearings are, to say the least, appalling. What is still more serious, such testimony was, in most cases, presented in such a plausible manner that it was much easier for the Commissioners to believe it than simple statements of truth from those whose only purpose was to make the superior service of FM broadcasting available to the greatest number of radio listeners in the shortest possible time.

"But," comes the impatient rejoinder, "if the Commissioners want to know the truth, they are smart enough to see through smoke-screen testimony that is intended to hide selfish interests."

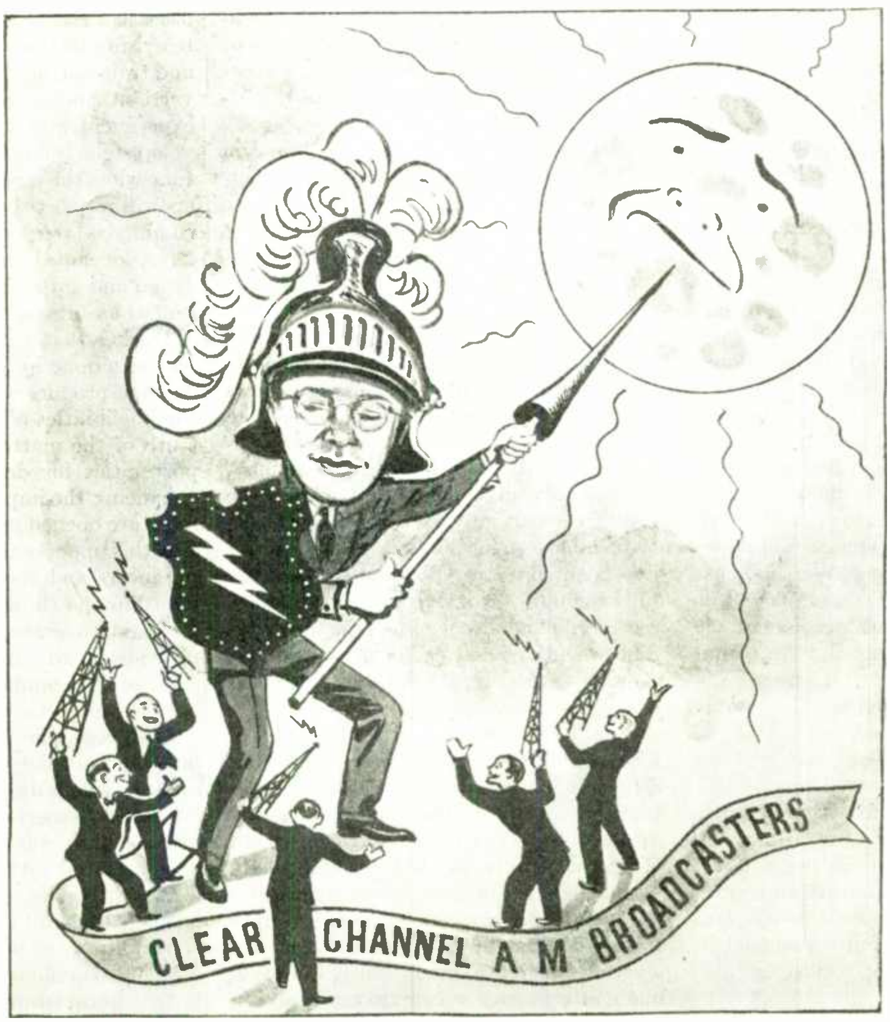
It might seem so, until it is remembered that the Commissioners are not former engineers or executives experienced in broadcasting or equipment manufacture. They are political appointees and, with the exception of Commissioner Jett, men with only legal-political experience, who may not have heard of megacycles or means for modulation before they took office in the FCC!

And if it seems shocking that radio engineers and executives should be so unethical as to plan and present testimony intended to mislead the Commissioners just because the best interests of their companies would be served by wrecking the expansion of FM broadcasting, it must be remembered that history is just repeating itself.

The Battle of the Currents ★ Go back just 60 years, and you'll find a parallel situation. In 1885, rival electrical companies were engaged in what was called the Battle of the Currents. Leader in the fight waged by vested interests against the progress of electrical transmission was Thomas A. Edison.

He was then the largest producer of direct current dynamos and lighting systems. His use of DC limited his lines to a distance of about 3 miles because of the heavy copper conductors required to deliver any substantial amount of current at low voltage. Nevertheless, Edison's opposition to the use of alternating current (and long-distance power transmission) was said to have been an obsession, for he was determined to hold the position of his company against the competition of AC at any cost, and by any means.

Indeed, Edison and George Westinghouse, who was the leading contender for alternating current, used the daily papers as the AC vs DC battleground for what was a veritable mud-slinging contest. No holds were barred, and distortion of facts and downright falsehoods were the order of the day in this colorful scrap.



An example comparable to some of the statements published currently by anti-FM interests was a scarlet-bound booklet entitled *A Warning from the Edison Electric Light Company*, a fantastic effort to build up a case against AC high-voltage distribution, declaring: "It is clear that high pressure, particularly if accompanied by rapid alternations, is not destined to assume any permanent position. It would be legislated out of existence in a very brief period even if it did not die a natural death."

Edison's propaganda threw the whole electric power business into complete confusion. Indeed, when Elihu Thomson introduced the "grounded secondary" method of AC distribution, re-

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quired today in every AC installation, the Insurance Underwriters actually prohibited its use, and it was only 24 years ago that Thomson was officially recognized as The Father of Protective Grounding.

In 1886, while the AC vs DC fight was still on, the first commercial AC line, and the longest ever attempted up to that time, was installed by William Stanley, a Massachusetts inventor, to supply electric lights for the town of Great Barrington, Mass., at a distance of one mile. (The offices of *FM* AND TELEVISION are located in Great Barrington on a street once lighted by Stanley's installation.)

Not long after this system was completed, Michael Pupin, a young professor of physics from Columbia University, delivered a brilliant defense of alternating current at a Boston meeting of the Institute of Electrical Engineers. Professor Pupin's paper caused a wide split among the members, and he was openly damned for having uttered "electrical heresy."

Today, history is repeated as radio broadcasters form ranks for the battle of AM vs FM, in which the central figure is Professor Pupin's outstanding pupil, Edwin Howard Armstrong.

The Battle of AM vs FM ★ If Edison were to conduct his historic fight today, he would benefit from the technique which Plausible Paul Kesten, CBS vice president, has used against FM. He would not have raved and ranted against the use of AC. Instead, he would have come out strongly in favor of high-voltage AC as the democratic way of making electricity available to every citizen. Moreover, he would have demanded that, in the interests of national economy, all AC power distribution be required to operate on a minimum of 50,000 volts. Finally, he would have induced Congress to pass a law against the use of insulators more than 5 ins. long, clinching his argument by demonstrating that longer insulators of any available material were too weak to support the lines.

Then he might have stood on the steps of New York's Sub-Treasury Building and thumbed his nose at George Westinghouse.

Whatever tactics Edison employed, he could not have won any permanent victory for, as time has proved, both technically and economically, DC power distribution cannot provide the public service that is made possible by AC.

Similarly, public interest, convenience, and necessity will be served, in the end, by the replacement of AM with FM broadcast transmission. In the meantime, AM broadcast interests are fighting a battle against FM in such a succinct and subtle manner that frontman Kesten has succeeded in creating the impression that he and CBS are among FM's most enthusiastic proponents.

Not that Mr. Kesten or any of the others fail to realize that FM will win eventually, any more than Edison thought that he would win out against AC. Why fight, then? The answer is clear. Edison's company was growing in wealth and power through the sale of DC equipment. The longer he could stave off the shift to AC, the stronger his company would become. Meanwhile, the AC group might become weakened by discouragement, and there was always the possibility of some unexpected, favorable development.

FM Group Lacks Showmanship ★ The same reasoning lies behind the fight against FM. However, the opposition is smart enough to know that an open, direct attack would hasten the ultimate victory of FM, and the complete replacement of AM by FM broadcasting. Why? Because the most exhaustive research into the possible weakness of FM has only revealed new possibilities for improving radio service to the listening public by shifting rural as well as regional and local broadcasting to FM.

That is why those most anxious to delay FM have consistently prefaced their remarks with enthusiastic praise of its possibilities, and then proposed some plan or other, obviously unsound from the technical point of view, that would degrade or limit FM broadcast service. Such instances appear repeatedly in the record of the Allocations Hearings.

But the only actual weakness found in FM was not in its theory, practice, or performance. It was in the utter indifference of FM's most loyal supporters to that vital factor on which the business of broadcasting has been built in this country, namely, showmanship.

Both individual FM station operators and the FMBI officers gave generously to the time and cost of presenting *arguments* before the FCC, but there is more conviction in a 30-minute *demonstration* of high-fidelity FM than in reams of testimony. There is reason to doubt that, within the last three years, any of the Commissioners or members of the FCC staff has heard a live-talent program, planned to show the full capabilities of FM, from a high-quality receiver. This may well be true of broadcast executives and engineers whose purpose in testifying at FCC hearings was antagonistic toward FM.

Nor do these men have the knowledge of FM's ability to eliminate interference conditions in many different locations. An indication of this is the conflicting statements to the effect that FM is valuable to listeners in rural areas, but it is little if any better than AM in cities served by nearby, powerful AM stations, and then other statements that FM is most useful in cities where there are many sources of man-made interference which are not found in rural areas. Neither opinion reflects knowledge of true conditions, for the facts are that FM reception from a well-designed receiver is decidedly superior to AM in *both* urban and rural areas, but not for the reasons quoted above.

While FM has had almost continuous publicity from the press, particularly in the last year, actual FM broadcasting has certainly not done credit to its capabilities. With negligible exceptions, the moment the FCC relaxed its requirement of an hour of high-fidelity programs during the day and at night, the FM stations fell back on transmitting AM network programs and recordings — many of them very bad indeed.

The excuse was lack of equipment or manpower. Yet some of the FM station operators have, at the same time, expanded their television activities. As a result, when inquiries are addressed to *FM* AND TELEVISION Magazine from broadcast engineers and executives and prospective FM station operators asking, "Where can I hear high-fidelity FM transmission?" it is only possible to say: "As far as we know, there is no such transmission on the air."

Information Please! ★ For more than a year, television stations have made their studio and transmitting facilities available to advertisers and agencies so that they could experiment with visual programs, and develop television techniques against the time when the number of television receivers will support the use of this medium for commercial purposes. In this manner they have developed an understanding of television and enthusiastic support for its potential usefulness to sponsors.

During that time, practically nothing has been done by FM broadcasters to encourage producers and directors to study the possibilities of FM broadcasting. The truth of the matter is that unlimited opportunities for dramatic effects and for enhancing the impact of advertisers' messages are opened up by the realism of FM. But this opportunity is being lost to both producers and sponsors by lack of salesmanship and showmanship on the part of FM station management. Consequently, no widespread support, based on knowledge of its commercial possibilities, has been developed.

Last year, the Radio Executives Club in New York City sponsored a television seminar which drew an initial attendance far beyond expectations. It fell rather flat because there was much talk, but nothing demonstrated. An FM seminar would draw a still greater attendance, and could be made the most interesting and valuable contribution to the radio broadcast art if it included demonstrations of the program

(CONTINUED ON PAGE 80)

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VIBRATING-REED FREQUENCY METERS

Information for Design Engineers on the Operation, Calibration, and Use of Reed-Type Instruments

BY DONALD E. ANDERSEN*

WHILE some engineers have thought that vibrating reed frequency meters went out of date years ago, their accuracy and ruggedness have made them useful for military equipment in all of the familiar applications and many others which are entirely new. The accuracy of vibrating reed frequency meters can be held to about .25%. This requires accurate calibrating equipment and reliable frequency standards. In addition, these instruments are now capable of withstanding rough use and jungle conditions.

Prior to 1941, the most familiar vibrating reed frequency meter design was that invented by Frahm, in Germany. In May, 1941 a new design [1] was developed by F. J. Lingel of the Triplett Electrical Instrument Company of Bluffton, Ohio. The basic parts are an exciting coil, a reed, and a permanent magnet. These are shown in Fig. 1. The coil A surrounding the reed B is connected to the source of frequency to be measured. The reed is held firmly in the mount C attached to the framework of the instrument. D is a permanent magnet.

Briefly stated, a field from the exciting coil will, by induction, make a magnet out of the reed which then reacts with the field from the permanent magnet. If the resonant frequency of the reed is the same as that of the frequency of the current in the coil, vibration will occur. If the incoming frequency is not correct, there will be little or no vibration. Tuning or calibration of the reed is accomplished by:

(1) Varying the length of the reed.
(2) Varying the thickness of the reed.
(3) By adding or subtracting weight at E, the free end of the reed.

The design shown at Fig. 1 is used in the majority of J-B-T frequency meters at the present time. Another design was developed in 1942 which is used in special applications, particularly where extremely low power consumption and a greater consecutive number of reeds are required than can be accommodated within the present exciting coil winding.

The basic parts are shown in Fig. 2. Part of laminations F extend through the coil A. Magnet D rests against the laminations with the free end of the reed B located above. The laminations, due to the permanent magnet, exert a steady pull on the reed which is varied by the action of the current through the coil. As with the first design, a frequency in tune with the reed produces vibration.

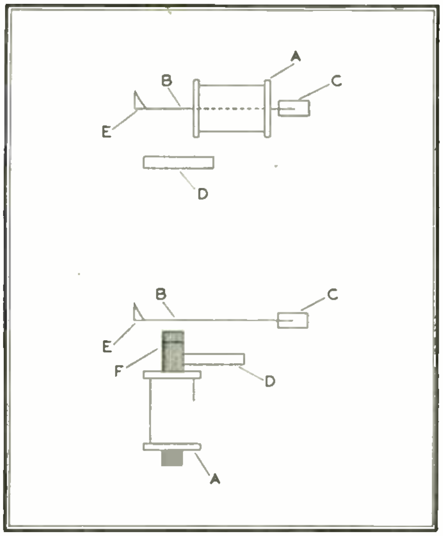

FIG. 1, ABOVE, ELEMENTS OF STANDARD METER. FIG. 2, BELOW, SPECIAL DESIGN FOR MORE REEDS, LESS POWER

The heart of the meter is the reed. The most commonly used material is a high-grade spring steel. This must be cut to length, the flag bent up, and the piece soldered firmly into the mount. One of the most important factors insuring stability of calibration is the firmness and permanence of this junction. Other factors include operation well below the elastic limit of the material, and the permanence of the weighting material used for calibration. The 60-cycle reed has a safety factor of 7, assuring reliable operation for years of continuous service.

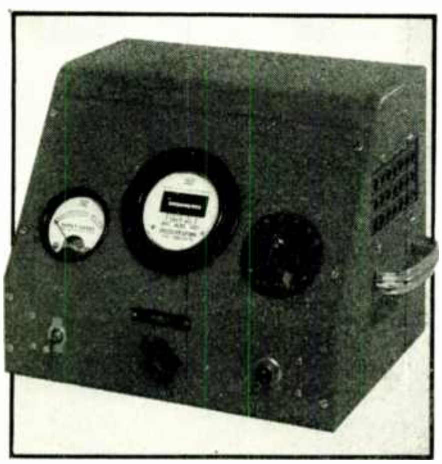

FIG. 3. VACUUM TUBE FREQUENCY METER

In addition, protection against rusting of the reed material is important for obvious reasons. This requires the use of special lacquers and paint for the flags. Some materials which afford protection against exposure for months along the Connecticut shore will not last over a week in jungle conditions. Formulas have been found which prevent rusting and do not discolor although exposed for several weeks in an atmosphere of about 95% humidity with temperature cycled between normal room temperature and 120° Fahrenheit. All coils and resistors are baked to remove moisture and are then coated with fungus resistant lacquer. All soldered connections are also covered.

Jungle tests are made with the use of a standard dessicator such as found in all chemical laboratories. The bottom section is filled with water to within an inch of the supporting plate. With parts to be tested inside and the cover in place, the unit is put in a temperature-controlled oven. The dessicator is made practically air-tight to reach maximum humidity. For fungus tests, the culture, Aspergillus Niger, is placed on several points of the components being tested. Several untreated parts of material known to support the fungus growth are included in one part of the dessicator to make sure that proper conditions are maintained.

Since springs, pivots, jewels, and other delicate parts are not used, vibrating reed instruments are quite rugged. Sustained shock tests on a tester built according to Signal Corps Specification No. 71–515–B indicate a ruggedness capable of withstanding this treatment much longer than the one hour required. Briefly this tester permits the meter to be mounted in various positions 15 ins. from the hinged end of a plywood board with a rotating square cam supporting the board directly under the meter.

In aircraft service, temperatures vary from + 140° F. on the ground to − 65° in flight. Tests of the spring steel reed material we use show that it has a temperature coefficient of approximately 75 parts per million per degree Fahrenheit. This agrees closely with the prior art in vibrating reed frequency meters on the market.

* Chief Engineer, J-B-T Instruments, Inc., 441 Chapel Street, New Haven 8, Conn.

[1] "Design of a Vibrating Reed Frequency Meter" by Fred J. Lingel, *The Instrument Maker*, Vol. 12, No. 3, p. 18–22, March–April, 1944.

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For the temperature span mentioned above, a 60-cycle reed would vary approximately plus or minus 0.45 cycle.

A new material for vibrating reeds has been found which has the extremely low temperature coefficient of 8 parts per million per degree Fahrenheit. A change in temperature of 200 degrees would produce a change in calibration scarcely detectable. It is a special grade of nickel steel with other characteristics combining to make it an ideal reed material. While the elastic limit is slightly less than the spring steel normally used, reeds under test in the laboratory for the past 17 months have withstood about 2,750,000,000 vibrations without sign of fatigue or change in calibration. The material is almost corrosion proof. No sign of rust has been found after weeks of exposure in an atmosphere of 95% humidity. This new material, now being introduced commercially, is known as the J-B-T Neutro-Temp Reed.

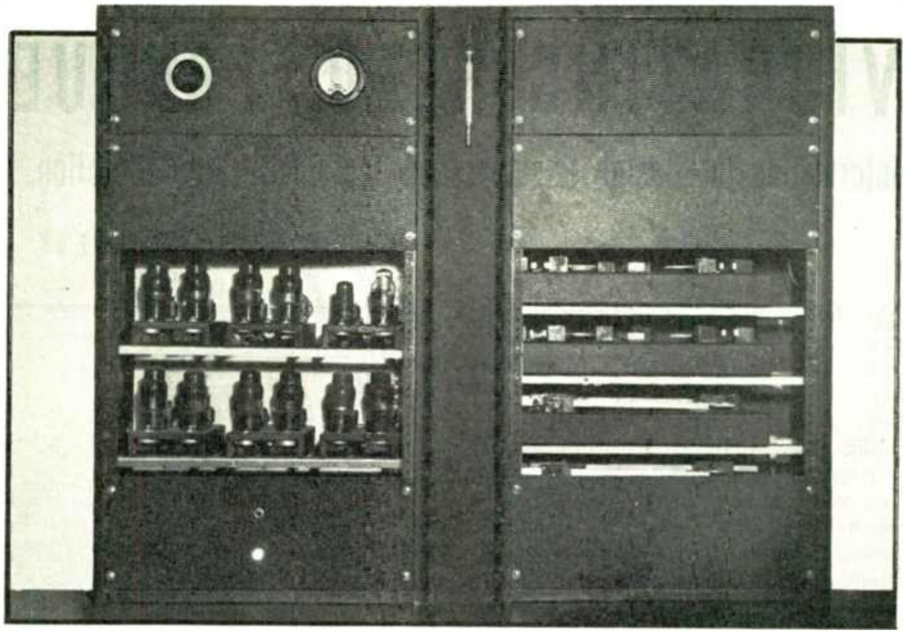


FIG. 4. TUNING FORK FREQUENCY STANDARDS, CHECKED AGAINST STANDARD FREQUENCY RADIO SIGNALS, ARE KEPT IN A TEMPERATURE-CONTROLLED CABINET

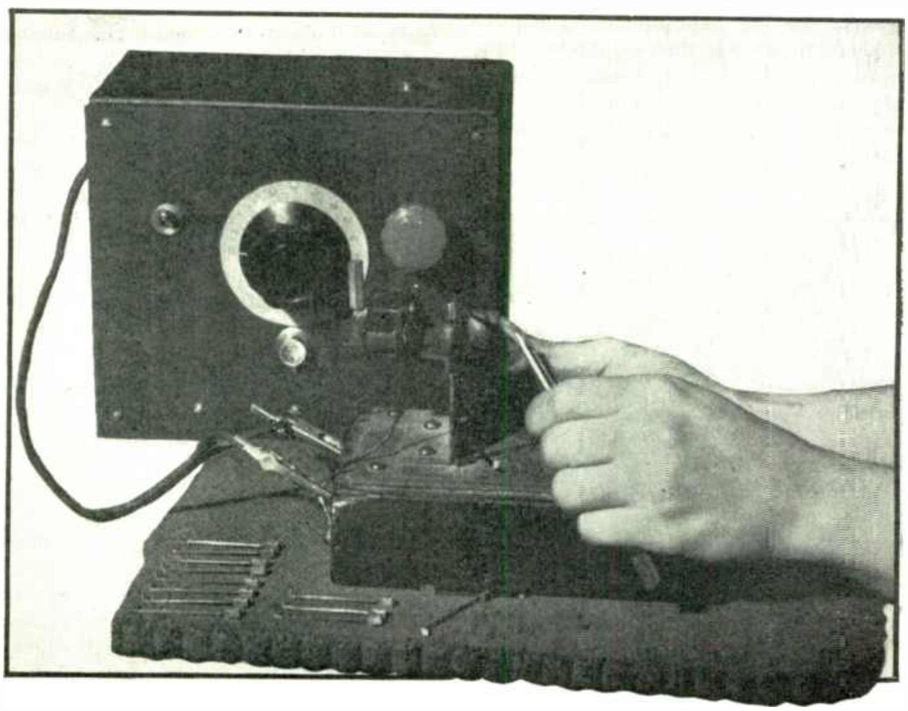
We have produced many special types of vibrating reed frequency meters, to meet the needs of the Armed Forces, and the wide range of voltages and frequencies now available is being constantly extended. A few examples will indicate the types available.

At the present writing, the lowest frequency being calibrated is 15 cycles. Experimentally, lower values have been produced, but due to the pressure of standard production, none is being manufactured now.

For frequencies between 15 and 30 cycles, the most sensitive meter in production operates at 4 volts, with a power consumption of approximately 0.007 watts. Its impedance is about 2,500 ohms. This particular model accommodates 13 reeds. As the frequency increases, more power is required. A standard 400-cycle, 9- or 11-reed meter can be operated on 75 volts at a power consumption of approximately 0.5 watt, having an impedance of about 7,500 ohms. Also, 400-cycle meters are built with lower impedance for 24-volt operation with the same power consumption. The above examples illustrate the ease with which these meters may be adapted to electronic circuits.

The same meters are easily adapted to higher voltages. At 120 volts, power consumption is 0.5 watts at 60 cycles, and 1.3 watts at 400 cycles.

FIG. 5. OPERATOR IS TUNING A REED DIRECTLY AGAINST A STANDARD TUNING FORK FREQUENCY. NOTE THE ROW OF REEDS IN THE FOREGROUND



The upper practical limit for vibrating reed frequency meters is about 550 cycles where substantial visibility is required. Due to the necessity of shortening the reed or increasing its thickness to attain the higher frequencies, the elastic limit is soon reached unless the flag size is radically reduced.

The well-known ability of the multivibrator to divide incoming frequencies was investigated with regards to extending the range of this frequency meter. While the usual circuits tried were not satisfactory, development was continued until a final design made possible the use of a 400-cycle meter to measure frequencies of 1, 2, 3, 4, 6, and 9 times the basic range of 380 to 420 cycles.

This instrument, known as the J-B-T Vacuum Tube Frequency Meter, is shown in Fig. 3. Accuracy of .25% is easily attained. Calibration at the factory is permanent, and the instrument is always ready for use without further standardization. Power consumption of the multivibrator is approximately 25 watts at 115 volts, 60 cycles. The input impedance is 500,000 ohms. Six tubes are used, with the entire instrument housed in a sloping-front metal cabinet 8 by 10 by 8 ins.

While this model derives its power for heaters and plate supply from the 60-cycle power line, another model is available which operates directly from the source of frequency being measured. The total power consumption for a standard model covering 2 or 3 ranges is 20 watts. Three tubes are used and overall dimensions of the electronic unit are 4⅝ by 5½ by 6 ins. high. This unit can be mounted wherever desired, with the indicating in-

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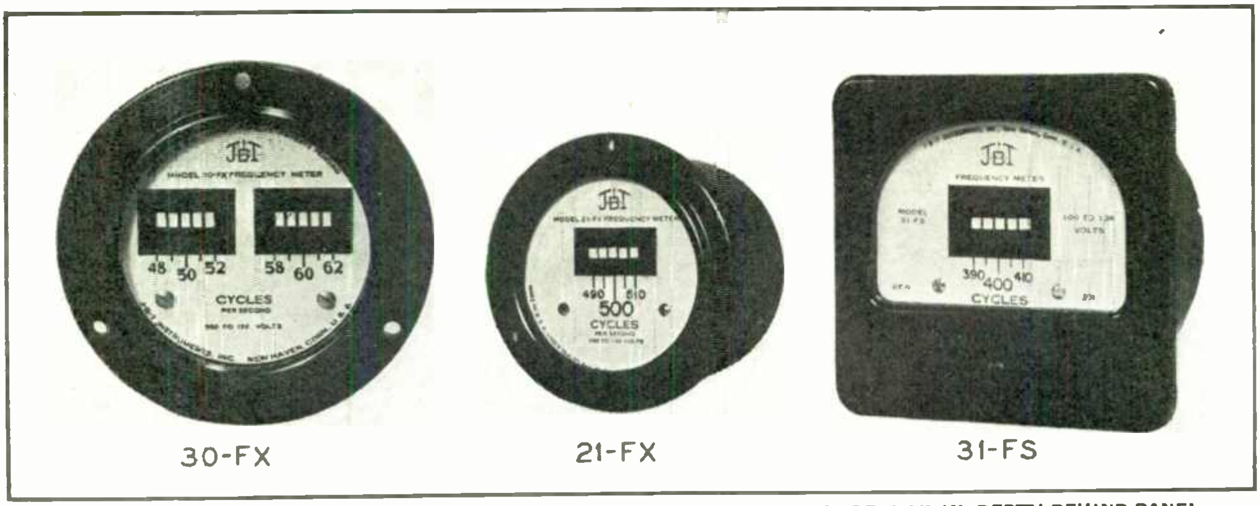


FIG. 7. THREE STANDARD METER TYPES. CENTER METER HAS 2-11/16-IN. FLANGE, 1-3/8-IN. DEPTH BEHIND PANEL

strument on the panel. The latter meets JAN-I-6 specifications for mounting.

Specifying frequency meter ranges requires care regarding several details. The range of a given frequency band and corresponding increments between reeds depends upon several factors. If continuous coverage is desired without so-called dead spots, the response curves of the individual reeds must overlap. If it is desired to set frequencies to definite values, individual reeds can have almost any calibration desired within the limits of present design. Two typical examples illustrate the basis for determining the band desired. With the J-B-T 34-FX 60-cycle frequency meter, it is possible to accommodate 11 reeds. With increments of 1 cycle, a range of 55 to 65 cycles can be covered. With one reed vibrating at full amplitude, practically no vibration occurs on adjacent reeds. Nevertheless, a frequency midway between two reeds will produce about ¼ of full amplitude vibration of each reed. With one-half cycle increments, the range is cut in half, but broader response is attained. It makes possible, however, closer reading of frequencies between reeds. If the meter is to be used to set frequencies at some definite point, the full-cycle increment is recommended.

It should be understood that for frequencies other than 60 cycles, increments must be kept proportional. Thus at 120 cycles, 2 cycles per reed gives performance comparable to single-cycle increments at 60.

All calibration of J-B-T frequency meters is done against tuning fork standards which in turn are checked by use of the Bureau of Standard's time signals.[2] Accuracy can be maintained within 0.05 per cent. Each fork is electrically coupled to a two-tube oscillator circuit, the output of which is wired throughout the plant. With provisions for 15 standard frequencies available to each operator, calibration of any frequency meter as low as 5 cycles or up to 1,000 cycles can be accomplished easily. The system thus provides a source of standard frequencies available to all operators alike. It is used for calibration, final testing, inspection, and by the laboratory for various research projects. The frequency standard racks are shown in Fig. 4.

At each test position is a small booster amplifier which converts the voltage from the relatively high impedance cable circuits into sufficient power to operate a frequency meter.[3] The meter contains reeds tuned to the various standard frequencies being used. With the selection of the frequency to be used, the corresponding reed vibrates at the same rate as the fork. A stroboscopic light, controlled by the oscillator to be standardized, is directed at the fork-controlled reed and the oscillator controls are adjusted until the vibration of the reed is "stopped". With the oscillator dial standardized at one or more points in the range to be used, the operator can then tune to any frequency desired.

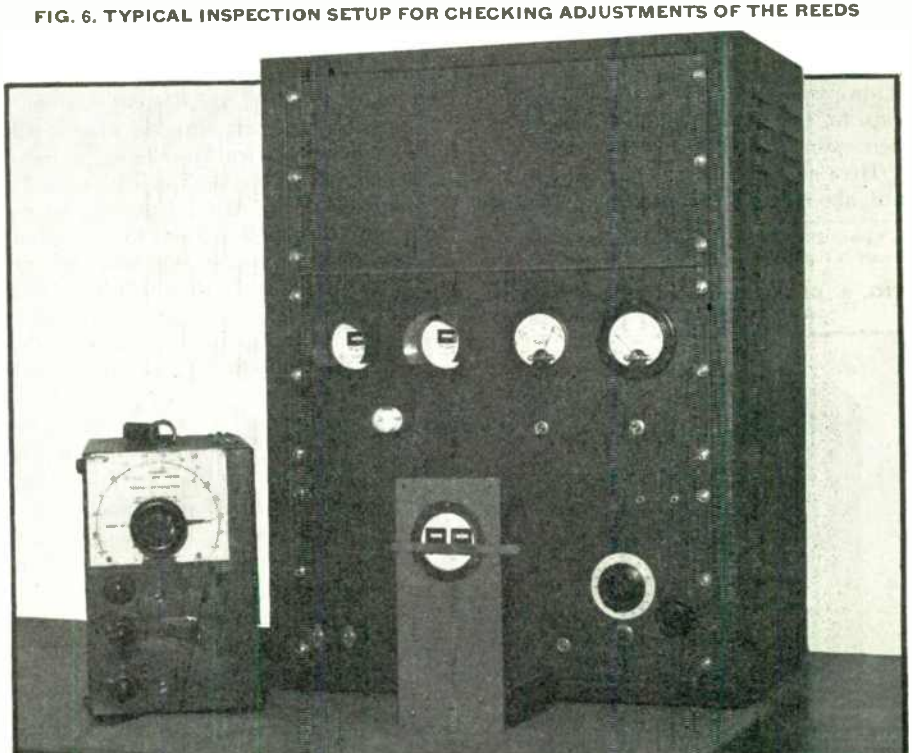
All oscillators, as well as other calibrating equipment, have been designed and built by our own engineers and techni-

(CONCLUDED ON PAGE 36)

[2] "Tuning Fork Standards for Meter Calibration" by Donald E. Andersen, *Electrical World*, Vol. 121, No. 2, p. 92, January 8, 1944.

[3] "Frequency Channels for Meter Calibration" by Donald E. Andersen, *Electrical World*, Vol. 120, No. 22, p. 72, Nov. 27, 1943.

FIG. 6. TYPICAL INSPECTION SETUP FOR CHECKING ADJUSTMENTS OF THE REEDS



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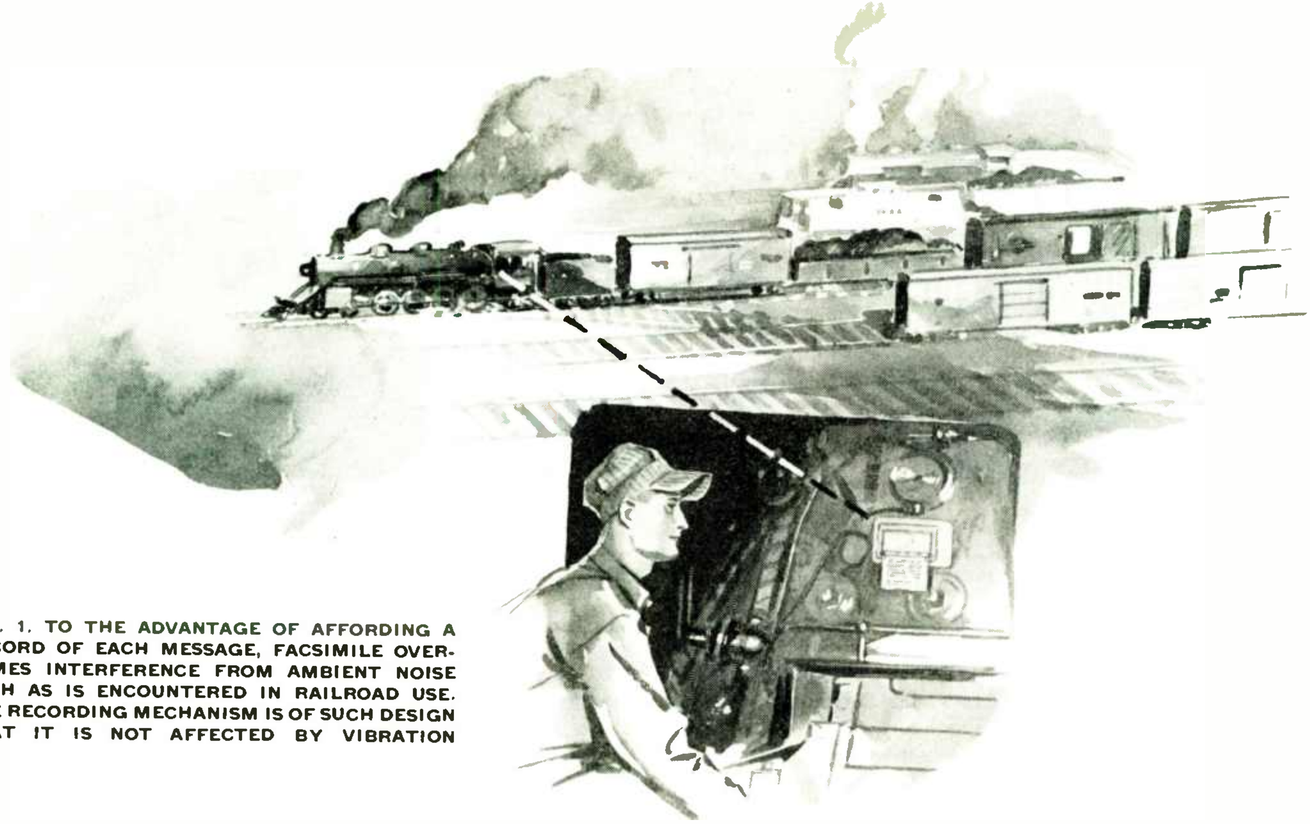


FIG. 1. TO THE ADVANTAGE OF AFFORDING A RECORD OF EACH MESSAGE, FACSIMILE OVERCOMES INTERFERENCE FROM AMBIENT NOISE SUCH AS IS ENCOUNTERED IN RAILROAD USE. THE RECORDING MECHANISM IS OF SUCH DESIGN THAT IT IS NOT AFFECTED BY VIBRATION

A NEW FACSIMILE DISPATCH AND REPORT SYSTEM

Prototype Equipment of New Facsimile System about to be Released for "Use Tests"

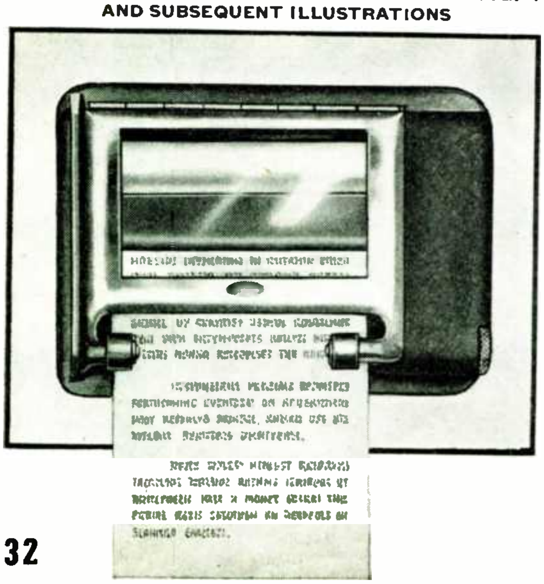
BY MILTON ALDEN*

A PERSON'S given name may be an asset or a liability. I once knew a girl named "Mamie," and although it is a good name, it always seemed to me that it was a handicap to her. How could she help but become plain and a little pudgy?

Here at Alden Products Company, we are about to christen a new facsimile system. We are afraid to dub it the wrong name and handicap its usefulness. For the purpose of this article, we are calling it a Facsimile Dispatch and Report System.

*President, Alden Products Company and Alfax Paper & Engineering Company, Brockton, Mass.

FIG. 3. CLOSEUP OF RECORDER SHOWN IN FIG. 1 AND SUBSEQUENT ILLUSTRATIONS



May I tell you its purpose, what it will do, and its special features? Then, perhaps, you can suggest further applications and a more appropriate name. But first, let me tell you some of the reasons for its design:

Its original consideration was pre-war, when tanks were still something of a curiosity. The laboratories thought it would be a swell idea to equip tanks with tape recorders, and in the absence of compact small page recorders, tape had its possibilities. But, in considering the tank recorder, visualize yourself in a tank driving over rough terrain, being knocked about, temperature over a hundred, visibility poor inside and out — and now you are supposed to pick up and read a ticker tape. And when you succeed in reading it, what are you to do with it? Imagine trying to thread a new tape under these conditions, and having the large roll of tape and bulky mechanism taking up the valuable restricted space in which you are operating!

Dispatch System Versus Tape ★ In contrast, visualize a recorder flat against the wall, printing out a recording with clear, distinct letters on paper 4 inches wide that is indirectly lighted, without glare. You have one place to look when the message starts automatically and the message comes out at a rate you can easily read, even if you are able to give it only part of your attention. The recorder paper rolls up on a spring take-up roll so that you may pull the recording back to refresh your memory on any message received.

Operating the recorder is simplicity itself. To insert a new roll of paper, you lift the cover, take the paper from a small screw top can, insert it on a hinged shaft that is pushed up to a convenient angle by a spring, slip the paper roll in place, close the cover, and the recorder is back in operation. It takes less time to complete the operation, as a matter of fact, than we have taken to describe it. And furthermore, there is not the usual delicate

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FIG. 2. SCANNING INSTRUMENT FOR FACSIMILE TRANSMISSION FROM A RAILROAD SIGNAL TOWER

printer mechanism of the tape recorder requiring adjustment from time to time to worry about.

Now at the transmitting end of a tape system, there is a practical if not serious problem. Tape transmitting and recording systems have often been chosen before our dispatch system was known, because they were considered simple and would operate over the poorer wire circuits or over narrow radio bands. In any tape system there was always the problem of getting the message onto the transmitter tape in uniform weight and bold enough to produce a good record at the receiving end. Typewriter companies have been approached to make special typewriters, with letters larger than the usual type, to print directly on the tape. Varitypers were used, and some manufacturers made typewriter-scanner combinations. However, the rate of typing and transmission never match, and such arrangements on busy circuits are very wasteful of either the circuit or the operator's time.

One service that wanted to use tape facsimile went so far as to use Teletype machines to print messages on the tape for scanning. For relaying, this is all right, but if you are to use a Teletype to produce your scanning type, you might as well use the complete Teletype system, the Hellschreiber, or the tape perforator code systems.

Then there is the problem of fading or interference. Teletype sends five to seven impulses in combination to make a letter. If static or fading varies any of these impulses, you may get the wrong letter, or, more particularly, static in the no signal space will print a letter. (In multiplexing and special transmitting circuits, this can be overcome by having no interval without a signal.) With page facsimile, you would lose only a portion of each letter in a line during an interval of fading long enough to wipe out a complete word in the tape recorder system, as shown in Fig. 11. Similarly, a static impulse of sufficient duration to render an entire word illegible in the tape recorder will simply cause a thin line of dots to appear across the copy in the page facsimile system, as shown in Fig. 12. In either case, misinterpretation will be impossible.

There is no way, for example, for atmospheric conditions to make facsimile record an A instead of an E, or a 2 for an 8. Yet this is quite possible when a typewriter is used as a recorder.

Another weakness of the typewriter system is that an inexperienced or unskilled operator must look at the keys of the transmitting machine. Thus he may, unknowingly, transmit the wrong letter. If he does not check his own tape after the message has been sent, he may not know that he made an error. On the other hand, customary practice with facsimile is to type the message completely, and then to read it to check mistakes, before it is fed into the transmitting scanner.

The new Alden system by-passes a lot of problems. To get an insight into how it works, let's take a specific application. Suppose the facsimile units are used for railroad dispatching. Figs. 1 and 2 show the recorder mounted in a locomotive cab, with the transmitting scanner in a signal tower. Detailed views of the two units are shown in Figs. 3 and 4, respectively.

In the signal tower, the message is first typed out on any typewriter. Even a portable typewriter would do, and in emergencies handwriting might be used. Good clear typing is preferred, of course, because the typewritten message takes less space and can, therefore, be transmitted in less time.

The paper on which the message is typed might be a standard form, or it could be ordinary 2¼-in. adding machine paper. This will accommodate five words to the line. Usual practice is to use all capital letters. At the end of the message, whether it is 5 or 50 lines long, the paper tape is torn off. Then the operator simply puts the starting edge of the paper on the table of the scanner, Fig. 4, and presses the lever at the right.

The scanner takes over from there. It pulls in the copy, scans it until it sees the end of the message, then stops, resets, and ejects the original copy.

Simultaneously, pressing the starting lever on the scanner flashes a radio signal to the recorder. As you will see from Fig. 10, the size of the original typing, shown at the left is enlarged 1½ times when it appears at the recorder, as shown at the right. This illustration is an actual-size reproduction of original copy and its reproduction at the receiving end. When the message has been transmitted, the recorder motor stops. Certainly nothing could be easier than this.

Summarizing this 4-in. dispatch system, as compared to the tape system:

We have done away with the need for a Varityper or special typewriter by taking the letter of standard typewriter size and recording it enlarged 1½ times.

The width of the lines that make up the letters of typewriter type are about 20 thousandths of an inch wide. When they are enlarged 1½ times, they measure about 30 thousandths. Thus, the automatic enlargement produces, in effect, bold face type which can be read at a distance of 4 to 6 ft. by a locomotive engineer of bifocal age (over 50) without his bifocals, by a policeman in his prowl car, or by a doughboy in his tank at distances from 4 to 6 ft.

FIG. 4. DETAILED VIEW OF THE SCANNER USED FOR FACSIMILE TRANSMISSION

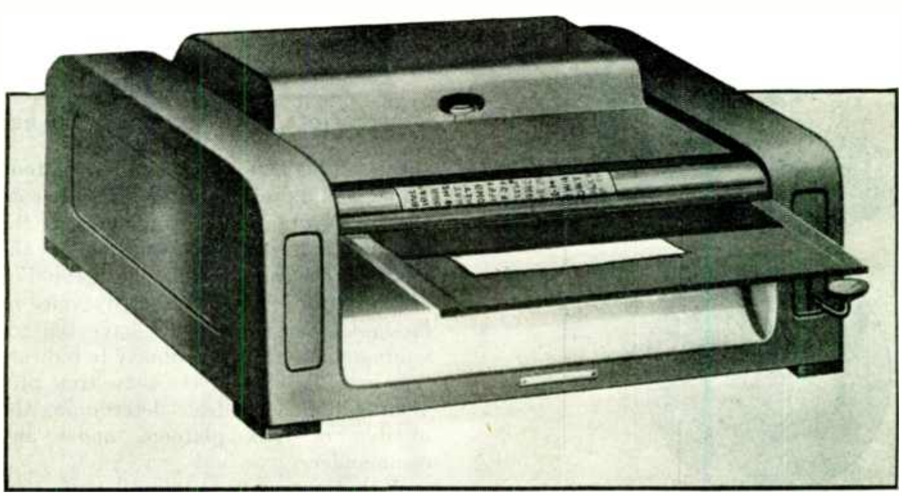

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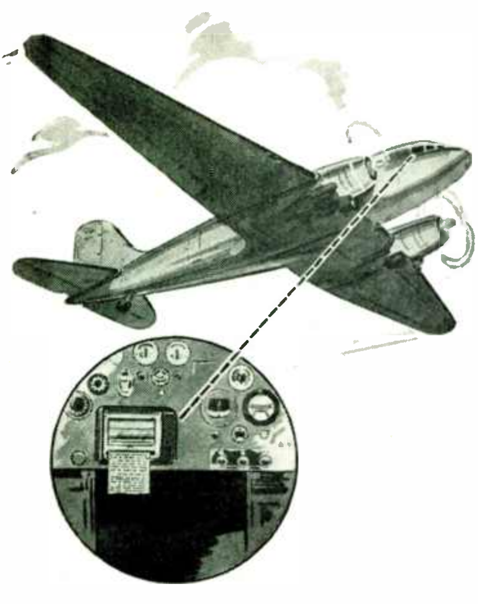
FIG. 5. LEFT, FACSIMILE MESSAGES CAN BE LEFT FOR PATROLS ON REMOTE OPERATIONS AND, FIG. 6, FOR TAXICAB DRIVERS

Incidentally, automatic facsimile enlargement can be 4 or more times, so that our 18-in. recorder makes an excellent automatic remote bulletin board.

This is but one of the varied requirements that may be missed if we christen this new baby a "Facsimile Dispatch and Report System." It was initiated to fill a variety of requirements, upon which we will elaborate and your imagination undoubtedly suggest many more.

The system is not limited to a typewritten message. It transmits, with equal facility, handwritten messages, sketches, drawings, maps, or whatever will best communicate your idea to the person at the other end.

FIG. 7. FACSIMILE IS IDEAL FOR AIRCRAFT COMMUNICATIONS AND INSTRUCTIONS



Being able to sketch directions would be a distinct advantage, for example, to a tank commander who wishes to communicate with his platoon leader. The platoon leader would presumably use voice to contact his own tanks, his commander, or the infantry with whom he is working, but the replies of the commanding officer could be at the latter's option, either by voice or facsimile. Facsimile would have the advantages of secrecy and ability to indicate terrain, etc., while at the same time preventing the enemy from determining the number of tank platoons under any commander.

With the war over, we all hope that military problems will soon occupy little of our thinking except that our country be well prepared with the best equipment. Nearly all war dispatch problems, however, have their civilian counterpart. Thus owners of trucks, tugboats, police cars, and taxis can benefit by not having their message received readily by competitors or criminals. Facsimile is more secret than voice systems. Moreover directions accompanied by sketches and names increase the efficiency of any kind of dispatching.

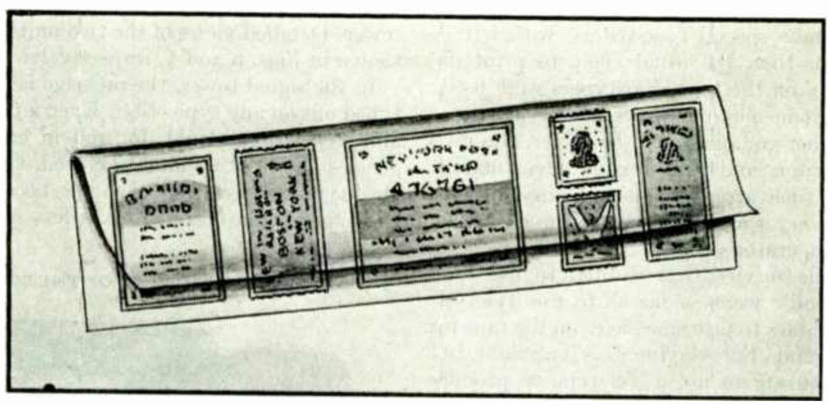


FIG. 8. SEVERAL TICKETS CAN BE SCANNED IN A TRANSPARENT FOLDER

Applications of Facsimile ★ The accompanying illustrations indicate some of the great number of uses for this equipment. Plans are being worked out right now by municipal and state police officials for the testing of prototype facsimile in conjunction with their present FM communications

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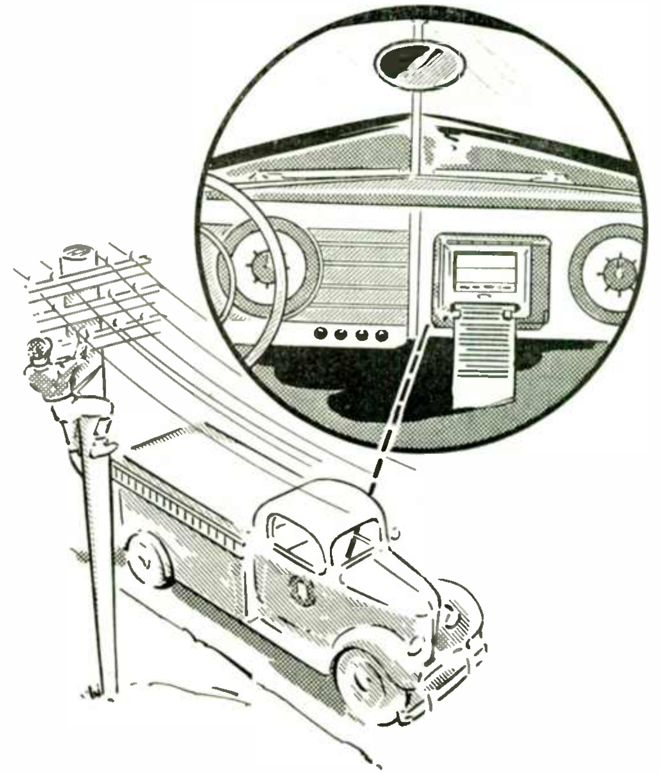

FIG. 9. ABOVE, RAILROAD STATIONS CAN BE TIED INTO RADIO FACSIMILE SYSTEMS. FIG. 11. RIGHT, THE RECORDER IS SMALL ENOUGH TO FIT ON TRUCK OR PATROL CAR DASHBOARDS

systems. The method of using facsimile will vary in accordance with local requirements.

In some cases, recorders will be installed in police cars, so that messages from headquarters will be recorded, thus eliminating the chance of mistakes under conditions of noise which compete with aural reception.

Electric light and street car companies are using 2-way FM to route their emergency repair trucks. This has proved so successful that this service has been extended greatly, even during the war. It has one disadvantage, however. If the men have to work at some distance from the truck, they may fail to hear an emergency call. With a facsimile recorder mounted on the truck, it will be necessary only to glance at the tape at frequent intervals. Then messages can not be missed and there is no need of repeated calls.

Similarly, facsimile will be valuable to fire departments. The one serious difficulty encountered in using 2-way FM for communications with fire trucks is the ambient noise both enroute and at the scene of a fire. Moreover, facsimile overcomes the objection to radio voice communication that has been voiced by fire chiefs, namely, that it does not provide a record for subsequent reference.

Prototype equipment has been so designed that it can be readily tested with existing sets.

This facsimile equipment can be readily installed by railroads and airlines. Recorders can be designed to provide duplicate copies of all messages received, with the duplicate rolling off into a locked compartment. It will not have the clarity of the original, but the messages will be sufficiently legible to prove that the original was received.

Because the recorder is so small in size, it can be mounted in a locomotive where the engineer can see it, or on an airplane instrument board between the pilot and co-pilot. On very large planes, messages can be received simultaneously on two or more recorders at different locations and, with scanners added, the facsimile equipment can be used for recorded intercommunication.

At remote points on Central or South American plantations or mining properties, or at forestry and pipe line stations visited only at irregular intervals, FM receivers could be left in continuous operation so that messages could be received at

GO AHEAD

CLEVELAND TOWER
ANSWERING NC ONE, FOUR,
ONE, FIVE, SEVEN. FIELD
ZERO. CEILING ONE THOU-
SAND FEET. VISIBILITY
FOUR MILES. ALTIMETER

FIG. 10. AN ORIGINAL TYPEWRITTEN MESSAGE, ACTUAL SIZE, IS SHOWN ABOVE. AT THE RIGHT, THE FACSIMILE RECEPTION, 50% ENLARGED, IS REPRODUCED TO SHOW HOW EASILY MESSAGES CAN BE READ

GO AHEAD

CLEVELAND TOWER
ANSWERING NC ONE, FOUR,
ONE, FIVE, SEVEN. FIELD
ELEVATION SEVEN EIGHT
ZERO. CEILING ONE THOU-
SAND FEET. VISIBILITY
FOUR MILES. ALTIMETER

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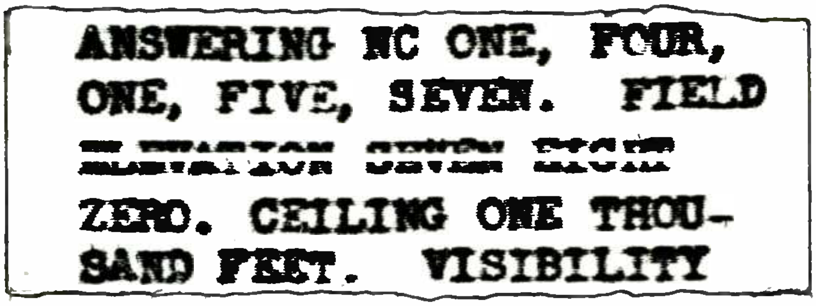

FIG. 11. FADING WHICH WOULD DROP OUT AN ENTIRE WORD ON TAPE RECORDING REMOVED ONLY A THIN SLICE FROM EACH LETTER OF THE MESSAGE ABOVE

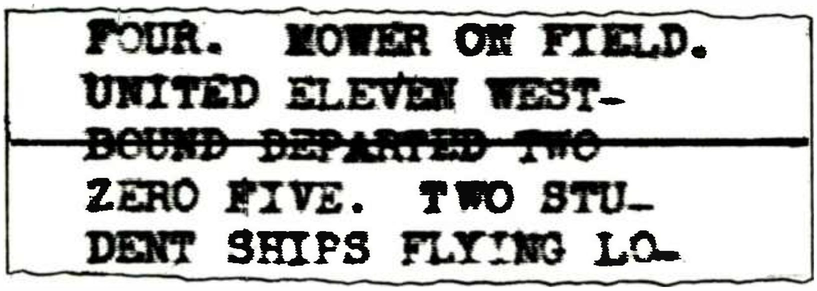

FIG. 12. STATIC THAT WOULD OBLITERATE AN ENTIRE WORD ON TAPE RECORDING MERELY CAUSED A THIN BLACK LINE TO APPEAR ACROSS THE MESSAGE ABOVE

any time, to be read upon arrival of the next patrol.

Similarly, messages can be sent to dispatch points for taxis, trucks and buses. A taxidriver, for example, returning to his stand, might find instructions for two calls. He would tear off the first address and go for his fare, leaving the second for the next car.

This recorder, arranged to reproduce in 1 to 1 ratio of size, is admirably adapted to becoming the basic part of a chair-side facsimile broadcast receiver in the home. The design is such that conventional types of cabinets, if modified slightly, can accommodate recorders, or the recorder can be mounted separately and connected to the radio set by a light cable.

In addition, there are many uses for these instruments for business services. Here is just one example: In railroad and airport ticket offices, stubs of tickets can be placed in a scanner and, almost instantly, at a clearing center, the stub and the information it contains will be reproduced. The ticket agent is then free to serve the next customer. He loses no time making a record of the ticket sold, or in reporting the sale. The clearing center would then have a voucher record with complete information necessary for keeping reservations up to date and for clearing the accounting for each road over which transportation is sold.

From this review of the applications for simplified scanning and recording units, you will see that we need a comprehensive name that will indicate the scope of possible uses, rather than the conventional name "facsimile". Suggestions on this point will be very welcome.

Part 2, to appear in our September issue, will disclose the mechanical features of the Alden units, with both drawings and detailed photographs.

In addition to the use of facsimile for various communications services, great impetus has been given to plans for providing transmission for home reception by the favorable attitude of the FCC. It should be noted that a 2-mc. band, 106 to 108 mc., has been assigned to home facsimile. This is adjacent to FM broadcasting, and is within the range of new FM receivers. If, as is expected, experimental tests on duplex FM and facsimile prove successful in practice, any FM station will be permitted to transmit sound and facsimile simultaneously from the same transmitter and on the same frequency. Then, in all probability, the 2-mc. facsimile band will be given over to FM broadcasting.

VIBRATING-REED METERS

(CONTINUED FROM PAGE 31)

cians. One important reason for this was the necessity of band spread in the frequency ranges being used. A frequency range such as 360 to 430 cycles covers an arc of 4 ins. on the scale, while 48 to 62 cycles is spread over 8 ins. A special oscillator built for low-frequency work covers the range of 15 to 62 cycles in 5 ranges, with the arc used between 15 and 19 cycles being 14 ins. long.

Where frequencies of reeds are to be the same as available standard frequencies, oscillators are not needed. The reed is placed in a calibrating jig operating from the booster amplifier and the reed tuned until full amplitude is attained. The photograph in Fig. 5 illustrates the simplicity of the method. With frequencies outside the range of the tuning forks, the special oscillators are used and no matter what the frequency, the stroboscopic light provides the means of standardizing. Fig. 6 shows a typical setup for checking meters in the inspection department. The special oscillator is located next to the rack which contains other equipment for operating the meter under test; and the booster amplifier operates the frequency meters for standardizing.

Many different models of frequency meters have been developed by J-B-T during the past few years. Some are shown in Fig. 7. The original models, and as yet the most widely used, are the round 3½-in. flush panel mounting type, known as the 30-F and 30-FX series. These are furnished in metal and bakelite cases respectively, the latter meeting JAN-I-6 specifications for mounting and stud size of electrical indicating instruments. A truly miniature frequency meter is found in the 2½-in. flush-panel mounting 21-FX, which meets the same specification for depth as well as other dimensions.

Other special meters include square-case models, known as the 30-FS series. These were developed to accommodate those wishing to match other square-case panel instruments. A different type of indication from any obtained with the above models is found in the 32-F type. In this model, the reeds are arranged vertically one above the other and vibrate horizontally. With the highest frequency on top, the level of indication is proportional to the frequency, and easier reading results. A larger meter is found in the 50-FX series, built in a round bakelite case for front-of-panel mounting, with diameter of 4¾ ins. and extending outward 1¾ ins.

Some of the applications of vibrating-reed frequency meters which will illustrate their wide use at this time, and perhaps serve to stimulate ideas for other applications are:

Aircraft inverter systems, both for planes and test units; motor generator sets used by the Armed Forces for communications and anti-aircraft systems; emergency standby power units for transmitters at aircraft landing fields, public utility stations, etc.; Weather Bureau equipment vibrator testing; geophysical applications, such as well-drilling; astronomical observatories; film speed in frames per second; broadcast deviation meters; oscillator standardization; and checking and tuning filters.

World Radio History

ON HILL 609, WHERE GERMANS MADE THEIR LAST MAJOR STAND BEFORE TUNIS, AN FM RELAY STATION WAS SET UP A FEW DAYS AFTER THE FIGHTING ENDED

FM RELAY EXPERIENCE IN NORTH AFRICA

Lessons Learned in Africa Were Applied to Improving Equipment for European Invasion

BY RUSSELL A. BERG*

THE introduction of the tank, truck, armored car and other relatively high speed cargo and combat vehicles during the current war has forced new developments in many branches of military science. One of the outstanding innovations in signal work has been the introduction of ultra-high frequency radio in rear echelon communications, that is, between the headquarters of divisions and higher units. Many of these, heretofore slow moving organizations, now travel at the unprecedented speeds of 25 miles a day. These groups need, because of their rapid changes on location, several telephone and teletype circuits to each unit on either flank and to the units next higher and next lower in command. In some situations, these circuits are 450 miles long. One method found particularly effective in this type of work has been the use of FM communications equipment, with FM relay stations where long distances could not be covered by direct transmission.

Ultra-high frequency FM relays have been found capable of providing systems of considerable length with signal-to-noise ratios equal to or better than wire lines furnishing similar facilities. AM equipment on 2 to 18 mc. cannot provide circuits of comparable quality and reliability.

In fast moving military situations, radio systems can be installed almost as quickly as a modern army can travel. In the post-war commercial field such installations may have application in opening new country, in new systems in undeveloped country, and for connecting large construction jobs in isolated areas to the nearest installed wire lines. Also, there will be a large field of application in emergencies when wire lines are down due to floods or hurricanes.

Radio has several advantages over wire lines which are particularly important in military applications. The conservative range of UHF radio stations with 40-ft. antennas is 25 miles over most terrain. The weight and volume of FM radio equipment is about 1/10 that of wire equipment which provides the same facilities when the wire is laid on the ground. Pole construction, which is far more satisfactory, is much slower to install and heavier. In hilly or mountainous terrain, the range of the FM stations can be increased, so that in this kind of country the advantage of radio goes up while the difficulty of wire installation generally increases. Radio can be used across water, gorges, and swamps where the employment of wire is difficult or impossible.

From a guarding and protection standpoint, radio stations, by their very nature, observe the fundamental military principle of concentration of forces, whereas the personnel guarding wire circuits must be strung over the whole of the wire system. On radio installations, the trouble shooting and maintenance personnel are always at the terminal and relay stations where the failures occur. The time of installation of a radio relay system is the time required to carry the equipment to the site plus the antenna installation time. A 500-mile radio circuit, for example, can be installed in 2 days in country where good roads exist. Facilities, however, must be available to feed personnel and supply gasoline for engine-driven generators. The main disadvantage of radio is the lack of security from interception by the enemy. Also wire circuits are not completely secure.

One of the first radio relay systems installed by the U. S. Army was in North Africa, during the fighting in Tunisia, near Hill 609. This system was improvised from commercial 250-watt police radio transmitters and receivers, modified in a number of ways so that, with tone equipment and other accessories, either one voice or one simplex teletype circuit was available. This system furnished a circuit between the forces fighting for Tunis and headquarters in Algiers. While it provided only one channel, less than the minimum necessary, it furnished communications at a time when every circuit counted.

* 138 Lexington Ave., Fair Haven, N. J.

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In basic principles of operation, this relay system followed the relaying part of the Pennsylvania Turnpike system.

The Turnpike setup, however, provided communications all along the length of the system. The system in Africa was only for end-to-end transmission. No traffic, except messages relating to the operation of the system, were handled between relay stations and the terminals, or other relay stations.

The particular way in which the relay transmitters and receivers at the relay stations were employed, however, was identical in principle to their employment in the Turnpike installation. Each relay station receiver in the system was equipped with a carrier-operated relay which was activated by the receiver squelch system when a carrier was received. Each of these relays performed two functions. It disabled the other receiver at the relay station by disconnecting the plate voltage and it started time delay circuits which, after about two seconds delay, turned on the transmitter plate voltage. The reason for the time delay is discussed below.

The audio outputs of the receivers were connected in parallel and to the input of the transmitter. It was found desirable to operate the terminal station receivers continuously, employing the carrier-operated relays in them to send "marking" signals to teletype machines.

Referring to Fig. 1, in transmitting from A to H, A sent to B, C to D, E to F, G to H, and receivers L, J and K were disabled. When the direction of transmission was reversed, I sent to J, G to K, E to L, and C to M and receivers B, D and F were disabled. Thus the transmitters sent in both directions but the respective relay receivers operated only in one direction. This arrangement, with all its relays and other features, was not as simple as a duplex set up, which uses a line of transmitters and receivers in each direction. However, lack of transmitters and other considerations dictated the simplex arrangement in N. Africa.

A number of difficulties were experienced with this circuit arrangement. Only four frequencies were supplied in the original shipment. When the circuit length required more than four stations, some of the frequencies had to be repeated. Occasionally, when the ionosphere conditions provided paths 200 to 300 miles, the 30- to 45-mc. signals would jump over two stations to the third and cause the system to jam.

To illustrate, assume that A and I were on the same frequency. I transmitted to B; this started C transmitting back toward D and E. Meanwhile, G would start because signals would be received by J. I, F and K would be disabled and the circuit would jam. It is probable that the higher frequencies (110 to 117 mc.) employed on the Pennsylvania Turnpike eliminate this difficulty. In addition, time delay circuits which were mentioned in the previous paragraph must be incorporated in each relay station transmitter or receiver so that, when communications were stopped to reverse the direction of transmission, the receivers which were disabled would not start up before the next transmitter in the circuit stopped. This led to "singing." In the African installation, the time delay was incorporated in the transmitters. The same effect would have been obtained whether the delay was in the transmitters or receivers. For example, in transmitting from A to I, when A was shut down, B lost its signal. The carrier-operated relay in B was then released, turning off C's plate voltage and making L capable of receiving signals.

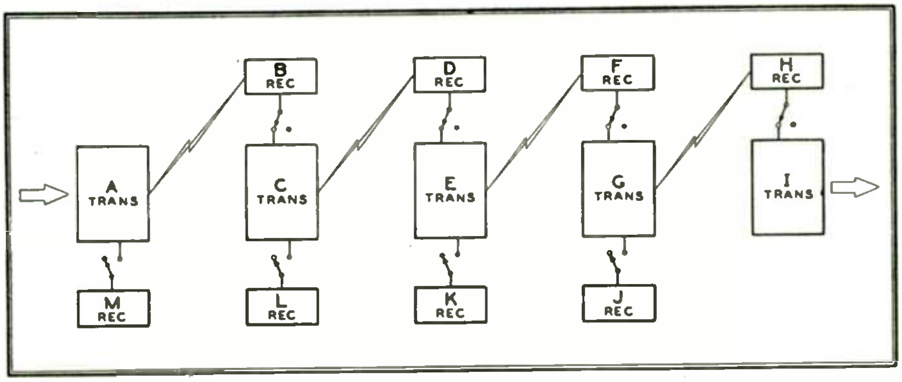

FIG. 1. THE OPERATING CIRCUIT FOR TRANSMISSION FROM TERMINAL "A" TO "H"

Receiver L picked up E. If there were no time delay, this would turn C's plate voltage on again and a "singing" loop around C, D, E, L and C would be established.

This was avoided by making each transmitter slow in starting to transmit after the carrier-operated relay of the receiver was activated by the incoming signal. C actually began to start, but C did not get on the air before E went off. When E went off, C's time delay was reset.

A third difficulty was encountered when harmonics of some high-powered, low-frequency transmitter were picked up by one of the receivers in the middle of the system, such as at K. This would start transmitter E which would be picked up by F; this would in turn start G. Signals from G would be quite strong and they would capture K from the offending har-

MOBILE FM TERMINAL STATION IN TRUCK COULD MOVE QUICKLY TO NEW LOCATION AS BATTLE LINES CHANGED

POWER SUPPLY FOR A MOBILE FM STATION WAS CARRIED IN A LIGHT TRAILER, AND HAULED BEHIND RADIO TRUCK

World Radio History

monic. This would establish a singing loop around K, E, F, G and back to K. Also, since D and J were disabled, no communications could go through. The first and third difficulty were inherent, and caused a number of system outages. The second was cleared by the installation of the time delays.

N. Africa is fairly mountainous with snow-covered, inaccessible Djebel Ta Babor, the highest peak, about 6,500 ft. The stations were located on various accessible peaks at heights of approximately: 600, 4,900, 3,600, 3,900 and 2,000 ft. respectively. This does not include the Tunis Terminal which was in a truck, and moved with the headquarters. Later, several trucks at different headquarters shared time on the circuit. No trouble was experienced in communicating up to 50 miles to the trucks. With these elevations, the longest path was about 115 miles. It was possible to receive useable signals over this path with the final amplifier plate voltage turned off during neutralizing adjustments. Needless to say, communications with the 250-watt amplifier were solid, with the exception noted below.

The only climatic difficulty which affected propagation was experienced when the stations were in thunder storm clouds. Apparently, the clouds discharged continuously to the earth through the sharpest point, namely, the antenna. Under these conditions the noise rose to such high levels that communications were impossible. A distinction must be made between that type of interference and lightning from local thunder storms, because the latter did not bother operation. Only actual contact between the antenna and the storm clouds caused interruptions.

This was probably the precipitation static phenomenon described by H. M. Hucke.[1] Except for this type of interruption, no outages were experienced which were the results of climatic propagation conditions. A parallel wire system experienced outages in these storms also. In general, however, it was found that the atmospheric conditions in the Mediterranean area were extremely stable and there was no perceptible fading due to refraction or tropospheric changes.

Because relay systems, particularly carrier-operated types such as are described in this article, may be interfered with by other services, and because these systems generally employ unusually strong signals, the squelch adjustments should be designed to have more range than is common in other types of FM equipment. In most police sets, the squelch adjustment, when set for minimum sensitivity, will not stay closed on signals higher than 10 microvolts. Sets for relay services should have squelchs adjustable over a range of at least from minimum useable signals to 100 microvolts.

The abuse experienced by the equipment in the Tunisian campaign was severe. The popular conception of Africa is jungle and desert, hot and either extremely humid or extremely dry. Actually, this is not true of the northern part of French Northwest Africa. Northern parts of Algeria and Tunisia are in the same latitude as Virginia. In the mountains, the weather is quite severe. At one site, the transmitter stood in 6 ins. of water when a thunder squall came up before the site was fully developed! During preliminary tests, shut-downs occurred when snow caused the high voltage rectifiers to flash over. There were heavy mists and the stations were in the clouds large parts of the day and night. During shipment from the U.S.A., the frames of most of the receivers were broken, and two of the transmitter racks were bent out of shape quite badly. In spite of such rough treatment, this equipment, which was designed to sit in attics of the city halls where it would be the pride and joy of the city fathers, nevertheless provided many hours of service. Replacements were made on the brute force method, namely, by putting in resistors of the next larger size until they didn't burn out.

The personnel who were in charge of this installation were basically radio engineers, with no experience on teletype machine techniques, or tone equipment.

(CONCLUDED ON PAGE 87)

[1] *Proceedings of the I.R.E.*, May, 1939, "Precipitation-Static Interference on Aircraft and at Ground Stations"

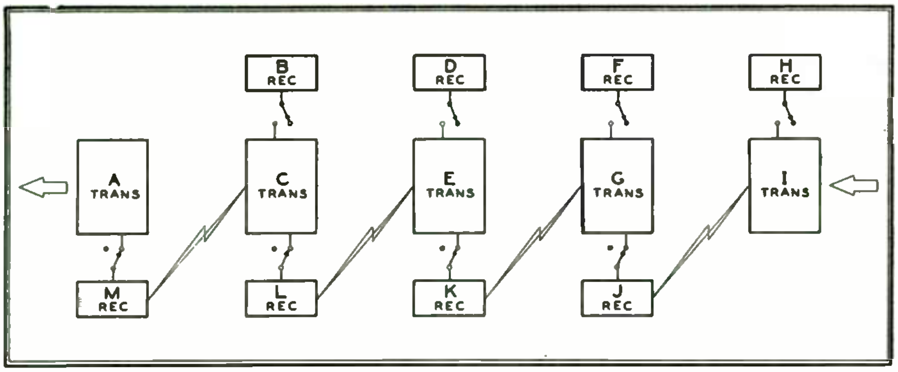

FIG. 2. THE SECOND SET OF RECEIVERS WAS USED FOR TRANSMISSION FROM "I" TO "M"

COMPLETE FM RELAY STATION, READY TO DEPART FOR A NEW POINT OF INSTALLATION NEAR THE AFRICAN FRONT

TYPICAL SEMI-FIXED FM TERMINAL STATION, SHOWING THE TELETYPE EQUIPMENT. MOBILITY WAS A GREAT ADVANTAGE

World Radio History

SPOT NEWS NOTES

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

A Great Opportunity: As the first Chairman of the FCC during the New Era of Peace, Paul A. Porter has an opportunity to implement the application of wartime radio developments to new public services that will win for him the respect, admiration, and support of the entire industry.

2-Band FM: John Meck Industries has announced that they will equip their FM-AM receivers with 2 FM bands, as recommended last month by the FM licensees. Stromberg-Carlson has withdrawn their objection to providing 2 FM bands in their new models. Only other expression of disapproval came from Motorola.

Commissioner William H. Wills: FCC Commissioner Norman S. Case, whose term expired June 30th, has been succeeded by William H. Wills, ex-governor of Vermont, sworn into office on July 23rd. Coming from Bennington, Vt., a section where FM is delivering acceptable radio service for the first time since the inception of broadcasting, he may prove to be one of the staunchest supporters of FM for rural service. Miss "Min" Sparks, who served Mr. Case during his term as Commissioner, will be administrative assistant to Commissioner Wills.

New Dry Cells: RCA is now producing a line of dry batteries for distribution through their tube and parts jobbers and radio dealers. The "preferred type" plan will be applied to keeping the variety of shapes and sizes at a minimum.

Merger: Utah Radio Products Company and Universal Cooler Corporation have been merged into the International Detrola Corporation, of which C. Russell Feldmann is president and board chairman. Among Utah's subsidiaries is the Caswell-Runyan Company, manufacturer of radio cabinets. Detrola headquarters are in Detroit.

Norman Wunderlich: The former sales manager of Motorola's emergency and communications equipment division has joined Federal Telephone and Radio Corporation as executive sales director of radio equipment. In this capacity, he will be responsible for the sale of all Federal radio equipment and associated products.

Indianapolis: Electronic Laboratories, Inc. has announced the election of Norman R. Kevers, former president, to board chairmanship; William W. Garstang, former vice president and general manager, has been elected president. Salesmanager Walter E. Peak, chief engineer Paul H. Frye, and works production manager Harry C. May have been elected vice presidents.

Conway Peyton Coe: Has been elected vice president in charge of RCA Laboratories patent department. He was U. S. Commissioner of Patents from 1933 until his resignation on June 15th of this year.

Radio Relay: A GE-IBM radio relay is planned for service between Los Angeles and San Francisco, to carry FM and television programs, facsimile, and radiotype circuits in both directions.

Star Witness: At the FCC FM regulations hearing was former chairman James Lawrence Fly, whose testimony, and manner of presenting it, kept leading broadcasting executives in Washington for an extra day. Concerning FCC and CBS plans limiting FM to single-market coverage, he said: "Now, the public interest, I would submit, is that of the listeners, and they are the forgotten men and women in the various presentations that were made to the Commission yesterday. . . . In other words, it (single-market plan) is devoted to pay dirt territory, and none of the brochures and none of the testimony on this plan gave one moment's attention to the Country's greatest need, and at no point do I find the public needs discussed. . . . Here the Commission recognizes a need for rural service, but it has seemingly failed to authorize the means which would make that service possible. Indeed, it suggests adding plant investment for the purpose of avoiding service. . . . I am warning merely against CBS, or the Commission's own staff, or anyone coming in with a map and saying, 'This is how it is going to be,' because we all know, as a matter of fact *it ain't going to be that way!* . . . I am not happy with the single-market plan in any area, Mr. Chairman. . . . I think the idea of having a large number of whistle-stop stations is a very good one. I do think, though, that it might be well to consider giving them a little greater coverage, let them cover a county, let them put it in the county seat and let them cover a county."

Promotion Needed: Another survey of post-war purchase plans, this one by the Office of Civilian Requirements and the Bureau of the Census, shows the effect of saturation in the market for AM radios. Published figures show that planned purchases of refrigerators exceed annual prewar production by 170%; of washing machines by 60%; of electric irons by 4%. But planned purchases of radio sets are 64% *below* annual prewar production! These figures, which check closely with other surveys made in the past year, indicate clearly that the radio industry must offset the lack of interest in buying new AM radios by capitalizing on the superior service of FM. This is the only feature which, by demonstrable performance, can earmark prewar sets as definitely obsolete.

Frank W. Walker: Radio engineer for the Michigan State Police and president of Associated Police Communications Officers, has resigned both posts to become chief communications engineer of the Greyhound Corporation. This announcement is of special significance, for it indicates the extent to which the largest bus transportation company plans to make use of highway radio. Frank Walker will be succeeded as APCO president by Ray Groenier, police radio supervisor at Madison, Wisc.

Westbrook Pegler: "Radio apparatus of the more elaborate sets is no more efficient than the same device in the cheap editions, which is a manner of saying that most of them, whatever the price, are capricious and not dependable. After all these years they still crackle with static, and cross-talk blurs reception." Lots of others still think the same way. If FMBI should undertake to bring Columnist Pegler up to date, and to acquaint like-minded people in and out of the radio industry with the service that can be rendered by FM, it would be doing a highly useful and constructive job.

RTPB: Officers elected for the term from October 1, 1945 to September 30, 1946 are: chairman, Haraden Pratt, Mackay Radio & Tel Co., 67 Broad Street, N. Y. C.; vice chairman, Howard S. Frazier, NAB, 1760 N Street, N. W., Washington, D. C.; treasurer, Will Baltin, TBA, 500 Fifth Avenue, N. Y. C.; secretary, Dr. W. H. Crew, IRE, 330 W. 42 Street, N. Y. C.

Daniel E. Noble: Director of research for Galvin Mfg. Corporation, has been given added responsibility as general manager of the communications and electronics division. In this new capacity, he will have direct authority over engineering, sales, and engineering production of the division.

W. G. H. Finch: Has been advanced from the

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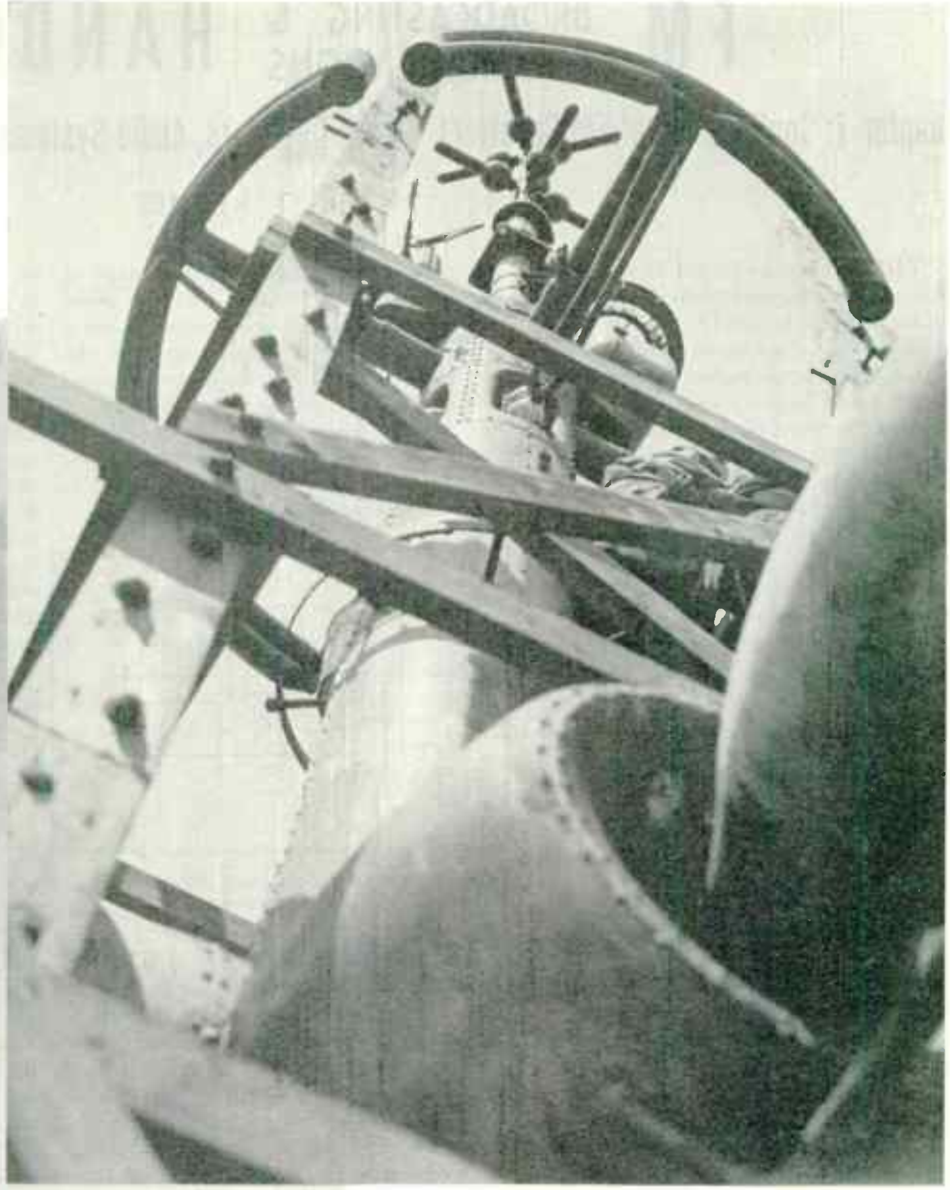

UNIQUE AMONG RADIO INSTALLATIONS IS THAT AT THE EMPIRE STATE BUILDING WHERE, 1,250 FT. ABOVE THE STREET, THE TOWER NOW CARRIES ANTENNAS FOR ONE FM AND TWO TELEVISION TRANSMITTERS

NEWS PICTURE

A NEW television antenna and a 5-kw. transmitter, designed to operate on 288 mc., are being installed at New York's Empire State Building. The transmitter, first of its kind ever put in operation, was built at the RCA Princeton laboratories, New Jersey.

Tests to be conducted by RCA, in conjunction with NBC, will show what problems lie ahead in the use of the higher channels assigned to television recently by the FCC. During the construction work, FM broadcasting has been continued on regular schedule. After the building was struck by an Army bomber on July 28th, RCA engineers reported that no damage was done to their equipment.

World Radio History

FM BROADCASTING & COMMUNICATIONS HANDBOOK

Chapter 7: Continuation of FM Receivers — FM Detectors, Audio Systems, and Special Receiver Circuits

BY RENÉ T. HEMMES

IN THE preceding chapter, it was shown that a conventional triode AM detector can be made to respond to FM signals by detuning the tuned input circuit slightly, so that operation occurs on the steep and nearly linear portion of the selectivity curve of the input circuit, either above or below the resonant frequency. The principle involved is that as the frequency of the FM signal swings *toward* the resonant frequency of the tuned circuit, the current in the tuned circuit and the voltage across the tuning condenser increases, and as the frequency of the FM signal swings *away from* the resonant frequency of the tuned circuit, the current in the tuned circuit and the voltage across the tuning condenser decreases. In this way the selectivity characteristic of the tuned circuit serves to translate the *frequency* variations of the FM signal into *amplitude* variations of the voltage across the tuning condenser, so that the detector responds to the FM signal.

It was pointed out, however, that the detuned AM triode detector would not be suitable for use in a high fidelity FM receiver because 1) it is incapable of handling strong signal voltages without introducing distortion, 2) the detuning adjustment, for operation at the mid-point of the most nearly linear portion of the selectivity characteristic, is quite critical, and 3) even at the optimum detuning adjustment, there is some departure from true linearity in the detector output, causing harmonic distortion. This distortion would be particularly severe on strongly modulated FM signals, where the frequency swings over a wide range.

The problem of overloading encountered with triode detectors can be obviated by using a diode detector. In so doing, the advantage of obtaining amplification in the detector is lost, but the amplification can be readily made up in the stages preceding and following the detector. By using a detector which has the property of rectification only, a much higher order of signal voltages can be handled without introducing distortion. Practically all modern FM broadcast receivers employ diode detectors.

The problem of critical detuning adjustment, and the problem of distortion resulting from operation at the curved portions of the characteristic arise from the fact that the characteristic is practically linear over only a narrow range of frequencies. The solution to these problems would seem to lie either in 1) using a system of coupled tuned circuits in the detector that will give an overall characteristic that is approximately linear over a much wider frequency range, or 2) devising a system of FM detection which does not depend in any way upon the selectivity characteristics of tuned circuits.

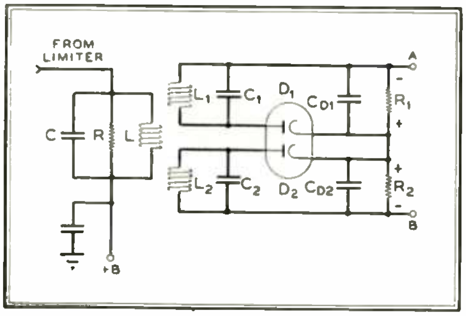

FIG. 59. DETUNED-CIRCUIT TYPE OF DISCRIMINATOR CIRCUIT

The solution which lends itself more readily to FM receiver design is that in which tuned circuits are coupled in such a way as to give a straight-line characteristic over a wide frequency range. Detectors of this type usually employ two diodes arranged to deliver an output voltage whose polarity depends upon whether the applied frequency is higher or lower than the mean frequency of the input tuned circuits, and whose amplitude depends on the extent by which the applied frequency differs from the mean frequency. Since these detectors are able to discriminate between frequencies above and below the mean frequency of the coupled tuned circuits, they are called *discriminators*.

Two types of discriminator circuits have been employed in receiver design, namely the detuned-circuit discriminator and the center-tuned discriminator. Both of these types were employed originally in AM receivers for automatic frequency control, but since they can be adjusted to give an overall characteristic having a uniform slope over a relatively wide frequency range, they are especially suited for use as FM detectors.

De-tuned Circuit Discriminator ★ The circuit diagram of the detuned-circuit discriminator, or amplitude discriminator, is shown in Fig. 59. The limiter output circuit LC is tuned to the intermediate frequency F_C of the superheterodyne receiver. The input circuit L_1C_1 for diode detector D_1 is inductively coupled to LC but is resonant to a frequency F_{R1}, somewhat *lower* than the intermediate frequency F_C of the FM receiver. The input circuit L_2C_2 for diode detector D_2 is also inductively coupled to LC but is resonant to a frequency F_{R2}, somewhat *higher* than the intermediate frequency F_C of the FM receiver. The coefficients of coupling of circuits L_1C_1 and L_2C_2 to circuit LC are equal, and each circuit is detuned from the resonant frequency of LC by the same amount.

If a signal current, modulated or unmodulated, flows in the tuned circuit LC, the expanding and contracting field about L induces equal voltages in coils L_1 and L_2, because of the equal degree of coupling.

When the signal is unmodulated and has a frequency equal to the resonant frequency of circuit LC, then the amplitude of the RF currents in the detuned circuits L_1C_1 and L_2C_2, set up by the induced voltages, will be essentially equal and the RF voltages established across the tuning condensers C_1 and C_2 will also be equal. Thus, the DC voltages produced across R_1C_{D1} and R_2C_{D2} by the diodes, which are very nearly equal to the respective amplitudes of the RF voltages across C_1 and C_2, will be essentially equal to each other. As shown in Fig. 59, the diode connections are such as to place the two DC output voltages of the diodes in opposite polarity between the discriminator output terminals A, B. Thus, zero *net* voltage is produced across terminals A, B of the discriminator when it is excited by an unmodulated signal at the resonant frequency of the tuned circuit LC, that is, at a frequency mid-way between the resonant frequencies of tuned circuits L_1C_1 and L_2C_2.

When the signal is frequency-modulated, its frequency is alternately increased and decreased with respect to the average or center frequency. If the center frequency of the FM signal is equal to the resonant frequency of LC, then, during the period when the instantaneous frequency of the FM signal is greater than its center frequency, the RF voltage established across the tuning condenser C_1 is decreased because the frequency of the voltage induced in L_1C_1 circuit is farther

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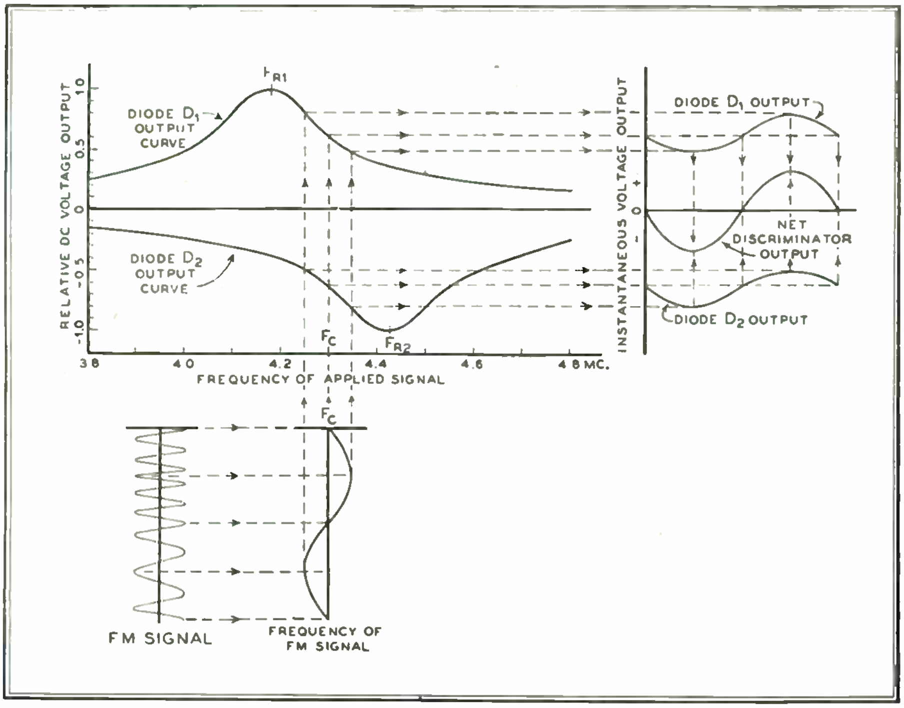

FIG. 60. DETECTION OF FM SIGNAL IN DETUNED-CIRCUIT DISCRIMINATOR. THE INDIVIDUAL DIODE OUTPUT VOLTAGES COMBINE TO PRODUCE AN AUDIO VOLTAGE HAVING THE SAME WAVE FORM AS THE MODULATING VOLTAGE AT THE TRANSMITTER

from the resonant frequency of that circuit. Conversely, when the instantaneous frequency is less than the center frequency, the RF voltage across C_1 is increased, because the applied frequency is nearer to the resonant frequency of L_1C_1.

This action is illustrated in Fig. 60. Here the FM signal is shown at the lower left and its frequency is shown as a function of time to the right of the signal. The frequency curve is projected upwards against the characteristic curve for the RF voltage across condenser C_1. Since the DC voltage established across R_1C_{D1} is very nearly equal to the amplitude of the RF voltage across C_1, this curve also represents the output voltage of diode D_1 as a function of the input frequency. It is observed that as the frequency of the input signal is increased during the first alternation of modulation, the frequency of the voltage induced in L_1 is farther from resonance and the DC output voltage across R_1C_{D1} is decreased. In the second alternation of the modulation, where the instantaneous frequency of the voltage induced in coil L_1 is nearer to the resonant frequency of L_1C_1 than the center frequency, the DC output voltage across R_1C_{D1} is increased. The wave form of the output voltage variation of diode D_1 is shown at the upper right in Fig. 60.

Since the tuned circuit L_2C_2 of diode D_2 is resonant to a frequency F_{R2} that is higher than the center frequency F_C of the input signal, the selectivity curve for the tuned circuit L_2C_2 would occupy a position to the right of the curve for tuned circuit L_1C_1 in Fig. 60. However, since the characteristic being plotted is that of the *DC output voltage* of diode D_2 rather than the amplitude of the RF voltage across tuning condenser C_2, the curve is plotted in the negative direction from the horizontal axis to take into account the opposite polarity of the DC output voltage of diode D_2.

It is observed in Fig. 60 that in the case of diode D_2, an increase in the instantaneous frequency during modulation produces an increase in the magnitude of the negative voltage developed across R_2C_{D2}. A decrease in the instantaneous frequency during modulation produces a decrease in the magnitude of the negative voltage across R_2C_{D2}. The variation of the output voltage of diode D_2 during modulation is shown at the right of the negative characteristic curve for diode detector D_2.

The output voltage of the discriminator is the algebraic sum of the positive and negative output voltages, respectively, of diodes D_1 and D_2 from instant to instant. The curve of the net discriminator output voltage is shown in Fig. 60 between the curves for the individual diode output voltages. It is observed that the DC components of the individual diode voltages have been balanced out and that an audio voltage is delivered by the discriminator which has an amplitude roughly twice that of the audio components of the individual diode output voltages.

The marked improvement in the quality of FM detection, obtained by combining the outputs of two detuned detectors in pushpull in the manner described above, is made evident by comparing the overall characteristic of the discriminator with the curves of the individual diode detec-

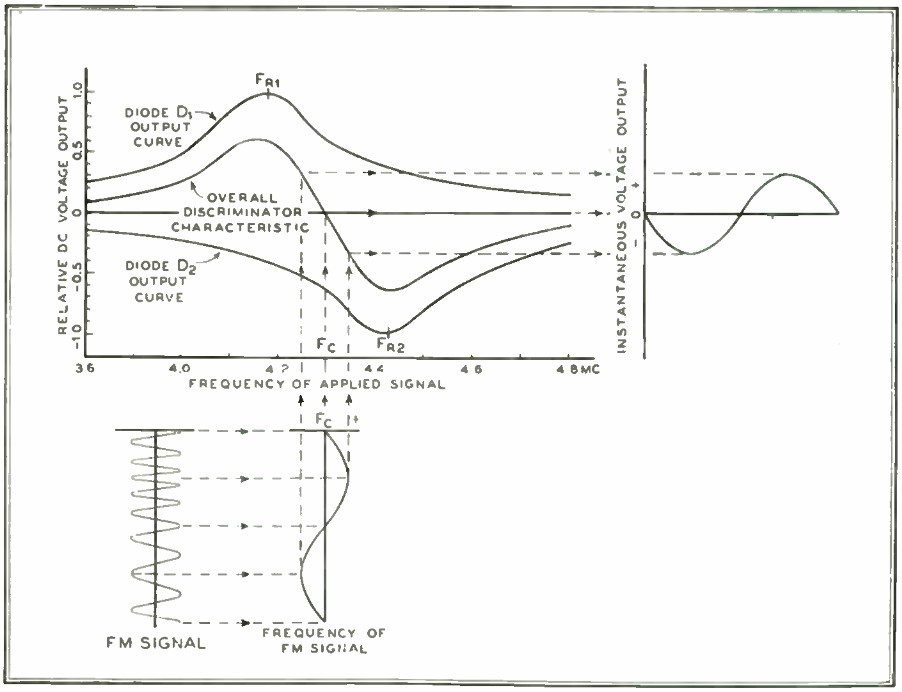

FIG. 61. THE OVERALL CHARACTERISTIC OF THE DISCRIMINATOR IS PLOTTED BY ADDING THE DIODE OUTPUTS ALGEBRAICALLY AT EACH FREQUENCY. THE COMPOSITE CHARACTERISTIC IS ESSENTIALLY LINEAR OVER A WIDE FREQUENCY RANGE

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FM Station WLOU

Studio of FM Station WLOU, Detroit, Michigan. RCA 77-B Microphones are used in this studio and RCA 88-A Microphones in the announce booth.

The RCA 76-B Consolette in the control room of WLOU. Also shown in the picture are the RCA 70-B Transcription Turntables.

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uses RCA Equipment from Microphone to Antenna

WLOU, the FM Station of John L. Booth, Inc., Detroit, Michigan, uses RCA equipment throughout. In the studios are RCA 77-C Microphones; in the control room are a 76-B Consolette and 70-B Turntables; in the transmitter room are an RCA FM-10-B Transmitter and RCA frequency and modulation monitors. The antenna is an RCA Type MI-7823-A assembly.

WLOU is a sister station of WJLB, the AM station operated by John L. Booth, Inc. It is interesting to note that WJLB, like hundreds of other AM stations, is also completely RCA equipped. Operators of both AM and FM stations—and station applicants—can make reservations right now for early delivery of RCA postwar broadcast equipment. For information on our Broadcast Equipment Priority Plan, write to Broadcast Equipment Section, Radio Corporation of America, Camden, N. J.

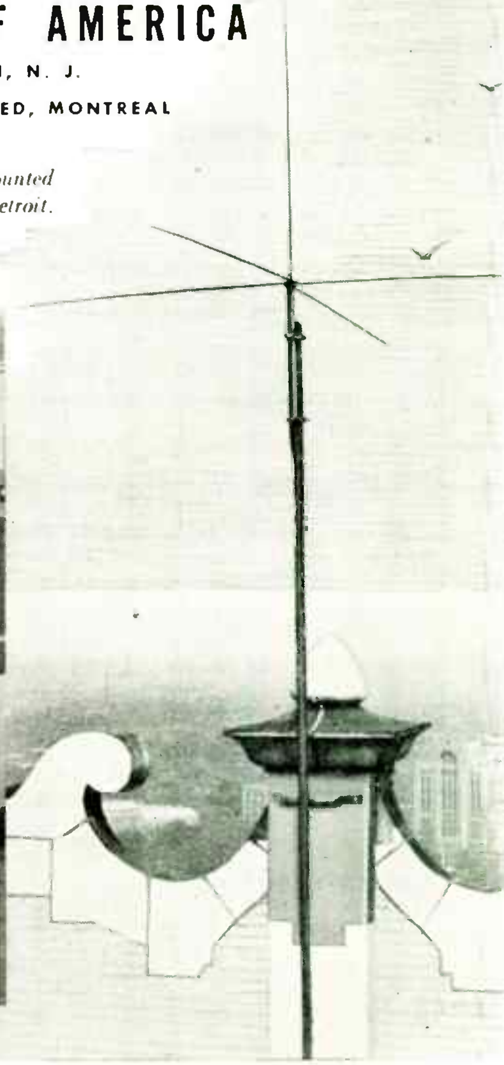
RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

IN CANADA, RCA VICTOR COMPANY LIMITED, MONTREAL

BUY WAR BONDS

Antenna of WLOU is an RCA Type MI-7823-A, mounted on the top of the Eaton Tower in downtown Detroit.



The transmitter of WLOU is an RCA Type FM-10-B (10 kw) Transmitter. Other RCA equipment includes frequency and modulation monitors.

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tors, as shown in Fig. 61. Here the curves for the individual detectors are the same as those shown in Fig. 60, but the composite characteristic has been plotted by taking the algebraic sum of the positive and negative diode voltages at each frequency.

It is observed that the composite characteristic for the discriminator is essentially linear over a much wider frequency range than either of the individual diode detector characteristics. Thus the discriminator can be made to deliver essentially distortionless audio voltage on strongly modulated FM signals and requires only moderate care in tuning the receiver.

As shown in Fig. 59, the primary circuit LC should be loaded by means of shunt resistance R so that the effective ratio of reactance to resistance, or Q, of the primary is about one-third of the ratio of the resonant frequency of the primary circuit to the maximum frequency deviation of the signal to be detected. The Q of the secondary circuits L_1C_1 and L_2C_2 should be twice that of the primary circuits. The diodes serve to load the secondary circuits. The secondary coils L_1L_2 are so placed that each has a coupling to the primary coil L much greater than their coupling to each other.

It is evident from Fig. 61 that the linearity of the discriminator depends not only upon the sharpness of the selectivity curves of the tuned circuits, as determined by their respective Q's, but upon the separation of the resonant frequencies of the circuits as well.

The condition for best linearity is that at which the resonant frequencies of the tuned circuits L_1C_1 and L_2C_2 are separated by 1.225 times the band width between the half-power points (or 70.7%-voltage points) on the curves of the tuned circuits. The band width between half-power points, in turn, is equal to the resonant frequency of each circuit divided by its Q. Fig. 61 illustrates the condition for best linearity.

Center-Tuned Discriminator ★ The circuit of the center-tuned or phase discriminator is shown in Fig. 62. In this circuit only two tuned circuits are employed and both are resonant to the intermediate frequency of the receiver. As will be explained presently, the signal voltage is conveyed from the limiter output circuit to the discriminator circuit by direct and inductive coupling. The diode detectors are connected in pushpull across the center-tapped secondary coil. By careful adjustment of the tuning and coupling it is possible to obtain the same overall characteristic as is shown for the detuned-circuit discriminator in Fig. 61.

The operation of the center-tuned discriminator depends upon the change that occurs in the phase relations of the voltages in the tuned circuits as the applied signal frequency varies from the resonant frequency of the tuned circuits during modulation. It is first necessary, therefore, to consider the phase relations of the voltages and currents in coupled tuned circuits for conditions of resonance and non-resonance.

Consider the coupled tuned circuits L_1C_1 and L_2C_2 at the upper left in Fig. 63. If an RF voltage E_1 is present across L_1C_1, the resulting current I_1 that flows in the turns of coil L_1 will lag voltage E_1 by nearly 90°, since the reactance of coil L_1 very greatly exceeds its resistance.

This relationship is shown in the top row of three vector diagrams in Fig. 63,

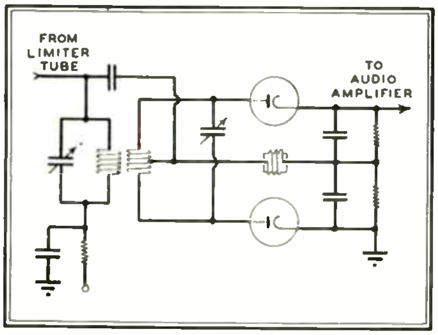

FIG. 62. CENTER-TUNED TYPE OF DISCRIMINATOR CIRCUIT

representing, from left to right, the conditions of operation at resonance, above resonance, and below resonance. The vector for voltage E_1 serves as a reference, and is assigned the position representing 0° in each of the three diagrams. The vector representing current I_1 is 90° clockwise from, or lagging, the applied voltage vector E_1.

The current I_1 in the turns of coil L_1 creates a magnetic field about L_1 that expands, collapses, and changes polarity in phase with the increase, decrease, and reversal of the RF current in coil L_1. The vector for current I_1 can, therefore, also be regarded as representing the field about coil L_1.

The expanding and collapsing field about L_1 sweeps the turns of L_2 and induces therein a voltage E_2 proportional at every instant to the *rate* at which the lines of force of the field above L_1 are cutting the turns of coil L_2. When the field about L_1 is changing most rapidly, that is, when the current in coil L_1 is falling through zero, the voltage E_2 induced in coil L_2 is at a peak. On the other hand, at the instant when the field about L_1 has reached a condition of maximum expansion and is about to contract, its *rate of change* is zero and zero voltage is induced in coil L_2.

Thus the voltage *induced* in coil L_2 is *90° out of phase* with the inducing field and inducing current I_2. This is shown in the top row of vector diagrams in Fig. 63, where the vector for the induced voltage E_2 appears at a position 90° clockwise from, or lagging, the vector for the inducing current I_1.

It is very important to note that the voltage E_{AB} which appears across the tuning condenser C_2 is *not* the induced voltage E_2. As shown in the diagram of the equivalent circuit, the induced voltage E_2 simply acts as a generator in series with coil L_2 and tuning condenser C_2, causing a current I_2 to flow in circuit L_2C_2 which establishes a *reactive voltage drop* E_{AB} across the tuning condenser C_2. Since the condenser C_2 offers a practically pure capacitive reactance, the voltage E_{AB} across condenser C_2 will lag the current I_2 by very nearly 90°, regardless of whether the circuit is resonant or non-resonant to the applied frequency.

At resonance, the reactances of L_2 and C_2 cancel each other and the current I_2 in the secondary circuit is in phase with the *induced* voltage E_2. This is shown in the vector diagram for the resonant condition which appears just to the right of the tuned circuits at the top of Fig. 63. It should be observed that the vector for current I_2 coincides with that for induced voltage E_2. The reactive voltage E_{AB} across tuning condenser C_2 is 90° lagging the current I_2. As shown in the vector diagram, at resonance the voltage E_{AB} across tuning condenser C_2 differs in phase by 90° with respect to the reference voltage E_1 applied across circuit L_1C_1.

Consider next the phase relations which exist when the applied frequency F_A exceeds the resonant frequency F_R of the tuned circuits. At the higher frequency, the inductive reactance of L_2 exceeds the capacitive reactance of C_2, thereby causing the current I_2 in circuit L_2C_2 to lag the induced voltage E_2. This is shown in the center vector diagram at the top of Fig. 63. The vector for current I_2 lags the vector for the induced voltage E_2 by an acute angle. The reactive voltage E_{AB} across tuning condenser C_2 lags current I_2 by the fixed angle of 90°. As a result, the voltage E_{AB} differs in phase from the reference applied voltage E_1 by *less than 90°*.

Conversely, when the applied frequency F_A of voltage E_1 is less than the resonant frequency F_R of circuits L_1C_1 and L_2C_2, current I_2 in circuit L_2C_2 leads the induced voltage E_2, as shown in the vector diagram at the top right of Fig. 63. This causes the voltage E_{AB} across condenser C_2 to differ in phase with respect to the reference input voltage E_1 by *more than 90°*.

Consider next the voltages that will be obtained when a center tap is placed on

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coil L_2, as shown in Fig. 63. Since the voltage at terminal A with respect to terminal B of the tuned circuit L_2C_2 is shown by vector E_{AB} in the top row of vector diagrams, then the voltage at terminal A with respect to the center-tap terminal C is shown by vector E of half the length in the second row of vector diagrams. The angular position of vector E_{AC} in the second vector E_{AC}, as shown in the second row of vector diagrams.

As the next step, a condenser C_C is connected between the high potential terminal of circuit L_1C_1 and the center-tap terminal C of tuned circuit L_2C_2, as shown at the left of the third row of vector diagrams in Fig. 63. At the same time, an RF choke RFC is connected between in the third row of vector diagrams is drawn in the same position as vector E_1 in the first row.

The final step in the evolution of the discriminator circuit is the connection of two diode detectors at terminals A, D, B. The output circuits of the detectors are connected in a pushpull as shown at the lower left on Fig. 63.

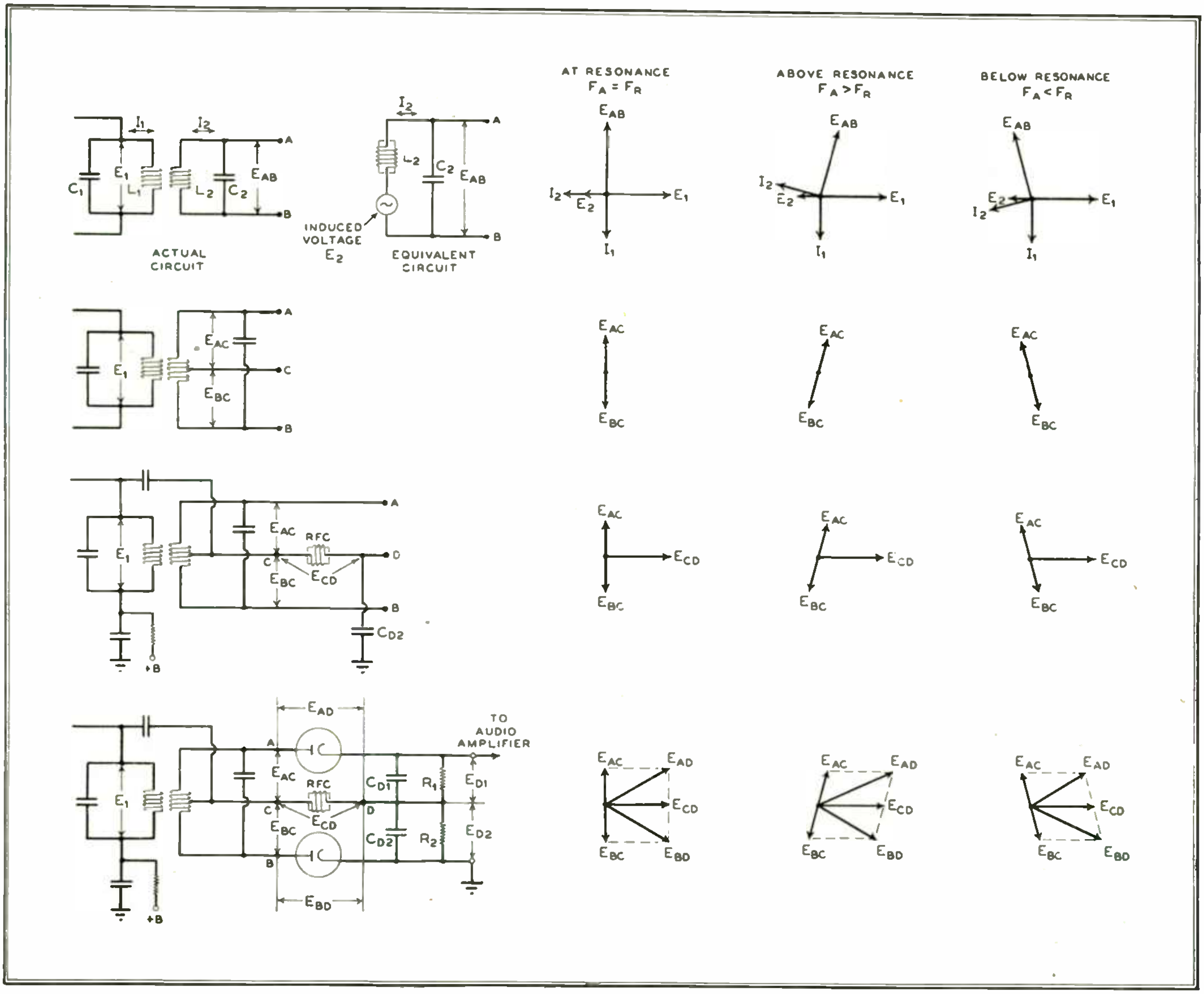

FIG. 63. EVOLUTION OF THE CENTER-TUNED DISCRIMINATOR CIRCUIT. STARTING WITH THE SIMPLE COUPLED TUNED CIRCUITS: TOP LEFT: CIRCUIT ELEMENTS ARE PROGRESSIVELY ADDED UNTIL THE COMPLETE DISCRIMINATOR CIRCUIT IS OBTAINED. PHASE RELATIONS OF VOLTAGES AND CURRENTS ARE SHOWN IN THE VECTOR DIAGRAMS TO THE RIGHT OF EACH CIRCUIT

row of vector diagrams is the same as that of vector E_{AB} in the top row.

The voltage of the *center-tap terminal C with respect to the lower terminal B* or voltage E_{CB} could also be represented by a vector in the position of vector E_{AC}. However, the voltage of *lower terminal B with respect to center-tap terminal C*, or voltage E_{BC}, is a voltage taken in the opposite direction and must be represented by a vector having the opposite polarity from center-tap terminal C and terminal D. Terminal D is held at ground RF potential by condenser C_{D2}. The reactance of RFC at the applied frequency is too high to affect appreciably the tuning of circuit L_1C_1 across which it is shunted. The reactances of C_C and C_{D2} are quite low at the applied frequency. Thus the voltage E_1 across L_1 also appears across RF choke RFC, with practically no change in magnitude or phase. Hence, the vector E_{CD}

Diode D_1 is connected to terminals A and D so that the voltage applied to the diode D_1 is the sum of voltages E_{AC} and E_{CD}. The voltage applied to the lower diode D_2 is the sum of voltages E_{BC} and E_{CD}, since this diode is connected to terminals B and D.

The sums of these respective pairs of voltages are obtained vectorally by completing the parallellograms and drawing in the diagonal resultants, as shown in the

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bottom row of vector diagrams in Fig. 63.

At resonance, where a 90° difference of phase exists between the directly coupled voltage E_{CD} and the reactive voltages E_{AC} and E_{BC}, the resultant or sum vectors E_{AD} and E_{BD} are of equal magnitude. At resonance, therefore, the individual diode output voltages E_{D1} and E_{D2} are equal, and since they are added in opposite polarity the net output voltage of the discriminator is zero.

When the applied frequency F_A exceeds the resonant frequency F_R, the vector representing E_{AC} lies closer to the vector for E_{CD} than the vector for E_{BC}. As a result, the sum vector E_{AD} has a greater magnitude than the sum vector E_{BD}. Therefore diode D_1 delivers a greater DC voltage than diode D_2. With the diode DC output voltages adding in opposite polarity, the net voltage delivered by the discriminator is positive when the applied frequency exceeds the resonant frequency.

Conversely, when the applied frequency is less than the resonant frequency, the voltage E_{AC} differs in phase from voltage E_{CD} by more than 90°, while voltage E_{BD} differs in phase from voltage E_{CD} by less than 90°. As a result, the sum voltage E_{BD} has a greater magnitude than the sum voltage E_{AD}, as shown in the vector diagram at the lower right of Fig. 63. Diode D_2 delivers a greater DC voltage than diode D_1 and the net output voltage of the discriminator is negative.

If the frequency of the applied signal is alternately greater and less than the resonant frequency of the discriminator, the discriminator output voltage is alternately positive and negative. This is the case when an FM signal is tuned in, so that the discriminator produces an audio voltage having the same wave form as the audio modulating voltage at the FM transmitter.

Readers unfamiliar with vector diagrams will understand the operation of the discriminator by reference to the wave diagrams shown in Fig. 64. The left hand column of wave diagrams applies to the condition of resonance. The voltage E_{CD} at the center of the left hand column is the limiter output voltage which is transferred to terminals C and D of choke RFC in the discriminator circuit of Fig. 63.

Since the tuned circuit L_2C_2, Fig. 63, is operating at resonance, the reactive voltages E_{AC} and E_{BC} established across coil L_2 will respectively lead and lag the limiter output voltage E_{CD} by 90°. The voltage waves of E_{AC} and E_{BC} are shown immediately above and below the wave of E_{CD} in Fig. 64. It is noted that the three waves have the same frequency but there are 90° phase displacements between them. When the wave of E_{AC} is added to that of E_{CD} from instant to instant, the resultant is a wave E_{AD} of greater amplitude than E_{AC}, shown at the top left in Fig. 64. Similarly, E_{BC} added to E_{CD} yields a wave E_{BD} of greater amplitude than E_{BC}, shown at the bottom left in Fig. 64. Since the two waves E_{BC} and E_{CD} added to E_{CD} are equally displaced in phase from E_{CD}, equal reinforcements of E_{CD} are obtained from the addition. The amplitude of the sum resultant voltage E_{AD} equals that of the sum resultant voltage E_{BD}. When these voltages are applied to diodes D_1 and D_2, equal DC output voltages E_{D1} and E_{D2} are obtained. Since these diode output voltages of equal magnitude are added in opposite polarity, the discriminator output is zero when the applied frequency F_A equals the resonant frequency F_R.

The voltages for the condition of applied frequency F_A exceeding the resonant frequency F_R of the tuned circuits is shown in the center column of waves in Fig. 64. In this case, the voltage E_{AC} across the upper half of the tuned circuit L_2C_2 leads the directly coupled voltage E_{CD} by less than 90°, while the voltage E_{BC} across the lower half of the tuned circuit L_2C_2 lags the directly coupled voltage E_{CD} by more than 90°.

When E_{AC} is added to E_{CD}, the amplitude of the sum voltage E_{AD} is found to be greater than the amplitude of the sum voltage E_{BD}, obtained when E_{BC} is added to E_{CD}. This is to be expected, since E_{AC} is more nearly in phase with E_{CD} than E_{BC} and, therefore, affords greater reinforcement of E_{CD} than E_{BC}. Since the voltage E_{AD} has a greater amplitude than E_{BD}, diode D_1 delivers a greater output voltage than diode D_2 and the net discriminator output voltage is positive.

Conversely, when the applied frequency F_A is less than the resonant frequency F_R, the phase displacement between E_{AC} and E_{CD} is greater than 90°, while that between E_{BC} and E_{CD} is less than 90°. This condition is shown in the right hand column of waves in Fig. 64. E_{BC} offers a greater reinforcement of E_{CD} than E_{AC}, so that E_{BD} exceeds E_{AD}. As a result, diode D_2 delivers a greater DC voltage than diode D_1 and the discriminator output voltage is negative.

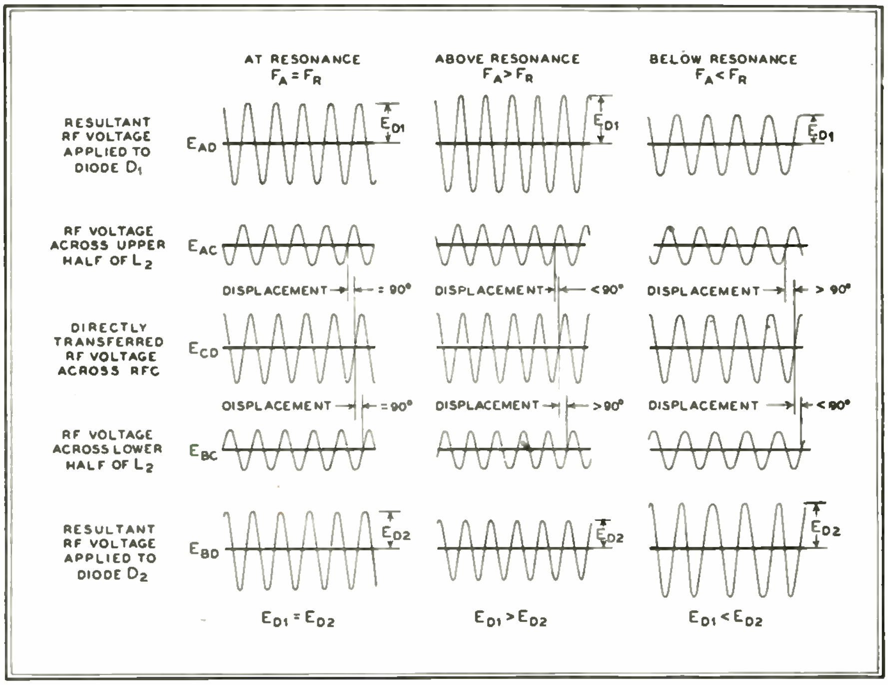

FIG. 64. WAVE DIAGRAMS OF VOLTAGES IN THE CENTER-TUNED DISCRIMINATOR CIRCUIT. THE VOLTAGES ARE TAKEN AT THE POSITIONS SHOWN IN THE CIRCUIT DIAGRAM: BOTTOM LEFT, FIG. 63

During the reception of an FM signal whose center frequency equals the resonant frequency of the tuned circuits, the discriminator output voltage changes polarity as the frequency alternately exceeds or is less than the center frequency. The magnitude of the discriminator output voltage should be proportional at every instant to the frequency deviation of the signal being received. By careful circuit design and coupling adjustments, the characteristic of the tuned-circuit discriminator can be made linear over a wide frequency range, similar to the characteristic of the detuned-circuit discriminator shown in Fig. 61.

Counter-Circuit FM Detector ★ While the use of discriminator circuits, as described above, presents a convenient and practical means for detecting FM signals of relatively large frequency deviation with

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minimum distortion, there are a number of other methods for detecting FM signals.

For example, it has been suggested previously in this chapter that a solution to the problem of overcoming the inherent non-linearity of tuned-circuit detectors might lie in the use of a detection system whose operation does not depend in any way upon tuned circuits. The counter-circuit shown in Fig. 65 is an FM detector of this type. Because of its very low distortion, it has been employed in precision FM monitors for checking FM modulation systems.

The first tube in the circuit shown in Fig. 65 is a beam pentode, operating with a low value of load resistance, R_L, adjusted to give plate-current saturation when the excitation voltage is not quite sufficient to draw grid current. The excitation voltage has a center frequency in the order of 100 to 300 kc. and its peak-to-peak value is at least 20% greater than the cut-off bias of the beam pentode. The plate current of the pentode swings between cut-off and saturation level, as determined by the pentode characteristic. The pentode therefore squares off the positive and negative peaks of the plate current variation, and delivers a *square wave pulse of practically uniform amplitude* at the frequency of the excitation signal, regardless of any amplitude fluctuations that are present in the excitation signal.

The peak value of the output voltage pulse of the pentode is equal to the plate supply voltage, because there is zero drop in resistor R_L during the interval when the plate current is cut off. During the interval when the voltage pulse is maximum positive, condenser C therefore charges through the low cathode-to-plate resistance of diode D_1 to a voltage very nearly equal to the plate supply voltage. During the interval when the pentode output voltage is minimum positive, the charged condenser C cannot discharge through diode D_1 because the cold plate of diode D_1 does not emit electrons. Condenser C will discharge through the cathode-to-plate path of diode D_2 and R_0 to ground. The capacity of the condenser C and the resistances of the charge and discharge paths are so small that the condenser acquires a voltage of at least 99.9% of the plate supply voltage by the end of the charge interval and discharges to within 0.1% of the minimum voltage at the pentode plate by the end of the discharge interval. Since the condenser voltage varies over a fixed range, the number of electrons moved through resistor R_0 during each discharge period is fixed. The number of electrons passed through R_0 per second is directly proportional to the number of discharge periods per second, that is, to the frequency of the excitation voltage at the grid of the pentode. Thus, it is said that this type of detector circuit *counts the pulses* and produces an average voltage across R_0 directly proportional to the input frequency.

If the input frequency increases and decreases at an audio rate, then the voltage across R_0 will increase and decrease at the same audio rate. The low-pass audio filter smooths out the RF fluctuations in the voltage across R_0 and allows only the DC and audio components of the voltage across R_0 to appear across the filter terminating resistor R. It is important that the filter be of the choke input type, so that no residual voltage will be maintained across R_0. Such a voltage would bias diode D_2 and prevent condenser C from discharging completely on each cycle. The linearity of this detector, when properly adjusted, is said to be excellent.

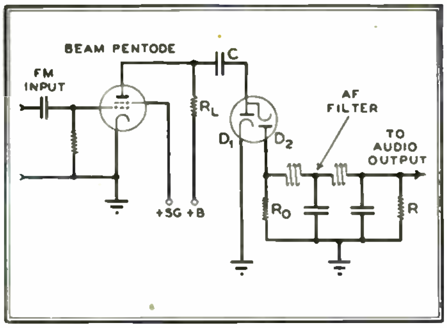

FIG. 65. COUNTER CIRCUIT TYPE OF FM DETECTOR

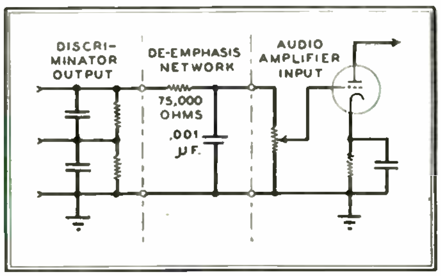

FIG. 66. POSITION OF DE-EMPHASIS NETWORK IN FM RECEIVER

It will be noted that the input frequencies at which this detector operates are of a low order. This permits the detector to deliver a larger audio voltage, since the frequency deviation is then a larger percentage of the center frequency. Moreover, a relatively low order of input frequencies is mandatory, since condenser C must very nearly acquire its full charge and must discharge to its residual voltage level, each within the half-cycle periods of the input voltage. The internal resistances of the diodes limit the extent to which the time constants of charge and discharge can be shortened. In view of the low input frequencies required, and other practical considerations, the use of the counter type of FM detector has been limited to special applications, such as checking the performance of FM signal generators, monitoring frequency-modulation systems in transmitters, and studying the distortion produced by the tuned stages in FM receivers.

De-emphasis Network ★ As explained in Chapter 5, pre-emphasis can be introduced in the modulation at the FM transmitter in order to increase the amplitude of the high-frequency components of the audio modulating voltage. Such pre-emphasis will cause the high-frequency components of the audio voltage at the discriminator output to be considerably stronger with respect to high-frequency noise than if pre-emphasis were not employed.

With pre-emphasis at the transmitter, it is necessary to have de-emphasis at the receiver for the purpose of bringing the high frequencies down to the same proportion with respect to the low frequencies that exists at the studio microphone. At the same time, the de-emphasis network will reduce the high frequency noise picked up by the receiver antenna or from thermal agitation and shot effect to inaudibility.

The circuit constants for the de-emphasis network at the receiver will depend upon those of the pre-emphasis network at the transmitter. Where a 75-microsecond pre-emphasis characteristic is introduced at the transmitter, as in FM broadcasting, a 75-microsecond de-emphasis network should be connected between the discriminator and the audio amplifier of the FM receiver, as shown in Fig. 66.

The Audio System ★ The theory of operation of the audio amplifier and loudspeaker system of an FM broadcast receiver does not differ from that of an AM receiver. However, in view of the wider range of audio frequencies to be handled, greater care is required in the design of the amplifier. Not only should the amplifier give a flat response over a range of 50 to 15,000 cycles but the distortion in the amplifier must be of a very low order over the entire frequency range.

If appreciable distortion is present, cross-modulation will occur when two or more audio frequencies are simultaneously present at the input, creating additional components at the sum and difference frequencies in the output. Harmonics of the input frequencies will also be generated. In view of the wider range of audio frequencies reproduced in the FM system, it is especially important that such undesirable distortion be held to a minimum.

In view of the marked reduction of noise obtained in the FM system, the noise and hum level of the audio amplifier must be very low. This permits the re-

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ceiver to deliver the dynamic range of the program at the studio and thereby to contribute to the realism of the reproduction.

No audio system is better than its loudspeaker. The wide frequency range to be reproduced by the loudspeaker system of an FM receiver creates a difficult problem in loudspeaker design. Unfortunately, the requirements of a loudspeaker for reproducing the high-frequency range most efficiently are opposed to the requirements of an efficient low-frequency speaker.

In general, low-frequency speakers demand a large diaphragm and comparatively heavy driving coil system to handle the large amplitudes of the audio currents, whereas high-frequency speakers should have a light cone and coil system capable of vibrating rapidly in response to high-frequency currents of much smaller amplitude.

In order to obtain efficient reproduction of both the high and the low frequencies, dual speaker systems are usually employed. The output of the audio amplifier is divided by means of an electrical network so that the low-frequency components are routed to a speaker designed for low frequencies, and the high-frequency components, say those above 1,500 or 2,000 cycles, are delivered to a high-frequency speaker.

The small high-frequency speaker, or *tweeter*, is usually mounted coaxially with and directly in front of the low-frequency speaker, or *woofer*. This simplifies the installation of the speaker system in the receiver cabinet.

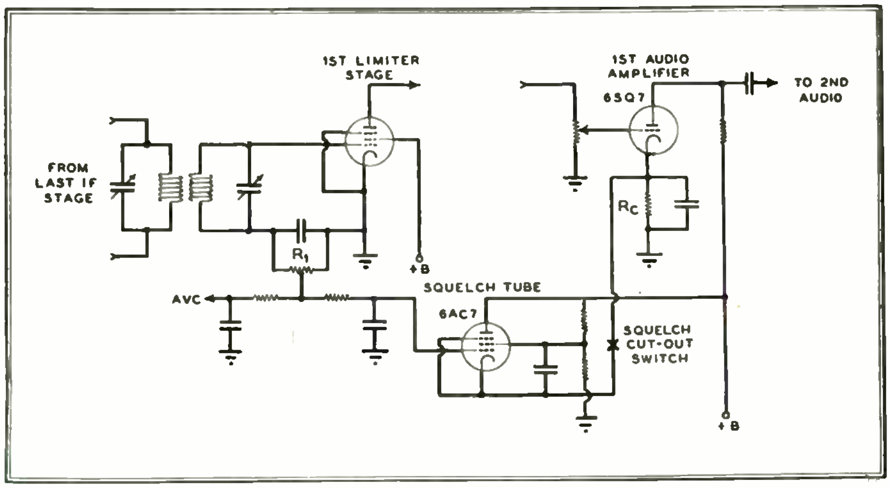

FIG. 67. CIRCUIT OF AN AUTOMATIC SQUELCH SYSTEM FOR SUPPRESSING INTERSTATION AND STANDBY NOISE IN FM RECEIVER

Squelch Circuits ★ FM receiver circuits inherently have a high noise level when no signal is tuned in. In the FM communications services, where a receiver is tuned to a specific frequency for long stand-by periods in anticipation of signals that may appear at any time, the continuous roar of noise is highly objectionable to the listener on watch. In a communications receiver, therefore, it is desirable that a *squelch system* be incorporated for the purpose of silencing the audio system during those periods when no signal is being received.

Similarly, in broadcast receivers, it is undesirable to have a large noise output when tuning from one station to another. A squelch system eliminates this undesirable interstation noise.

Most squelch circuits operate on the principle of applying a large negative bias on the grid of the first audio amplifier tube whenever the signal voltage is very low or entirely absent at the limiter input. The squelch bias must be sufficiently in excess of cut-off to prevent the noise output of the discriminator from causing a plate current to flow in the first audio amplifier tube, even momentarily on the noise peaks.

Figure 67 shows a typical squelch circuit. During the reception of signals, the first amplifier tube obtains its normal operating bias from cathode resistor R_C. The squelch tube is biased beyond cut-off by the negative voltage taken from the first limiter resistor R_1.

When the signal voltage at the limiter is removed, either through shutting down the transmitter or detuning the receiver, the rectified voltage across resistor R_1 of the first limiter falls to a very low value. The squelch tube bias is, therefore, almost entirely removed and the tube draws a heavy plate current by way of cathode resistor R_C. The increased voltage drop across R_C biases the first audio amplifier tube beyond cut-off, until a signal is applied again at the first limiter grid.

In this typical case, the first audio-amplifier tube is a 6SQ7 which draws 0.9 milliamperes through the cathode resistor R_C of 2,200 ohms, and operates with a normal bias of 2 volts. The squelch tube is a 6AC7 which is operated without a plate load resistor and draws 36 milliamperes at zero grid voltage. Thus, in the absence of signal, the voltage across the cathode resistor R_C is about 36/2 or 18 times the

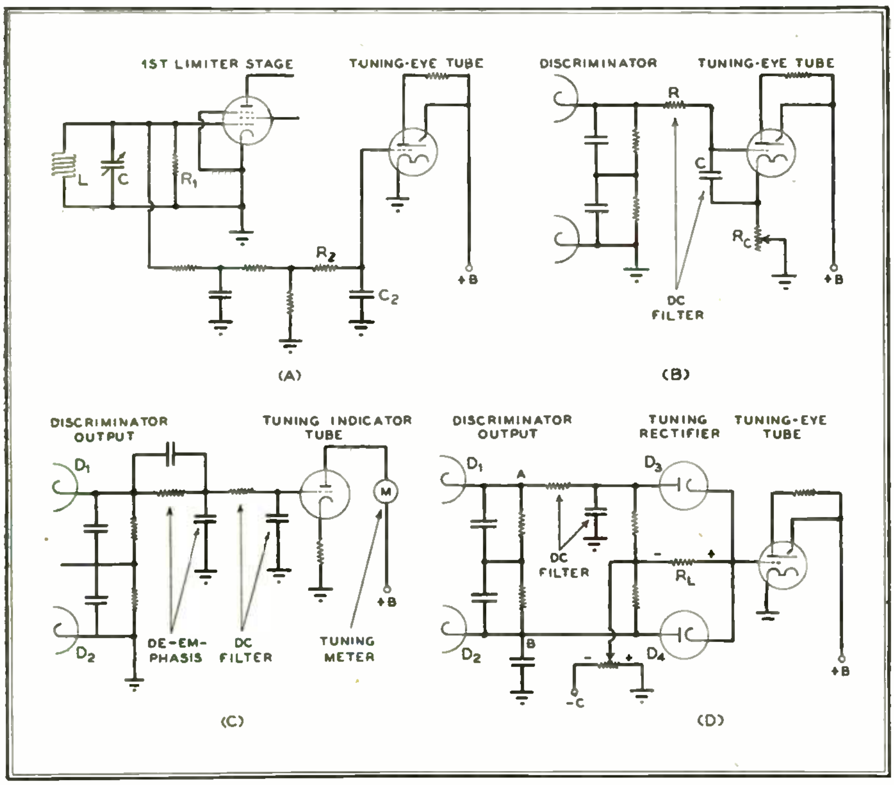

FIG. 68. FOUR TYPES OF TUNING INDICATOR CIRCUITS USED IN FM RECEIVERS

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normal bias of the first audio amplifier. A negative bias of only −5 volts is necessary to bring about complete cut-off of plate current in the 6AC7 squelch tube, restoring the normal bias of −2 volts on the first audio amplifier tube. This voltage appears across the first limiter resistor R_1 at relatively low signal level.

In locations where the noise level is very low, the squelch system may shut off weak signals from which reasonably satisfactory reception could be obtained. It is desirable, therefore, that a switch be provided for stopping the squelch action. In the circuit shown in Fig. 67, this switch serves to disconnect the cathode of the squelch tube, and thus opens the circuit through which the squelch current is drawn.

Tuning Indicators ★ To avoid distortion in the discriminator, the center frequency of the voltage at the limiter output should equal the resonant frequency of the discriminator tuned input circuit. The discriminator will then be operated at the mid-point of its linear characteristic and will deliver an audio voltage having the same wave form as the audio modulating voltage at the transmitter.

When the center frequency of the signal applied to the discriminator approaches but does not equal the resonant frequency of the discriminator tuned circuit, operation occurs about a point off the center of the linear portion of the discriminator characteristic. Under such conditions the discriminator output contains 1) a DC component having a magnitude and polarity depending upon the extent and direction by which the applied frequency differs from the resonant frequency, 2) an AF component of the same frequency as that of the audio modulating voltage at the transmitter and 3) harmonics of the AF component representing distortion resulting from operation on the curved portions of the discriminator characteristic.

In order to minimize such distortion, a device is needed to enable listeners to tune their receivers more accurately than is possible when depending upon the ear alone.

One solution of the tuning problem lies in the use of an AFC system actuated by the DC component of the discriminator output, which would automatically correct the oscillator frequency by means of a reactance tube whenever the receiver is slightly mis-tuned or the oscillator drifts. The theory of operation of the reactance tube has been already explained.

The other solution involves the use of a visual tuning indicator, such as a meter or tuning-eye.

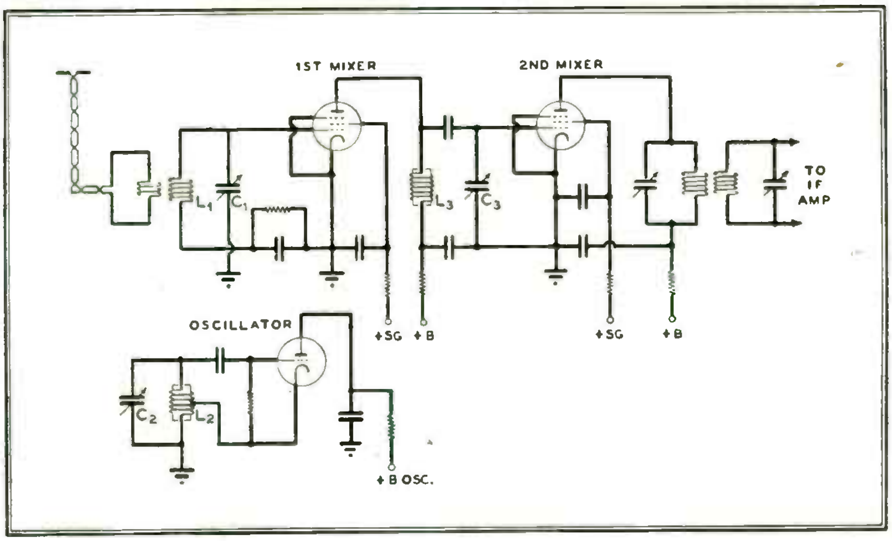

FIG. 69. FUNDAMENTAL CIRCUIT OF DOUBLE SUPERHETERODYNE RECEIVER, WHICH PROVIDES LARGE RF GAIN WITH GOOD STABILITY

Fig. 68 (A) shows a tuning-eye indicator circuit controlled by DC voltage taken from the grid leak of the first limiter stage. As the receiver dial is tuned *toward* the setting for the station, the beat frequency created by the signal and oscillator frequencies approaches the intermediate frequency of the receiver, to which the IF amplifier, limiter, and discriminator circuits are resonant. This causes the RF voltage across the limiter tuned circuit condenser C to rise, creating a large DC voltage across grid leak R_1. This DC voltage is applied by way of DC filter R_2C_2 to the grid of the tuning-eye tube in negative polarity, and causes the shadow angle to diminish.

If the receiver dial is tuned beyond the setting for the station, the beat frequency created by the signal and oscillator frequencies draws away from the intermediate frequency of the receiver to which the tuned circuits are resonant. The RF voltage across the limiter tuning condenser C decreases, thereby reducing the negative bias applied by grid leak R_1 to the limiter tube, and causing the shadow angle to increase.

At the correct tuning adjustment, the *maximum* negative voltage is developed in the limiter grid leak and applied to the grid of the tuning eye, so that the *least* shadow angle is obtained.

As stated previously, the condition to be satisfied for correct tuning adjustment is that the applied frequency at the discriminator be equal to the resonant frequency of the discriminator input circuit. The above method of tuning assumes that the alignment of the limiter, IF amplifier, and discriminator tuned circuits will be maintained exactly at the intermediate frequency of the receiver.

Actually, in view of the high order of the intermediate frequency involved, it can be expected that the circuits may be slightly out of alignment at times. Some set designers prefer to obtain the control voltage of the tuning eye from the discriminator, since this is the receiver stage in which exact tuning is important.

Fig. 68 (B) and 68 (C) show two tuning indicator circuits actuated by the DC component of the discriminator output, which appears whenever the center frequency of the signal applied at the discriminator differs from the resonant frequency of the discriminator tuned circuit.

In Fig. 68 (B), the DC component of the discriminator output voltage is isolated by means of a DC filter RC, and is applied to the grid of a tuning-eye tube. The tuning-eye is adjusted by means of a variable cathode resistor R_C, so that the eye just closes when there is zero voltage at the discriminator output. A convenient way to make this preliminary adjustment is to remove the last limiter tube temporarily, while adjusting R_C to make the eye close.

In the case of the circuit shown in Fig. 67 (B) it will be found that when no signal is tuned in, the eye is closed. When the dial is tuned past the setting at which a station is heard, the eye first opens and then closes and overlaps, or vice-versa, depending upon the direction in which the dial is turned. The correct tuning adjustment is at the transition point between an opening and an overlap, where the eye is just closed.

Fig. 68 (C) shows a circuit operating on the same principle as that of Fig. 68 (B), except that a tuning meter is employed instead of a tuning-eye. Tuning is accomplished by bringing the meter indicator to a reference mark on the meter scale.

While the indicator circuit in Fig. 68 (B) has the advantage of being operated from the discriminator stage, an ob-

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jection may be raised because, during tuning, the shadow angle of the eye varies in a manner that may puzzle the uninformed operator who has been accustomed to seeing the eye open *above and below* resonance in his AM receiver. Thus the use of a tuning rectifier, as shown in Fig. 64 (D), is favored by some set designers.

In this circuit, when the applied frequency exceeds the resonant frequency and the voltage at the discriminator output terminal A is, say, positive with respect to ground, the current drawn through tuning rectifier diode D_3 produces a voltage drop in the rectifier level resistor R_L of such polarity as to reduce the negative voltage on the grid of the tuning-eye, thereby opening the eye. When the applied frequency is less than the resonant frequency and terminal A is negative with respect to ground, then current is drawn in the *same* direction through R_L as before, but by way of diode D_4. Again a voltage is applied to grid of the tuning eye in such polarity as to open the eye. Therefore, the eye closes at the correct dial setting of the receiver and opens above or below the correct setting, similarly to tuning eyes in AM receivers.

Double Superheterodyne FM Receivers ★ In the preceding chapter, stress was laid upon the need for high RF and IF gain in FM receivers, in order that weak signal voltages can be brought up to a level sufficient to saturate the limiter. Moreover, it was stated that a gain of 15,000 represented about the maximum that could be obtained safely from the mixer and IF stages in the factory production of receivers without running serious risk of encountering instability in the IF amplifier because of regenerative coupling between stages. This condition demands a large gain in the first RF amplifier stage; in fact, a larger gain than can be obtained easily at FM frequencies.

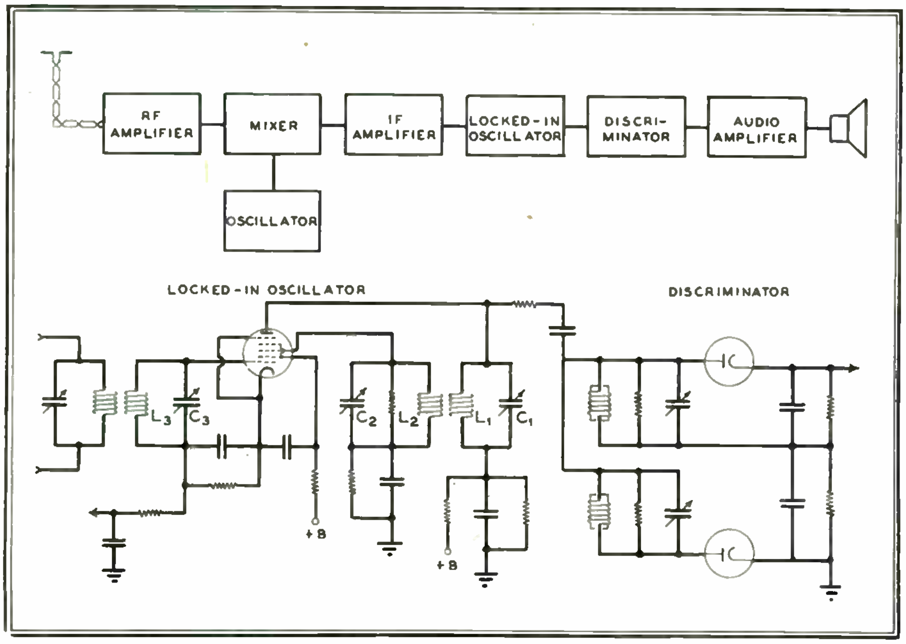

FIG. 70. BLOCK DIAGRAM OF BEERS FM RECEIVER WITH CIRCUIT DIAGRAM OF LOCKED-IN OSCILLATOR AND DISCRIMINATOR

One solution to this problem of obtaining large overall gain without requiring excessive gain at one intermediate frequency lies in the use of a special circuit arrangement called the *double superheterodyne* or *triple-detector superheterodyne*. Here, two intermediate frequencies are employed, thus reducing the amount of gain that is required at each frequency.

The logical circuit arrangement for a double superheterodyne would appear at first thought to include a variable-frequency oscillator to reduce the signal frequency to the first intermediate frequency in the first mixer, and another oscillator, of the fixed-frequency type, to lower the frequency to the second intermediate frequency in the second mixer. Actually, such an arrangement causes serious difficulty because of spurious signals produced by beating together the fundamentals and harmonies of the oscillator.

A practical circuit arrangement employed in FM receivers designed to tune over a range of frequencies is shown in Fig. 68. Here the oscillator frequency at any particular dial setting is half the difference between the signal frequency for that dial setting and the second IF.

For example, in Fig. 69, assume that the second intermediate frequency is 4.3 mc. and the signal frequency is 45.5 mc. The input tuned circuit of the first mixer is resonant at 45.5 mc. and the oscillator tuning circuit constants L_2C_2 are such as to give an oscillator frequency of (45.5−4.3)/2, or 20.6 mc.

The oscillator is coupled inductively or capacitively to the first mixer and causes a beat component to appear in the output at the difference frequency of 45.5−20.6 or 24.9 mc. The tuned parallel circuit L_3C_3 is resonant at this difference frequency, causing a voltage of the difference frequency to be established across L_3C_3.

The plate current of the first mixer also contains a strong component at the oscillator frequency. The impedance offered by L_3C_3 to the oscillator frequency of 20.6 mc. is less than that offered to the first intermediate frequency of 24.9 mc. However, the strong component at the oscillator frequency of 20.6 mc. is able to build up an appreciable voltage across the small impedance of L_3C_3, and this voltage is applied to the grid together with the voltage at the first intermediate frequency of 24.9 mc. This, a difference frequency component at 24.9−20.6 or 4.3 mc. appears in the plate circuit of the second mixer, and serves to excite the IF amplifier.

Since the output circuit of each mixer tube is tuned to a frequency other than that of its input circuit, high-gain tubes can be employed in both mixer stages without risking oscillation. Since the conversion transconductance of a tube used as a mixer is from one-third to one-half of the mutual conductance of the same tube used as an amplifier, reasonably good gain can be obtained in the two mixer stages. The use of a single oscillator for both mixer stages overcomes the difficulty with spurious responses that is encountered when two oscillators at different frequencies are employed.

Where still greater receiver gain is desired, as in FM mobile communications services, an additional stage of amplification at the first intermediate frequency may be employed. The selectivity of the IF amplifier between the first and second mixers would be too great to permit a component of voltage at the oscillator frequency to reach the second converter grid by way of the first converter as in Fig. 69. However, where reception at only one frequency is desired, the circuit can be designed so that only one crystal oscillator is employed. The fundamental of the oscillator is applied to the second mixer and a higher harmonic is coupled to the first mixer.

The Beers Receiver ★ Fig. 70 shows a block diagram of a special receiver circuit ar-

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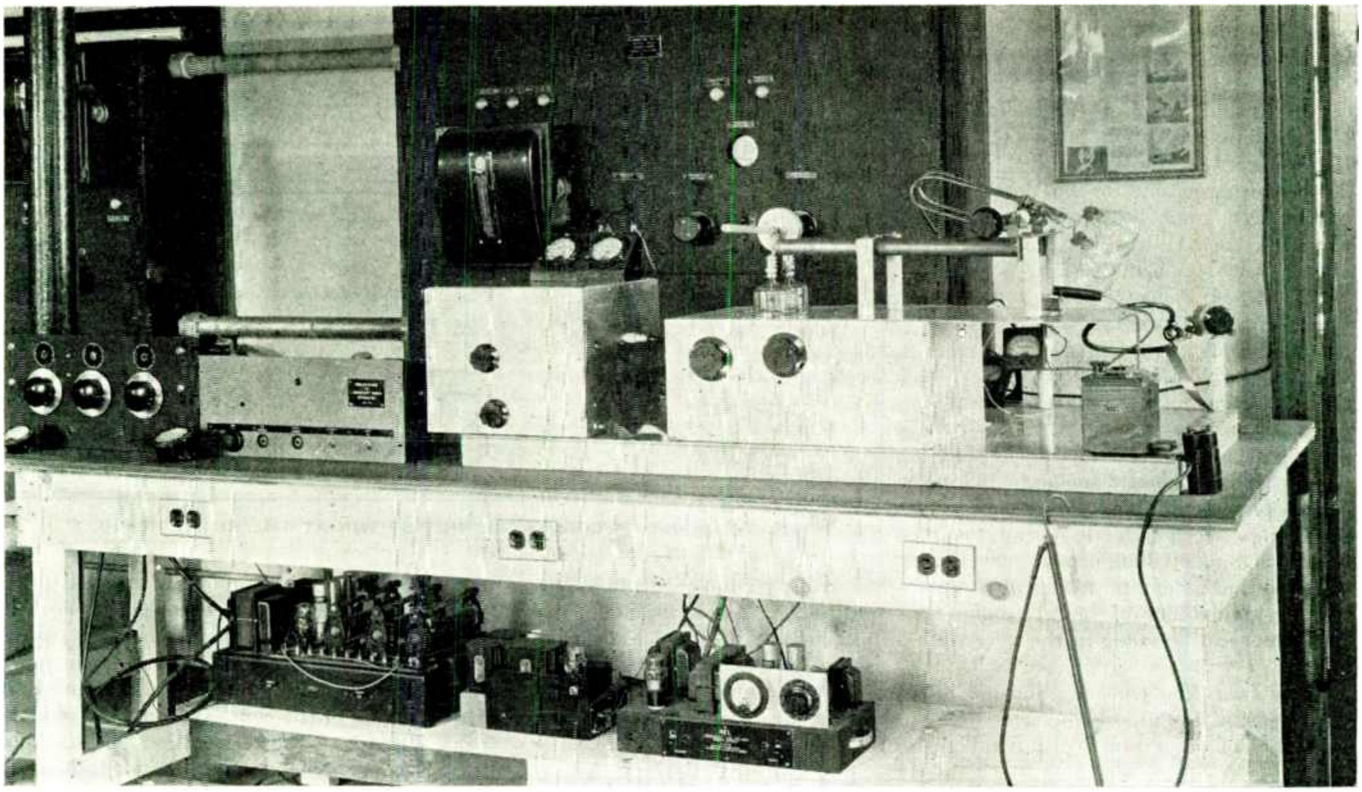

FIG. 1. FREQUENCY CONVERTER AT FINAL STAGE OF LABORATORY DEVELOPMENT

POWER FREQUENCY CONVERTER FOR FM

Interim FM Operation on Old and New Bands at Minimum Investment

BY FRANK A. GUNTHER*

THE FCC decision of June 27th, whereby FM broadcasting will move to the 88- to 108-mc. band, confronts the FM broadcast station owner with the serious practical problem of transmitting on both his old and new frequencies during the transition period.

How can operation on the new band be inaugurated at the earliest possible moment while maintaining service to the present audience on the old band? Is it necessary to install a second, completely new transmitter, or can auxiliary equipment be added to the present transmitter for dual-frequency operation? If auxiliary apparatus can be used, what are the economic factors involved? For example, will it be necessary to write off the cost of the additional equipment as a complete loss at the end of the transition period, when the FCC finally orders transmission exclusively in the new band?

Anticipating the possibility that the FCC would decide to move FM upstairs, REL set about finding the best answers to these questions several months ago. The result, as announced by Major Armstrong in a public statement immediately following the FCC decision, is the development of an efficient power frequency converter for FM broadcast transmitters which permits simultaneous operation on the old and the new bands.

The power frequency converter is a self-contained unit that can be installed adjacent to, or at any convenient distance from, the present transmitter. The converter may be used with an FM transmitter of any power and any type of manufacture. There is but one simple connection between the converter and the present transmitter, whereby a small amount of power is drawn from the transmitter output stage for the excitation of the converter. Other than this, the converter circuit is independent of the main transmitter. The converter operates from its own power supply and is designed to deliver 1 kw. or 3 kw. to its own antenna at the desired frequency in the 88- to 108-mc. range.

Operational Advantages ★ Dual operation on the old and new FM bands is highly desirable, of course, because it will obviate another chicken-or-the-egg dilemma in shifting to the new band. Stations now operating in the lower band will be able to serve their established FM audiences, while the new audiences on the higher frequency band are being developed.

In this connection, the power frequency converter has something special to offer. Since it is a relatively simple device, it can be manufactured quickly and installed with a minimum of delay or inconvenience. This means that stations now in operation will be able to begin transmission in the upper band much sooner than would be possible if they wait for the production of complete high-power transmitters for the new band.

Since it is axiomatic that receivers can be sold only in areas where FM signals are on the air, it follows that the shift of re-

* Vice President in Charge of Engineering, Radio Engineering Laboratories, Inc., Long Island City, N. Y.

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ception to the new band will be expedited by the early establishment of transmission in this portion of the spectrum provided, of course, that reception and coverage on the new band will prove to be as good as that obtained on the 42 to 50-mc. band.

Spot authorizations for the construction of a limited number of power frequency converters for FM broadcast stations have already been applied for, and while the WPB has not indicated its action at the time this is being written, it is reasonable to expect that a number of converter installations will be in operation well before the appearance of the first post-war FM receivers on the civilian market. Quite possibly, the use of converters will permit regular transmissions in the 88 to 108-mc. band soon enough for extensive field testing of new receiver models prior to the resumption of civilian production. It is expected that a definite statement regarding the availability of power frequency converters can be made in the very near future.

Aside from the considerations of the time element, the use of converters offers a number of other practical advantages.

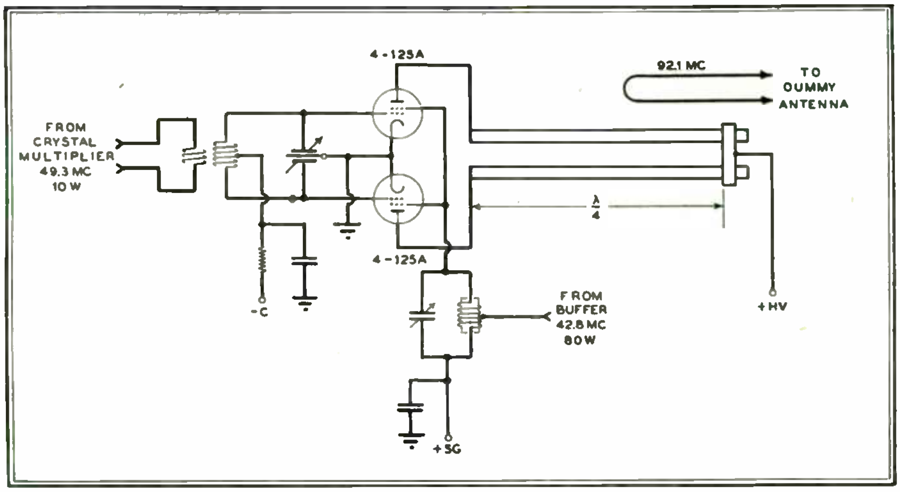

FIG. 2. CIRCUIT OF CONVERTER UNIT SHOWN AT THE RIGHT IN FIG. 1.

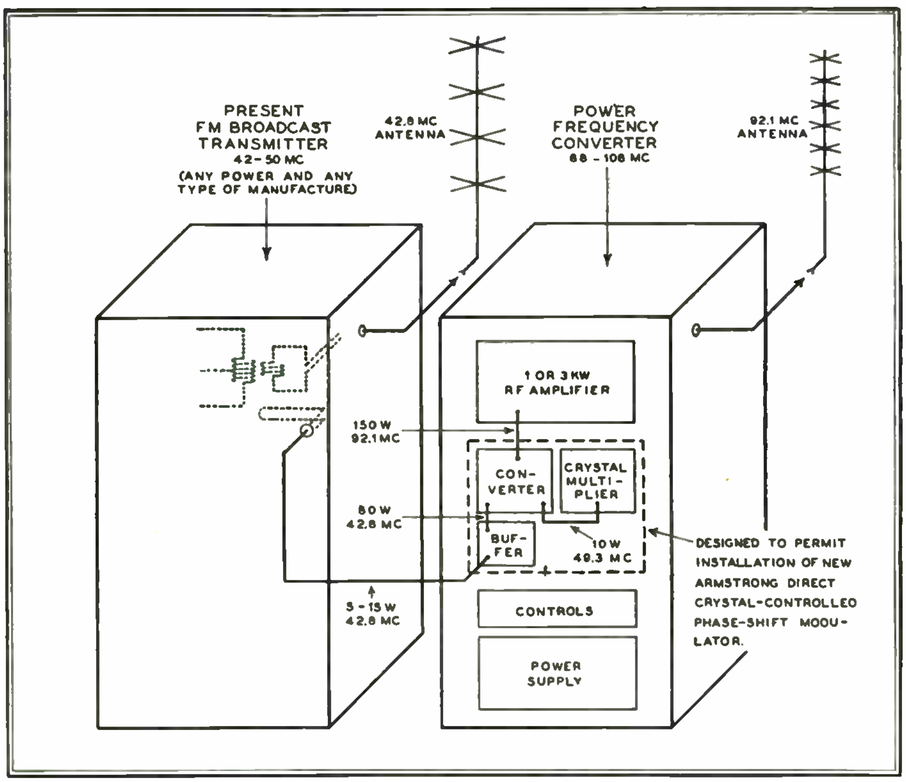

FIG. 3. ONE CONNECTION SERVES TO LINK CONVERTER AND TRANSMITTER

For example, it will be unnecessary to acquire additional real estate for the housing of a new transmitter at the present time. The same operating staff can attend the additional unit.

No new monitoring problems are introduced, since the frequency deviation of the converter output on the new band is identical with that of the output of the present transmitter. The same monitoring equipment already in use at the station can be used to check both transmissions. The frequency stability of the output of the converter is excellent, being well within the requirements of the FCC.

An important consideration to the station owner contemplating the use of the power frequency converter is the matter of obsolescence. Will the entire cost of the converter have to be written off as a loss when the interim period of dual operation is ended and transmission solely on the 88- to 108-mc. band is initiated?

The physical layout of the REL converter is such that the elements actually involved in frequency conversion (as distinguished from those involved in power amplification) are mounted in a removable section of the converter unit. At some future date, when operation on the lower frequency band is discontinued, these elements can be removed easily and a new Armstrong direct crystal-controlled phase-shift type of modulator substituted. The use of the 1-kw. or 3-kw. final power amplifier of the converter, together with its power supply and power control systems, will be retained for the new transmitter. Thus the major part of the present investment in the frequency converter can be saved. While exact cost figures are not available, it is estimated that only about 15% of the cost of the converter will be lost when the frequency-converting elements are removed.

Principle of Operation ★ The power frequency converter operates on the same general principles as the other converter stages employed in FM transmitters. The main points of difference lie in the higher order of frequencies and the higher level of power at which the frequency conversion takes place, plus the fact that the converter output circuit is tuned to the sum rather than to the difference of the converter input frequencies.

The converter in its final stage of development on the laboratory bench is shown in Fig. 1. The unit at the extreme left is a crystal multiplier, delivering a constant-amplitude output at a frequency equal to the difference between the assigned frequencies in the new and the old FM bands.

For example, in a power frequency converter for Alpine, which is now operating on 42.8 mc. and plans to transmit simultaneously on 92.1 mc., the crystal multi-

(CONTINUED ON PAGE 78)

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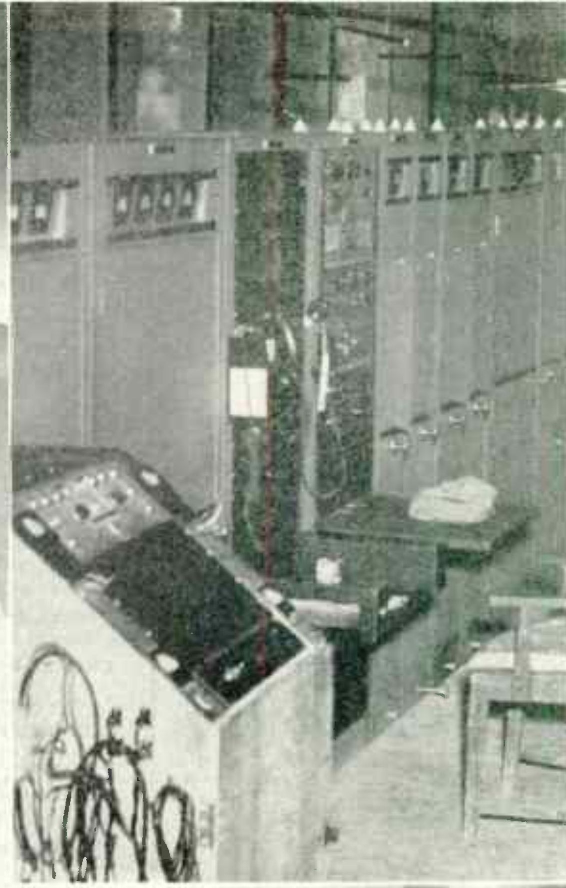
AACS Domestic Station showing a pair of Eimac 450-T tubes



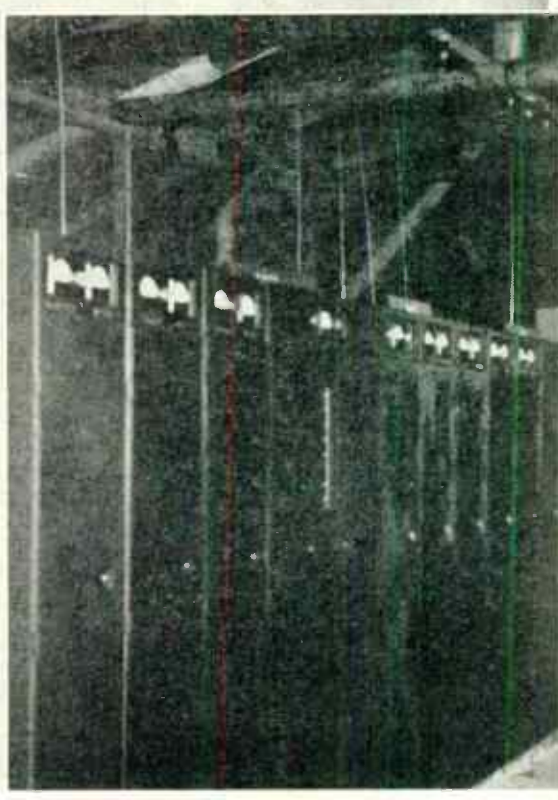
AACS Ground Station China-Burma-India Theatre

AACS* BLAZES THE TRAIL FOR SAFE FUTURE WORLD AIR TRANSPORTATION

World-wide aviation communications are an established fact today. Almost overnight a great radio network has been created. The actual physical difficulties involved were great enough, to say nothing of the variety of extreme operating conditions encountered and overcome. Needless to say, the equipment employed must be dependable, both from a standpoint of construction and performance capability.

The establishment of radio ground stations on every continent and in fifty-two different countries... overcoming the widest extremes in operating and climatic conditions (from 40 degrees below zero to 140 degrees above)... stations in jungles ...in deserts...in mountains and towns...and to have these stations constantly operating at near peak levels is a tribute to the equipment employed. On this page are shown three AACS Stations located at widely separated spots on the globe.

AACS Station on an island in South Pacific



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The Radio Engineers' & Purchasing Agents' Guide to Essential Materials, Components, and Equipment

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Company addresses will be found in the Directory listings

We shall be pleased to receive suggestions as to company names and hard-to-find items which should be added to this Directory

NOTE: For the convenience of engineers and purchasing agents, we have added, under the heading "SUPPLY HOUSES," a list of parts jobbers in 48 cities. These houses carry large stocks of components, instruments, and tubes, and are prepared to fill mail or telegraph orders.

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Daven Co., Summit Ave., Newark, N. J.
General Radio Co., Cambridge, Mass.
Intl. Resistance Co 429 Broad St Phila
Mallory & Co., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Remler Co., Ltd., 2101 Bryant St., San Francisco
Shallcross Mfg. Co., Collingdale, Pa.
Tech Labs. Lincoln St Jersey City N J
Utah Radio Prod. Co., 842 Orleans St., Chicago

BEADS, Insulating

Amer. Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.

BEARINGS, Glass Instrument

Bird, Richard H., Waltham, Mass.

BERYLLIUM

Clifton Products Inc Painesville O

BINDING POSTS

Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge 39 Mass.
Radex Corp., 1308 Elston Ave., Chicago

BINDING POSTS, Push Type

Amer Radio Hdware Co., Mt. Vernon, N. Y.
Eby, Inc., H. H., W. Chelten Ave., Phila.

BLOWERS, for Radio Equipment

Eastern Air Devices, Inc., 585 Dean St., Bklyn 17
L-R Mfg. Co., Torrington, Conn.
Trade-Wind Motorfans, Inc., 5725 S. Main St., Los Angeles

BOOKS on Radio & Electronics

Macmillan Co., 60 Fifth Ave., N. Y. C.
Maedel Pub. House, 593AE 38 St., Bklyn, N. Y.
McGraw-Hill Book Co., 330 W. 42 St., N. Y. C.
Pitman Pub. Corp., 2 W. 45 St., N. Y. C.
Radio Tech. Pub. Co., 45 Astor Pl., N. Y. C.
Rider, John F., 404 Fourth Ave., N. Y. C.
Ronald Press Co., 15 E. 26 St., N. Y. C.
Van Nostrand Co., D., 250 Fourth Ave., N. Y. C.
Wiley & Sons, John, 440 Fourth Ave., N. Y. C.

BRIDGES, Percent Limit Resistance

Leeds & Northrup Co., 4901 Stenton Ave., Phila.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.

BRIDGES, Wheatstone

Industrial Instruments, Inc., Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4901 Stenton Ave., Phila.
Shallcross Mfg. Co., Collingdale, Pa.

BUSHINGS, Terminal Sealing

Corning Glass Works, Corning, N. Y.
Electrical Industries, Inc., 42 Sumner Ave., Newark 4, N. J.
Lenox Inc Trenton 5 N J
Peerless Electrical Prod. Co., 6920 McKinley Ave., Los Angeles 1
Sperti, Inc., Cincinnati, O.
Sprague Elec Co N Adams Mass
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CABINETS, Metal

Cole Steel Equip. Co 349 Bway N Y C
Corry-Jamestown Mfg Corp Corry Pa

World Radio History

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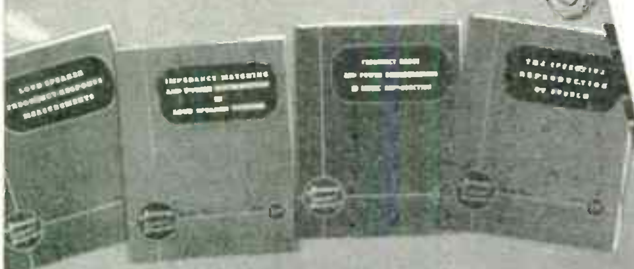

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Par-Metal Prod. Corp., 32-49th St., L. I. City, N. Y.
Porter Metal Prod Co 490 Johnson Av Bklyn

SCHEDULE OF DIRECTORIES IN *FM* AND TELEVISION

JANUARY	FEBRUARY	MARCH	APRIL
All Police and Emergency Stations in the U. S. A.—includes names of the Radio Supervisors. CLOSING DATE JAN. 5	Radio Products Directory, listing manufacturers of equipment, components, materials, and supplies. CLOSING DATE FEB. 5	FM, AM, and Television Stations in the U. S. A. and Canada—includes general managers, chief engineers. CLOSING DATE MAR. 5	Set and Parts Jobbers, listing general managers & service managers; and Factory Representatives CLOSING DATE APR. 5
MAY	**JUNE**	**JULY**	**AUGUST**
Radio Manufacturers in the U. S. A.—includes the names of general managers and chief engineers. CLOSING DATE MAY 5	Railway Signal Engineers on all roads in the United States, Canada and Mexico. CLOSING DATE JUNE 5	All Police and Emergency Stations in the U. S. A.—includes names of the Radio Supervisors. CLOSING DATE JULY 5	Radio Products Directory, listing manufacturers of equipment, components, materials, and supplies. CLOSING DATE AUG. 5
SEPTEMBER	**OCTOBER**	**NOVEMBER**	**DECEMBER**
FM, AM, and Television Stations in the U. S. A. and Canada—includes general managers, chief engineers. CLOSING DATE SEPT. 5	Set and Parts Jobbers, listing general managers & service managers; and Factory Representatives CLOSING DATE OCT. 5	Radio Manufacturers in the U. S. A.—includes the names of general managers and chief engineers. CLOSING DATE NOV. 5	Railway Signal Engineers on all roads in the United States, Canada and Mexico. CLOSING DATE DEC. 5

CABINETS, Wood, for Home Radios
Churchill Cabinet Co., 2119 Churchill St., Chicago
Tillotson Furniture Co., Jamestown, N.Y.

CABLE, Coaxial
American Phenolic Corp., 1830 S. 54 Av., Chicago
Anaconda Wire & Cable Co., 25 B'way, N. Y. C.
Andrew Co 363 E 75 St Chicago
Belden Mfg. Co., 4673 W. Van Buren, Chicago
Boston Ins Wire & Cable Co Boston
Comm Prods Co 346 Bergen Av Jersey City 5 N J
Cornish Wire Co., 15 Park Row, N. Y. C.
Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
General Cable Corp., 420 Lexington, N. Y. C.
General Insulated Wire Corp., 53 Park Pl., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Lenz Electrical Mfg. Co.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, Fittings
Andrew Co 363 E 75 St Chicago
Comm Prod Co 346 Bergen Av Jersey City 5 N J
Johnson Co, E. F. Waseca Minn

CABLE, Coaxial, Solid Dielectric
American Phenolic Corp., 1830 S. 54 Ave., Chicago
Federal Tel. & Radio Corp., E. Newark, N. J.
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Microphone, Speaker & Battery
Alden Prods. Co., Brockton, Mass.
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Dorchester, Mass.
Gavitt Mfg. Co., Brookfield, Mass.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Universal Microphone Co., Inglewood, Calif.

CABLES, Preformed
Alden Products Co., Brockton, Mass.
Belden Mfg. Co., 4633 W. Van Buren St., Chicago
Wallace Mfg. Co., Wm. T., Rochester, Ind.
Whitaker Cable Corp Kansas City 16 Mo.

CASES, Wooden Instrument
Hoffstatter's Sons, Inc., 43 Ave. & 24 St., Long Island City, N. Y.
Tillotson Furniture Co., Jamestown, N.Y.

CASTINGS, Die
Aluminum Co. of Amer., Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Dow Chemical Co., Dow Metal Div., Midland, Mich.

CERAMICS, Bushings, Washers, Special Shapes
Akron Porcelain Co., Akron, O.
Amer. Lava Corp., Chattanooga, Tenn.
Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Paterson, N. J.
Gen'l Ceramics & Steatite Corp., Keasbey, N. J.
Isolantite, Inc., Belleville, N. J.
Lapp Insulator Co., Leroy, N. Y.
Lenox, Inc., Trenton, N. J.
Louthan Mfg. Co., E. Liverpool, O.
Mycalex Corp. of America, Clifton N. J.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Victor Insulator Co., Victor, N. Y.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CHANGERS, Record
See Turntables, Record

CHASSIS, Metal
See STAMPINGS, Metal

CHOKES, AF
Hadley Co., R. M., 707 E. 61 St., Los Angeles
Langevin Co 37 W 65 St N Y C 23

CHOKES, RF
Albion Coil Co Albion Ill
Aladdin Radio Industries, 501 W. 35th, Chicago
Alden Prods. Co., Brockton, Mass.
American Communications Corp., 306 B'way, N. Y. C.
Automatic Winding Co., Inc., Passaic Ave. E., Newark, N. J.
Barker & Williamson, Upper Darby, Pa.
Coto-Coil Co., Providence, R. I.
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Fast & Co., John E., 3109 N. Crawford, Chicago 41
Gen. Winding Co., 420 W. 45 St., N. Y. C.
General Radio Co., Cambridge, 39 Mass.
Guthman & Co., Edwin, 15 S. Throop, Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Jeffers Electronics Du Bois Pa
Johnson Co., E. F., Waseca, Minn.
Lectrohm, Inc., Cicero, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Miller Co., J. W., 5917 S. Main, Los Angeles, Cal.
Muter Co., 1255 S. Michigan, Chicago
National Co., Malden, Mass.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Radex Corp., 1328 Elston Av., Chicago
Sickles Co., F. W. Chicopee, Mass.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co., 913 W. Van Buren St., Chicago

CLIPS, Connector
Mueller Electric Co., Cleveland, O.

CLIPS & MOUNTINGS, Fuse
Alden Prods. Co., Brockton, Mass.
Dante Elec. Mfg. Co., Bantam, Conn.
Ilsco Copper Tube & Prods., Inc., Station M., Cincinnati
Jefferson Elec. Co., Bellwood, Ill.
Jones, Howard B., 2300 Wabansia, Chicago
Littlefuse, Inc., 4753 Ravenswood, Chicago
Patton MacGuyer Co., Providence, R. I.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Stewart Stamping Co., 621 E. 216 St., Bronx, N. Y.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

CLOTH, Insulating
Acme Wire Co., New Haven, Conn.
Brand & Co., Wm., 276-4th Av., N. Y. C.
Endurette Corp. of Amer., Cliffwood, N. J.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Irvington Varnish & Insulating Co., Irvington, N. J.
Mica Insulator Co., 196 Varick, N. Y. C.

COIL FORMS, Glass
Corning Glass Works, Corning, N. Y.

COILS, Radio
See Transformers, IF, RF

CONDENSERS, Ceramic Case Mica Transmitting
Aerovox Corp., New Bedford, Mass.
Cornell-Dubilier, S. Plainfield, N. J.
RCA Mfg. Co., Inc., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Solar Mfg. Corp., Bayonne, N. J.

CONDENSERS, Fixed
Aerovox Corp., New Bedford, Mass.
American Condenser Corp., 2508 S. Michigan, Chicago
Art Radio Corp., 115 Liberty, N. Y. C.
Atlas Condenser Prods. Co., 548 Westchester Ave., N. Y. C.
Automatic Winding Co., E. Newark, N. J.
Bud Radio, Inc., Cleveland, O.
Capacitron Co 318 W Schiller Chicago 10
Centralab, Milwaukee, Wis.
Condenser Corp. of America, South Plainfield, N. J.
Condenser Prods. Co., 1375 N. Branch, Chicago
Cornell-Dubilier Elec. Corp., S. Plainfield, N. J.
Cosmic Radio Co 699 E 135th St N Y C
Crowley & Co., Henry, W. Orange, N. J.
Deutschmann Corp Tobe Canton Mass
Dumont Elec. Co., 34 Hubert St., N. Y. C.
Electrical Reactance Corp Franklinville N Y
Electro-Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., Erie, Pa.
Fast & Co., John E., 3109 N. Crawford, Chicago 41
General Electric Co Schenectady N Y
General Radio Co., Cambridge, Mass.
Girard-Hopkins, Oakland, Calif.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago
H. R. S. Prods, 5707 W. Lake St., Chicago
Illinois Cond. Co., 1160 Howe St., Chicago
Industrial Cond. Corp., 1725 W. North Av., Chicago
Insuline Corp. of America, Long Island City, N. Y.
Jeffers Electronics Du Bois Pa
Johnson Co., E. F., Waseca, Minn.
Magnavox Co., Fort Wayne, Ind.
Mallory & Co., P. R., Indianapolis, Ind.
Micamold Radio Corp., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan, Chicago
Noma Electric Corp 55 W 13 St N Y C
Polymet Condenser Co., 699 E. 139 St., N. Y. C.
Potter Co., 1950 Sheridan Rd., N. Chicago
RCA Mfg. Co., Camden, N. J.
Sangamo Elec. Co., Springfield, Ill.
Sickles Co., F. W., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J.
Sprague Electric Co., N. Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., N. Y. C.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CONDENSERS, Gas-filled
Johnson Co, E. F. Waseca Minn
Lapp Insulator Co., Inc., Leroy, N. Y.

CONDENSERS, High-Voltage Vacuum
Centralab, Milwaukee, Wis.
Eitel-McCullough, Inc., San Bruno, Calif.
Erie Resistor Corp., Erie, Pa.
General Electric Co., Schenectady, N. Y.
General Electronics, Inc., Paterson, N. J.

CONDENSERS, Small Ceramic Tubular
Centralab; Div. of Globe-Union, Inc., Milwaukee, Wis.
Erie Resistor Corp., Erie, Pa.

CONDENSERS, Transmitter Neutralizing
Hammarlund Mfg Co 424 W 34 St N Y C
Johnson Co, E. F. Waseca Minn
National Co Inc Malden Mass
Millen Mfg Co Inc Malden Mass

CONDENSERS, Trimmer
Alden Prods. Co., Brockton, Mass.
American Steel Package Co., Defiance, O.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Brooklyn, N. Y.
Centralab, Milwaukee, Wis.
Comar Electric Co., 2701 Belmont Ave., Chicago
General Radio Co., Cambridge, Mass.
Guthman, Inc., E. I., 400 S. Peoria, Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Insuline Corp. of America, Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Av., Chicago
National Co., Malden, Mass.
Potter Co., 1950 Sheridan Rd., N. Chicago
Sickles Co., F. W., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J.
Teleradio Eng. Corp., 484 Broome, N. Y. C.

CONDENSERS, Variable Receiver Tuning
Alden Prods. Co., Brockton, Mass.
American Steel Package Co., Defiance, Ohio
Barker & Williamson, Ardmore, Pa.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
General Inst. Corp., Elizabeth, N. J.
Hammarlund Mfg. Co., 424 W. 34th St., N. Y. C.
Insuline Corp. of Amer., L. I. City, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., Malden, Mass.
National Co., Malden, Mass.
Oak Mfg. Co., 1267 Clybourn Ave., Chicago
Radio Condenser Co., Camden, N. J.
Rauland Corp., Chicago, Ill.

CONDENSERS, Variable Transmitter Tuning
Barker & Williamson, Upper Darby, Pa.
Bud Radio, Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson, E. F., Waseca, Minn.
Millen Mfg. Co., James, Malden, Mass.
National Co., Malden, Mass.
Radio Condenser Co., Camden, N. J.

CONNECTORS, Cable
Aero Electric Corp., Los Angeles, Calif.
Alradio, Inc., Stamford, Conn.
Alden Prods., Brockton, Mass.
Amer. Microphone Co., 1915 S. Western Av., Los Angeles
Amer. Phenolic Corp., 1830 S. 54th St., Chicago
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Andrew Co 363 E 75 St Chicago
Astatic Corp., Youngstown, O.
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Birnbach Radio, 145 Hudson St., N. Y. C.
Breeze Mfg. Corp., Newark, N. J.
Brush Development Co., Cleveland, O.
Bud Radio, Cleveland, Ohio
Cannon Elec. Development, 3209 Humboldt, Los Angeles
Diamond Inst. Co Wakefield Mass
Eby, Inc., Hugh H., Philadelphia
Electro Voice Mfg. Co., South Bend, Indiana
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Intl. Resistance Co 401 N Broad St. Phila 8
Harwood Co., 5405 S. La Brea, Los Angeles 36
Insuline Corp. of Amer., L. I. City, N. Y.
Jones, Howard B., 2432 W. George, Chicago
Mallory & Co., P. R., Indianapolis, Ind.
Monowatt Electric Co., Providence, R. I.
Northam Warren Corp., Stamford, Conn.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Schott Co., W. L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Selectar Mfg. Co., L. I. City, N. Y.
Universal Microphone Co., Ltd., Inglewood, Calif.

CONTACT POINTS
Brainin Co., C. S., 233 Spring St., N. Y. C.
Callite Tungsten Corp., Union City, N. J.
Fansteel Metallurgical Corp., N. Chicago, Ill.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Wilson Co., H. A. 105 Chestnut St., Newark 5 N. J.

CORES, Powdered Iron
See IRON CORES, Powdered

COUPLINGS, flexible
Cardwell Mfg. Corp., Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
Hammarlund Mfg Co Inc 460 W 34 St N Y C
Millen Mfg. Co., James, Malden, Mass.
National Co., Inc., Malden, Mass.

World Radio History

CRYSTAL GRINDING EQUIPMENT

Cons. Diamond Saw Blade Corp., Yonkers Ave., Yonkers 2, N. Y.
Felker Mfg. Co., Torrance, Calif.

CRYSTAL HOLDERS

REC Mfg. Co., Holliston, Mass.
Howard Mfg. Co., Council Bluffs, Ia.

CRYSTALS, Quartz

Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bausch & Lomb Optical Co., Rochester, N. Y.
Bliley Elec. Co., Erie, Penna.
Collins Radio Co., Cedar Rapids, Iowa
Crystal Prod. Co., 1519 McGee St., Kansas City, Mo.
Crystal Research Labs., Hartford, Conn.
DX Crystal Co., 1200 N. Claremont, Chicago
Electronic Research Corp., 800 W. Washington Blvd., Chicago
Federal Engineering Co., 37 Murray St., N. Y. C.
General Electric Co. Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Harvey-Wells Communications, Southbridge, Mass.
Henney Motor Co., Omaha, Nebr.
Higgins Industries, Santa Monica, Calif.
Hipower Crystal Co., 2035 W. Charleston, Chicago
Hunt & Sons, G. C., Carlisle, Pa.
Jefferson, Inc., Ray, Westport, L. I., N. Y.
Kaar Engineering Co., Palo Alto, Cal.
Knights Co., The James, Sandwich, Ill.
Meck Industries, John, Plymouth, Ind.
Miller, August E., North Bergen, N. J.
Monitor Piezo Prod. Co., S. Pasadena, Calif.
Peterson Radio, Council Bluffs, Iowa
Precision Piezo Service, Baton Rouge, La.
Premier Crystal Labs., 63 Park Row, N. Y. C.
Quartz Laboratories, 1512 Oak St., Kansas City, Kans.
Radell Corp., Guilford Ave., Indianapolis, Ind.
RCA Mfg. Co., Camden, N. J.
Reeves Sound Labs., 62 W. 47 St., N. Y. C.
Scientific Radio Products Co., Council Bluffs, Ia.
Scientific Radio Service, Hyattsville, Md.
Standard Piezo Co., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
Wallace Mfg. Co., Wm. T., Peru, Ind.
Zeiss, Inc., Carl, 485 Fifth Ave., N. Y. C.

DIAL LIGHTS

See PILOT LIGHTS

DIALS, Instrument

Barker & Williamson, Upper Darby, Pa.
Crowe Name Plate Co., 3701 Ravenswood Ave., Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St. Chicago
Gordon Spec. Co 823 S Wabash Ave Chicago
Mica Insul. Co., 198 Varick St., N. Y. C.
National Co., Inc., Malden, Mass.
Rogan Bros., 2003 S. Michigan Ave., Chicago

DISCS, Recording

Advance Recording Products Co., Long Island City, N. Y.
Allied Recording Products Co., Long Island City, N. Y.
Audio Devices, Inc., 1600 B'way, N. Y. C.
Federal Recorder Co., Elkhart, Ind.
Gould-Moody Co., 395 B'way, N. Y. C.
Pilot Radio Corp., Long Island City, N. Y.
Presto Recording Corp., 242 W. 55 St., N. Y. C.
RCA Mfg. Co., Camden, N. J.
Wilcox-Gay Corp., Charlotte, Mich.

DYNAMOTORS —
See Motor-Generators, Small

ENAMELS, Wood & Metal Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago 22

ETCHING, Metal

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago
Etched Prod. Corp., 39–01 Queens Blvd., Long Island City, N. Y.
Premier Metal Etching Co., 21–03 44th Ave., Long Island City, N. Y.

FACSIMILE EQUIPMENT

Alden Products Co., Inc., Brockton, Mass.
Bunnell & Co., J. H., 215 Fulton, N. Y. C.
Faximile, Inc., 730 5th Ave., N. Y. C.
Federal Tel. & Radio Corp., Newark, N. J.
Finch Telecom., Inc., Passaic, N. J.
Press Wireless, Inc., 1475 B'way, N. Y. C.
R.C.A. Mfg. Co., Camden, N. J.

FASTENERS, Separable

Camloc Fastener Co., 420 Lexington Ave., N. Y. C.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago

FELT

Amer. Felt Co., Inc., Glenville, Conn.
Western Felt Works, 4031 Ogden Ave., Chicago

FIBRE, Vulcanized

Brandywine Fibre Prods. Co., Wilmington, Del.
Continental-Diamond Fibre Co., Newark, Del.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

FILTERS, Electrical Noise

Bendix Aviation Corp., Pacific Div. 11600 Sherman Way, N. Hollywood.
Com. Equip. & Eng. Co., N. Parkside Ave., Chicago
Cornell-Dubilier Elec. Corp. South Plainfield N J
General Electric Co Schenectady N. Y.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Miller Co., J. W., 5917 S. Main St., Los Angeles
Solar Mfg. Corp., 285 Madison Ave., N. Y. C. 17
Tobe Deutschmann Corp., Canton, Mass.

FINISHES, Metal

Alrose Chemical Co., Providence, R. I.
Aluminum Co. of America, Pittsburgh, Pa.
Ault & Wiborg Corp., 75 Varick, N. Y. C.
Hilo Varnish Corp., Brooklyn, N. Y.
Maas & Waldstein Co., Newark, N. J.
New Wrinkle, Inc., Dayton, O.
Sullivan Varnish Co., 410 N. Hart St., Chicago 22

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Secondary

Amer. Time Products, 580 Fifth Ave., N. Y. C.
Garner Co., Fred E., 43 E. Ohio St., Chicago
General Radio Co., Cambridge 39 Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
James Knights Co Sandwich Ill
Millen Mfg. Co., Inc., Malden, Mass.

FUSES, Enclosed

Dante Elec. Mfg. Co., Bantam, Conn.
Jefferson Elec. Co., Bellwood, Ill.
Littlefuse, Inc., El Monte, Calif.

GEARS & PINIONS, Metal

Continental-Diamond Fibre Co., Newark, Del.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago
Gear Specialties, Inc., 2650 W. Medill, Chicago
Perkins Machine & Gear Co., Springfield, Mass.
Quaker City Gear Wks., Inc., N. Front St., Phila.
Thompson Clock Co., Bristol, Conn.

GEARS & PINIONS, Non-Metallic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
Gear Specialties, Inc., 2650 W. Medill, Chicago
General Electric Co., Pittsfield, Mass.
Mica Insul. Co., 196 Varick St., N Y C
National Vulcanized Fibre Co., Wilmington, Del.
Perkins Machine & Gear Co., Springfield, Mass.
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

GENERATORS, Beat Frequency

Boonton Radio Corp Boonton N J
General Radio Co Cambridge Mass

GENERATORS, Electronic AC

Communication Meas. Lab., 118 Greenwich St., N. Y. C.

GENERATORS, Gas Engine Driven

Hunter-Hartman Corp., St. Louis, Mo.
Kato Engineering Co., Mankato, Minn.
Leland Electric Co Dayton O
Onan & Sons, Royalston Ave., Minneapolis, Minn.
Pioneer Gen-E-Motor, 5841 W. Dickens Ave., Chicago, Ill.

GENERATORS, Hand Driven

Burke Electric Co., Erie, Pa.
Carter Motor Co., 1608 Milwaukee, Chicago
Chicago Tel. Supply Co., Elkhart, Ind.

GENERATORS, Standard Signal

Boonton Radio Corp., Boonton, N. J.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

GENERATORS, Wind-Driven, Aircraft

General Armature Corp., Lock Haven, Pa.

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HANDSETS, Telephone

Automatic Electric Co., 1033 W. Van Buren, Chicago
Stromberg-Carlson Co Rochester N Y
Universal Microphone Co., Inglewood Calif.
Western Electric Co., 195 B'way, N. Y. C.

HEADPHONES

Brush Development Co., Cleveland, O.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen, Chicago
Connecticut Tel. & Elec. Co., Meriden, Conn.
Consolidated Radio Prod. Co., W. Erie St., Chicago
Elec. Ind. Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Murdock Mfg. Co., Chelsea, Mass.
Permoflux Corp., W. Grand Ave., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Telex Products Co Minneapolis Minn
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago
Utah Radio Prod. Co., 842 Orleans St., Chicago

HORNS, Outdoor

Altec Lansing Corp., 1680 N. Vine, Hollywood 28
Graybar Elect. Co., Lexington Ave. at 43 St., N. Y. C.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago
Langevin Co 37 W 65 St N Y C 23
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago
Racon Electric Co., 52 E. 19 St., N. Y. C.
RCA Mfg. Co., Camden, N. J.
University Laboratories, 225 Varick St., N. Y. C.

INDUCTION HEATING EQUIPMENT

Induction Heating Corp., 389 Lafayette St., N. Y. C.
Lepel High Frequency Labs., 39 W. 60 St., N. Y. C.

INDUCTORS, Transmitter

Barker & Williamson, Upper Darby, Pa.
Johnson Co. E. F. Waseca Minn

INDUCTORS, Variable Tuning

Barker & Williamson, Upper Darby, Pa.
Standard Winding Co Newburgh N Y

INSTRUMENTS, Radio Laboratory

Ballantine Laboratories, Inc., Boonton, N. J.
Boonton Radio Corp., Boonton, N. J.
Ferris Inst. Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

INSULATORS, Ceramic Stand-off, Lead-in, Rod Types

America Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Clifton, N. J.
Gen. Ceramics & Steatite Corp. Keasbey N J
Isolantite, Inc., Belleville, N. S.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., Inc., Leroy, N. Y.
Locke Insulator Co., Baltimore, Md.
Millen Mfg. Co., Malden, Mass.
Mycalex Corp. of America, Clifton, N. J.
National Co., Inc., Malden, Mass.
Stupakoff Ceramic & Mfg Co Latrobe Pa

INTERFERENCE SUPPRESSORS

See FILTERS, Electrical Noise

IRON CORES, Powdered

Aladdin Radio Industries, Inc., 501 W. 35 St., Chicago
Crowley & Co., Henry, W. Orange, N. J.
Ferrocart Corp. of Amer., Hastings-on-Hudson, N. Y.
Genl. Aniline Wks., 485 Hudson St., N. Y. C.
Gibson Elec. Co., Pittsburgh, Pa.
Magner Mfg. Co., Inc., 444 Madison Ave., N. Y. C.
Mallory & Co., P. R., Indianapolis, Ind.
Pyroferric Co., 175 Varick St., N. Y. C.
Stackpole Carbon Co., St. Marys, Pa.
Western Electric Co., 195 Broadway, N. Y. C.
Wilson Co., H. A., Newark, N. J.

IRONS, Soldering

Acme Electric Heating Co., 1217 Washington St., Boston
Amer. Electrical Heater Co., 6110 Cass Ave., Detroit
Drake Elec. Wks., Inc., 3656 Lincoln Ave., Chicago
Electric Soldering Iron Co., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Elec. Co., Roselle Park, N. J.
Sound Equipment Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Ungar, Inc., Harry A., 615 Ducommun St., Los Angeles 12

Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone

Alden Prods. Co., Brockton, Mass.
Amer. Molded Prods. Co., 1753 N. Honore St., Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
Guardian Elec. Mfg. Co., 1627 W. Walnut St., Chicago
Insuline Corp. of Amer., L. I. C., N. Y.
Johnson, E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Mangold Radio Pts. & Stamping Co., 6300 Shelbourne St., Philadelphia
Molded Insulation Co., Germantown, Pa.
Presto Electric Co., Union City, N. J.
Utah Radio Prod. Co., Orleans St., Chicago

KEYS, Telegraph

Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Bunnell & Co., J. H., 215 Fulton, N Y C
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago
Renier Co., Ltd., 2101 Bryant St., San Francisco
Signal Electric Mfg. Co., Menominee, Mich.
Telegraph App. Co., 325 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Winslow Co., Inc., Liberty St., Newark, N. J.

KNOBS, Radio & Instrument

Alden Prods. Co., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
Chicago Molded Prods. Corp., 1025 N. Kolmar, Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Gordon Spec. Co 823 S Wabash Ave Chicago
Imperial Molded Prods. Corp., 2921 W. Harrison, Chicago
Kurtz Kasch, Inc., Dayton, O.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Millen Mfg. Co., James, Malden, Mass.
Nat'l Co., Inc., Malden, Mass.
Northeastern Molding, Inc., 584 Commonwealth Ave., Boston 15, Mass.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Rogan Bros., 2001 S. Michigan, Chicago

LABELS, Coding

Western Litho. Co., 600 E. 2nd, Los Angeles

LABELS, Removable

Avery Adhesives, 451 3rd St., Los Angeles
Western Litho. Co., 600 E. 2nd, Los Angeles

LABELS, Stick-to-Metal

Ever Ready Label Corp., E. 25th St., N. Y. C.
Tablet & Ticket Co., 1021 W. Adams St., Chicago
Western Litho. Co., 600 E. 2nd, Los Angeles

LABORATORIES, Electronic

Browning Labs., Inc., Winchester, Mass.
Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Hazeltine Electronics Corp., 1775 B'way, N. Y. C.
Sherron Metallic Corp., Flushing Ave., Brooklyn, N. Y.
Worner Electronic Devices 609 W Lake St Chicago 22

LACQUERS, Wood & Metal Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago 22

LOCKWASHERS, Spring Type

Natl. Lock Washer Co., Newark, N. J.

LUGS, Soldering

Cinch Mfg Corp W Van Buren St Chicago
Dante Elec. Mfg. Co., Bantam, Conn.
Ideal Commutator Dresser Co., Sycamore, Ill.
Ilsco Copper Tube & Prods., Inc., Station M, Cincinnati
Krueger & Hudepohl, Third & Vine, Cincinnati, O.
Patton-MacGuyer Co., 17 Virginia Ave., Providence, R. I.
Sherman Mfg. Co., Battle Creek, Mich.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

LUGS, Solderless

Aircraft Marine Prod., Inc., Harrisburg, Pa.
Burndy Eng. Co., 107 Eastern Blvd., N. Y. C.
Thomas & Betts Co., Elizabeth 1, N. J.

MACHINES, Impregnating

Stokes Machine Co., F. J., Phila., Pa.

MACHINES, Screwdriving

Detroit Power Screwdriver Co., Detroit, Mich.
Stanley Tool Div. of the Stanley Works, New Britain, Conn.

MAGNETS, Permanent

Arnold Engineering Co., 147 E. Ontario St., Chicago 11

General Elec. Co., Schenectady, N. Y.
Indiana Steel Prod. Co., 6 N. Michigan Ave., Chicago, Ill.
Thomas & Skinner Steel Prod. Co., Indianapolis, Ind.

MAIL ORDER SUPPLY HOUSES

See listing at head of Directory

MARKERS, Wire Identification

Brand & Co., Wm., 276 4th Ave., N. Y. C.
Irvington Varnish & Ins. Co., Irvington, N. J.
Minn. Mining Co., 155 Sixth Ave., N. Y. C.
Ntl. Varnished Prod. Corp., Woodbridge, N. J.

MARKING MACHINES, Letters, Numbers

Marken Machine Co., Keene, N. H.

METAL, Thermostatic

Baker & Co., 113 Astor, Newark, N. J.
C. S. Brainin Co., 20 VanDam, N. Y. C.
Callite Tungsten Corp., Union City, N. J.
Chace Co., W. M., Detroit, Mich.
Metals & Controls Corp., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut, Newark, N. J.

METERS, Ammeters, Voltmeters, Small Panel

Cambridge Inst. Co., Grand Central Terminal, N. Y. C.
De Jur-Amsco Corp., Shelton, Conn.
General Electric Co., Bridgeport, Conn.
Hickok Elec. Inst. Co., Cleveland, O.
Hoyt Elec. Inst. Works, Boston, Mass.
J-B-T Instruments Inc New Haven Conn
Marion Elect. Inst. Co. Manchester N H
M B Mfg. Co. Inc Dodge Ave East Haven Conn
McClintock Co., O. B., Minneapolis, Minn.
Norton Elect Inst Co Manchester Conn
Readrite Meter Works, Bluffton, O.
Roller-Smith Co., Bethlehem, Pa.
Simpson Elec. Co., 5218 W. Kinzie, Chicago
Triplett Elec. Inst. Co., Bluffton, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Weston Elec. Inst. Corp., Newark, N. J.
Wheelco Inst. Co., 847 W. Harrison St., Chicago

METERS, Frequency

Andrew Co 363 E 75 St Chicago 9
Bendix Radio, Towson, Md.
Browning Labs., Inc., Winchester, Mass.
Daven Co 191 Central Ave Newark N J
General Radio Co., Cambridge, Mass.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
J-B-T Instruments Inc New Haven Conn
Lavoie Laboratories, Morganville, N. J.
Link, F. M., 125 W. 17 St., N. Y. C.
Measurements Corp., Boonton, N. J.
North Amer. Philips Co., Inc., 419 Fourth Ave., N. Y. C.
Radio Corp. of Amer. Camden N J

METERS, Q

Boonton Radio Corp., Boonton, N. J.

METERS, Vacuum Tube Volt

Ballantine Labs. Inc., Boonton, N. J.
Barber Labs. 34-04 Francis Lewis Blvd Flushing N Y
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.
Radio City Products Co., 127 W. 26 St., N. Y. C.

METERS, Vibrating Reed

Biddle, James G., 1211 Arch St., Phila.
J-B-T Instruments, Inc., New Haven 8, Conn.
Triplett Elec. Inst. Co., Bluffton, O.

MICA

Brand & Co., Wm. 276 Fourth Av N Y C
Ford Radio & Mica Corp., 538 63rd St., Bklyn, N. Y.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Macallen Co., Boston, Mass.
Mica Insulator Corp 196 Varick N Y C
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
New England Mica Co., Waltham, Mass.
Richardson Co., Melrose Park, Ill.

MICROPHONES

Amer. Microphone Co., 1015 Western Av., Los Angeles
Amperite Co., 561 B'way, N. Y. C.
Astatic Corp., Youngstown, O.
Brush Development Co., Cleveland, O.
Electro Voice Mfg. Co., South Bend, Ind.
Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago
Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., Chicago
Radio Corp. of Amer., Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Rowe Industries, Inc., Toledo, O.
Shure Bros., 225 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Turner Co., Cedar Rapids, Ia.
Universal Microphone Co., Inglewood, Cal.

MONITORS, Frequency

Doolittle Radio Inc., 7421 S. Loomis Blvd., Chicago, 36
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.

MONITORS, FM

Doolittle Radio Inc 7421 S Loomis Blvd Chicago 36
General Electric Co Schenectady N Y

MOTOR-GENERATORS, Rotary Converters

Alliance Mfg. Co., Alliance, O.
Air-Way Mfg. Co., Toledo, O.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Black & Decker Mfg. Co., Towson, Md.
Bodine Elec. Co., 2262 W. Ohio, Chicago
Carter Motor Co., 1608 Milwaukee, Chicago
Clements Mfg. Co., Chicago, Ill.
Continental Electric Co., Newark, N. J.
Delco Appliance, Rochester, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dormeyer Co., Chicago, Ill.
Eclipse Aviation, Bendix, N. J.
Eicor, Inc. 1060 W Adams, Chicago
Electric Indicator Co., Stamford, Conn.
Electric Motors Corp., Racine, Wis.
Electric Specialty Co., Stamford, Conn.
Electrolux Corp., Old Greenwich, Conn.
Eureka Vacuum Cleaner, Detroit, Mich.
General Armature Corp., Lock Haven, Pa.
General Electric Co., Schenectady, N. Y.
Jannette Mfg. Co., 558 W. Monroe, Chicago
Knapp-Monarch, St. Louis, Mo.
Leland Electric Co., Dayton, O.
Ohio Electric Co., 74 Trinity Pl., N. Y. C.
Pioneer Gen-E-Motor, 5841 W. Dickens Av., Chicago
Redmond Co., A. G., Owosso, Mich.
Russell Co., Chicago, Ill.
Small Motors, Inc., 1308 Elston Ave., Chicago
Webster Co., Chicago, Ill.
Webster Products, 3825 Armitage Ave., Chicago
Westinghouse Elect. Mfg. Co., Lima, O.
Wincharger Corp., Sioux City, Iowa

MOTORS, Very Small Types

Eastern Air Devices, Inc., 585 Dean St., Bklyn. 17, N. Y.
Kollsman Instrument Div., Elmhurst, Long Island, N. Y.
Utah Radio Prod. Co., 842 Orleans St., Chicago

MOUNTINGS, Shock Absorbing

Gen. Tire & Rubber Co Wabash Ind
Lord Mfg. Co., Erie, Pa.
Pierce-Roberts Co., Trenton, N. J.
Robinson Aviation, Inc 730 Fifth Ave N Y C 19
U. S. Rubber Co., 1230–6th Ave., N. Y. C.

MYCALEX

Colonial Kolonite Co., 2212 W. Armitage Ave., Chicago
Electronic Mechanics, Inc Clifton Blvd Clifton N J
General Electric Co., Schenectady, N. Y.
Intl Products Corp Baltimore 18 Md
Mycalex Corp. of Amer., Clifton, N. J.
Precision Fab. Inc Rochester N Y

NAME PLATES, Etched Metal

See ETCHING, Metal

NAME PLATES, Plastic

Crowe Name Plate & Mfg. Co., 3700 Ravenswood Ave., Chicago
Hopp Press, Inc., 460 W. 34 St. N. Y. C.
Parisian Novelty Co., 3502 S. Western Ave., Chicago
Virginia Plate Co., 270 Madison Ave., N. Y. C. 16

NICKEL, Sheet, Rod, Tubes

Eagle Metals Co., Seattle, Wash.
Pacific Metals Co., Ltd., San Francisco, Calif.
Steel Sales Corp 3348 S Pulaski Rd Chicago
Tull Metal & Supply Co Atlanta, Ga
Whitehead Metal Prod. Co., 303 W. 10th St., N. Y. C.
Williams and Co., Inc., Pittsburgh, Pa.

NOISE FILTERS

See FILTERS, Electrical Noise

NUTS, Self-locking

Boots Aircraft Nut Corp., New Canaan, Conn.
Elastic Stop Nut Corp., Union, N. J.
Palnut Co., Inc., Irvington, N. J.
Standard Pressed Steel Co., Jenkintown, Pa.

OSCILLATORS, AF

General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Jackson Electrical Inst. Co., Dayton, O.

OSCILLOSCOPES, Cathode Ray

Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Millen Mfg. Co., Malden, Mass.
Panoramic Radio Corp., 242 W. 55 St., N. Y. C.
RCA Mfg. Co., Inc., Camden, N. J.
Radio City Products Co., Inc., 127 W. 26 St., N. Y. C.
Sherron Electronics Co 1201 Flushing Ave Bklyn 6

World Radio History

OVENS, Industrial & Laboratory

General Elec. Co., Schenectady, N. Y.
Trent Co., Harold E., Philadelphia

PANELS, Metal Etched
(See Etching, Metal)

PANELS, Phenolic, Cast without Molds

Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

PHONOGRAPH RECORDING BLANKS

See DISCS, Recording

PHONOGRAPH RECORD PLAYERS

See TURNTABLES, Phonograph

PILOT LIGHT MOUNTINGS

Alden Prods. Co., Brockton, Mass.
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Dial Light Co. of Amer., 90 West, N. Y. C.
Drake Mfg. Co., 1713 W. Hubbard, Chicago
General Control Co., Cambridge, Mass.
Gothard Mfg. Co., Springfield, Ill.
Herzog Miniature Lamp Works, 12-19 Jackson Av., Long Island City, N.Y.C.
Kirkland Co., H. R., Morristown, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Signal Indicator Corp., 140 Cedar St., N. Y. C.

PHOSPHOR BRONZE

American Brass Co., Waterbury, Conn.
Bunting Brass & Bronze Co., Toledo, O.
Driver-Harris Co., Harrison, N. J.
Phosphor Bronze Smelting Co., Philadelphia
Revere Copper & Brass, 230 Park Av., N. Y. C.
Seymour Mfg. Co., Seymour, Conn.

PLATING, Metal on Molded Parts

Metaplast Corp., 205 W. 19 St., N. Y. C.

PLATINUM

Sigmund Cohn & Co 44 Goldt St N Y C
Wilson Co., H. A., 105 Chestnut St., Newark 5, N. J.

PLUGS (Banana), Spring Type

Amer. Radio H'dw're Co., Mt. Vernon, N. Y.
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Eastman Kodak Co., Rochester, N. Y.
Eby, Inc., Hugh H., Philadelphia, Pa.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Johnson Co., E. F., Waseca, Minn.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ucinite Co., Newtonville, Mass.

PLUGS, Coaxial

Andrew Co 363 E 75 St Chicago 19

PLUGS, Miniature Battery

Intl. Resist. Co 429 N Broad St Phila 8

PLUGS, Telephone Type

Alden Prods. Co., Brockton, Mass.
Amal. Radio Television Corp 476 Bway N Y C 13
American Molded Prods. Co., 1753 N. Honore, Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
Guardian Elec. Mfg. Co., 1400 W. Wash. Blvd., Chicago
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, H. B., 2300 Wabansia, Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Remler Co., Ltd., Bryant St., San Francisco
Trav-Ler Karenola Corp., 1030 W. Van Buren St., Chicago 7
Utah Radio Prod., Orleans St., Chicago

PLYWOOD, Metal Faced

Haskelite Mfg. Corp., 208 W. Washington St., Chicago

POINTS, Contact

See Contact points

PUMPS, Dry Air

Andrew Co., 363 E. 75 St., Chicago, 19

QUARTZ, Rods, Tubes, Plates

Hanovia Chem. & Mfg Co Newark 5 N J

RACKS & PANELS, Metal

See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS

Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
Admiral Corp Chicago Ill
Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Aircraft Radio Corp., Boonton, N. J.
Aircraft Radio Equip. Corp., 6244 Lex. Ave., Hollywood, Calif.
Air Communications, Inc., 2233 Grant Ave., Kansas City, Mo.
Air King Products Co., 1523 63rd Ave., Brooklyn, N. Y.
Airplane & Marine Inst., Inc., Clearfield, Pa.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Amplex Engineering, Inc., New Castle, Ind.
Ansley Radio Corp 2110-49th Av L I City N Y
Arnessen Electric Co., 116 Broad St., N. Y. C.
Automatic Radio Mfg. Co., 122 Brookline Ave., Boston, Mass.
Bassett, Inc., Rex, Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 Dickens Ave., Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Boes Co., The W. W., Dayton, O.
Browning Laboratories, Inc., Winchester, Mass.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Burnett Radio Lab., 4814 Idaho St., San Diego, Calif.
Collins Radio Co Cedar Rapids Ia
Colonial Radio Corp., Rano St., Buffalo, N. Y.
Com Equip Corp 134 W Colorado St Pasadena Calif
Communications Co., Inc., Coral Gables, Fla.
Conn. Tel. & Elec. Co., Meriden, Conn.
Continental Radio & Telev. Corp., 3800 W. Cortland St., Chicago
Cover Dual Signal Systems, Inc., 125 W. Hubbard St., Chicago
Crosley Radio Corp., Cincinnati, O.
Forest Labs. Lee, 5106 Wilshire deBlvd., Los Angeles
Delco Radio, Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., N. Y. C.
Dictaphone Corp., 420 Lexington Ave., N. Y. C.
Doolittle Radio Inc., 7421 S. Loomis Blvd., Chicago, 36
DuMont Labs., Inc., Allen B., Passaic, N. J.
Echophone Radio Co., 201 E. 26 St., Chicago
Eckstein Radio & Telev. Co., Inc., 1400 Harmon Pl., Minneapolis, Minn.
Electrical Ind. Mfg. Co., Red Bank, N. J.
Elect. Research Lab Inc Evanston Ill.
Electronic Communications Co., 36 N. W. B'way, Portland, Ore.
Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Electronic Specialty Co., Glendale, Calif.
Emerson Radio & Phone Corp., 111 8th Ave., N. Y. C.
Erco Radio Labs. Inc Hempstead N Y
Espey Mfg Co Inc 33 W 46 St N Y C
Fada Radio & Elec. Corp. 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Tele. & Radio Corp., Ft. Wayne 1, Ind.
Federal Electronics Div., 209 Steuben St., B'klyn, N. Y.
Federal Tel. & Radio Corp., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Lab., Palo Alto, Calif.
Foote Pierson & Co Inc 75 Hudson St Newark 5 N J
Freed Radio Corp., 200 Hudson St., N. Y. C.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago
Garod Radio Corp., 70 Washington St., B'klyn, N. Y.
Gates Radio & Supply Co., Quincy, Ill.
General Communication Co., 681 Beacon St., Boston, Mass.
General Electric Co., Schenectady, N. Y.
General Telev. & Radio Corp., 1240 N. Homan Ave., Chicago
Gibbs & Co., Thomas B., Delavan, Wis.
Gilfillen Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Girdler Corp., Louisville, Ky.
Gray Mfg. Co., Hartford, Conn.
Gray Radio Co., West Palm Beach, Fla.
Grenby Mfg. Co., Plainville, Conn.
Guided Radio Corp., 161 6th Ave., N. Y. C.
Hallicrafters Co., 2611 Indiana Ave., Chicago
Halstead Traffic Com. Corp., 155 E. 44 St., N. Y. C.
Hamilton Radio Corp., 510 Sixth Ave., N. Y. C.
Hammarlund Mfg. Co., 460 W. 34th St., N. Y. C.
Harrel, D. H., 1527 E. 74 Pl., Chicago
Harvey Machine Co., Inc., 6200 Avalon Blvd., Los Angeles
Harvey Radio Labs, Inc., Cambridge, Mass.
Harvey-Wells Com., Inc., Southbridge, Mass.
Hazeltine Electronics Corp., Great Neck, N. Y.
Herbach & Rademan Co., 522 Market St., Phila.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hoffman Radio Corp 3330 S Hill St Los Angeles
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
Howard Radio Co., 1731 Belmont Ave. Chicago
Howard Pacific Corp 923 N Western Av Los Angeles
Hudson Amer Corp 25 W 43 St N Y C

Intl Detrola Corp Beard & Chatfield Sts Detroit 9
Jefferson, Inc., Ray, Freeport, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 E 23 St., N. Y. C.
Karadio Corp., 1400 Harmon Pl., Minneapolis, Minn.
Kemlite Labs., 1809 N. Ashland Ave., Chicago
Lear Avia, Inc., Piqua, O.
Lewyt Corp., 60 B'way, B'klyn, N. Y.
Link, F. M., 125 W. 17 St., N. Y. C.
Machlett Labs., Inc., Springdale, Conn.
Magnavox Co., Indianapolis, Ind.
Majestic Radio & Tel. Corp., 2600 W. 50 St., Chicago
McElroy Mfg. Corp., Brookline Ave., Boston
Megard Corp., 381 W. 38 St., Los Angeles, Calif.
Meissner Mfg Co Mt Carmel Ill
Midwest Radio Corp., Cincinnati, O.
Millen Mfg. Co., Inc., Malden, Mass.
National Co., Inc., Malden, Mass.
Noblitt-Sparks Ind. Inc., Columbus, Ind.
North Amer. Philips Co., 100 E. 42 St., N. Y. C.
Operadio Mfg. Co., St. Charles, Ill.
Packard Bell Co 1115 S Oak St Los Angeles
Panoramic Radio Corp., 245 W. 55 St., N. Y. C. 19
Philco Corp., Tioga & C Sts., Phila.
Philharmonic Radio Corp., 216 Williams St., N. Y. C.
Pierson-DeLane, Inc., 2345 W. Washington Blvd., Los Angeles
Pilot Radio Corp., L. I. City, N. Y.
Powers Electronic & Communication Co., Glen Cove, N. Y.
Precision Tube Co., 3828 Terrace St., Phila. 28
Press Wireless, Inc 1475 B'way N Y C
Radiation Products, Inc., 1142 S. Wall, Los Angeles 15
Radio Corp. of Amer., Camden, N. J.
Radio Craftsmen, 1340 S. Mich. Ave., Chicago
RadioEngineering Labs L I City N Y
Radio Frequency Labs., Inc., Boonton, N. J.
Radio Mfg. Engineers, Inc., Peoria, Ill.
Radiomarine Corp. of Amer., 75 Varick St., N. Y. C.
Radio Receptor Co., Inc., 251 W. 17 St., N. Y. C.
Radio Transceiver Labs., 86–27 115th St., Richmond Hill, L. I.
Remler Co Ltd 2101 Bryant St San Francisco
Richardson-Allen Corp., 15 W. 20 St., N. Y. C.
Rosen Co., Raymond, 32 & Walnut Sts., Phila.
Rauland Corp., Chicago, Ill.
Sanborn Co., Cambridge 39, Mass.
Schuttig & Co., 9th & Kearny Sts., Washington, D. C.
Scott Radio Labs, Inc., 4450 Ravenswood Ave., Chicago
Seeburg Corp., J. P., 1500 N. Dayton St., Chicago
Sentinel Radio Corp., Evanston, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Calif.
Sonora Radio & Telev. Corp., 325 N. Hoyne Ave., Chicago
Sparks-Withington Co., Jackson, Mich.
Sperry Gyroscope Co Garden City N Y
Sperti, Inc., Cincinnati, O.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago
Stromberg-Carlson Co., Rochester, N. Y.
Tech. Radio Co 275 9th St San Francisco 3
Templetone Radio Co., Mystic, Conn.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
Trav-Ler Karenola Corp 1030 W Van Buren St Chicago
United Cinephone Corp Torrington Conn
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Waugh Laboratories, 420 Lexington Ave., N. Y. C.
Western Electric Co 195 B'way N Y C
Westinghouse Elec. & Mfg. Co., Wilkens Ave., Baltimore, Md.
Wilcox Electric Co., 14th & Chestnut Sts., Kansas City, Mo.
Wilcox-Gay Corp Charlotte Mich
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECORD CHANGERS
See TURNTABLES, Record

RECORDS, Blank
See DISCS, Recording

RECTIFIERS, Metallic Current
Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.
Federal Tel. & Radio Corp Newark 1 N J
General Electric Co., Bridgeport, Conn.
Green Elect. Co., Inc., 130 Cedar St., N. Y. C.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles
United Cinephone Corp., Torrington, Conn.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

RECTIFIERS, Metallic Instrument & Relay
Bradley Labs. Inc New Haven 10 Conn
Conant Elect. Labs. Lincoln Nebr
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

REGULATORS, Temperature
Allen-Bradley Co., Milwaukee, Wis.
Dunn, Inc., Struthers, 1321 Cherry, Philadelphia
Fenwal Inc., Ashland, Mass.
General Electric Co., Schenectady, N. Y.
Mercoid Corp., 4217 Belmont, Chicago
Minneapolis-Honeywell Regulator, Minneapolis, Minn.
Spencer Thermostat Co., Attleboro, Mass.

REGULATORS, Voltage
Acme Elec. & Mfg. Co., Cuba, N. Y.
Adams & Westlake Co., Elkhart, Ind.
Amperite Co., 561 Broadway, N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
General Elec. Co., Schenectady, N. Y.
H-B Electric Co., 6122 N. 21 St., Phila.
Sola Electric Co., 2525 Clybourn Av., Chicago
United Transformer Corp., 150 Varick St., N. Y. C.

RELAYS, Hermetically Sealed
Allied Control Co Inc 2 E End Ave N Y C
Betts & Betts Corp 551 W 52 St N Y C 19
Clare & Co. C. P. 4719 Sunnyside Ave Chicago 30
Sigma Instruments Inc 70 Ceylon St Boston 21

RELAYS, Plug-in
Clare & Co. C. P. 4719 Sunnyside Ave Chicago 30
Leach Relay Co 5915 Avalon Blvd Los Angeles
Sigma Instruments Inc 70 Ceylon St Boston 21

RELAYS, Small Switching
Advance Elec. Co., 1260 W. 2nd, Los Angeles
Allied Control Co Inc 2 W End Ave N Y C
Amperite Co., 561 Broadway, N. Y. C.
Automatic Elec. Co., 1033 W. Van Buren, Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Birtcher Corp., 5087 Huntington Dr., Los Angeles 32
Cook Elec. Co., 2700 Southport Ave., Chicago
Electrical Prod. Supply Co., 1140 Venice Blvd., Los Angeles 15
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St., Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward-Leonard Elec. Co Mt Vernon N Y

RELAYS, Small Telephone Type
Advance Elec. Co., 1260 W. 2nd, Los Angeles
Allied Control Co 2 E End Ave N Y C
Automatic Elect. Co., 1033 W. Van Buren, Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
Cook Elec. Co., 2700 Southport Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Stepping
Automatic Elect. Co., 1032 W. Van Buren St., Chicago
Autocall Co., Shelby, O.
Guardian Elect. Mfg. Co., 1620 W. Walnut St., Chicago
Presto Elect. Co., N. Y. Ave., Union City, N. J.
Struthers Dunn, Inc., Arch St., Phila.

RELAYS, Time Delay
Advance Elec. Co., 1260 W. 2nd, Los Angeles
Amperite Co., 561 Broadway, N. Y. C.
Automatic Elec. Co., 1033 W. Van Buren, Chicago
Haydon Mfg. Co., Inc., Forestville, Conn.
H-B Electric Co., 6122 N. 21 St., Phila.
Industrial Timer Corp., Newark, N. J.
Sangamo Elec. Co., Springfield, Ill.
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAYS, Transmitter Switching and Keying
Gordon Spec. Co 823 S Wabash Ave Chicago
Johnson Co., E. F. Waseca Minn
Leach Relay Co., 5915 Avalon Blvd., Los Angeles

RELAYS, Vacuum
Ind & Com Electronics Belmont Calif
Struthers Dunn Inc 1326 Cherry St Phila

RELAY TESTERS, Vibration
Kurman Electric Co., Inc., 3030 Northern Blvd., L. I. City, N. Y.

RESISTORS, Fixed
Acme Elec. Heating Co., Boston, Mass.
Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
Carborundum Co., Niagara Falls, N. Y.
Centralab, Milwaukee, Wisconsin
Clarostat Mfg. Co., 130 Clinton St., Bklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Elec Resistors Co 114 W 18 St N Y C
Erie Resistor Corp., Erie, Pa.
Globar Div. Carborundum Co., Niagara Falls, N. Y.
Groves Corp Cape Girardeau Mo
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila
Jeffers Electronics Du Bois Pa
Lectrohm, Inc., Cicero, Ill.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy, Chicago
Sensitive Research Inst., Corp., 4545 Bronx Blvd., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prod. Co., 842 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision
General Radio Co Cambridge Mass
Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Presto Electric Co., Union City, N. J.
Shallcross Mfg. Co., Collingdale, Pa.

RESISTORS, Flexible
Clarostat Mfg. Co., Inc., Brooklyn, N. Y.

RESISTORS, Variable Laboratory Type
Biddle Co., J. G., 1211 Arch St., Phila.
General Radio Co Cambridge Mass
Sticht Co., Inc., H. H., 27 Park Pl., N. Y. C.

RESISTORS, Variable
Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Inst. Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila.
Centralab, Milwaukee, Wis.
Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., 130 Clinton, Bklyn, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wis.
DeJur Amsco Corp., Shelton, Conn.
Electro Motive Mfg. Co., Willimantic, Conn.
General Radio Co., Cambridge, Mass.
G-M Labs., Inc., Chicago, Ill.
Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila
Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Shallcross Mfg. Co., Collingdale, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prods. Co., 820 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
Wirt Co., Germantown, Pa.

RESISTORS, Variable, Ceramic Base
Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Presto Electric Co., Union City, N. J.

SCREW MACHINE PARTS, Brass, Steel
Chicago Aviation Co., 1200 N. Claremont, Chicago
Ward Products Corp., E. 45 St., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic
Continental-Diamond Fibre Co., Newark, Del.

SELENIUM
Federal Tel. & Radio Corp., S. Newark, N. J.
Benwood Linze Co., St. Louis, Mo.
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

SHAFTING, Flexible
Breeze Corps., Inc., Newark, N. J.
Mall Tool Co., 7708 S. Chicago Ave., Chicago
Steward Mfg. Corp., 4311 Ravenswood Ave., Chicago
Walker-Turner Co., Inc., Plainfield, N. J.
White Dental Mfg. Co., 10 E. 48 St., N. Y. C.

SHEETS, Electrical
Amer Rolling Mill Co Middletown Conn
Carnegie-Illinois Steel Corp Pittsburgh Pa
Follansbee Steel Corp Pittsburgh Pa
Granite City Steel Co Granite City Ill
Newport Rolling Mill Co. Newport, Ky.
Republic Steel Corp Cleveland O
Ryerson & Son Inc Jos T Chicago
Westinghouse Elect & Mfg Co E Pittsburgh Pa

SHIELDS, Tube
Eby Inc H H 18 W Chelton Av Phila 44
Goat Metal Stampings Inc 314 Dean St Brooklyn N Y
Cinch Mfg Corp 2335 W Van Buren St Chicago 12
Hammarlund Mfg Co Inc 460 W 34 St N Y C

SHOCK ABSORBERS
See MOUNTINGS Shock Absorbing

SIGNAL GENERATORS
See GENERATORS Standard Signal

SOCKETS, Cathode Ray Tube
Franklin Mfg Corp 175 Varick St N Y C

SOCKETS, Tube
Aladdin Radio Industries 501 W 35th St Chicago
Alden Prods Co Brockton Mass
Amer Phenolic Corp 1830 S 54th Av Chicago
Amer Radio Hdware Co Mt Vernon N Y
Birnbach Radio Co 145 Hudson N Y C
Bud Radio Inc Cleveland O
Cinch Mfg Co 2335 W Van Buren St Chicago
Cont'l-Diamond Fibre Co Newark Del
Eagle Elec Mfg Co Brooklyn N Y
Eby Inc H H Philadelphia
Federal Screw Prods Co 26 S Jefferson Chicago
Franklin Mfg Corp 175 Varick N Y C
Hammarlund Mfg Co 424 W 33 St N Y C
Johnson Co E F Waseca Minn
Jones Howard B 2300 Wabansia Chicago
Micarta Fabricators Inc 4619 Ravenswood Chicago
Millen Mfg Co James Malden Mass
Miller Co J W Los Angeles Cal
Nat'l Co Malden Mass
Remler Co San Francisco Cal

SOCKETS, Tube, Ceramic Base
Hammarlund Mfg Co Inc 460 W 34 St N Y C
Johnson Co E F Waseca Minn
National Co Inc Malden Mass
Nat'l Fabricated Products W Belden Ave Chicago
Ucinite Co Newtonville Mass

SOLDER, Self-fluxing
Garden City Laboratory 2744 W 37th Pl Chicago
Gardiner Metal Co S Campbell Ave Chicago
General Elec Co Bridgeport Conn
Kester Solder Co 4209 Wrightwood Ave Chicago
Ruby Chemical Co Columbus O

SOLDER POTS
Elec Soldering Iron Co Inc Deep River Conn
Lectrohm Inc Cicero Ill
Sound Equip Corp of Calif 6245 Lex Ave Los Angeles 38
Westinghouse Elect & Mfg Co E Pittsburgh Pa

SPEAKERS, Cabinet Mounting
Altec Lansing Corp 1680 N Vine Hollywood 28
Best Mfg. Co Inc Grove St Irvington 11 N J
Cinaudagraph Speakers Inc 3911 S Michigan Ave Chicago
Crescent Industries Inc Belmont Ave Chicago
General Instrument Corp Elizabeth 3 N J
Jensen Radio Mfg Co 6601 S Laramie St Chicago
John Meck Industries Plymouth Ind
Langevin Co 37 W 65 St N Y C 23
Magnavox Co Fort Wayne Ind
Operadio Mfg Co St Charles Ill
Quam-Nichols Co 33rd Pl Chicago 16
Rola Co Inc Superior St Cleveland O
Utah Radio Prod Co 842 Orleans St Chicago

SPEAKERS, Outdoor Type
Altec Lansing Corp 1680 N Vine Hollywood 28
Cinaudagraph Speakers Inc 3911 S Michigan Ave Chicago
Jensen Radio Mfg Co 6601 S Laramie St Chicago
Langevin Co 37 W 65 St N Y C 23
University Labs 225 Varick St N Y C

SPRINGS
Accurate Spring Mfg Co 3817 W Lake Chicago
Ace Mfg Corp 1255 E Erie Ave Phila 24
American Spring & Mfg Corp Holly Mich
American Steel & Wire Co Rockefeller Bldg Cleveland O
Barnes Co Wallace Bristol Conn
Crescent Industries Inc 4132 W Belmont Ave Chicago
Cuyahoga Spring Co Cleveland O
Gibson Co Wm D 1800 Clybourn Av Chicago
Hubbard Spring Co M D Pontiac Mich
Hunter Pressed Steel Co Lansdale Pa
Instrument Specialties Co Little Falls N Y
Muehlhausen Spring Corp Logansport Ind
Peck Spring Co Plainville Conn
Raymond Mfg Co Corry Pa
Security Steel Equip Corp Avenel N J
Standard Spring & Mfg Co Inc 236–42 St Brooklyn N Y
Willor Mfg Corp 794 E 104 St N Y C 54

STAMPINGS, Metal
Bud Radio Inc E 55 St Cleveland O
Goat Metal Stampings Inc 314 Dean St Brooklyn N Y
Hadley Co R M 707 E 61st Los Angeles
Insuline Corp of Amer Long Island City N Y
Par-Metal Prod Corp Long Island City N Y
Stewart Stamping Corp 621 E 216 St N Y C

World Radio History

Willor Mfg Corp 288-A Eastern Blvd N Y C

STEATITE, See Ceramics

SUPPRESSORS, Parasitic

Ohmite Mfg Co 4835 Flournoy St Chicago

SWITCHES, Aircraft Push

Square D Co Kollsman Inst Div Elmhurst N Y

SWITCHES, Key

Audio Development Co Minneapolis Minn
Chicago Tel Supply Co Elkhart Ind
Federal Tel. & Radio Corp Newark 1 N J
General Control Co Cambridge Mass
Mossman Inc Donald P 6133 N Northwest Hy Chicago
Presto Electric Co Union City N J
Western Electric Co 195 B'way N Y C

SWITCHES, Midget Snap

Allied Control Co Inc E End Ave N Y C
Aero Electric Co 3167 Fulton Rd Cleveland
General Electric Co Schenectady N Y
Micro Switch Corp Freeport Ill
Spencer Thermostat Co Attleboro Mass
Ucinite Co Newtonville 60 Mass.

SWITCHES, Rotary, Bakelite Wafer

Mallory & Co Inc P R Indianapolis Ind
Stackpole Carbon Co St Marys Pa

SWITCHES, Rotary, Ceramic Wafer

Centralab Milwaukee Wis
Comm Prods Co 744 Broad Newark N J
Oak Mfg Co 1267 Clybourn Ave Chicago
Ohmite Mfg Co 4835 Flournoy St Chicago
Shallcross Mfg Co Collingsdale Pa

SWITCHES, Time Delay

Haydon Mfg Co Inc Forestville Ct
Industrial Timer Corp 115 Edison Pl Newark N J
Sangamo Elect Co Springfield Ill

SYNTHETICS, Wood & Metal Finish

Sullivan Varnish Co 410 N Hart St Chicago 22

TERMINALS, Hermetically Sealed

See BUSHINGS Terminal Sealing

TERMINALS, Soldered or Solderless

See LUGS Soldering and Solderless

TERMINALS (Turret Lugs)

Cambridge Thermionic Corp 443 Concord Ave Cambridge 38 Mass
Manufacturers Screw Prod 216 W Hubbard St Chicago 10
Ucinite Co Newtonville Mass

TERMINAL STRIPS

Burke Electric Co Erie Pa
Cinch Mfg Corp W Van Buren St Chicago
Cook Electric Co 2700 Southport Ave Chicago 14
Curtis Devel & Mfg Co N Crawford Ave Chicago
Franklin Mfg Corp 175 Varick St N Y C
Jones H B 2432 W George Chicago
Kulka Electric Mfg Co Mt Vernon N Y

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

American Coils Co 25 Lexington St Newark N J
Industrial Filter & Pump Mfg. Co., W. Carroll Ave., Chicago
Kold-Hold Mfg. Co., 446 N. Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630–5th Ave., N. Y. C.
Northern Engineering Labs., 50 Church St., N. Y. C.
Tenney Engineering Inc Montclair N J

THERMISTERS

Western Electric Co 195 Bway N Y C

TRACING PAPERS, CLOTH, CELLOPHANE

Arkwright Finishing Co., Providence, R. I.
Brown & Bro., Arthur, 67 W. 44 St., N. Y. C.
Keuffel & Esser, Hoboken, N. J.

TRANSFORMERS, Constant-Voltage

Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
General Electric Co., Schenectady, N. Y.
Raytheon Mfg. Co., Waltham, Mass.
Sola Electric Co., 2525 Clybourn Ave., Chicago

TRANSFORMERS, IF, RF

Albion Coil Co Albion Ill
Aladdin Radio Industries, 501 W. 35th St., Chicago
Amer. Transformer Co., Newark, N. J.
Auto. Windings Co Inc 900 Passaic Ave E Newark N J
Browning Labs., Inc., Winchester, Mass.
Cambridge Thermionic Corp., Concord Ave., Cambridge, Mass.
Caron Mfg. Co., 415 S. Aberdeen, Chicago
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Essex Electronics 1060 Broad St Newark N J
Gen'l Winding Co 420 W 45 St N Y C
Greyhound Equip. Co., 1720 Church Ave., Brooklyn, N. Y.
Guthman & Co., 15 S. Throop, Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., 5917 S. Main, Los Angeles, Cal.
Nat'l Co., Malden, Mass.
Radex Corp., 1308 Elston Ave., Chicago
Sickles Co., F. W., Chicopee, Mass.
Sound Equip. Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Standard Winding Corp Newburgh N Y
Super Elec. Prod. Corp., Jersey City, N. J.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co 4017 W Lake Chicago

TRANSFORMERS, Receiver Audio & Power

Acme Elec. & Mfg. Co., Cuba, N. Y.
Altec Lansing Corp., 1680 N. Vine, Hollywood 29
Amer. Transformer Co., Newark, N. J.
Amplifier Co. of Amer., 17 W. 20th St., N. Y. C.
Audio Devel. Co., N. Minneapolis, Minn.
Chicago Transformer Corp., 3501 Addison St., Chicago
Cinaudagraph Speakers, Inc., 3911 S. Michigan, Chicago
Cons. Radio Prod. Co 350 W Erie St Chicago 10
Dinion Coil Co., Caledonia, N. Y.
Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
Electronic Trans. Co., 515 W. 29 St., N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
Foster Co., A. P. Lockland O
Freed Trans. Co., 72 Spring St., N. Y. C.
Gen'l Radio Co., Cambridge, Mass.
General Trans. Corp., 1250 W. Van Buren, Chicago
Hadley Co., R. M., 707 E. 61st, Los Angeles
Halldorson Co., 4500 Ravenswood, Chicago
Hercules Elec. & Mfg Co 2416 Atlantic Ave Bklyn 33
Howard Pacific Corp 932 N Western Av Los Angeles
Jefferson Elec Co Bellwood Ill
Kenyon Trans Co 840 Barry St N Y C
Kyle Corp South Milwaukee Wis
Langevin Co 37 W 65 St N Y C 23
Magnetic Windings Co Easton Pa
Merit Coil & Trans Corp 4427 N Clark Chicago 40
Newark Transformer Co., Newark, N. J.
N Y Transformer Co 22 Waverly Pl N Y C 3
Norwalk Transformer Corp S Norwalk Conn
Peerless Elec Prod Co 6920 McKinley Av Los Angeles
Permoflux Corp 4900 W Grand Ave Chicago 39
Raytheon Mfg Co Waltham Mass
Rola Co Inc Superior St Cleveland O
Standard Transformer Corp 1500 N Halsted Chicago
Super Elect Prod Co Jersey City N J
Superior Elec Co Bristol Conn
Thermador Elect & Mfg Co Riverside Dr Los Angeles
Thordarson Elec Mfg Co 500 W Huron Chicago
Utah Radio Prods Co 820 Orleans St Chicago
United Trans Co 150 Varick St N Y C
Westinghouse Elect & Mfg Co E Pittsburgh Pa

TRANSFORMERS, Variable Voltage

Amer Transformer Co Newark N J
General Radio Co Cambridge Mass
Superior Electric Co Bristol Conn

TRANSMITTERS, FM

Communications Co Inc Coral Gables Fla
Doolittle Radio, Inc 7421 Loomis Blvd Chicago 36
Federal Tel. & Radio Corp Newark 1 N J
Galvin Mfg. Corp Chicago 51
General Electric Co Schenectady 5 N Y
Harvey-Wells Southbridge Mass
Kaar Engineering Co Palo Alto Calif
Link, F. M. 125 W 17 St N Y C 11
RCA Victor Camden N J
Radio Engineering Labs. Inc Long Island City N Y
Western Electric Co 195 Bway N Y C
Westinghouse Electric Corp Pittsburgh 30 Pa

TRANSMITTERS, Television

Du Mont Labs. Inc. Allen B., 2 Main Ave Passaic N J
General Electric Co Schenectady N Y
RCA Victor Camden N J

TUBE MANUFACTURING MACHINES

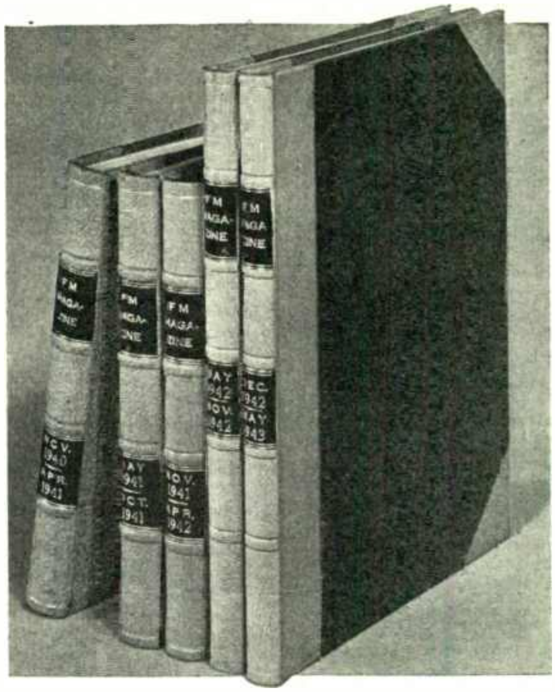
Hilton Eng Labs Redwood City Calif
Eisler Eng Co 7518 13th St Newark N J

TUBES, Cathode Ray

Dumont Labs Allen B Passaic N J
Electronic Tube Corp 1200 E Mermaid Phila 18
Farnsworth Tele & Radio Corp Ft Wayne Ind
General Elec Co Schenectady N Y
Nat'l Union Radio Corp Newark N J
North Amer Philips Co Inc Dobbs Ferry N Y
Rauland Corp Chicago Ill
RCA Mfg Co Camden N J
Sylvania Elect Prod Inc Emporium Pa
Westinghouse Elect & Mfg Co E Pittsburgh Pa

TUBES, Current Regulating

Amperite Co 561 Broadway N Y C
Champion Radio Works Danvers Mass
Hytron Corp & Hytronic Labs Salem Mass
RCA Mfg Co Camden N J
Sylvania Elec Prod Inc Emporium Pa
Western Elec Co 195 B'dway N Y C



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De Jur-Amsco Corp-Shelton Conn
De Vry Herman A 1111 W Center Chicago
Electronic Laboratory Los Angeles Cal
Emby Prods Co Los Angeles Cal
General Elec Co Schenectady N Y
General Scientific Corp 4829 S Kedzie Av Chicago
G-M Labs 4313 N Knox Av Chicago
Leeds & Northrop Co Philadelphia
Nat'l Union Radio Corp Newark N J
Photobell Corp 123 Liberty St N Y C
RCA Mfg Co Camden N J
Rectron Corp 2159 Magnolia Av Chicago
Westinghouse Lamp Div Bloomfield N J
Western Elec Co 195 B'way N Y C
Weston Elec Inst Corp Newark N J

TUBES, Receiving

General Elec Co Schenectady N Y
Hytron Corp Salem Mass
Nat'l Union Radio Corp Newark N J
Raytheon Prod Corp 420 Lexington Av N Y C
RCA Mfg Co Camden N J
Sylvania Elect Prod Inc Emporium Pa
Tung-Sol Lamp Works Newark N J
Western Electric Co 195 B'way N Y C

TUBES, Transmitting

Amperex Electronic Corp 25 Washington St Bklyn 1
Eitel-McCullough Inc San Bruno Cal
Electronic Enterprises Inc 65-67 Av Newark N J
Federal Telephone & Radio Corp Newark N J
General Elec Co Schenectady N Y
Gen'l Electronics Inc 101 Hazel St Paterson N J
Heintz & Kaufman S San Francisco Cal
Hytron Corp Salem Mass
Machlett Labs Inc Norwalk Conn
Nat'l Union Radio Corp Newark N J
North Amer Philips Co Inc Dobbs Ferry N Y
Raytheon Prod Corp 420 Lexington Av N Y C
RCA Mfg Co Camden N J
Slater Electric & Mfg Co Brooklyn N Y
Sperry Gyroscope Co Inc Brooklyn N Y
Sylvania Elect Prod Inc Emporium Pa
Taylor Tubes Inc 2341 Wabansia Chicago
United Electronics Co Newark N J
Western Elec. Co., 195 B'way, N. Y. C.
Westinghouse Lamp Div., Bloomfield, N. J.

TUBES, Voltage-Regulating

Amperite Co., 561 Broadway, N. Y. C
Hytron Corp., Salem, Mass.
RCA Mfg. Co., Camden, N. J.
Sylvania Elec. Prod., Inc., Salem, Mass.

TUBES, X-Ray

Genl. Elec. X-Ray Corp 2012 Jackson Blvd Chicago
Machlett Labs. Inc South Norwalk Conn
North Amer. Philips Co Inc 100 E 42 St N Y C
Picker X-Ray Corp 300 4th Ave N Y C
Westinghouse Elec & Mfg Co E Pittsburgh

TUBING, Laminated Phenolic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
General Electric Co., Pittsfield, Mass.
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del.
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

TUBING, Precision Metal

Superior Tube Co., Norristown, Pa.

TUBING & SLEEVING, Varnished Cambric, Glass-Fibre, Spaghetti

Bentley-Harris Mfg. Co., Conshohocken, Pa.
Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Electro Tech. Prod., Inc., Nutley, N. J.
Endurette Corp. of Amer., Cliffwood, N. J.
Insulation Mfgrs. Corp., 565 W .Washington Blvd., Chicago
Irvington Var. & Ins. Co., Irvington, N. J.
Mica Insul. Co., 196 Varick St., N. Y. C.
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
Surprenant Elect. Ins. Co 84 Purchase St Boston 10 Mass
Varflex Corp., Rome, N. Y.

TURNTABLES, Record

Fairchild Camera & Inst. Co., 475 Tenth Av N. Y. C.
General Industries Co., Elyria, O.
General Inst. Corp., Elizabeth 3, N. J.
Presto Recording Corp., 242 W. 45 St., N. Y. C.
R C A Mfg. Co., Camden, N. J.
Russell Electric Co 362 W Huron St Chicago 10
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago
Webster Products, 3825 Armitage Ave., Chicago
Western Electric Co., 125 B'way, N. Y. C.
Wilcox-Gay Corp Charlotte Mich

VARNISHES, Fungus Resistant

Comm. Prod. Co Inc 744 Broad St Newark
Insl X Co Inc 857 Meeker Ave Bklyn
Mass & Waldstein Co Newark N J

VARNISHES, Insulating, Air-Drying & Baking

Comm Prods Co 744 Broad Newark N J
Dolph Co., John C., Newark, N. J.
Irvington Var. & Ins. Co., Irvington, N. J.
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
Stille-Young Corp., 2300 N. Ashland Av., Chicago
Zophar Mills, Inc., 112-26 St., Bklyn. N. Y.

VARNISHES, Wrinkle Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago

VIBRATION TEST EQUIPMENT

All American Tool & Mfg. Co., 1014 Fullerton Ave., Chicago
Vibration Specialty Co., 1536 Winter St., Philadelphia

VIBRATORS, Power Supply

Amer. Telev. & Radio Co., St. Paul, Minn.
Electronic Labs., Indianapolis, Ind.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Radiart Corp., W. 62 St., Cleveland, O.
Turner Co., Cedar Rapids, Ia.
Utah Radio Prod. Co., Orleans St., Chicago

WAXES & COMPOUNDS, Insulating

Irvington Varnish & Ins. Co., Irvington, N. J.
Western Elec. Co., 195 B'dway, N. Y. C.
Zophar Mills, Inc., 112-26 St., Bklyn

WELDING, Gas, Aluminum & Steel

Treitel-Gratz Co., 142 E. 32 St., N. Y. C.

WIRE, Bare

Amer. Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 B'dway N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Copperweld Steel Co., Glassport, Pa.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
General Elec. Co., Bridgeport, Conn.
Phosphor Bronze Smelting Co., Phila.
Rea Magnet Wire Co., Fort Wayne, Ind.
Roebling's Sons Co., John, Trenton, N. J.
Velliff Mfg. Corp., Southport, Conn.

WIRE, Glass Insulated

Bentley, Harris Mfg. Co., Conshohocken Pa.
Gavitt Mfg. Corp., Brookfield, Mass.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6
Owens-Corning Fiberglas Corp., Toledo, O.

WIRE, HOOKUP

Bentley, Harris Mfg. Co., Conshohocken Pa.
Gavitt Mfg. Co., Brookfield, Mass.
Lenz Elec. Mfg. Co., 1751 N. W. Av., Chicago
Rockbestos Prod. Corp., New Haven, Conn.
Runzel Cord & Wire Co., 4723 Montrose Ave., Chicago
Surprenant Elect. Ins. Co 84 Purchase St Boston 10, Mass
Whitney Blake Co., New Haven, Conn.

WIRE & CABLE

Acme Wire Co., New Haven, Conn.
Amer. Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 B'dway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Bentley, Harris Mfg. Co Conshohocken Pa
Collyer Ins. Wire Co., Pawtucket, R. I.
Consolidated Wire Co., 1634 Clinton St., Chicago
Crescent Ins. Wire & Cable Co., Trenton N. J.
Elec. Auto-Lite Co., The, Port Huron, Mich.
Essex Wire Corp Ft Wayne 6 Ind
General Cable Corp., Rome, N. Y.
General Elec. Co., Bridgeport, Conn.
Hazard Ins. Wire Works, Wilkes-Barre, Pa.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Hudson Wire Co., Winsted, Conn.
Rea Magnet Wire Co., Fort Wayne, Ind.
Rockbestos Prods. Corp., New Haven, Conn.
Roebling's Sons Co., John, Trenton, N. J.
Runzel Cord & Wire Co., 4723 Montrose Ave., Chicago
Simplex Wire & Cable Co., Cambridge, Mass.
Surprenant Elect. Ins. Co 84 Purchase St Boston 10 Mass
Western Ins. Wire, Inc., 1000 E. 62 St., Los Angeles
Wheeler Insulated Wire Co., Bridgeport, Conn.

WIRE, Silver Jacketed on Steel Copper, Invar

Wilson Co H A 105 Chestnut St Newark 5 N J

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Formica Insulation Co., Cincinnati, O.

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0-400 ohms (60 ohms center scale)
0-50,000 ohms (300 ohms center scale)

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—30 to +3, +15, +29, +43, +55, +69 DB

TEMPERATURE COMPENSATED CIRCUIT FOR ALL CURRENT RANGES D.C. MICRO-AMPERES

0-50 Microamperes, at 250 M.V.

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AN IT&T ASSOCIATE

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THERE are times in the lives of all good engineers when a crystal ball would come in mighty handy. We know because we've had many a problem where it looked like aid from the occult was the only solution. Instead, we found that sound engineering plus the outstanding physical properties of Corning's electrical glasses usually supplied the answers.

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YOUR CHECK LIST OF NEW IRC PRODUCTS

To a line of resistors already broader than that of any other manufacturer in the entire resistor industry, IRC has, in the last few months, announced several new and important contributions. Among the newer developments having wide-spread application in the electronics field are the components here briefly reviewed. All of these products are available in reasonable quantities except the Type BTR Resistor, which is still wholly allocated to a special war project. However, samples of this unit are available and will be gladly sent for test or experimental purposes. Your inquiries will receive prompt and welcome attention.

TYPE PRT POWER RHEOSTAT

Rugged yet light in weight and of neat appearance the PRT conforms fully with AN3155 specs. Has heavy screw type terminals at rear of enclosed all-metal housing. Available in 25 and 50 watt models.

TYPE BTA 1 WATT METALLIZED INSULATED RESISTOR

Pencil-thin, less than ¾" in length and conservatively rated at one watt the BTA is a quality resistor throughout and meets RC30 specs. Low in operating temperature it has proportionately high wattage dissipation.

TYPE BTR ⅓ WATT METALLIZED INSULATED RESISTOR

Scarcely bigger than a bump on a wire (L. 13/32"-Dia. 3/32") the BTR ⅓-watt resistor has all the quality characteristics and features that have long made IRC's BT line "Preferred for Performance." Suitable for Army-Navy RC 10 applications. *Available postwar.*

TYPE FRW FLAT WIRE WOUND RESISTOR

Efficient as a tubular wire wound, the type FRW has many features that recommend it for limited space use. In 5 standard sizes to comply with JAN-R-26, specs for RW 20, RW 21, RW 22, RW 24 requirements.

TYPE GRW GRADE 1-CLASS 1 RESISTOR

Thoroughly dependable and of sound construction these completely sealed units meet or surpass every requirement of JAN-R-26 specs. Made in 7 standard sizes with power ratings of 15 to 140 watts and resistance ranges of 0.1 to 63,000 ohms.

FINGERTIP CONTROL

No bigger round than a nickel and wafer-thin, this control will find many useful applications in the smaller electronic devices. All-inclusive design eliminates the usual knob, shaft and bushing without impairing functional operation.

For more complete, technical information on any of the above IRC products write to Dept. 9-H

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PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS

IRC makes more types of resistance units, in more shapes, for more applications, than any other manufacturer in the world.

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Call on Kyle Engineers

For transformers designed to your own specifications

Postwar plans are under way. The sensational development in the use of electronic power will soon be converted to building products for home and industrial use, for transportation, communications, agriculture—for almost every service of modern living.

Kyle experience in building transformers for war can serve you well. Kyle's many years in developing and manufacturing electric power distribution equipment established their reputation for sound, practical engineering.

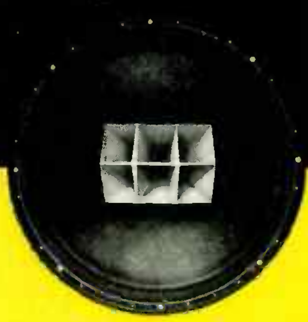
Based on their knowledge of the latest trends in the fields of radio communication, radar detection, and electronic controls, Kyle engineers will build the transformers you need to meet your exact specifications. These precisely built, dependable, small transformers are hermetically sealed to function perfectly under extreme conditions of climate and altitude.

Call on Kyle engineers to work with you on your own transformer requirements.

KYLE CORPORATION

SOUTH MILWAUKEE, WISCONSIN

60 DEGREE *Horizontal*



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The new amazing Altec Lansing multi-cellular Duplex Speaker provides up to 1200% increased area of quality sound distribution in the horizontal plane. Horizontally the Duplex delivers a sixty degree angle of distribution, or twelve times the area distribution at high frequencies as compared to single unit speakers of comparable size. Another reason why the DUPLEX is the SPEAKER that REVOLUTIONIZES the methods of sound REPRODUCTION.

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One to forty-eight contacts in aluminum shells. For radar, radio and electronic applications.

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Similar to A-N connectors—for special purposes.

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For medium base prefocused lamps used in movie projectors, floodlights, beacons, searchlights, etc.

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Polystyrene, Acrylic and transparent vinyls. A synthetic for almost every type of radio or electronic use.

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Low-loss connectors and adapters—large and small sizes in many styles for coaxial and twinax cables.

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Coaxial and twinax cables in most of the Army-Navy new RG U types as well as beaded and special cables.

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HIGH VACUUM NOW CONTROLLED TO ONE-BILLIONTH OF AN ATMOSPHERE

HIGH on the list of important recent electron tube developments in the National Union Research Laboratories is this ultra sensitive N. U. Ionization Gauge.

Used as a control device in the evacuation of other electron tubes, this gauge reads pressures of .00001 of a micron! High vacuum is assured with resulting uniform high performance characteristics of all N. U. Tubes it helps to manufacture.

Having no grid element, this gauge is completely free from Barkhausen oscillations. Construction is simple, rugged, dependable—and, of course, economical to manufacture.

Here again is an example of the many contributions National Union engineers are making to the advance of electronics. For progress through research—count on National Union. *National Union Radio Corporation,* Newark 2, New Jersey.

N. U. IONIZATION GAUGE

Typical Operation

- Filament voltage—3.0 volts
- Filament current—1.8 A.
- Electron collector voltage—13 volts
- Electron current—20 Ma.
- Ion collector voltage—200 volts
- Sensitivity—Ten times the ion current in amperes equals the pressure in mms. of mercury.

It is possible to expose the hot filament of this gauge to air at atmospheric pressure and later have it function efficiently under vacuum conditions.

NATIONAL UNION RADIO AND ELECTRON TUBES

Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs

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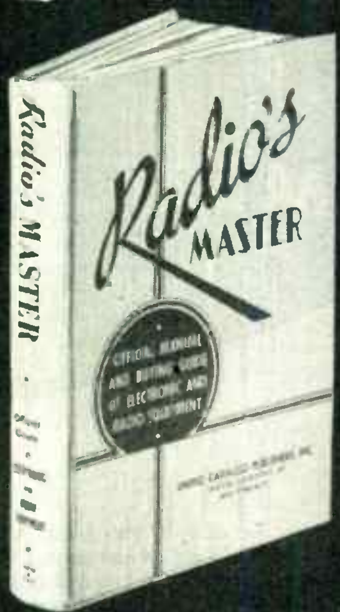

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FM does it—

THROUGH STORM AND NOISE

with clear reception that will build and hold greater audiences

Over a period of a year, more radio receivers are turned off during programs because of man-made and natural electrical disturbances than for any other cause. If your station serves areas where electrical devices produce high noise-levels, if you are geographically located where static is a problem, consider FM. Frequency Modulation will give your listeners vastly improved reception, virtually free from noise — and do it with less transmitter power and reductions in operating costs. Or, with the same power and the same cost, it will enlarge your primary service area.

In order to provide radio reception with low background noise level, the signal strength of an AM broadcast station should be about 100 times stronger than that of the interfering noise or signal. By comparison, an FM broadcast station can provide reception with the same low background noise level but with a signal strength only about twice that of the noise level itself.

Consider, for example, the case of the 1-kw AM station on 1200 kc. With a 400-ft half-wave antenna overlooking flat country and where conditions of ground conductivity are average (3 x 10^{-14} EMU) this station can generally provide its radio audience with satisfactory noise-free service over the following approximate effective areas:

AM Service	*Range*	*Coverage*
Day	22 miles	1520 square miles
Night	10.5 miles	346 square miles

Compare this performance with the virtually interference-free reception that a 1-kw FM station can provide over the same terrain, using a 2-bay circular antenna 400 feet high:

FM Service	*Range*	*Coverage*
Day and Night	43 miles	5800 square miles

Performance like this provides better service. Service like this builds larger audience and greater advertiser interest.

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

GENERAL ELECTRIC

World Radio History

160-D1-4918

Look to General Electric when you plan your FM station. G.E. is the one radio manufacturer with experience in designing and building complete FM systems—from transmitters to receivers. G.E. has designed and built more FM broadcast transmitters than any other manufacturer. G.E. built the first FM home receivers and has furnished a large percentage of today's half-million now in use. Today, the six studio-transmitter FM relay links now operating in the 340-megacycle band are all G.E.—with thousands of hours of regular operation to their record. G.E. operates its own FM proving-ground, station WGFM, at Schenectady. For information on General Electric FM broadcast equipment, write: *Electronics Department, General Electric, Schenectady 5, N. Y.*

ESTABLISH A PRIORITY ON DELIVERY OF YOUR FM EQUIPMENT. Write for your copy of the "G-E Equipment Reservation Plan" which tells you about General Electric's plan to help you obtain early delivery of transmitters and associated equipment.

50 FM BROADCAST STATIONS ON THE AIR
OVER 300 APPLICATIONS PENDING

FM DOES IT—

- FM multiplies your effective coverage day and night.
- FM gives your audience programs with lower background noise.
- FM minimizes station interference on your frequency.
- FM contributes to the economy of your broadcasting system.

General Electric's FM equipment will include revolutionary circuit developments, new component designs, and improved layout features that will contribute directly to the quality and economy of your broadcasting system.

Tune in General Electric's "The World Today" and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS network. On Sunday evening listen to the G-E "All Girl Orchestra" at 10 E.W.T. over NBC.

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FM • TELEVISION • AM

See G.E. for all three!

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Look to COMCO for VHF

Customized

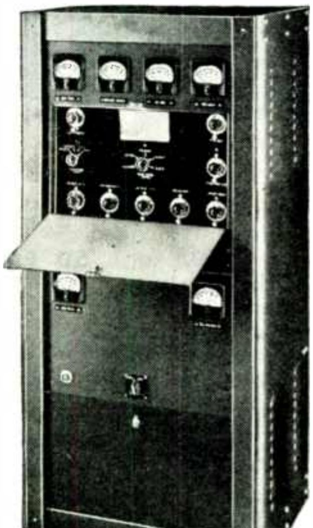
Radio and Electronic Equipment

Test-Proved for Dependable Performance

The Comco system of testing and inspection maintains a continuous and rigid control of quality. The finest scientific devices and instruments in the hands of experienced technicians insure positive protection against all usual causes of sub-standard performance. It is no accident that COMCO *customized* equipment has become widely known for unvarying quality and dependable performance.

COMCO VHF TRANSMITTER MODEL 170

Reliable VHF, 50 watts output. Frequency range 100 to 160 Mc. Cabinet size: Width 23"; depth 18"; height 48". COMCO Model 127AA Transmitter also available for operation on a frequency range of 200 to 550 kc.



COMCO VHF RECEIVER MODEL 132

Compact VHF crystal controlled, fixed frequency, superheterodyne. Single channel reception; 5¼-inch relay rack panel mounting. 12 tubes. Frequency range 100 to 160 Mc. Medium and low frequency receivers also available.

WRITE! *Just a note on your company letterhead outlining your exact requirements. We'll give you the benefit of our specialized experience. We can supply a wide variety of* customized *equipment on priority NOW. We are accepting non-priority orders for post-war delivery.*

MANUFACTURERS OF RADIO COMCO & ELECTRONIC EQUIPMENT

COMMUNICATIONS COMPANY, Inc.

CORAL GABLES 34, FLORIDA

FM HANDBOOK

(CONTINUED FROM PAGE 52)

rangement devised by G. L. Beers of RCA, in which the conventional limiter and discriminator are respectively replaced by a locked-in oscillator and a reduced-range discriminator. The circuit of the oscillator and discriminator are shown beneath the block diagram.

The locked-in oscillator employs a pentagrid-converter type of tube. The plate circuit L_1C_1 of the oscillator is tuned to a frequency that is one-fifth of the nominal intermediate frequency of the receiver. For example, if the intermediate frequency is 4.3 mc., circuit L_1C_1 will be tuned to 4.3/5 or .86 mc.

Energy is transferred by inductive feedback from the oscillator plate circuit L_1C_1 to circuit L_2C_2, which is connected to grid No. 3. In order to accentuate the even harmonic content in the oscillator output, grid circuit L_2C_2 is tuned to the second harmonic, 1.72 mc., instead of the oscillator fundamental, .86 mc.

The FM signal is applied to grid No. 1 by way of tuned circuit L_3C_3, which is coupled to the IF amplifier. Grids Nos. 2 and 4 are held at RF ground potential and serve to minimize electrostatic coupling between the signal input and oscillator circuits.

When no signal is being received, the oscillator operates at the frequency of its tank circuit, 860 kc. Under this condition the discriminator output voltage is zero.

If a signal voltage having a frequency *near* the intermediate frequency of 4.3 mc. is applied to grid No. 1 of the oscillator tube, it will modulate the electron stream and will combine with the fourth harmonic of the oscillator frequency, 3.44 mc., to give a component of oscillator plate current having the difference frequency of *nearly* $4.3-3.44$ mc., or .86 mc. Such a component of plate current can produce a voltage across the tank circuit L_1C_1 resonant to 860 kc. that is appreciable compared to the voltage set up across this circuit by the oscillator alone. The result is that the oscillator will *lock-in* at one-fifth of the signal frequency and *will follow any small variations in the signal frequency* that may occur. For example, if the FM signal at the oscillator input is 4.3 mc. $\pm$ 75 kc., the signal at the oscillator output will be .86 mc. $\pm$ 15 kc. The oscillator output signal is demodulated in the discriminator, which is designed to have a linear characteristic over a range somewhat in excess of 2×15 or 30 kc.

The sixth harmonic of the oscillator frequency may also combine with the signal frequency to produce a component in the plate current having a frequency nearly equal to the natural frequency of the oscillator. Whether the fourth or the sixth harmonic will be the one which causes the locking-in effect will depend

(CONCLUDED ON PAGE 78)

TELEFAX— *printed, illustrated news by Radio, via Finch Facsimile*

With Finch Facsimile, planes in long sustained flight can receive printed Air-Press newspapers for the pleasure of passengers, besides weather maps, photos of air fields, etc.

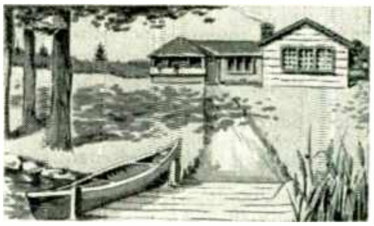
Let us ask you some questions

This is a call for frank expressions of opinions from broadcasters who are planning to publish news by telefax Air-Press (radio facsimile) when equipment is available:

1. Will you prefer delivery in a continuous roll like a glorified ticker-tape, or in cut sheets like a standard newspaper?
2. A 5-column tabloid-size printing recorder would cost the consumer considerably more than a 4-column recorder, and would therefore cut down the "circulation" or reading audience but increase its "buying power." Under these circumstances, will you prefer a 5-column or 4-column delivery as standard?
3. Will you prefer a speed of 1/4 page per minute, 1/2 page per minute or a full page per minute, considering that the cost will be higher for each speed increase, thus resulting in a reduced community coverage?

A prompt, full answer will be greatly appreciated. Address, Finch Telecommunications, Inc., Passaic, N. J. New York Office, 10 East 40th Street.

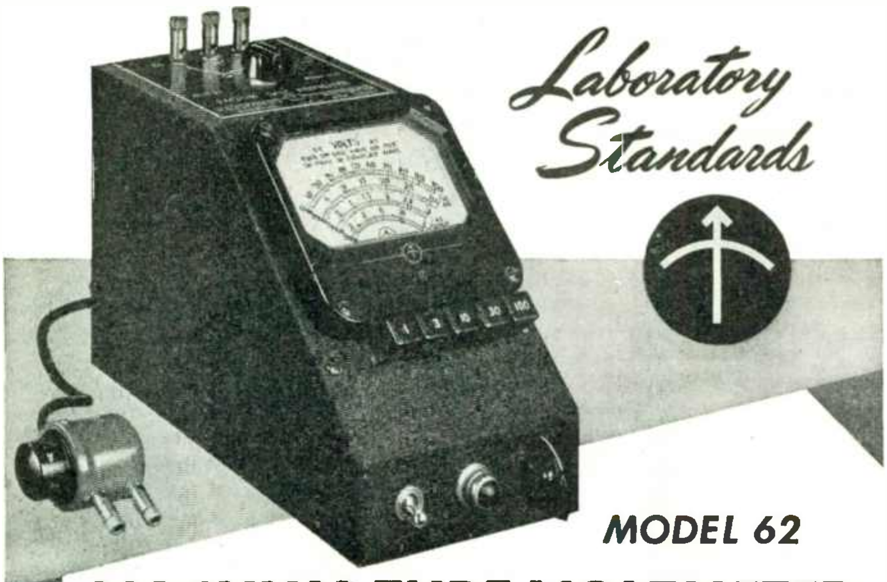
Trains will receive by Finch Facsimile Air-Press newspapers as well as routine point-to-point communications.



In camps, mines and other remote spots, contact is provided by Finch Facsimile and the Air-Press.

SELF SYNCHRONIZING **finch facsimile**

World Radio History



Laboratory Standards

MODEL 62

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SPECIFICATIONS:

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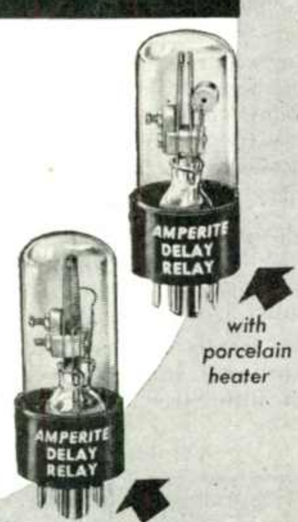

FM HANDBOOK

(CONTINUED FROM PAGE 76)

on which of the harmonics predominates. The end result is essentially the same. The oscillator operates at one-fifth of the instantaneous signal frequency at the IF amplifier output, and the amplitude of the oscillator output voltage is substantially independent of the amplitude of the signal.

The frequency range over which lock-in control of the oscillation frequency will be maintained is limited. In fact, the discriminator input circuit constants are so chosen as to tend to keep the oscillator tank circuit impedance essentially resistive over a wider range than would be obtained if the discriminator were not coupled to the oscillator. In this manner, lock-in operation can be obtained over a range of about ± 110 kc. with a 1-volt signal on the No. 1 grid of the oscillator. This is sufficiently in excess of the ± 75-kc. deviation of an FM broadcast signal to allow for slight mis-tuning and for oscillator drift.

When the applied frequency differs from the intermediate frequency by appreciably more than 110 kc., say by 200 kc., a voltage very much in excess of 1 volt is necessary on the No. 1 grid of the oscillator to obtain lock-in operation. Thus the oscillator is prevented from responding to signals on channels adjacent to the one occupied by the desired signal. In fact, the improvement in the suppression of adjacent channel interference is the primary advantage claimed for the Beers receiver arrangement.

POWER FREQUENCY CONVERTER

(CONTINUED FROM PAGE 54)

plier output frequency is 92.1 − 42.8 or 49.3 mc.

This is a higher frequency than it is practical to generate in a crystal oscillator directly. Hence the crystal operates at one-twelfth of 49.3 mc. and its output is passed through two doubler and one tripler stages. The tuning controls appear on the front panel in Fig. 1. The crystal multiplier delivers 10 watts at 49.3 mc. to the frequency converter unit at the extreme right.

The only connection between the present FM transmitter and the new equipment is a small sampling link, coupled to the final stage of the transmitter, which draws off 5 to 15 watts to excite the buffer signal amplifier. In the laboratory set-up shown in Fig. 1, the second unit from the left is a signal generator delivering 5 watts at 42.8 mc., representing the power that would be sampled from Alpine's present transmitter.

The output of the signal generator is applied to the buffer signal amplifier, third unit from the left in Fig. 1, which delivers 80 watts at the same frequency of 42.8 mc. to the frequency converter unit at the extreme right.

World Radio History

The circuit diagram of the frequency converter unit is shown in Fig. 2. The 10-watt output of the crystal multiplier at 49.3 mc. is used to excite the grids of two Eimac 4-125A tetrodes in pushpull. The screens of these tetrodes are excited in parallel at 42.8 mc. by the 80-watt output of the buffer signal amplifier. The output at the sum frequency of 92.1 mc. is segregated in the quarter-wave shorted line connected in pushpull to the plates. The line is mounted on the top of the frequency converter as shown in Fig. 1. With 1,500 volts on the tetrode plates, 150 watts of output at 92.1 mc. were readily obtained in the dummy antenna shown coupled to the line. This is adequate power for the excitation of a 1-kw. final amplifier.

The front-panel arrangement of the factory-built power frequency converter is indicated in Fig. 3. The power supplies for the 1- or 3-kw. final amplifier are installed in the bottom compartment. The power supply controls are located on the front panel just above. The buffer signal amplifier, crystal multiplier and frequency converter units are mounted on a removable platform within a shielded cabinet so that they can be easily replaced with a new Armstrong direct crystal-controlled phase-shift type of modulator at some future date when transmission on the 42- to 50-mc. band is discontinued. Thus, about 85% of the first cost of the power frequency converter is to be saved toward the construction of the transmitter for permanent service on the new band.

SPOT NEWS

(CONTINUED FROM PAGE 40)

rank of Commander to Captain, U.S.N.R. In civilian life, he is the president of Finch Telecommunications, Inc., manufacturers of facsimile equipment.

New Construction: Hoffman Radio Corp., Los Angeles, has started construction on a new plant annex which will be used as an office and engineering building. This, with four other buildings now occupied, brings the factory space up to 150,000 square feet.

Realistic Thinking: The end of the war will probably bring more realistic thinking to bear on matters related to the radio industry. For example, the FCC explained its failure to settle FM and television frequencies when other allocations were made above 25 mc. by saying that WPB did not anticipate civilian radio production in 1945 or even in the first part of 1946 unless Japan capitulates, and that "The War Production Board has advised the Commission that in the event there is any change in its prediction, it will give 90 days advance notice." Characterized as "cockeyed" in the June issue of this Magazine, that statement was issued *less than 90 days* before the official offer of peace from Japan set in motion the machinery for wholesale cancellations of military contracts!

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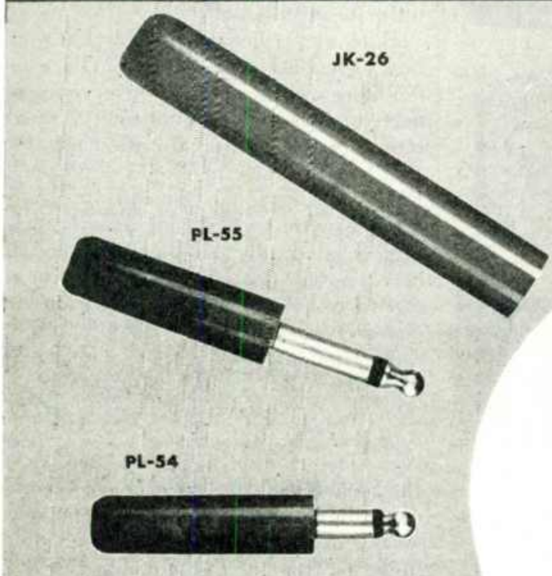

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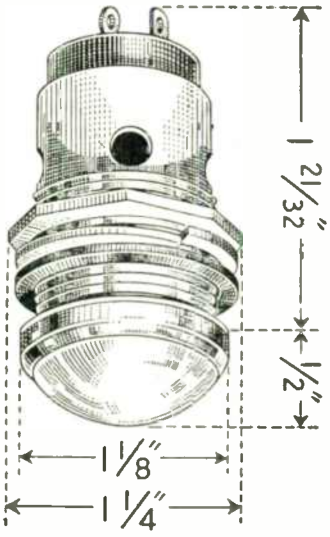

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DISTORTION METER

Direct reading device which indicates as a percentage of the fundamental frequency, the square root of the sum of the squares of the harmonic components. It is used for audio frequency measurements in any audio device in the usual range of voice or musical notes from 150 to 15,000 cycles.

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THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 28)

possibilities of FM, and of the special microphone techniques required. In short. its true worth has been kept a secret from those upon whom it must depend for its ultimate success.

Here is a public relations job that would be a logical undertaking for FMBI, and a far more useful service to everyone connected with the broadcasting industry than anything the organization has done so far for its members. Myles Loucks, FMBI manager, has proved to be a most capable organizer and could handle such a project admirably, but his usefulness has been limited by the inclination of the directors to be satisfied with doing nothing constructive since the ODT put a stop to conventions. However, there is nothing to prevent FMBI from holding seminars successively in New York, Chicago, and Los Angeles.

The Single Market FM Plan ★ While the FM group has coasted along on its lethargic way, AM broadcasters have been doing some fast thinking that goes like this: low-power FM stations in a number of cities are delivering greater coverage than local or regional AM stations. High-power FM stations are delivering far greater coverage than the primary areas of 50-kw. AM station. However, the secondary coverage of clear channel AM stations, uncertain as it may be, is greater than can be obtained with FM.

Since time sales on 50-kw. AM stations represent the lion's share of the total AM volume, if FM transmitters can be limited as to power and antenna height, they can then compete only with local and regional AM stations. Further, the AM position will be strengthened if local and regional AM transmitters are shifted to FM, because that will leave the whole AM band for clear channel AM stations of 50 kw. or more.

Because there is not space to examine all the testimony of AM station operators. let us review the CBS contribution to the record. Acting director of engineering William B. Lodge fired the first shot in an article in *Broadcasting*, August 14, 1944 when he raised the question of long-distance interference on the 42- to 50-mc. band, and proposed that FM broadcasting be put up to 100 mc. He had no experience which indicated that interference at 50 mc. would actually require such a shift, or that there would be any net gain to listeners. His information on interference related to sunspots was completely inaccurate.

However, in proposing such a change of FM frequencies, he could be reasonably certain that 1) the expansion of FM broadcasting would be embarrassed by shifting the band to frequencies for which neither home receivers nor broadcast transmitters had ever been built, and 2) the transmit-

(CONTINUED ON PAGE 81)

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World Radio History

THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 80)

ting range of high-power FM stations would be less than on the lower band. In addition to advocating this shift to the FM Panel of RTPB and at the FCC hearings, he proposed other limitations on FM service, chief of which was the reduction of the FM channel width. Examined on this point on October 12, 1944 by Mr. Denny, Mr. Lodge stated that a change from 200 kc. to 100 kc. "would result in an approximate reduction in half of the (transmitting) radius."

On October 11, 1944, Plausible Paul Kesten testified before the FCC concerning the CBS single market plan for FM broadcasting. This plan, which will be described briefly, has certain admirable features, in that it would put all FM in any given area on an equal and competitive basis as to coverage. However, the CBS plan, as it has been presented, is a vicious device which leaves high-power AM stations free to sell multiple-market coverage, while limiting FM stations to the sale of single market coverage only. This is what Mr. Kesten said: "We want FM broadcasting to be wholly democratic . . . that what we have called the prince-and-pauper status of big and little (AM) stations be avoided as the end result of (FM) licensing," and "That FM licensees be limited, by Commission policy, to coverage of the single market area within which they are broadcasting rather than covering several separate markets by placing a high, and high-powered transmitter somewhere between them." Mr. Kesten further testified: "There are no jokers in this, there are no aces up this sleeve."

Mr. Kesten must have said that with his tongue in his cheek, for the one hope of protecting the 50-kw. AM stations owned by CBS and its 50-kw. AM affiliates, who are the chief CBS customers, is to assure those stations of multi-market coverage on clear channels and limiting FM "to coverage of the single market area within which they are broadcasting rather than covering several markets."

No Democracy in This ★ In other words, consider the position of such an AM station as WTAG, a CBS affiliate in Worcester, Mass. This station can sell time to advertiser's that buy the CBS net because it can deliver a better AM signal to the Worcester audience than any 50-kw. CBS station.

But suppose WTAG, along with other local and regional AM stations, shifts to FM, and its AM frequency is given to a clear channel 50-kw. transmitter affiliated with CBS. That, or some other clear channel station, supposedly operating to provide rural coverage, may well put an AM signal into Worcester as good as or better than WTAG now provides.

Obviously, if WTAG-FM is limited to local market coverage and forced to com-

(CONTINUED ON PAGE 82)

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FAMOUS for accurate reproduction of all desired sounds without harmonics or distortion . . . for rugged dependability under difficult operating conditions. Turner Crystal and Dynamic microphones have won world-wide reputations for outstanding performance. When you want utmost in intelligibility under any and all acoustic and climatic conditions, Turn to Turner for sure-fire results.

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World Radio History

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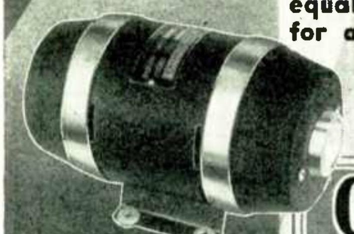

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THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 81)

pete with 50-kw. clear channel AM affiliates of CBS, the management will find itself set down firmly behind the 8-ball of what Mr. Kesten calls a "democratic" setup for FM, in which the prince-and-pauper situation will continue, with FM stations playing the pauper rôle.

This is a situation which WTAG could only view with alarm — unless the management has reason to expect that, when local and regional AM stations are shifted to FM, it will be able to get a clear channel and 50 kw. on AM.

Let us see how Mr. Edward E. Hill, managing director of WTAG and WTAG-FM thinks about the position of his station:

First of all, Mr. Hill sent out a letter on July 14th, presumably addressed to all broadcast stations, endorsing the CBS single market plan in these words: "The Single Market Plan hurts no one but the fellow who wants to hog his own market and the other fellow's market too. It places no limit on the power required to do a specific, worthwhile job. It means that no one else can come into your market and get more power or coverage than is available to you.

". . . I'm not plugging the Single Market Plan because it was proposed by the Columbia Broadcasting System. Far from it. I would get behind such a plan regardless of the source. It's just that CBS has come up with a plan which helps to insure my being in the broadcasting business ten years from now, regardless of my network affiliation. If it does this for me, it will do the same for you."

Mr. Hill also sent the writer a copy of a statement prepared for delivery as testimony before the FCC hearing on FM allocations. First, concerning program duplication, the statement sets forth that: "During the past five years we have been operating WTAG-FM, we have had occasion to duplicate our entire AM schedule, more recently to broadcast a more limited schedule of hours — still duplicating our AM schedule — and, for a time, to broadcast a completely *different* schedule of programs.

"Listener reactions indicated conclusively that the public preferred the duplication of our AM programs. In fact, listeners seemed to resent any curtailment in the programs customarily available on AM receivers. I feel that this is a natural reaction for several reasons. In our area, a number of programs are continuously available, including the programs of all four national networks. I don't think the public wants more programs, and I'm very sure the public isn't even remotely interested in high-fidelity [1] as such. What it does want — and all it wants — is to hear its favorite programs clearly and with complete freedom from interference of any kind.

(CONTINUED ON PAGE 83)

World Radio History

THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 82)

". . . Idealistically, it is intriguing to think that the public will buy FM receivers because, thereby, it will hear new and different programs; but, *practically*, listeners want to hear their favorite programs and will hear them if they have to turn from FM to AM to do so."

In other words, Mr. Hill thinks that if he is required to give up his AM frequency and operate only on FM, and to find a new source of high-fidelity programs, he could not compete against a 50-kw. AM clear channel station affiliated with CBS.

Yet Mr. Hill wants FM stations limited to single market coverage, for his statement continues: "At this point, I would like to commend the Columbia network for proposing a plan which, at first reading, seems to be contrary to their own network interest; but which, with study, develops into a well-defined, far-sighted allocations plan, designed to protect the future of radio and of network radio through the encouragement of free but legitimate competition.

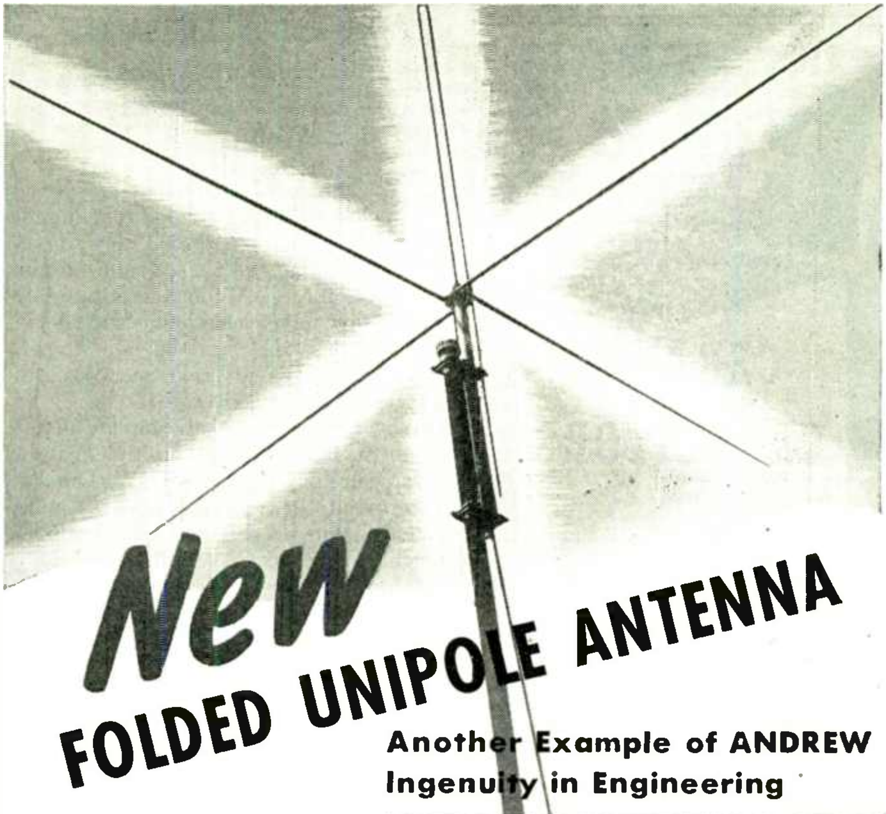
". . . My Company has been operating an FM station in Worcester for the past five years, with a power of 1,000 watts. Our competition has been a 50,000-watt station located at Paxton, Mass., just outside of Worcester. It, and a satellite station on Mt. Washington in New Hampshire, purports to cover most of New England, including the majority of the metropolitan markets. These stations carry the programs of one national and one regional network.

"Since one national network enjoyed such exceptional FM facilities in New England, it was only natural that other networks should follow suit. Consequently, CBS filed an application for a 50-kw. station in Paxton. If this were granted, I don't need to tell you that, in time to come, *our* network affiliation (with CBS) would be terminated. This would indeed be ironical after what is already 21 years of broadcasting effort.

"Nor do I need to tell you that, since a 50-kw. station in Paxton is capable of covering Boston, Providence, Springfield, Manchester, and other important markets, network affiliates in those cities would suffer a similar fate. Then it would naturally follow that other networks should do the same thing, with the end result that a few network-owned stations would completely dominate the New Eng-

[1] Apparently Mr. Hill, in common with most broadcasters, pays more attention to listener surveys than listeners' reception. The truth is that, even on AM network programs transmitted by FM, while listeners attribute their enjoyment of FM to the elimination of static, their enjoyment is enhanced by 1) the use of receivers of far greater audio capability than the average straight AM set, and 2) because, since it is not necessary on FM to cut the higher frequencies in order to reduce background noise, they can at least hear all the frequencies transmitted over circuits intended for AM stations. — *Editor's Note.*

(CONTINUED ON PAGE 84)



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Another Example of ANDREW Ingenuity in Engineering

Concentrating on electrical performance, Andrew engineers have designed a unique Folded Unipole Antenna which—according to comparative tests—*easily outperforms other antennas at several times the price.*

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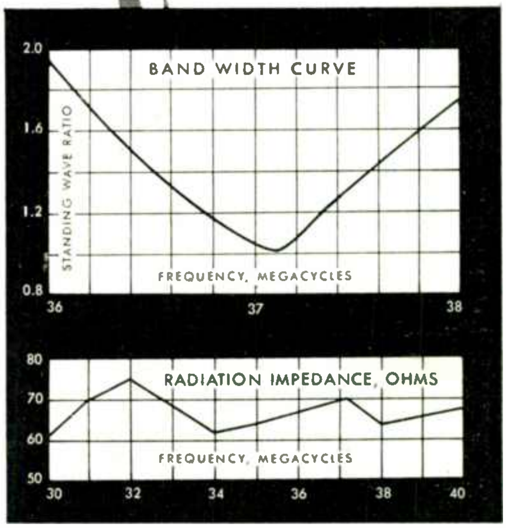

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- Light weight — only 15 pounds — simplifies installation.
- Lightning hazard minimized by grounded vertical element.
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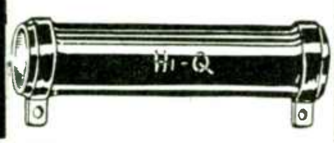

CHOKE COILS

ELECTRICAL REACTANCE CORPORATION
FRANKLINVILLE, N. Y.

THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 83)

land area, to the competitive disadvantage of all other stations."

Here's the Joker ★ What Mr. Hill said is very convincing until it is recalled that, in advocating the single market FM plan, he, like Mr. Kesten, made no reference to the fact that if the AM band is ultimately used to give more clear channels to 50-kw. AM stations, they will be able to sell multi-market primary coverage, plus substantial secondary coverage.

Why, right now, AM stations are advertising that they deliver multiple-market coverage. For example, WOW, Omaha, advertises to deliver a signal of 2.5 millivolts at 100 miles. This radius includes Lincoln and Sioux City, both of which are listed by Mr. Kesten as metropolitan districts. Therefore, under the single market plan, separate FM stations in Omaha, Lincoln, and Sioux City would have to compete with WOW's AM coverage of the three metropolitan districts. More than that, WOW advertises that its .5 millivolt contour "reaches out nearly 200 miles!"

A careful study of the CBS plan and the testimony of Messrs. Kesten and Lodge does not reveal a single reference to putting limitations on AM stations so that they, too, will have a "wholly democratic" part in the competition for the program sponsors' dollars.

To be perfectly fair to Mr. Hill of WTAG, when the writer asked him by letter if he endorsed the CBS plan because he failed to realize that his FM station would be at a competitive disadvantage with respect to multiple market AM stations, or if he endorsed the plan for FM because he hoped to get 50-kw. on AM with a clear channel, he replied: "I was not sufficiently aware of the Commission's plan to establish high-power AM stations in the present AM band." Then he explained: "Again, my recommendations were based upon the theory that FM was to entirely replace the AM system, although I realize that for some indefinite period of time AM stations might be used in the far west to cover wide but thinly populated areas. As I see it, and as you point out, any other use to which such stations might be put would defeat the whole purpose of either the Single Market plan or the allocations plan contained in the FCC proposal."

Now, that is a definite qualification of Mr. Hill's testimony. But he made no such statement in his testimony prepared for the FCC hearing. Why didn't Mr. Kesten write that limitation on AM into the CBS plan to limit FM stations? Was it purely an oversight, or was it something that he meant to keep quietly up his sleeve? Why didn't the FCC bring out this point in its proposal on frequency allocations and coverage for FM stations?

(CONCLUDED ON PAGE 85)

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THE AM VS. FM BATTLE

(CONTINUED FROM PAGE 84)

No plan is honest or "wholly democratic" that puts FM stations on a common competitive basis if, by so doing, it prevents them from competing with AM stations. Considering the background of testimony by Messrs. Kesten and Lodge, and the manner in which the FCC hearings on FM frequencies were conducted, it is logical to conclude that the purpose was to protect the operators of high-power, clear channel AM stations. Therefore, there is every reason to look upon the CBS plan and the FCC proposal with doubt, distrust, and suspicion unless and until they, like Mr. Hill, add the qualification that, within some reasonable and specified period of time, all AM broadcasters must shift to FM transmission.

That Dead Mackerel ★ To this observer, the apparent determination of the Commissioners to use the Allocations Hearings to find support for shifting FM frequencies, and its proposal to set up rules which, in effect, limit FM stations to single market coverage indicates 1) that they had decided to protect the 50-kw. stations against FM competition or 2) Mr. Kesten had sold them a bright idea without their knowing it would have that end result.

The strenuous objection registered by the FCC to the postwar manufacture of FM-AM sets capable of tuning both the old and new FM frequencies indicates that they are deliberately trying to protect themselves against the consequences of their actions because:

First, if the new FM band does not provide reception equal to that on the lower band, it will be immediately apparent to the public and to the industry, for listeners would be able to tune in the same programs on both bands while the present stations are operating old and new transmitters simultaneously.

Second, if new sets can tune both FM bands, the FCC will have no excuse for not giving the 44- to 50-mc. band back to FM for rural or multi-market stations or for other needs.

Under the single market plan, there is a threat of congestion already in some sections of the country, and the FCC may be forced to keep the old FM band in use.

Now, the attempt of the FCC to tell the radio manufacturers how many tuning bands they shall have on new receivers seems to confirm the growing suspicion that there is something other than consideration of public interest, convenience, and necessity behind the actions of the Commissioners.

Ultimately, FM will win on its merits as surely as AC won over DC, sixty years ago. Meanwhile, there is something very fishy about what's going on that has the odor of ex-chairman Fly's dead mackerel which shone and stank in the moonlight.

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ENGINEERING SALES

(CONTINUED FROM PAGE 8)

is Wabash 2550. E. H. Aberdeen is in charge.

Zenith: A. V. Duke has been appointed assistant to H. C. Bonfig, vice president in charge of household radios. Duke has been with Zenith since 1928.

Stewart Warner: New radio distributors are: Bright Distributing Company, Knoxville, for eastern Tennessee — owner, H. C. Bright; Minnesota Electric Supply Company, Willmar, for the Willmar and Minneapolis areas — owners, M. R. Oman and H. W. Linder; William's Wholesale Distributors, 35 S. 4th Street, Newark, O., for 23 central Ohio counties — owner, William S. Moore; Southern Minnesota Supply Company, Mankato, Minn. (branches at Rochester and Eau Claire), for the Mankato and Rochester, Minn., and Eau Claire, Wis., areas — general manager, C. E. Lytle; Appliance Distributors, Mt. Vernon, N. Y., for Westchester and Rockland counties — president, Jack Klarman.

St. Paul: G. W. Bauman of Electronic Distributing Company, 1937 University Avenue, St. Paul 4, Minn., is interested in distributing a line of household electrical appliances.

G.E.: E. A. Leach has been appointed sales manager of emergency radio equipment. A native of Boston and a graduate of M.I.T., he joined the G.E. engineering department in 1928 at Schenectady. In 1938 he was made assistant superintendent of the transmitter manufacturing division of Syracuse. Thus he brings to sales work an unusual background of engineering experience.

Magnovox: Has announced the appointment of Del Wakeman as advertising manager. He is former vice president of Keeling & Company, Indianapolis advertising agency.

Newcomb: Los Angeles manufacturer of sound systems has appointed the following representatives: C. E. Anderson, 231 Rockefeller Bldg., Cleveland; Harry Halinton, 612 N. Michigan Avenue, Chicago; H. M. Linter & Son, 50 Warren Street, New York City; and Richard A. Hyde, 4253 Quitman Street, Denver.

Amperex: Tubes will be distributed in Canada and New Zealand exclusively by Rogers Electronic Tubes, Ltd., 622 Fleet Street West, Toronto.

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FM RELAY IN N. AFRICA

(CONTINUED FROM PAGE 39)

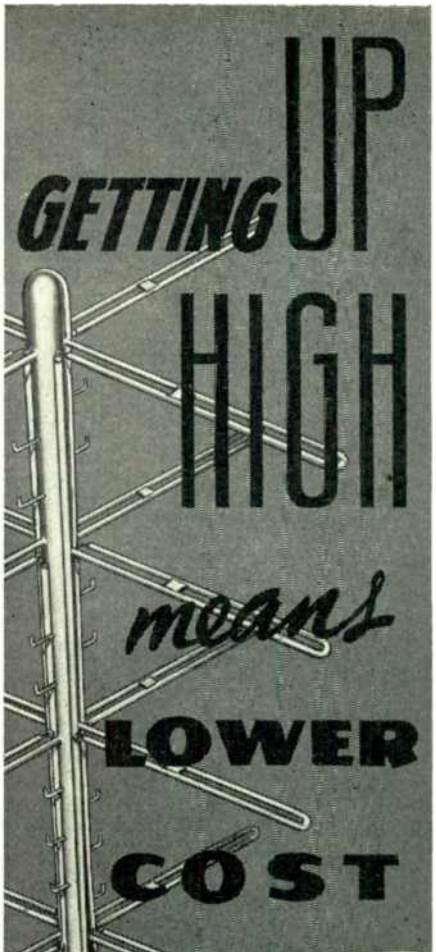
A number of tricks for employing radio and teletype apparatus in an integrated system were thrust upon them. When no signals are received by teletype machines, they "run open," unless a "marking signal" prevents this. While the circuit was being reversed in direction and during shut downs or circuit failures, no signals were received and, in consequence, the machines ran open. On wire circuits, this is a sign of trouble which caused considerable consternation to the operators. The carrier-operated relays of the terminal receivers were, therefore, arranged to send marking signals to their respective teletype machines when no signal was received.

Another trick, which can be used with simplex radio arrangements, checks the teletype machine, the tone equipment, the terminal station, and the first relay station. Ordinarily, in simplex teletype circuits, the sending contacts of the machine are connected in series with the receiving magnets, so that whatever is sent will also be printed. For the radio circuits, a slightly different set up was used. The sending contacts were connected through the tone equipment to the terminal transmitter, and the receiving magnets were connected through the tone equipment to the terminal receiver. When signals were transmitted from A, they were relayed from C. These could be received at M as well as continuing on down the circuit through D. The signals at M were used to operate the receiving part of the machine. While the operator had a local copy, as is usual with simplexing, he received it through his tone, terminal, and relay station apparatus, thus continuously checking all those parts of his circuit.

Where it is necessary to pick up signals anywhere along a system, as on the Pennsylvania Turnpike, the simplex arrangement seems necessary. Also, it has the advantage of using fewer transmitters than the duplex scheme. The kind of system described here cannot be used for multichannel communications. Duplex circuits, on the other hand, avoid the difficulties inherent in the simplex system.

Nevertheless, this particular system served the very important function of demonstrating to the Army the possibilities of radio relaying, provided a badly needed circuit, and led to increased interest in the development of really military radio relay[2] equipment for field application which had an important use subsequently in Northern France. The equipment described in this article was used in Sicily and Malta during the Sicilian campaign and in Southern Italy, Anzio, and in Corsica while the development and the initial of production of military radio relay sets was going on in the U. S. A.

[2] See "How FM Links Army Wire Systems" by Lieut. Robert W. Ehrlich, *FM* AND TELEVISION, April, 1945, and "FM Carrier Equipment" by Frederick T. Budelman, *FM* AND TELEVISION, Jan., 1945.



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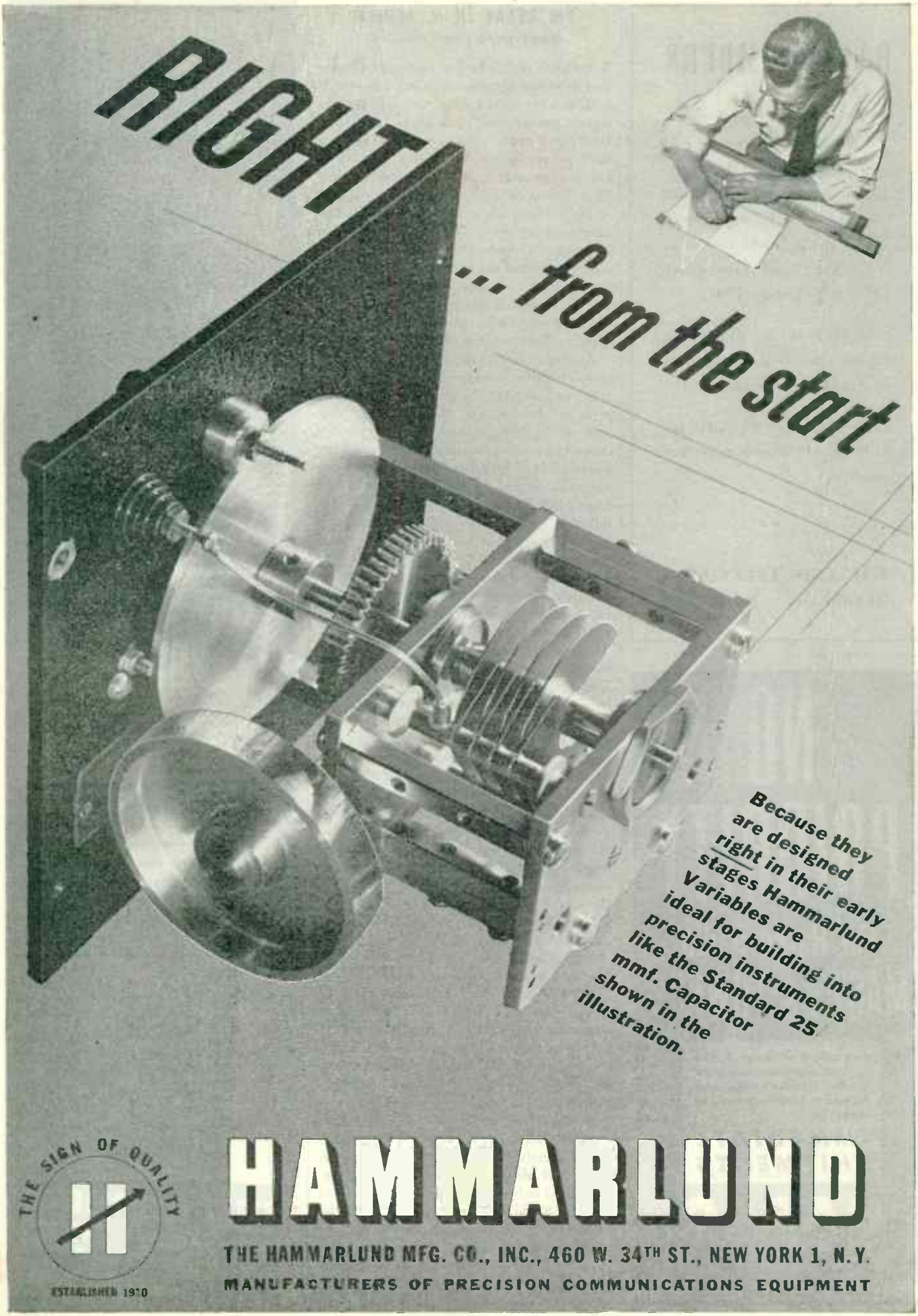

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